

## TERRITORIAL SCHEMES OF WASTE MANAGEMENT IN THE RUSSIAN ARCTIC: A STARTING POINT FOR A DISCUSSION

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The problems of household waste management in the Arctic region are complicated by low temperatures at which the waste freezes and plastics burst, as well as by an undeveloped (or completely absent) road network and a low population density. Another issue is that the legal system of the Arctic regions requires harmonization. Requirements that seem to be difficult to meet in settlements located in temperate climates become impossible to achieve in the North. The usual logistic schemes can't be drawn up as well, and even a small distance can become an obstacle to the regular transportation of municipal solid waste. Furthermore, a need for an individual approach to the issue of waste management in the Arctic should be emphasized, on the one hand, and on the other, close coordination among different regions and justification of the use of the best available technologies in the field of waste management in the Russian Arctic are necessary.

**Key words:** the Arctic, Arctic zone of the Russian Federation, water supply, socio-economic development, the best available technologies, territorial schemes of waste management.

The natural and climatic conditions of the Arctic as well as its current economic conditions establish special requirements for individuals, the society and the country in general. The routine actions that don't present difficulties in favorable climatic conditions become extremely challenging and require special solutions in the North. This can be fully applied to the sphere of waste management, which is one of the country's most problematic and conflict fields on the whole.

Municipal solid waste (MSW) is disposable materials generated by households in the process of use by individuals, as well as the goods that have lost their usefulness in the process of use by individuals in residential accommodations for personal and domestic needs. The waste generated by juridical persons and individual entrepreneurs with a composition similar to that of the waste generated in the process of use by individuals in residential accommodations also belongs to MSW [1]. According to the law, MSW management is a public service [2]. The main stages of MSW management include waste accumulation, its collection, one-step or multiple-step transportation to waste processing facilities, waste processing (sorting), recycling or burial of MSW and/or the resulting products of processing or recycling [3]. Each stage possesses its own managerial, ecological and economic properties and has its own ecological and economic cost.

The most significant issues of MSW management in the Russian Federation include:

- a lack of demand for recycled resources (as a result of absence of any incentive for this field until recent times);
- a lack of any inducements for the population residing in private houses to conclude a contract for MSW removal;
- a lack or a poor technical condition of

vehicles used for waste transportation;

- technological complexity and comparatively high cost price of MSW processing with a risk of secondary environment pollution;
- in case of waste burial: taking of valuable land, interference in natural landscape, soil pollution, surface and groundwater pollution, air pollution, loss of valuable components contained in MSW etc. [3-5].

The MSW management in the far northern environment is substantially complicated by a number of objective reasons including:

- Extreme climatic conditions that threaten the financially affordable technological operations to collect, transport and neutralize waste. Another issue caused by low temperature is an impossibility of waste composting within house estates.
- Large areas of land that are little-developed and difficult of access; lack of development or total lack of transport infrastructure. In certain cases (for instance, in the insular territories) the only way to access the area is by water (during the navigational period), by an all-terrain vehicle (not for the whole year, as well) or by small aircraft. A year-round car road connection is unavailable in many cases. Recently, the ice-roads are also not always fully functional due to climate change.
- Absence of a waste management infrastructure. In most settlements, there is no system of regularly scheduled MSW collection; waste processing plants are lacking.
- Small population size. This factor significantly increases the specific costs of any MSW management processes.

Consequently, MSW gets into the environment, ends up in unequipped dumps or is mixed with unneutralized hazardous waste. These difficulties are aggravated by high vulnerability of the northern ecosystems, low intensity of self-purification

processes in all mediums and at all levels, and high activity of contaminant bioaccumulation and biomagnification processes.

To this must be added such factors as the rapid development of oil-and-gas and metallurgical industry in the Arctic zone in the conditions of insufficient elaboration of the issues of environmental and hygienic safety guaranteeing or even a failure to take them into account; long-term waste accumulation within the region, including persistent toxic substances; absence or poor development of public health and ecological monitoring systems, as well as the monitoring systems taking proper account of the peculiarities of the Arctic zone and its individual regions; the making of decisions concerning MSW management under conditions of high uncertainty caused by insufficient database of primary information on the environmental conditions, waste volume and composition [6, 12].

There are numerous environmental and sanitary requirements for the MSW management in the Russian Federation [1], [7-9]. Requirements that are difficult to meet in settlements located in temperate climates become impossible to achieve at affordable cost in the North. This applies above all to waste disposal frequency [9], duration of waste accumulation [1], licensing [1], landfill organization etc. In the great majority of cases, these requirements were not fulfilled (and still are not at present); the household waste that has been managed by the municipal government for a long time is now stored in dumps.

In the last decade, it became apparent that the waste problem must be solved in a comprehensive way, at the strategic level. In 2014, a notion of a «territorial scheme of waste management, including municipal solid waste» (TSWM) was included in the Federal Law No. 89-FZ of June 24, 1998 «On Production and Consumption Wastes» [1]. A territorial scheme is a strategy document prepared by each federal subject of the Russian Federation, with a minimum validity period of 10 years. This document contains data on the sources and the amount of waste, targets of the sphere of waste management and a description of the existing scheme of waste management [10]. Territorial schemes must also contain a description of the development prospects of the waste management sphere: plans to build new waste management establishments and to decommission landfills; the amount of necessary investments; tariff forecasts etc.

Currently, the territorial schemes are elaborated for all the Arctic regions (the Arctic Zone of the Russian Federation encompasses the territories of the Murmansk Region, the Nenets, Chukotka and Yamalo-Nenets Autonomous Areas, some municipal formations of the Republic of Karelia, the Komi Republic, the Sakha Republic (Yakutia), the Krasnoyarsk Territory and the Arkhangelsk Region [11]).

In some of the regions these schemes have already been updated in accordance with the

decree of the Government of the Russian Federation «On the Development, Public Discussion, Approval, Adjustment of Territorial Schemes in the Field of Waste Management of Production and Consumption, Including Solid Municipal Waste, as well as Requirements for the Composition and Content of Such Schemes» which came into force a year ago [10]. These documents are diverse; their length ranges from several pages without annexes and up to thousands pages. Their comprehensive analysis goes beyond the scope of a single article. In the present article, the question is put as follows: to what extent do these documents that are aimed at the description of the development prospects of the waste management sphere take into account the specific features of the Arctic region? Do they offer any possible solutions of the existing issues?

The weakest spots of waste management in the Arctic region are MSW accumulation and transportation, construction of new landfills that match up to modern requirements, and MSW processing. The northern conditions should be taken into account in these interrelated stages of waste management.

An explanatory note to the territorial scheme of the Murmansk Region [13] is startlingly short: 6,5 pages only. An annex to the explanatory note includes 388 pages of tables and graphic materials. The explanatory note doesn't give any clear indication that the scheme concerns a northern region.

The scheme of the waste stream in the Murmansk Region includes 8 waste transfer stations; technical solutions to the problems of waste transfer and transportation are not presented in the document. Several remote settlements located along the White Sea coast will not be covered by the transportation routes, and yet, neither landfills nor waste incinerators are planned for construction in these areas. Instead, a «waste sorting system» which lacks a description is envisaged for these settlements. This establishes the prerequisites for emergence of unauthorized waste dump sites. A system of containerless MSW accumulation in the apartment houses equipped with the refuse collection rooms providing MSW transfer to a waste collection vehicle directly from a collection room is also questionable. This system is contrary to SanPiN 42-128-4690-88, according to which the waste dumping through a refuse chute directly on the floor of a refuse collection room is strictly forbidden.

Further, the TSWM specifies a direction of several MSW streams straight to waste burial repositories. As the existing waste placement areas are filled, the MSW streams must be redirected to Murmansk. The issues of a year-round MSW transportation are not addressed in the TSWM. A specific character of 5 closed administrative units including Vidyayevo within the territory of which a MSW landfill is present is also not revealed in this territorial scheme.

A description and a comparison of waste processing technologies are absent from the TSWM; a technology selection is not made. In Murmansk, the construction of a combustion

plant and a waste sorting complex (WSC) with secondary raw materials extraction and burial of remains is planned. The efficiency ratings for these enterprises are not provided. Waste accumulation and incineration are specified in Krasnoshchelye [10].

In general, the scheme under consideration leaves many questions and does not provide solutions to the issues of MSW management in the region.

The TSWM of the Nenets Autonomous Area [14] suggests MSW transportation directly to waste sorting stations or its primary accumulation in 40 accumulation areas with subsequent transportation to the burial repository in Naryan-Mar or to the waste processing facilities in the neighboring regions: the city of Arkhangelsk, a town of Mezen (the Arkhangelsk Region), a town of Usinsk (the Komi Republic). However, the territorial schemes of the Arkhangelsk Region and the Komi Republic do not involve MSW receiving from the Nenets Autonomous Area; the agreements between the neighboring regions haven't been concluded yet.

Waste is planned to be transported by barges, all-terrain vehicles and cars; particularly, during the summer period the MSW transportation should be carried out by means of a tractor with a trailer; in winter a tractor with trailer skid shoe runners should be used; for swampy terrains a caterpillar tractor is recommended, and in the areas that are difficult to access all-terrain vehicles are planned to be used. Such a decision may be faced with licensing difficulties of waste transportation by means of non-standard types of transport. An original regional waste management operator in the Nenets Autonomous Area, which was selected by a competition, refused to work in the region. As a consequence, the region was subdivided into 2 service areas of regional operators which will start their work on January 1, 2020.

The TSWM contains plans for the construction of 4 small-size waste sorting stations with a capacity from 80 t/year to 12,000 t/year in the future. Given that small-scale MSW sorting is not recompensed, a market for the obtained salvage will be hard or impossible to find in the conditions of transport inaccessibility.

An explanatory note to the TSWM of the Chukotka Autonomous Area [15] emphasized the absence of intraregional MSW transit. This fact justifies the creation of 24 isolated service areas of regional operators. In fact, this is the only way to organize waste transportation: there will always be isolated areas from which it's impossible to transport MSW without using a helicopter. However, in the TSWM of the Komi Republic, for instance, these isolated areas are called «technological zones», and they don't require separate regional operators.

The reason of this contradiction is a wording from the Federal Law No. 89-FZ of June 24, 1998 «On Production and Consumption Wastes», according to which it's a regional operator, the data on whose zones of activity should be included in a territorial scheme of waste management. Thus, the issue

solution is referred to the TSWM technical authors, and not to the regional authorities.

The creation of regional operators' service zones is a decision more of a political nature. Within a single region, several technological zones (the territories which domestic waste is transported to a single final unit of utilization and storage) can be formed. The problem is that in the areas that are difficult to access some of these zones are small and unprofitable. In cases like this, it would be appropriate to unite several more or less profitable technological zones into a single service area of a regional operator that would be more attractive to investors. But this decision can be made by regional authorities on the basis of a TSWM with the economic details planned and described. In practice, in the process of formation of such «microzones» it's municipal enterprises that become regional operators.

Among the advantages of the TSWM of the Chukotka Autonomous Area are the most realistic values of targets for waste neutralization, utilization and placement: 10% of MSW sent for processing (utilization is a more precise term here).

The territorial scheme of waste management of the Yamalo-Nenets Autonomous Area (YaNAO) [16] provides a single service area of a regional operator; these conditions are more attractive for an operator. The scheme includes creation of numerous MSW accumulation and collection areas in the future. In many routes, the MSW transport distance is 100 km and more. Practice will show the efficiency of this approach. This scheme is aimed at decentralization and the use of small waste incinerators. The TSWM of the Yamalo-Nenets Autonomous Area is in the process of actualization until the end of 2019.

The territorial scheme of waste management of the Komi Republic [17] provides a very complicated system of waste accumulation and transportation consisting of numerous transfers, areas of accumulation and sorting, and technology parks.

The TSWM of the Sakha Republic (Yakutia) [18] suggests 5 service areas of regional MSW management operators. The Arctic territories are included in the Northern Arctic zone. Needless to say, the operator was chosen not from the first attempt, and this important responsibility has been entrusted to a state unitary enterprise.

The territorial scheme of waste management of the Krasnoyarsk Territory [19] is one of the longest documents reviewed. However, we are only interested in the Arctic regions, namely Turukhansk District, Taimyr Dolgan-Nenets District and the urban district of Norilsk. All three municipal formations are separate technological zones which were created in order to overcome the above-mentioned problem. Still, the competitions were announced independently in each technological zone. The disadvantages of this approach were discussed above. As a result, in the Turukhansk technological zone a regional operator is not selected (in 3 other remote regions of the Krasnoyarsk Territory, which are not included in the Arctic zone, regional MSW operators were not found as well).

This TSWM reviews the specific character of the northern territories in detail. A series of decisions different from the ones for the central and southern areas of the Krasnoyarsk Territory is suggested for remote settlements.

- MSW neutralization in thermal neutralization plants in isolated settlements;
- MSW accumulation and storage areas that are suggested for small and very small settlements. Transportation from these places is possible only once in 11 months and once in few years, respectively.

However, the system of waste collection with the use of refuse sacks leaves a possibility for waste freezing. It should be noted that a uniform solution of the issue of transportation of neutralized waste (ashes) and MSW kept in storage areas is not reflected in the TSWM. For Turukhansk District, truck transportation by ice roads is suggested, while for Taimyr Dolgan-Nenets District the solution lays in the creation of storage areas. That is due to the requirements of the administration of these municipal formations.

An objective of complete neutralization of MSW that is to be buried is stated in the TSWM of the Krasnoyarsk Territory. Two ways of household waste neutralization are considered in the northern territories: with the use of small incinerators (no energy is generated in this case) and with the use of larger generating units. Not all the TSWMs of the Arctic territories include the exploration of the MSW neutralization.

Currently, the scheme is in the process of revision. The materials of the public discussions of the updated TSWM project published on the website of the Ministry of Ecology and Rational Nature Management of the Krasnoyarsk Territory prove that this scheme is functional. Specific issues of waste transportation, advisability of placing of waste storage areas in certain settlements etc. are discussed.

In the explanatory note to the territorial scheme of waste management of the Arkhangelsk Region [20] various options of MSW accumulation, transportation, utilization and neutralization are explicitly considered. The climatic conditions are taken into account in choosing a system of waste accumulation. In general, the TSWM authors have selected a two-container system of separate waste accumulation (earlier: «separate waste collection») in the zone of service of waste sorting and waste processing complexes. At the initial stages, the TSWM entails the deployment of separate waste collection in 10 most populated settlements with the most developed infrastructure.

For the settlements that are difficult to access and have low population density and a low waste

generation rate (less than 5,000 t/year) the TSWM suggests waste separation by the local people:

- paper and carton waste is burnt in stoves;
- food waste is composted within house estates;
- secondary raw materials (plastic, glass, metal) are delivered to the secondary raw material reception points (in every settlement); the materials are periodically transported (by available land or air means) from these points for processing;
- for hazardous waste (accumulators, mercury-containing waste) reception terminals are installed in large infrastructure objects (shops, rural club-houses in every settlement); the waste is periodically transported (by available land or air means) from these points for neutralizing.

In fact, the TSWM relieves the regional operator of the MSW management responsibility in settlements that are difficult to access and shifts it onto the population's shoulders. In reality, no one can obligate population to burn and compost waste. Thus, conditions for continuing of dump formation are created. Another controversial point concerns the periodical transporting of secondary raw materials by available land or air means for processing. Since this process does not involve waste, this responsibility cannot be entrusted to the regional operator and included in the tariff.

The TSWM of the Arkhangelsk Region considers transportation by rail and by water as basic means of waste transit, which once again leads to the above-mentioned licensing issue of waste transportation by means of non-standard types of transport.

### Conclusions

None of the territorial schemes examined allows specific solutions to the issues of MSW accumulation and transportation. The requirements of the Russian legislation concerning waste management cannot be completely fulfilled in the northern living conditions without excessive costs which, according to the law, must be borne by the population. These requirements include both waste processing and utilization priority over its landfill burial and sanitary standards for the frequency of MSW disposal and the organization of container areas. The usual logistic schemes can't be drawn up as well, and even a small distance can become an obstacle to the regular transportation of MSW. A need for an individual approach to the issue of waste management in the Arctic should be emphasized, on the one hand, and on the other, a close coordination among different regions and justification of the use of the best available technologies in the field of waste management in the Russian Arctic are necessary.

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