ENVIRONMENTAL PROBLEMS

Vol. 10, No. 4, 2025

ENVIRONMENTAL IMPACT OF SAND EXTRACTION FROM A DEPOSIT IN THE TSYR RIVER BASIN

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https://doi.org/10.23939/ep2025.04.367

Received: 09.09.2025

Abstract. The problem of building restoration is one of the key challenges of today in Ukraine, due to the consequences of military operations, as well as the expected depletion of stores of building materials and the harmful impact on the environment. One of the important sources of building materials, economically attractive and available in the Volyn region, is sand mining, on the basis of an appropriate permit from the Ukrainian Geological Survey. The Kamin-Kashirske-1 sand deposit is administratively located in the Kamin-Kashirskiy town community of the Kamin-Kashirskiy district, 0.62 km southwest of the town of Kamin-Kashirskiy and 0.68 km northwest of the village of Pidtsyrya. The mineral is represented by water-glacial yellow-gray sands of Quaternary age, natural, fine and very fine sands with a low content of organic impurities. The total thickness of the mineral within the calculation of balance reserves on the area varies from 1.0 to 7.7 m and averages 3.64 m. The development of the Kamin-Kashirske-1 sand deposit results in the harmful impact on the environment as expressed in noise pollution and emissions of pollutants into the atmosphere from the operation of quarry equipment. The quality of atmospheric air and the noise level correspond to the maximum permissible values of pollutants, at which there is no negative impact on human health and the state of the environment. Rehabilitation of land plots disturbed by sand mining and their return to natural state is also projected.

Keywords: sand deposit, reclamation, pollutant concentration, sand, sanitary protection zone.

1. Introduction

The rational use of natural minerals in various sectors of the economy is one of the necessary conditions

For citation: Radzii, V., Voloshyn, V., Kochanov, E., Boiaryn, M., Skrajna, T. (2025). Environmental impact of sand extraction from a deposit in the Tsyr river basin. *Journal Environmental Problems*, *10*(4), 367–376. DOI: https://doi.org/10.23939/ep2025.04.367

for the environmental safety of the raw material base. The successful use of mineral adsorbents in environmental protection technologies (Zelenko et al., 2019, Malyovanyy et al., 2013), and in the production of mineral fertilizers (Vakal et al., 2020) was reported. Studies on the synthesis and use of magnetically sensitive adsorbents obtained from natural raw materials are promising (Soloviy et al., 2020, Ptashnyk et al., 2020). However, until now, insufficient attention has been paid to the analysis of the raw material base of natural materials for the construction industry, including construction sand.

The restoration of buildings and structures is one of the key problems in Ukraine, due to the challenges of today, and the reasons are the expected depletion of reserves of building materials, harmful impact on the environment, as well as the consequences of military operations. Every day, great attention is paid to the restoration of civil infrastructure, economic and communal buildings to avoid negative consequences in the communal sphere and restore the economic capabilities of the state. One of the important sources of building materials, economically attractive and available at the regional level, is sand mining, which requires an appropriate permit from the Ukrainian Geological Survey, which is issued by the results of auctions for the sale of plots for mining activities. The sand producer, with a maximum extraction volume of 96.000 tons, will pay approximately UAH 478.800 in rent payments to the budget per year, as well as personal income tax. At the same time, with the seizure of 15.02 hectares of agricultural land, a one-time compensation for agricultural production losses is provided for in the amount of approximately UAH 625.000, as well as the implementation of measures to recultivate the depleted sand deposit. Reclamation will be carried out gradually, as the quarry is worked out.

Sand, as a construction resource, is extremely important for the Volyn region, as there are no alternative sources of raw materials (e.g., waste processing, etc.) in the region that could ensure the development of the construction industry. According to the Regional Waste Management Plan for the Volyn region until 2030, the study area belongs to subregion G1, which covers the northern part of the Kamin-Kashirsky district (Zubko & Radziy, 2024). The plan provides for the creation of regional facilities for the reception and storage of construction and repair waste with intermediate sorting and crushing using mobile crushing and sorting plants with a capacity of 100–200 thousand tons per year. Currently, such waste is not accounted for in the region. In 2019, the volume of bulky waste generated amounted to 5.522 tons (approximately 0.02 % of the total amount of waste), of which 4.018 tons were generated in the cities of Lutsk and Novovolynsk alone. This indicates that such a quantity of alternative raw material sources is not sufficient to meet the demand for construction sand. Sand raw material obtained from the processing of construction and repair waste can be used mainly for reverse paving works.

Sand is an extremely important but exhaustible construction resource, since not all types of sand are suitable for construction, e.g. desert sand. The most common mining are sand deposits in the river basin and the development of channel sands. A number of environmental problems are caused by the operation of powerful machines and mechanisms used in sand mining. Regarding the Kamin-Kashirske-1 sand deposit, the deposit territory is not flooded, therefore there is no decrease in the level of ground and underground water. According to the ecological network of the Volyn region, this territory falls into the Tsyr local ecological corridor, the harmful impact on which is expressed in noise pollution and emissions of pollutants into the atmosphere from the operation of quarry equipment. Since the Kamin-Kashirske-1 sand deposit is located in the Tsyr river basin, the topic of the study is relevant. The state and prospects for the development of the mining industry, namely, the environmental impact of mining of sand as a raw material for construction, requires detailed and in-depth study.

The study of the environmental impact of sand mining as a raw material for construction in Ukraine is covered in the works of a number of scientists (Mudrak & Magdiychuk, 2020, Yeterevskaya, 2017). Ecological safety and environmental impact during the development of mineral deposits, including sand, are covered in the works of (Tymochko et al., 2008, Sereda, 2019).

2. Materials and Methods

The research process used the following methods: instrumental, calculation, generalization, systematization, comparative analytical, descriptive, cartographic. The concentrations of polluting substances in the surface layer of atmospheric air were determined at points on the boundary of regulatory sanitary protective zone.

The pollutant emissions during dumping were calculated according to the methodology “Collection of methods for calculating pollutants in emissions from non-organized sources of atmospheric pollution” (Collection of methods for calculating…, 2004).

The calculation of pollutant concentrations in the surface layer of atmospheric air utilized the EOL+ software. The algorithms of the program elements of the software implement the "Methodology for calculating concentrations in atmospheric air of harmful substances contained in enterprise emissions" (Collection of methods for calculating…, 2000, Collection of indicators of emission (specific emissions) of pollutants …, 2004).

The concentration of pollutants in the surface layer of atmospheric air was determined from calculations on the boundary of the regulatory sanitary protection zone. The dimensions of the calculation site are assumed to be 2000×2000 m. The calculation grid step is 50×50 m.

The calculation of pollutant and greenhouse gas emissions into the air from internal combustion engines of transport was performed according to the "Methodology of calculation of emissions of polluting substances and greenhouse gases in the air from transport" (Methodology of calculation of emissions…, 2008).

The calculation of the acoustic impact on the environment from construction equipment is determined in accordance with "Guidelines for calculating noise levels on premises and territories" (DSTU N B V.1.1-33:2013, 2014), and "Protection of territories, buildings and structures from noise" (DBN V.1.1-31:2013, 2013).

3. Results and Discussion

The territory of the Kamin-Kashirskiy district, like most of the Volyn region, occupies the main part of the Polissia lowland of the East European Plain, has a slightly undulating surface, the average absolute height of which is 165 meters above sea level. The surface of the district was formed during many geological eras, its development was influenced by tectonic movements, ancient glaciations, the erosion of rivers and human economic activities. The territory of Kamin-Kashirskiy district lies within the Volyn-Podilsky plate of the East European platform. The crystalline foundation lies at a depth of 400–1000 meters. The foundation is covered by sedimentary rocks of various ages and origins. Most of them are Mesozoic rocks of the Cretaceous system. The upper layer is made up of glauconite sands and clays of the Paleogene system of the Cenozoic era. Modern rock deposits are represented by Upper Quaternary peat deposits of varying degree of decomposition, deposits of sands and clays of the postglacial period and sands of rivers and lakes. Aquifers within the district are located in modern swamp and alluvial deposits, in mid-Quaternary water-glacial deposits. In the plain areas of Kamin-Kashirskiy district, the groundwater flow is very slow, the area is swamped. The chemical composition of groundwater has compounds of nitrogen oxide in increased quantities (up to 20 mg/l) and iron of swamp origin. This also affects the quality of water in wells, which can be yellow in color with an unpleasant aftertaste.

The Kamin-Kashirske-1 sand deposit (Figs. 1, 2) is administratively located in the territory of the Kamin-Kashirskiy town community of the Kamin-Kashirskiy district, 0.62 km southwest of the town of Kamin-Kashirskiy and 0.68 km northwest of the village of Pidtsyrya. The site has an irregular shape, extends from south to north, and covers a spontaneously organized quarry in the central part from the north, west and south.

Fig. 1. The Kamin-Kashirske-1 sand deposit within the Volyn region

Fig. 2. The Kamin-Kashirske-1 sand deposit within the framework of Special Permit for Subsoil Use No. 5496 dated April 13, 2023 for the purpose of geological study of sand as a raw material, approval of reserves of the State Committee for the State Reserve of Ukraine by industrial categories (Google Earth Pro7.3.6.9796 (64-bit)

Geological survey on the site found (Fig. 3), according to the geological exploration network which provides the detection of reserves of categories C1 and C2, that the mineral is represented by water-glacial yellow-gray sands of Quaternary age. Sand of yellow-gray to grayish-yellow color according to the classification belongs to the group of natural, ordinary, heavy with a bulk density of 1400 kg/m^3; by the size module – fine, very fine; by the amount of dusty and clay particles and of organic impurities – to the group with a low content. The total thickness of the mineral layer within the calculated balance reserves varies from 1.0 to 7.7 m and averages 3.64 m. Overburden is represented by a soil-vegetable layer with an average thickness of 0.45 m, with fluctuations from 0.2 to 0.8 m. The lower limit of the reserve calculation is the clayey sandy marl. The thickness of the underlying sediments has been revealed to be up to 0.5 m (Mineral Resources of Ukraine, 2021).

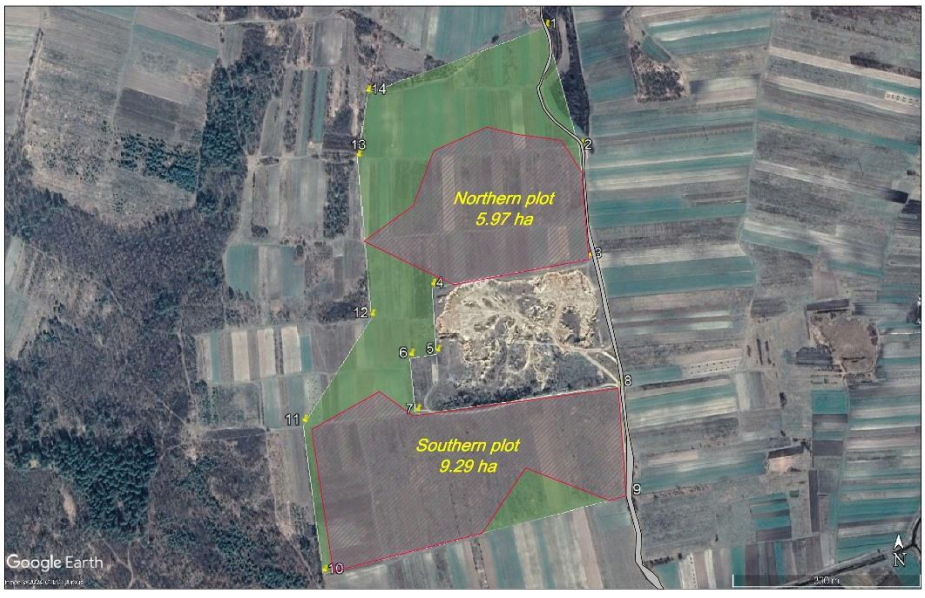

Fig. 3. Northern and Southern sections of the Kamin-Kashirske-1 sand deposit for the implementation of the planned activity (Protocol No. 5629 of the State Committee for the State Control of Ukraine dated October 31, 2023) (Google Earth Pro7.3.6.9796 (64-bit)

All Quaternary sands of the Kamin-Kashirske section within the limits of the reserve calculation according to quality indicators by cross-sections are natural, dense, heavy according to the Technical Conditions of DSTU B V.2.7-32-95 "Natural dense sand for construction materials, products, structures and works" (DSTU B V.2.7-32-95, 1996) and the DSTU B V.2.7-29-96 "Fine natural aggregates, from industrial waste, artificial for construction materials, products, structures and works. Classification" (DSTU B V.2.7-29-96, 1996). They are suitable for use as a binder component in the production of dense silicate concrete; for road construction, for the production of cellular concrete, for reclamation, landscaping and planning in accordance with the recommendations of Table A1 of DSTU B V.2.7-29-96 "Fine natural aggregates, from industrial waste, artificial for construction materials, products, structures and works. Classification" (DSTU B V.2.7-29-96 1996).

The sands of the Kamin-Kashirske-1 deposit can be used for the manufacture of plaster mortars, and according to the radiation and hygienic assessment of the sand site, they meet the requirements of NRBU-97 and belong to the first class, i.e. they are suitable for use in all types of construction without restrictions (Zubko & Radziy 2024). The main technical and economic indicators of the development of the sands of the deposit are given in Table 2. The extraction of the mineral is planned by an open method, a backhoe and bulldozer pair. The area of the reserves is 15.26 hectares. The supply of balance reserves of the mineral is 8.08 years with an annual extraction capacity of 60.000 m^3 of sands in a dense body. The thickness of the mineral in the sand site in the calculation of reserves ranges from 1.0 to 7.7 m, the average is 3.4 m (Mineral Resources of Ukraine, 2021). In accordance with the Resolution of the Cabinet of Ministers of Ukraine dated May 5, 1997 No. 432 "On Approval of the Classification of Mineral Reserves and Resources of the State Subsoil Fund", mineral reserves (sand) are classified by industrial significance as explored balance reserves, and by the degree of feasibility study as GEO-1 (Table 1).

The quarry complex is planned to include a quarry, an industrial site, overburden dumps (separately for storing waste rock and stripping rocks), and quarry roads.

The industrial site of the mining enterprise is planned to include a mobile administrative-household building; a site for check-up, maintenance, and minor repairs of quarry transport, etc.

Preparatory work on the quarry field is planned to include removing the soil and vegetation layer and cleaning up the mineral resources.

Table 1

Balance sand reserves

Class code	Category of reserves by degree of geological study and reliability	Sand reserves, thousand m^3		
		Northern section	Southern section	Together
111	C1	132.3	210.9	343.2
122	C2	60	125	185.0
111+122	C1+C2	192.3	335.9	528.2

Table 2

Expected technical and economic indicators of the development of the sands of the deposit

No.	Indicator	Unit of measurement	Value
1	Balance reserves of minerals within quarries	thousand m^3	528.23
2	Overburden volume, including: – soil-vegetation layer – sand stripping layer	thousand m^3 thousand m^3 thousand m^3	83.7 68.5 15.2
3	Opening ratio	m^3/m^3	0.19
4	Exploitable sand reserves	thousand m^3	484.86
5	Annual capacity of sand extraction quarries: – from the extraction of overburden	thousand m^3 thousand m^3	60.0 12.2
6	Exlpoitation period	year	8.08
7	Labor resources	person	6

The main equipment used in the exploitation of the deposit during stripping and mining operations:

– stripping of soil layer and the main overburden rock – CAT D5 bulldozer, or similar by technical and environmental parameters.

– loading – JCB 220 backhoe with a bucket capacity of 1.25 m^3 (or similar),

– transportation – KAMAZ 5511 dump truck with a carrying capacity of 10 tons (or similar).

The technological scheme of mining and stripping operations provides for direct development by backhoe and bulldozer. Since the deposit is relatively small in area and the sand deposit is small (up to 8 meters), and also taking into account that the mining equipment is a JCB 220 backhoe (universal type, with a bucket capacity of 1.25 m^3) and a CAT D5 bulldozer, the development is carried out by one mining ledge. The movement of vehicles involves a loading stop next to the backhoe and through-passage. Transportation of mined rocks is by dump trucks, dump formation is by internal arrangement of dumps of the soil-vegetable layer and the stripping layer within the boundaries of the land allotment.

As a result of the development of the Kamin-Kashirske-1 sand deposit, the harmful impact on the environment is expressed in noise pollution and emissions of pollutants into the atmosphere from the operation of quarry equipment.

The emission of pollutants (Table 3) into the atmosphere occurs: during stripping and mining operations as the formation of dumps of soil and vegetation layer and sands; during the operation of quarry equipment in stripping, mining, and transportation of minerals.

Table 3

List of pollutants emitted into the atmosphere, t/year (at maximum load)

No.	Pollutant	MPC, m.r. ODRV, mg/m^3	Emission capacity of pollutant. t/year
	Emissions from strip mining and mineral extraction:		
1	Dust (micro-particles and fibers)	0.5	
Emissions from internal combustion engines of quarry equipment:			
2	soot	0.15	0.1391
3	Nitrogen oxides (as nitrogen dioxide [NO + NO_2])	0.2	0.1343
4	Nitrous oxide (N_2O)	0.4	0.00429
5	Sulfur dioxide	0.5	0.1558
6	Carbon monoxide		0.3077
7	Carbon dioxide		0.3608
8	Non-methane light organic compounds (hydrocarbons)		0.2953
9	methane		0.0091
10	Benzo(a)pyrene		0.00108

Minerals and overburden are characterized by high humidity (over 10 %). All sources of pollutant emissions are non-stationary (mobile) or sources with disorganized emissions (linear). The sanitary protection zone for the sand mining deposit (according to the "State Sanitary Rules for Planning and Development of Settlements" No. 173, approved by the order of the Ministry of Health of Ukraine dated June 19, 1996 No. 173 (SSP No. 173) (DSP 173-96, 2019) is accordingly established according to the sanitary classification class IV as 100 m from the deposit boundary. The sufficiency of the dimensions of the sanitary protection zone was checked by calculating surface concentrations. The size of the sanitary protection zone of 100 meters was maintained. There are no residential buildings, preschools, schools, medical and prophylactic institutions, sports facilities, water supply protection zones in the sanitary protection zone. The land mass of the sand deposit is located outside the town. Expected concentrations of pollutants in the area of influence of the facility do not exceed hygienic standards. The quality of atmospheric air corresponds to the maximum permissible content of pollutants, at which there is no negative impact on human health and the state of the natural environment.

The production site of the sand deposit development contains identified 4 emission sources (disorganized): formation of dumps (soil-vegetable layer, sand + work of special equipment), excavator); mining operations (sand extraction + work of special equipment); transportation of sandy raw materials; refueling of quarry equipment. Maximum one-time (g/s) and gross emissions (t/year) into the atmosphere of emission sources were determined by the calculation method.

The surface concentrations of pollutants were calculated according to the technique (Collection of indicators of emission … 2004) assuming the following conditions: background concentrations of pollutants; meteorological characteristics and coefficients of the area; simultaneous operation of all processes and equipment that are sources of pollutant formation.

The calculated concentrations in the surface layer of atmospheric air for substances un-feasible for dispersion calculations do not exceed 0.05 MPC. The dispersion of pollutants during operations was calculated at the maximum emission power taking into account the production technology. To verify compliance with the requirements of sanitary rules, the dispersion of the concentration of pollutants in the surface layer of atmospheric air at the checkpoints (CP) at the boundary of the sanitary protection zone was calculated (Tables 4, 5).

Table 4

Dispersion of pollutant concentrations in the surface layer of atmospheric air, North section

No.	Pollutant	Background pollution, parts of MPC	Enterprise contribution, parts of MPC / including background pollution, parts of MPC						
			CP1	CP2	CP3	CP4	CP5	CP6	CP7
1	Dust	0.4	0.17 / 0.57	0.255 / 0.655	0.25 / 0.65	0.42/ 0.62	0.35/ 0.75	0.345/ 0.745	0.14/ 0.54
2	Nitrogen oxides (as nitrogen dioxide [NO + NO_2])	0.4	0.33/ 0.72	0.4/ 0.80	0.39/ 0.79	0.41/ 0.81	0.38/ 0.78	0.45/ 0.75	0.29/ 0.69
3	Benzo(a)pyrene	0.4	0.33/ 0.73	0.29/ 0.69	0.34/ 0.74	0.34/ 0.74	0.30/ 0.70	0.27/ 0.67	0.23/ 0.63
4	Summation group (nitrogen dioxide + sulfur dioxide)		0.38	0.45	0.44	0.46	0.43	0.50	0.34

Note: maximum values of pollutant concentrations calculated in the EOL+ software at the boundary of the sanitary protection zone; checkpoints 1, 2 are located in the direction of residential development of the town of Kamin-Kashirskiy.

Table 5

Dispersion of pollutant concentrations in the surface layer of atmospheric air, South section

No.	Pollutant	Background pollution, parts of MPC	Enterprise contribution, parts of MPC / including background pollution, parts of MPC				
			CP8	CP9	CP10	CP11	CP12
1	Dust	0.4	0.05/ 0.45	0.08/ 0.48	0.15 0.55	0.29/ 0.69	0.36/ 0.77
2	Nitrogen oxides (as nitrogen dioxide [NO + NO_2])	0.4	0.10/ 0.5	0.11/ 0.51	0.23/ 0.63	0.28/ 0.68	0.30/ 0.70
3	Benzo(a)pyrene	0.4	0.18/ 0.58	0.19/ 0.59	0.34/ 0.74	0.33/ 0.73	0.33/ 0.73
4	Summation group (nitrogen dioxide + sulfur dioxide)		0.15	0.16	0.28	0.33	0.35

Note: maximum values of pollutant concentrations calculated in the EOL+ software at the boundary of the sanitary protection zone; checkpoints 9, 10, 11 are located in the direction of residential development in the village of Pidtsyrya.

The calculations based on estimated emission capacities show that the concentrations of pollutants in the surface layer of atmospheric air within the effect of the object do not exceed hygienic standards in Ukraine (Order of the Ministry of Health of Ukraine No. 52 dated January 14, 2020 "On approval of hygienic regulations for the permissible content of chemical and biological substances in the atmospheric air of populated areas",

registered with the Ministry of Justice on February 10, 2020 under No. 156/34439). The quality of atmospheric air corresponds to the maximum permissible content of pollutants, at which there is no negative impact on human health and the state of the environment.

The sources of acoustic impact of the planned activity are the technological processes of the deposit development. During the field development process, typical construction noise will be created by the movement of a dump truck on the access roads to the site and the work of the backhoe and bulldozer. Noise impact from construction and motor transport equipment will be temporary. Work at the production site is operated during the daytime (Zubko & Radziy, 2024). Sound pressure levels (Lw, dB) and equivalent sound levels (Leq, dBA) from construction vehicles and equipment during the development of deposit were calculated to assess the noise load on the environment. According to the calculations in accordance with the methodology (DSTU-N B V.1.1-33:2013. 2014), the equivalent sound levels in the operation of the North section at the checkpoints, without background pollution, are (standard levels are 55 dBA (daytime), 45 dBA (nighttime):

- checkpoint 1 – 29.95 dBA;
- checkpoint 2 – 24.80 dBA;
- checkpoint 3 – 44.80 dBA;
- checkpoint 4 – 36.25 dBA;
- checkpoint 5 – 34.45 dBA.

The sound pressure level in octave bands at the checkpoints (without background pollution) does not exceed the permissible sound pressure levels at the border of the sanitary protection zone and for the territories directly adjacent to the residential building.

The maximum sound pressure levels, according to the calculation, are expected in the 63 Hz octave band (standard level is 67 dB):

- checkpoint 1 – 41.88 dB;
- checkpoint 2 – 37.61 dB;
- checkpoint 3 – 55.80 dB;
- checkpoint 4 – 47.41 dB;
- heckpoint 5 – 45.81 dB.

In other octave bands, the sound pressure level is lower and within normal limits.

According to calculations, the equivalent sound levels in the operation of the South section at the checkpoints, without background pollution, are (standard levels 55 dBA (daytime), 45 dBA (nighttime):

- checkpoint 1 – 29.53 dBA;
- checkpoint 2 – 27.59 dBA;
- checkpoint 6 – 31.48 dBA;
- checkpoint 7 – 44.33 dBA;
- checkpoint 8 – 44.41 dBA.

The sound pressure level in octave bands at the checkpoints (without background pollution) does not exceed the permissible sound pressure levels at the border of the sanitary protection zone and for the territories directly adjacent to the residential building. The maximum sound pressure levels, according to the calculation, are expected in the 63 Hz octave band (standard 67 dB):

- checkpoint 1 – 41.45 dB;
- checkpoint 2 – 39.86 dB;
- checkpoint 6 – 43.17 dB;
- checkpoint 7 – 55.12 dB;
- checkpoint 8 – 55.02 dB.

In other octave bands, the sound pressure level is lower and within normal limits.

The calculations of acoustic pollution levels show that the noise level at the checkpoint at the boundary of the sanitary protection zone during mining operations does not exceed the standards. Therefore, the noise load level is within the permissible levels. The planned activity is expected to generate wastes in the amount of about 1.161 t/year (Table 6). Waste classification was in accordance with the National List of Wastes approved by the Resolution of the Cabinet of Ministers of Ukraine dated October 20, 2023 No. 1102.

Table 6

Waste generation for the period of planned activity

No.	Waste type	Waste code	Volume, t/year	Handling method
1	Mixed household waste	20 03 01	0.27	contracted transfer to a specialized organization for further handling
2	Absorbents, filter materials, wiping materials and protective clothing other than those mentioned in 15 02 02	15 02 03	0.039	
3	Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths and protective clothing contaminated with dangerous substances	15 02 02	0.52	
4	Septic tank sludge	20 03 04	0.332	

There is no accumulation of other waste directly on the territory, however, separate collection, temporary storage in specially designated places and timely removal to the production base of the operating organization are ensured. Waste for disposal or neutralization is transferred to specialized enterprises and organizations according to contracts. Accordingly, the generation of waste related to transport services (motor oils and lubricants, transmission oils and other spoiled or used, contaminated wiping materials, used batteries, used tires) on the territory of the planned activity object is not expected. The operation of a sand deposit undergoes environmental monitoring throughout the year, which is the most important tool for environmental safety management and can be considered as one of the information components. After the operation of the Kamin-Kashirske-1 sand deposit, reclamation measures are planned after sand extraction. During the complete completion of mineral extraction, quarry excavations with a total area of 15.26 hectares are formed at the deposit. The depleted quarries are subject to mining and biological reclamation. As a result of the development of the sand site, basin-shaped quarry excavations with a depth of up to 8 meters are formed. The volume of overburden excludes the possibility of reclamation of the excavated area to the surface. Based on this, in the excavated area of the quarry, it is planned to arrange an area for agricultural use. The slopes of the quarry sides are leveled to an angle of 18°, a soil layer of at least 0.2 m thickness is applied to the planned areas, and the land is recultivated by a local agricultural enterprise using biological methods by sowing perennial grasses, etc.

4. Conclusions

The operation of the Kamin-Kashirske-1 sand deposit will undergo environmental monitoring throughout the year, which is the most important tool for environmental safety management and can be considered as one of the information components. The state of the air is monitored by taking samples to analyze the air for the content of harmful gases and dust.

The calculations based on estimated emission capacities determined that the concentration of pollutants in the surface layer of atmospheric air within the effect of the operation do not exceed the hygienic standards in Ukraine. The quality of atmospheric air corresponds to the maximum permissible content of pollutants, at which there is no negative impact on human health and the state of the natural environment. The calculations of acoustic pollution levels show that during mining operations, the noise level at the points on the boundary of the sanitary protection zone does not exceed the standards. Therefore, the noise load level is within the permissible levels.

The rehabilitation of land plots disturbed by sand mining and their return to natural state is planned. A set of measures aimed at restoring and rehabilitating the territory include arranging the area for agricultural needs, levelling the slopes of the quarry sides to an angle of 18°, applying a soil layer of at least 0.2 m thickness, and the land is rehabilitated by using biological methods such as sowing perennial grasses, etc.

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