

# Assessment of Environmental, Ecological and Human Risks of Drilling Waste Management in the Tundra Ecosystems of the Yamalo-Nenets Autonomous District

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doi: <https://doi.org/10.21467/abstracts.93.98>

## ABSTRACT

The relevance of environmental protection measures in the Yamalo-Nenets Autonomous District (YNAD) is connected with both specific role of the region in ensuring the required level of hydrocarbon production and considerable vulnerability of the Arctic tundra ecosystems in the conditions of increasing anthropogenic pressure. Use of different drilling fluid compositions and the formation of drilling waste are inseparable from the drilling procedure. Presence of technological challenges facing the industry has a major influence on expansion of the range of chemical compounds used for preparation of drilling fluids, and, accordingly, present in drilling waste.

The need to ensure the planned level of hydrocarbon production dictates the need to use new drilling technologies; this fully applies to used drilling fluids. There is a complication of the component composition of water-based mud (WBM), and the introduction of oil-based drilling mud (OBM) into widespread use. In turn, this changes the package of measures for managing waste from drilling operations within the framework of rational nature management.

The main location for cuttings in the Yamalo-Nenets Autonomous district are sludge pits scattered throughout the area. The average area of the slurry barn in the Yamalo-Nenets Autonomous District is 3,100 m<sup>2</sup>, and the average design capacity is 5,338 tons. These indicators differ to a greater extent compared with the average for the Russian Federation (area 2500 m<sup>2</sup>; average filling 500m<sup>3</sup>). Our previous publications have shown the coincidence of trends in total oil and gas condensate production and the number of sludge pits.

There is a reason to believe that the number, total area and fullness of sludge pits in the future will grow at a faster rate than hydrocarbon production. Particular attention is drawn to the technology of injection of drilling waste into the reservoir (CRI, Cutting Re-Injection). The only facility in the Yamalo-Nenets Autonomous Okrug, where from April 2016 and until present, with the technical support of AKROS LLC, the CRI technology was being used, is the Prirazlomnaya offshore ice-resistant stationary platform (IRSP). From the beginning of work until October 2019, a total of 177.4 thousand m<sup>3</sup> of waste was pumped into the reservoir, of which: sludge pulp - 21.5 thousand m<sup>3</sup>; spent drilling fluid - 33.3 thousand m<sup>3</sup>; other waste, including not directly related to drilling / development - 122.6 thousand m<sup>3</sup>.

According to the specialists of AKROS LLC, the total volume of waste that one injection well can accept varies from 500 to 1000 thousand m<sup>3</sup> and depends on specific geological conditions. The next important direction of complicating the component composition of drilling fluids is the deep involvement of salts of mono- and divalent metals (chloride, nitrate and calcium bromide; zinc bromide; sodium and potassium formates, etc.), previously used in widespread drilling practice and occasionally represented in the component composition of drilling fluids solutions.



This tendency is dictated by the realities of the drilling operations of our time, namely the involvement in the development of deposits with the presence of complex thermobaric conditions. Such conditions inevitably lead to the need to use drilling fluids of high densities and high thermal stability. Obviously, the use of bromides, in comparison with formates, carries additional environmental risks in case of violation of the technological regulations for the disposal of drilling waste and subsequent reclamation of the sites. The potential for self-healing of tundra ecosystems is much lower than for more southern communities due to reduced biota productivity.

The unfavorable climatic conditions of high-latitude reclamation sites, low potential for self-restoration of land cover and transport isolation of the Yamalo-Nenets Autonomous Region determine the need for great efforts to reclamation of disturbed lands, the use of special methods of reclamation different from those used in more southern regions. Due to vulnerability of the Arctic tundra ecosystems, it is necessary to move from assessment of the environmental damage of the post factum formation and disposal of drilling mud waste to the forecast of the volume of waste generation and early planning of appropriate measures for rehabilitation of the territories.