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ON THE DEVELOPMENT OF WORKING LAND MANAGEMENT PROJECTS FOR THE RECLAMATION OF DISTURBED LANDS

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Abstract. *Scientific and methodical approaches to the development of working land management projects for the reclamation of lands disturbed by industrial production are proposed.*

After the completion of mining operations, their restoration, i.e. reclamation, must be carried out on the disturbed territories. Land reclamation is a complex of works aimed at restoring the productivity and economic value of disturbed lands, as well as improving environmental conditions in accordance with the interests of society.

Any construction, mining, geological exploration, etc. cannot begin until a reclamation project for the disturbed soil cover is developed. Reclamation is subject to all lands undergoing changes in relief, soil cover, parent and underlying rocks that occur or have already occurred in the process of mining, construction, hydraulic engineering, geological exploration and other works.

The working project of land management regarding the reclamation of disturbed lands should become a document that takes into account: preservation and rational use of the main wealth - land; compliance with the order and rules aimed at preserving the natural environment, performed in the complex of land management works; preservation of the fertile soil layer and its use in other areas. The economic effect of these measures in the working project of land management for the reclamation of disturbed lands must be calculated using the discount method, which takes into account both the outflow of money (investments) and the inflow that occurs due to the increase in land productivity and the elimination of damage to the natural environment.

Keywords: *reclamation, working project of land management, disturbed lands, grounding, soil protection.*

Formulation of the problem.

In the system of national land resources management, the issues of state policy in the field of rational use and protection of agricultural land, conservation and restoration of soil fertility are of great importance.

Development of industry, transport, construction works, development of mineral deposits are inevitably associated with land disturbance. Disturbed lands are lands of all categories that, as a result of production activities, have lost their economic value or have become a source of negative impact on the environment due to changes in soil and vegetation cover, hydrological regime and the formation of anthropogenic relief. They are often a source of soil, water and air pollution in the adjacent territories, worsen the hygienic living conditions of the population and the general appearance of the landscape.

In market conditions, this issue becomes particularly acute, as it affects the economic interests of existing enterprises and organizations engaged in agricultural production and other business entities that need to improve or replace the soil cover.

Recultivation of disturbed lands is carried out to restore them for agricultural, forestry, water management, construction, recreational, environmental and sanitary purposes. The lands disturbed during development of mineral deposits in an open or underground way, as well as peat extraction; laying of pipelines, construction, reclamation, logging, geological exploration, testing, operational, design and survey and other works related to the disturbance of soil cover liquidation of industrial, military, civil and other facilities and structures; storage and burial of industrial, domestic and other wastes; construction, operation and conservation of underground facilities and communications; elimination of the consequences of land pollution, if their restoration requires the removal of the top fertile soil layer [7].

Analysis of the latest scientific research and publications

Such scientists as V. Andrienko, O. Kanash, V. Kryvov, A. Martyn, S. Osypchuk, S. Pogurelsky, M. Stetsiuk, etc. were engaged in the issues of land protection in the course of economic activity. At the same time, the issue of reclamation of disturbed lands is relatively poorly studied by modern science.

Materials and methods of scientific research.

During the study on the development of working land management projects for the reclamation of disturbed lands, the following generally accepted methods of scientific research were used: theoretical method, monographic method, comparative method and generalization method.

The aim of the research is highlighting the methodological approach to the development of working land management projects for the reclamation of disturbed lands.

Research results and discussion.

Intensification of production often leads to the violation of valuable agricultural and forest lands. Especially great damage is caused by open mining of minerals - coal, ores of ferrous and non-ferrous metals, construction materials, etc.

In these conditions, there is an important task to preserve the land fund and prevent the violation of the natural complex that has developed over thousands of years, not only directly in the places of mining, but also in large adjacent areas. This is especially important for areas with developed agriculture, in order to preserve agricultural land alienated for use by industrial enterprises.

Land reclamation is carried out to restore disturbed areas and prevent their harmful impact on the environment. Land plots should be returned to production as soon as possible, and then they should be transferred to agricultural or forestry use.

Pokrovske Mining and Processing Plant occupies an important place in the mining industry segment of the whole Ukraine. Its primary tasks are: extraction of manganese ore (oxide, carbonate and oxide-carbonate types), its processing and production of manganese ore concentrate. The main consumers of our products are enterprises of steel and ferroalloy branches of metallurgical industry [5]. The location of land use of JSC "Pokrovsky GOK" on the territory of Pokrovsky village council is shown in Fig. 1.

Mining works at the plant are carried out in an open way - in quarries. The technological cycle of production consists of several stages: first, special equipment is used to open the ore layer in the quarries, then with the help of mining machines, the ore is loaded into vehicles that carry raw materials to the ore warehouses near the quarry. It is from there that the ore is loaded into dump cars that deliver it to the processing plants. There the raw material goes through a full enrichment cycle, the final result of which is manganese concentrate.

With the development of the mining industry, the needs and areas of extraction grew, and with the development of technology, so did the depth.

In accordance with Article 52 of the Law of Ukraine "On Land Protection" [4], lands that have undergone changes in the relief structure, ecological condition of soils and parent rocks and in the

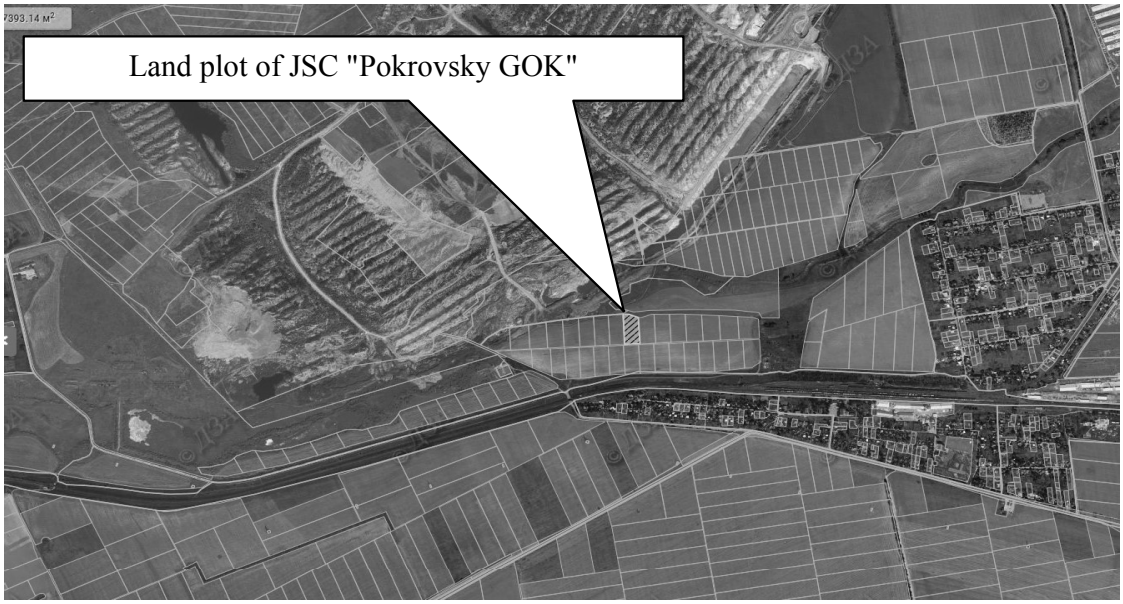

Fig. 1. Location of land use of JSC "Pokrovsky GOK" on the territory of Pokrovsky village council of Dnipropetrovsk region

hydrological regime as a result of mining, geological exploration, construction and other works are subject to reclamation.

When carrying out mining, geological exploration, construction and other works related to disturbance of soil cover, the separated soil mass shall be subject to removal, storage, preservation and transfer to disturbed or unproductive land plots in accordance with the working land management projects. When removing soil cover, layer-by-layer removal and separate storage of the top, most fertile soil layer, and other soil layers is carried out in accordance with the structure of the soil profile, as well as the parent rock.

Recultivation of land plots is carried out by layer-by-layer application of excavated soil mass and, if necessary, the parent rock to low-productive land plots or plots without soil cover in the order that ensures the highest productivity of the reclaimed land.

One of the main tasks of reclamation is to improve the soil as a necessary component of the ecosystem. The soil cover should be fully functional. As defined by ISO 11074:2015-10, soil is the surface layer of the earth's crust, consisting of mineral particles, organic matter, water, air and organisms. Under natural conditions, the process of soil formation lasts several tens or even several hundred years.

The whole process of land reclamation of JSC "Pokrovsky GOK" on the territory of Pokrovsky village council can be divided into the following stages: removal, transfer, storage and preservation of soil cover, technical reclamation and biological reclamation of these lands.

According to Article 52 of the Law of Ukraine "On Land Protection" [4], during mining, geological exploration, construction and other works related to soil disturbance, the separated soil mass is subject to removal, storage, preservation and transfer to disturbed or unproductive land plots.

When removing the soil cover, layer-by-layer removal and separate storage of the upper, most fertile soil layer and other soil layers is carried out in accordance with the structure of the soil profile, as well as the parent rock.

According to DSTU 7941:2015 "Soil quality. Land reclamation. General requirements", agrochemical passport dated 17.05.2021 № 08/08/474, (developed by the State Enterprise "Research Institute of Land Management") and scientific publication "Technozem and modern technogenesis", Kyiv, 2013, V.O. Zabaluev, M.G. Babenko, I.B. Zlenko, National University of Life and Environmental Sciences of Ukraine, UDC 631. 618:631.45:633.31:631.82, BBK 40.3, Z-12, the depth of removal for the southern chernozem and its slightly saline and slightly saline heavy loamy sediments (code of agro group 71d), which lie on the land plot of JSC "Pokrovsky GOK" on the territory of Pokrovsky village council will be (Fig. 2):

- top most fertile soil layer - 0.40 m
- other soil layers - 0.20 m.

The soil without roots of bushes and trees by the difficulty of development by construction machines and mechanisms belongs to the I group (DSTU B D.2.2-1: 2012. Resource element estimates for construction works. Earthworks (Collection 1).

Norms of soil cover removal are given in Tables 1 and 2.

The removed soil cover with a total volume of 4500 m³ is planned to be transferred and stored in temporary dumps No. 1 and No. 2. Temporary

Table 1. **Norms of removal of the top most fertile soil layer**

№	Area on which the top most fertile soil layer is removed, m^2	Depth of removal of the top most fertile soil layer, m	Volume of the top most fertile soil layer, m^3	Density of the most fertile soil layer, t/m^3	Mass of removal of the most fertile soil layer, tons
1	7500	0,40	3000	1,28	3840
Total	7500	-	3000	-	3840

Table 2. **Norms of removal of other soil layers**

№	Area on which other soil layers are removed, m^2	Depth of removal of other soil layers, m	Volume of other soil layers, m^3	Density of other soil layers, t/m^3	Mass of removal of other soil layers, tons
1	7500	0,20	1500	1,40	2100
Total	7500	-	1500	-	2100

dumps of soil cover shall be protected from destruction by denudation processes (washing, blowing, etc.) by manually sowing perennial grasses on the surface.

When removing the soil cover it is unacceptable to mix it together with underlying infertile soils and mineral rocks.

Since, when removing the soil cover, its loosening occurs, as a result of which the volume increases by 5-7%, respectively, the volume of temporary dumps for storage also increases by 5-7%. That is, for the storage of the upper most fertile soil layer with a volume of 3000 m^3, a temporary dump No. 2 with a volume of ~ 3200 m^3, a length of 22 m, a width of 40 m, a height of 4.0 m, slopes 1:1, with a surface area of 0.0900 ha and for other soil layers with a volume of 1500 m3 temporary dump No. 1 with a volume of ~ 1600 m^3, length 11 m, width 40 m, height 4.0 m, slopes 1 : 1, with a surface area of 0.0450 ha. Cross-sections of the temporary dumps are shown in Fig. 5.

Usually, the process of self-overgrowing of waste heaps lasts several decades after their filling. Therefore, the works to protect the temporary dumps from denudation processes (washing, blowing, weathering, etc.) are carried out by sowing perennial grass seeds on their surface.

To prevent the processes of humus mineralization in the dumps, the storage period of the soil cover should not exceed 20-25 years.

The technology of soil cover removal is shown in Fig. 4, the technology of storage - in Fig. 5.

After the completion of mineral resources development, the land plot will be rehabilitated by layer-by-layer application of soil cover in the following order (Fig. 3):

1. application of overburden (if necessary);

2. application of other soil layers with a depth of 0.20 m from the dump No. 1;

3. application of the top most fertile soil layer with a depth of 0.40 m from the dump No. 2.

The main design decisions on remediation, removal, transfer, storage and preservation of soil cover are shown in Figures 3, 5

For example, the reclamation of disturbed soils in Germany.

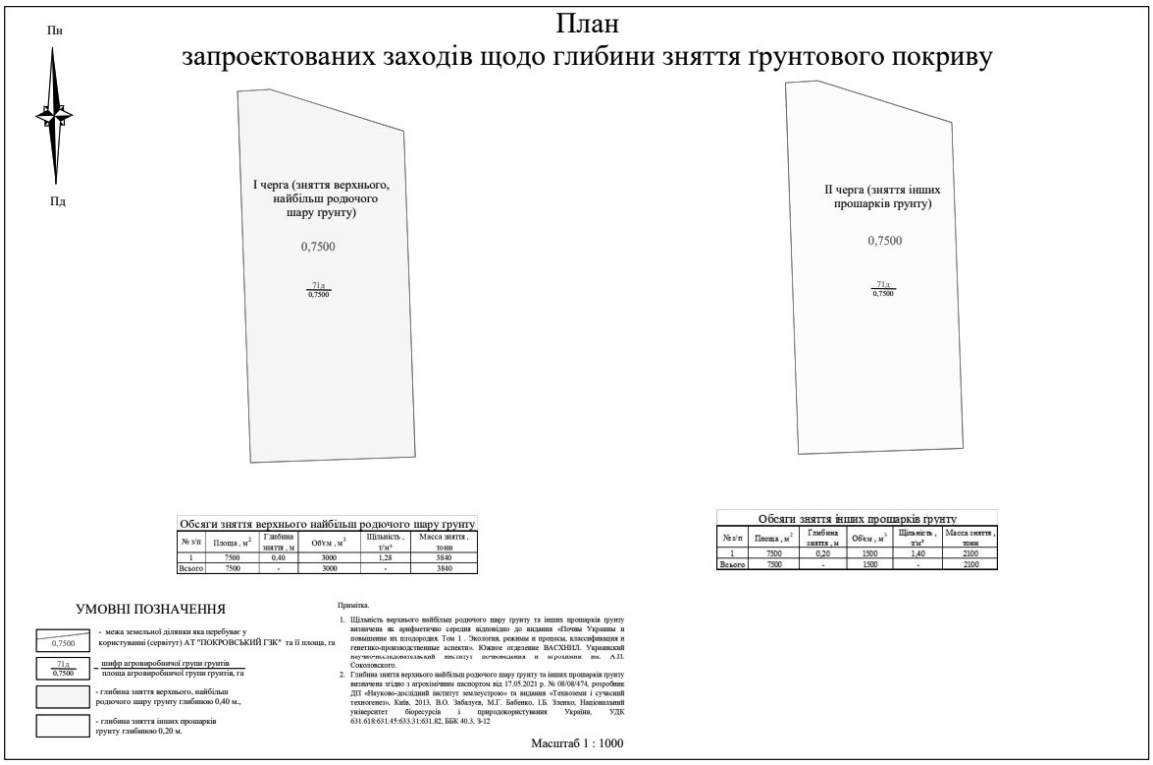

Fig. 2. Plan of planned measures for the depth of soil removal

Fig. 3 General plan for land reclamation (removal, transfer, storage and preservation of soil cover)

Fig. 4 Plan of planned measures for the removal

In Germany, in 2017, there were more than 220,000 sites whose soil cover was disturbed as a result of various human activities. Soil remediation involves various measures to eliminate or reduce pollutants in the soil. The aim is to eliminate existing hazards and ensure sustainable, healthy and environmentally friendly use of soil through its active protection [10].

By means of reclamation, the soil disturbed by economic activities becomes usable again and is preserved in the long term. The German Federal Soil Protection Act distinguishes between disturbed sites and areas suspected of disturbing their soil cover: a) disturbed sites Waste disposal plants (old deposits) and all facilities where waste and environmentally hazardous substances have been processed (except for facilities falling under the Atomic Energy Act); b) an area suspected of being disturbed: soil with signs of contamination due to previous use (e.g. lignite zones, military or industrial areas).

A land plot is declared as a disturbed area only when a detailed soil analysis confirms the suspicion beyond any doubt.

The study of disturbed areas is carried out in several stages:

1. Initial assessment by means of a non-sampling survey, the suspicion of a disturbed site is initially considered not significant. For this purpose, the history of land use is assessed by examining files and aerial photographs. The current condition is assessed during the inspection.

2. If the previous use of the land plot raises suspicion of existing disturbed areas, a laboratory soil test is carried out, during which percussion core probing is carried out at certain points. The type, quantity, distribution and mobility of contaminants are investigated. If the soil samples exceed the control values (in accordance with the Federal

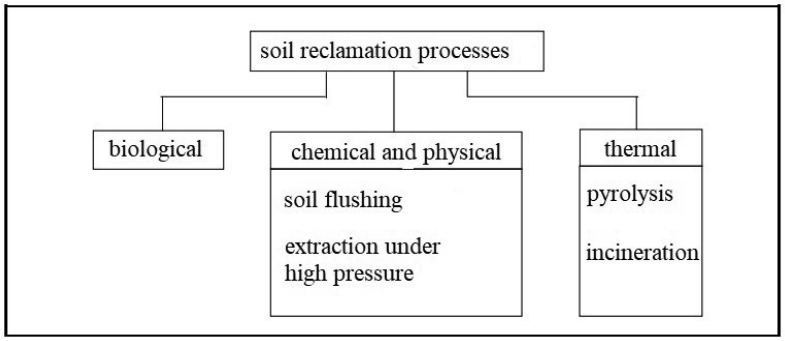

Fig. 5 Classification of disturbed land and soil remediation processes

Regulation "On Soil Protection"), a specific land plot is identified as possibly disturbed as a result of economic use.

3. If necessary, additional investigations (e.g. groundwater) are carried out as part of a detailed study to determine the exact extent of soil disturbance. If the threshold values are exceeded, the surveyed area is classified as disturbed. The result of the detailed survey is recorded in the final risk assessment.

The method of soil management largely depends on the scale of the identified disturbed land plots. Depending on the future use of the land plot, safety measures to prevent the spread of contaminants or decontamination measures to remove existing contaminants are initiated. In the case of a minor load, it may be sufficient to remove the affected soil or apply a layer of fertile soil. More serious contamination may require complete soil replacement. The following soil remediation methods are available:

1. On site this is the name of the process used on site where, for example, soil is accumulated. The principle of on-site operation usually corresponds to mobile or convertible systems of small and medium size, which are optimized for the respective application.

2. Off-site-this is the name of a process that is not used on-site, where, for example, soil is stored. Off-site facilities are designed as stationary multi-purpose facilities for a variety of disposal tasks and can absorb and process contaminated soil from a variety of land disturbed by economic use.

In both methods of remediation of disturbed land, excavation of soil is necessary in any case. The material should then be processed either on-site or in a suitable stationary off-site facility. During excavation, gas and dust may be emitted into the air, which may also be associated with odour. In any case, mixing of fertile and potentially fertile soil should be avoided. Figure 5 shows different methods of remediation of disturbed land and soil with examples.

Biological processes.

Biological methods can be used for many remediation cases. However, they are not suitable for the following cases: strong adsorption of the contaminant on the soil; presence of fine soil fractions.

Some groups of pollutants (e.g. polycyclic aromatic hydrocarbons and polychlorinated biphenyls) are toxic to microorganisms. These groups of pollutants are difficult or impossible to be degraded by microorganisms. Another disadvantage of this method is the amount of time (weeks to months) required for remediation.

Advantages of biological methods compared to other remediation methods: possible as an on-site measure; soil cover structure is preserved.

Chemical and physical processes.

The best known and most commonly used chemical-physical method in practice is the soil washing process. The disturbed soil cover is separated from the coarse-grained fraction and joined to the fine-grained fraction (up to 100 microns). The heavily contaminated fine fraction is then treated as hazardous waste or further treated with a thermal process. The disadvantage of the process is the disposal of chemical detergents.

Thermal processes.

The most important thermal processes to date have been pyrolysis and incineration. These procedures are particularly suitable for organically contaminated soils. Through thermal treatment, organic pollutants are essentially oxidized to form carbon dioxide and water.

Other trace elements found in the exhaust gas stream (primarily sulphur and nitrogen oxides) must be removed through comprehensive exhaust air treatment. This occurs in the process of combustion of the material at temperatures from 800°C to 1300°C. This requires high energy consumption. The disadvantage of this method is the destruction of the fertile soil layer.

The establishment of soil microflora is possible only by mixing the decontaminated soil with the fertile soil layer.

In pyrolysis, which is technically more complicated than burning (smoldering), soil is decontaminated at temperatures from 400°C to 800°C. Due to the low temperatures involved in this process, hydrocarbon bonds are returned to the soil.

Conclusions.

The development of working land management projects for the reclamation of disturbed lands is extremely important for the development of land relations at the local level of amalgamated territorial communities, namely, it will contribute to the restoration and protection of land in the implementation of economic activities.

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ДО ПИТАННЯ ПРО РОЗРОБЛЕННЯ РОБОЧИХ ПРОЄКТІВ ЗЕМЛЕУСТРОЮ ЩОДО РЕКУЛЬТИВАЦІЇ ПОРУШЕНИХ ЗЕМЕЛЬ

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Анотація. *Запропоновано науково-методичні підходи до розроблення робочих проєктів землеустрою щодо рекультивації земель порушених промисловим виробництвом.*

Після завершення гірничих робіт на порушених територіях має здійснюватися їх відновлення, тобто рекультивація. Рекультивація земель – це комплекс робіт, спрямованих на відновлення продуктивності та господарської цінності порушених земель, а також на поліпшення умов довкілля відповідно до інтересів суспільства.

Будь-яке будівництво, добування корисних копалин, геологорозвідка тощо не можуть починатися, доки не буде розроблено проєкт рекультивації порушеного ґрунтового покриву. Рекультивації підлягають усі землі, що зазнають змін у рельєфі, ґрунтовому покриві, материнських та підстильних породах, які відбуваються або вже відбулися у процесі гірничих, будівельних, гідротехнічних, геологорозвідувальних та інших робіт.

Робочий проєкт землеустрою щодо рекультивації порушених земель має стати документом, що враховує: збереження та раціональне використання основного багатства – землі; дотримання порядку і правил, спрямованих на збереження природного середовища, що виконуються в комплексі землевпорядних робіт; збереження родючого шару ґрунтів та його використання на інших ділянках. Економічний ефект цих заходів у робочому проєкті землеустрою щодо рекультивації порушених земель необхідно розраховувати дисконтним методом, що враховує як відтік грошей (інвестиції), так і приплив, що виникає завдяки підвищенню продуктивності земель, ліквідації шкоди, що завдається природному середовищу.

Ключові слова: *рекультивація, робочий проєкт землеустрою, порушені землі, землювання, охорона ґрунтів.*