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## Some Recommendations on the Use of Background Values of the Concentration of Oil and Oil Products for Remediated Land

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# Some Recommendations on the Use of Background Values of the Concentration of Oil and Oil Products for Remediated Land

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**Abstract.** The study aims to solve the methodological problem of comparing the quantitative residual pollution of oil and oil products of an organogenic substrate (peat) that composes the surface of remediated land plots with background indicators of the content of this pollutant in the organic-mineral horizons of natural soils that have contrasting properties. To solve this problem, the method of recalculating the pollutant content through its layer-by-layer reserves was used. A case study illustrates a calculation option that allows you to evaluate the range of oil and oil products objectively after restoration work. The authors conclude that it is necessary to determine the different density as a parameter in the studied layers of 0–5 and 5–20 cm of ameliorant substrate and soil standards. The data availability allows recalculations to occur, taking into account the difference in properties of the compared substrates which build up land plots.

**Keywords:** Remediated Land · Soil · Background Territories · Background · Oil and Oil Products in Soil

## 1. Introduction

The issue of sustainable development in the world (ecologically rational, according to one version of the translation of the foreign term “sustainable development”) has become rather acute since the 1970s, and it is gaining attention every year.

For Russia, where the oil and gas industry plays one of the critical roles of the economy, an essential step in the work of oil companies is to build a strategy that will, firstly, ensure a balance between economic, social, and environmental factors, while respecting the priority of future needs of society. Secondly, it is essential to solving one of the country’s most serious problems: oil pollution of the land [11].

Meanwhile, some branches of environmental-related regulatory documentation related to the Russian Federation’s oil industry have not been developed in detail. The documentation often demonstrates the lack of a unified approach in determining standards [3, 13], that reveal several problems when recultivation work is carried out by oil organizations, despite the compliance with their legislative requirements.

On the Russian Federation territory, the subjects have been empowered since 2002 to prepare and submit for regional approval standards for the permissible residual content of oil and its transformation products after reclamation [4]. However, according to other valid documents for the year 2020 [9], in the absence of developed standards, pollution control of land plots (literally: soil territories) can be



carried out by comparative analysis of soil samples taken with background indicators. These values are quite stringent, but necessary for parts that have environmental protection status. Simultaneously, however, the following problem is revealed: if there were insult landscapes on the land plot before the oil spill, accordingly, there would be natural soils, often of an organo-mineral composition. Suppose a heavily contaminated surface layer is removed and replaced with a technogenic substrate in the process of land recultivation, even if it is potentially fertile (peat). In that case, there are no soils on this site (or they are severely disturbed). Accordingly, comparisons should be made solely based on oil and oil products at specific depths, as recommended by regulatory enactments [10]. The contrasting difference in the substrates' composition and properties, which are composed of organo-mineral soil horizons and the organogenic mass of peat, is not considered in calculations in any current standard of the Russian Federation. This inadvertently distorts the conclusions about the quality of work.

In this regard, there is a need to adjust the calculations, which would make it possible to objectively compare the content of pollutants on land with qualitatively different surface compositions.

To account for this discrepancy, it is possible to use the method proposed to solve a similar problem with soils that have been contaminated with heavy metals [5]. The authors of this work consider it necessary to take into account the addition density (synonyms: volumetric weight, volumetric mass) of the horizons/layers of the compared objects/soils (or land plots in our case) and, accordingly, to reach the content of the polluting substance through its reserves in the considered layers.

## 2. Materials and Methods

Information from a damaged site during an emergency pipeline breakthrough in the Tomsk Region was used as material for the study as the content of the residual amount of oil and oil products (NNP) in the site's organogenic substrate was recovered after the oil spill. After the reconstruction, the surface of the site is composed of an organogenic substrate (peat). The land is located in the river's floodplain, respectively, the type of background soil is defined as alluvial acidic turf / Fluvisols [1-2].

Samples were taken from the studied sites, which correspond to the pooled samples from depths of 0–5 and 5–20 cm [10]. Quantitative indicators of the residual content of oil and oil products correspond to their determination, which was received using the IR spectrometry method.

The volumetric weight of the horizons was taken as an approximation (solely for demonstration of calculations), based on information published in the literature on this physical parameter for the turf and organo-mineral horizons of alluvial soils and an organogenic substrate (peat) [7].

The calculation of the pollutant reserves was carried out according to the generally accepted methodology in soil science, according to the formula:

$$M = m \cdot h \cdot d_v$$

where: M is the storage of matter in the layer h, t/ha; m is the content of the determined component, %;  $d_v$  – addition density, g/sm<sup>3</sup>

## 3. Results

Initially, we had information about the residual content of oil and oil products (mg/kg) and averaged data on the layers' density in the studied land (c 1).

**Table 1.** Initial data for calculations.

Objects	Depth of sampling, cm	The residual content of OOP		Addition density <sup>1</sup> , g/sm <sup>3</sup>
		mg/kg	%	
Fluvisols (background)	0–5	<50	0.005	0.82
	5–20	<50	0.005	1.33
Peat substrate	0–5	1940(±480)	0.194	0.16
	5–20	350(±90)	0.035	0.18

Source: Compiled by the authors; [7].

Further calculations must convert OOP units from mg/kg to % (table 1).

According to the formula given above, the pollutant reserves are then calculated in layers, while the layers correspond to a thickness of 5 and 15 cm (table 2). To facilitate the number's perception, storage is converted from t/ha to kg/ha.

**Table 2.** Contaminant storage.

Objects	Depth of sampling, cm	Storage of OOP	
		t/ha	kg/ha
Fluvisols (background)	0–5	0.0205	20.5
	5–20	0.0998	99.8
Peat substrate	0–5	0.1552	155.2
	5–20	0.0945	94.5

*Source:* Compiled by the authors.

Thus, for the surface of background soil, the oil and oil products reserves amounted to 20.5 kg/ha, and for a layer of 5–20 – 99.8 kg/ha, while for organogenic ameliorate, these figures correspond to 155.2 and 94.5 kg/ha.

#### 4. Discussion

The sorbing properties of peat substrates about pollutants, including oil and oil products, are used quite actively to clean and restoring ecosystems and various natural environments [6, 8, 12]. Experts who are studying peat, as well as peat soils, unequivocally indicate the fulfillment by this natural substance of the role of a biogeochemical barrier, in the mechanism of functioning of which all properties of this natural resource are involved (including the degree of decomposition, addition density, ash content, significant pore space, and many others) [7]. Thus, peat's high ability to absorb and a relatively low addition density determines its features concerning the natural organic-mineral substrates composing soils and performs the functions of reference unpolluted biological systems.

Analyzing the initial data without considering the stratified pollutant reserves, the conclusion is unambiguous: the excess oil and oil products in the ameliorant over the background are very significant. It is about 40 units in the 0–5 cm layer and seven units in the 5–20 cm layer (table 3).

**Table 3.** The ratio of excess oil and oil products relative to the background.

The ratio of the content of OOP: “Background / remediated site”	Depth of sampling, cm	The ratio of excess, times
Used data on the concentration of a pollutant in the layers	0–5	36.9
	5–20	7.1
Used data on the storage of pollutant in the layers	0–5	7.6
	5–20	0.9

*Source:* Compiled by the authors.

These indicators demonstrate a high level of pollution of the remediated area and the failure to achieve the procedure for recovering it after an oil spill. Nevertheless, taking into account the diversity of the ratio of precisely the pollutant reserves in the peat layers of the cultivated plot and the soil of the comparison plot (table 3), it is noticeable that the excess is much lower: in the 0–5 cm layer it is about eight units, and in the 5–20 layer the values already roughly correspond to the background indicators. It is possible because a recalculation was made, taking into account the substrates' properties. Such information is closest to the truth and allows an objective assessment of the results obtained.

## 5. Conclusion

When comparing the content of oil and oil products in soils and the material used for recultivation, an indispensable condition for the work performance should be a layer-by-layer account of the substrate's added density that composes the surface of land plots. This procedure will allow recalculations to consider the contrasting properties of the compared organo-mineral and organic components of the natural and natural anthropogenic ecosystems, and objectively assess the pollutant content with "background / remediated land." This approach will ultimately determine the objective conclusion about the quality of the work performed.

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