

# Assessment of the impact of poultry farms on some environmental components by the example of CJSC Novorossiysk poultry farm

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**Abstract.** Failure to take appropriate measures for waste utilisation and neutralisation has led to the fact that many poultry farms have now become sources of environmental pollution, thereby causing serious economic, environmental and social damage. In this paper we have assessed the impact of poultry farms on some components of the environment by the example of the CJSC Poultry Farm "Novorossiysk". The main sources of impact of the poultry farm "Novorossiysk" on the environment are identified. The activity of the enterprise as a source of waste generation is studied. The level of atmospheric pollution created by emissions of the poultry farm was analysed. Easily and moderately soluble forms of elements and acid-alkaline conditions in soil were determined. The results of biotesting substrate toxicity by sprouts of indicator plants were analysed. Measures to improve the environmental situation on the territory of the CJSC Poultry Farm "Novorossiysk" and in the zone of its direct influence were recommended.

**Key words.** priority waste, maximum permissible concentration, methane, ammonia, carbon monoxide dust, poultry manure, biotesting, indicator plants.

## 1 Introduction

The problem of various pollutants entering the air and soil, utilisation and neutralisation of waste from poultry farms is very important. Gaseous, liquid and solid wastes of poultry farms are highly concentrated heterogeneous systems containing a wide range of organic substances and products of their metabolism. The chemical composition of such wastes is difficult to establish, and, consequently, it is difficult to identify priority ecotoxicants, to give an adequate characterisation of real and potential environmental risk.

The CJSC Novorossiysk Poultry Farm is located in the Tsem dolina settlement of Novorossiysk (Figure 1).



Fig. 1. CJSC Novorossiysk Poultry Farm Plan

The enterprise is located on one industrial site. From the north-west, north-east, south-west and south, the territory of the site borders with vacant land (wasteland) behind which there are residential buildings at different distances (60 m – 325 m). From other sides, the enterprise borders with residential buildings at a distance of 2 m – 150 m.

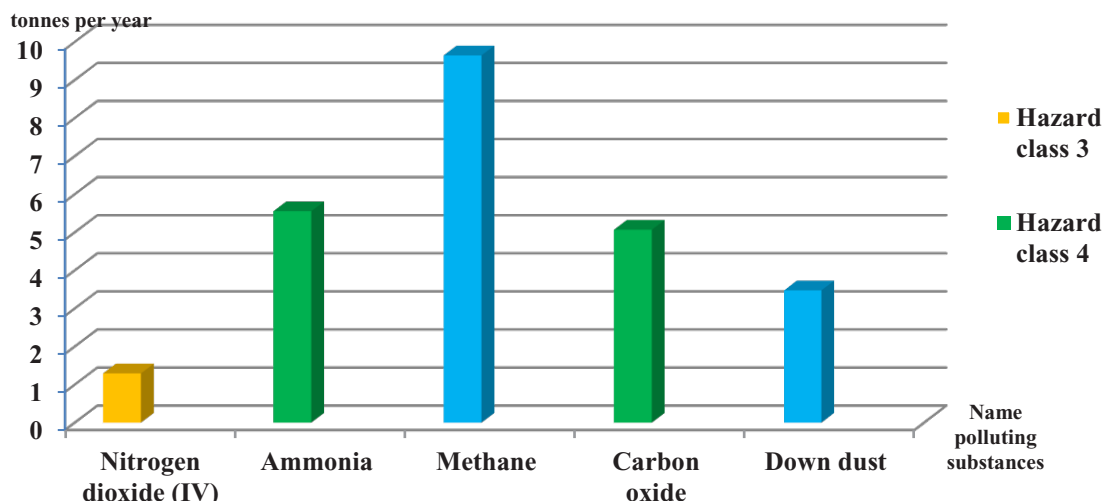
The company's main production is poultry farming and the production of marketable food products (chicken eggs, poultry meat, sausages, smoked meat). The company's annual capacity is 555,000 laying hens and 132,000 broilers.

## 2 Problem statement

The main impacts on the environment and human health during the operation of the poultry farm are possible from pollution of atmospheric air, soil cover and water bodies.

The company has identified 172 emission sources, including 142 unorganised sources, emitting 68 pollutants into the atmosphere. The largest amount of pollutants entering the atmospheric air belongs to: methane – 9.65 tonnes/year, ammonia – 5.55 tonnes/year, carbon oxide – 5.07 tonnes/year, fur (down) dust – 3.47 tonnes/year, nitrogen dioxide – 1.3 tonnes/year. These pollutants belong to the 3-4 hazard class [1]. The hazard class for OPVs is not set, involving methane and downy dust (Figure 2).

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**Fig. 2.** List of priority pollutants entering the atmosphere in amounts exceeding 1 tonne/year

Priority substances that get into the atmospheric air in the amount of less than 1 tonne/year are hydrogen sulphide, dimethyl sulphide, limiting hydrocarbons C12–C19, grain dust, ethyl formate, nitrogen oxide and others. Pollutants belong to hazard classes 2–4.

The main sources of emissions of priority pollutants are presented in Table 1.

**Table 1.** Sources of emissions of priority pollutants

Contaminant	Sources of pollutant emissions
Methane	Poultry housing, cesspools
Nitrogen dioxide (IV)	Houses for poultry housing, motor transport section, repair and mechanical shop, boiler house, crematorium, sausage and smoked meat production section
Ammonia	Poultry housing, disposal area, crematorium, litter storage, sausage and smoked meat production area, cesspools
Carbon monoxide (IV)	Crematorium, road transport section, pit latrines, mechanical repair shop, boiler house, sausage and smoked meat production section
Fur (down) dust	Housing for birds
Hydrogen sulphide	Poultry housing, cesspools, litter storage facility
Ethanethiol (ethylmercaptan)	Disposal site, pit latrines, disposal site, crematorium

Analysis of the dispersion calculation (taking into account the background) showed that the calculated maximum surface concentrations at the border of residential buildings are higher than the maximum permissible concentrations for the following substances:

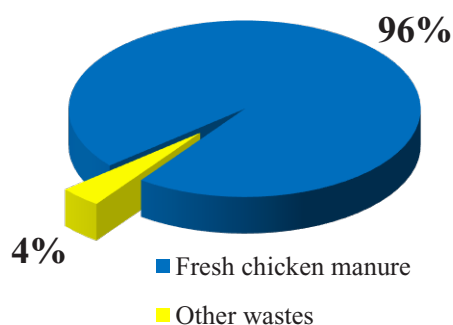
- hydrogen sulphide – 2.73 MPC;
- ethanethiol – 1.060 MPC;
- down dust – 1.030 MPC;
- ammonia and hydrogen sulphide – 2.890 MPC;
- sulphur dioxide and hydrogen sulphide – 2.730 MPC.

For other substances, no exceedance of MPC at the border of residential buildings is observed [2].

Hence, five names of pollutants and groups of summations exceed MPC, nine pollutants and groups of summations create concentrations from 0.800 to 1 MPC in the surface layer of atmospheric air. The condition of atmospheric air on the territory of the enterprise and in the zone of its direct influence does not comply with the norms for some pollutants.

## 2.1 Characterisation of the enterprise as a source of waste generation

As a result of the work, it was revealed that the poultry farm generated 39 waste items belonging to hazard classes 1–5. A total of 10,822.5 tonnes of waste was generated at the poultry farm during the year. The priority waste was 10,403 tonnes/year or 96% of fresh chicken manure. Other wastes account for 4% (Fig. 3).



**Fig. 3.** List of priority wastes generated at the Novorossiysk Poultry Farm

More detailed information on the remaining waste is presented in Figure 4. Waste of meat, skin, other parts of carcass from poultry slaughter is 144.8 tonnes/year (35%), waste of poultry innards is 78.8 tonnes/year (19%), waste of feathers and down is 53 tonnes/year (13%), waste of bird blood is 44.7 tonnes/year (11%) [3].

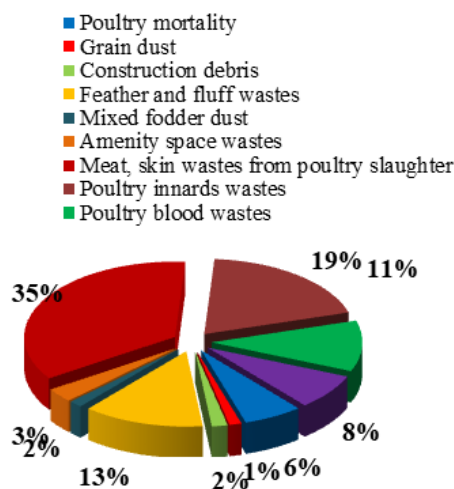


Fig. 4. List of remaining priority wastes

The generated poultry manure is transported by special vehicles to a manure storage facility, where it is composted and then exported to agricultural fields as organic fertiliser. Wastes from slaughtering and processing birds are transferred for processing to the animal-processing vacuum boiler and further to the feed shop for mixing with granulated mixed fodder. The resulting mixed fodder is used for feeding birds.

Unsorted solid waste from households (excluding bulky waste) and rubbish from territory cleaning are stored in special containers and taken to the municipal landfill. Unsorted ferrous metal scrap is stored in an open area and then transferred to Novorosmetall LLC.

### 3 Results and discussions

To identify the most contaminated sites on the territory of the poultry farm and in the zone of its direct influence, chlorine ions, sulphate ions, nitrates in soil extract, acid-alkaline conditions of soil, biotesting substrate toxicity by seedlings of indicator plants were identified [4].

For this purpose, 30 soil samples were collected on the territory of the enterprise and in the zone of its influence, and 3 samples were collected in the conditionally clean area. The results of the soil analysis showed that at all investigated points, there is a reduced content of chlorine and sulphate ions. Nitrates are absent practically at all points, except for those sampled near the eastern border of the enterprise and at the car park near the management.

According to the results of determination of acid-alkaline conditions, we found out that soils in the study area are slightly alkaline. A strong alkaline reaction is unfavourable for most plants. High alkalinity causes unfavourable physical and chemical properties. At pH 9-10, soils are characterised by high viscosity, stickiness, water tightness in the wet state and hardness, cementation and structurelessness in the dry state. Due to increased alkalinity, a sharp decrease in seedling length was observed.

According to the results of the analysis of biotesting the indicator plant, the toxicity of soils on the territory of the enterprise and in the zone of its direct influence was assessed according to the values of mass and length of the root and stem of the indicator plant (Figures 5, 6).

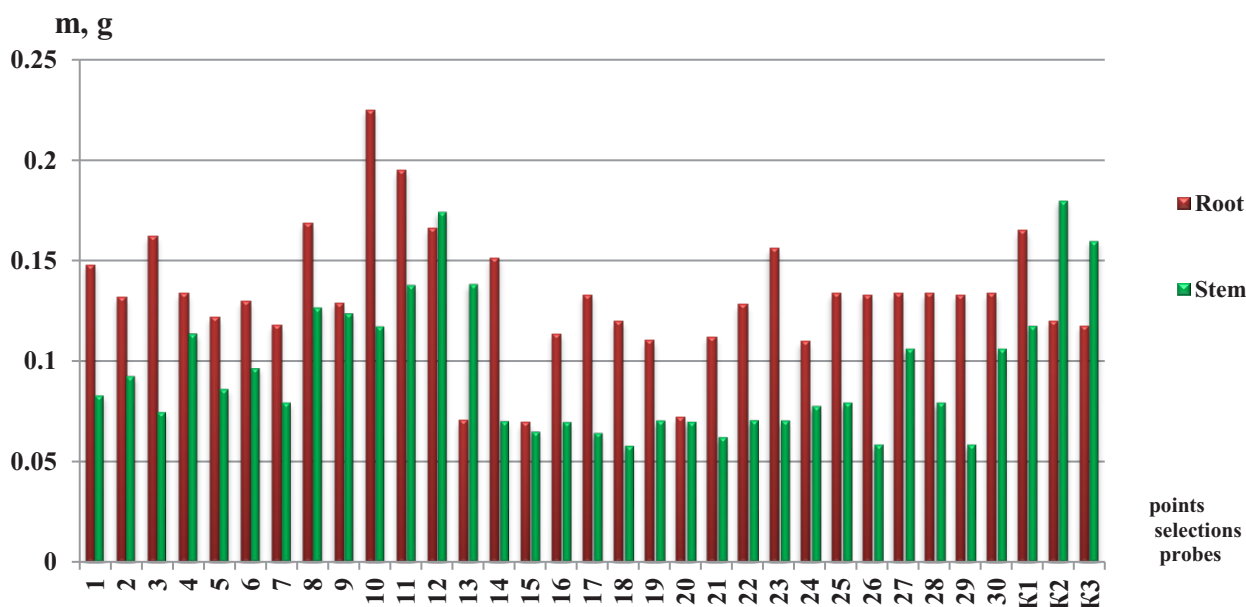
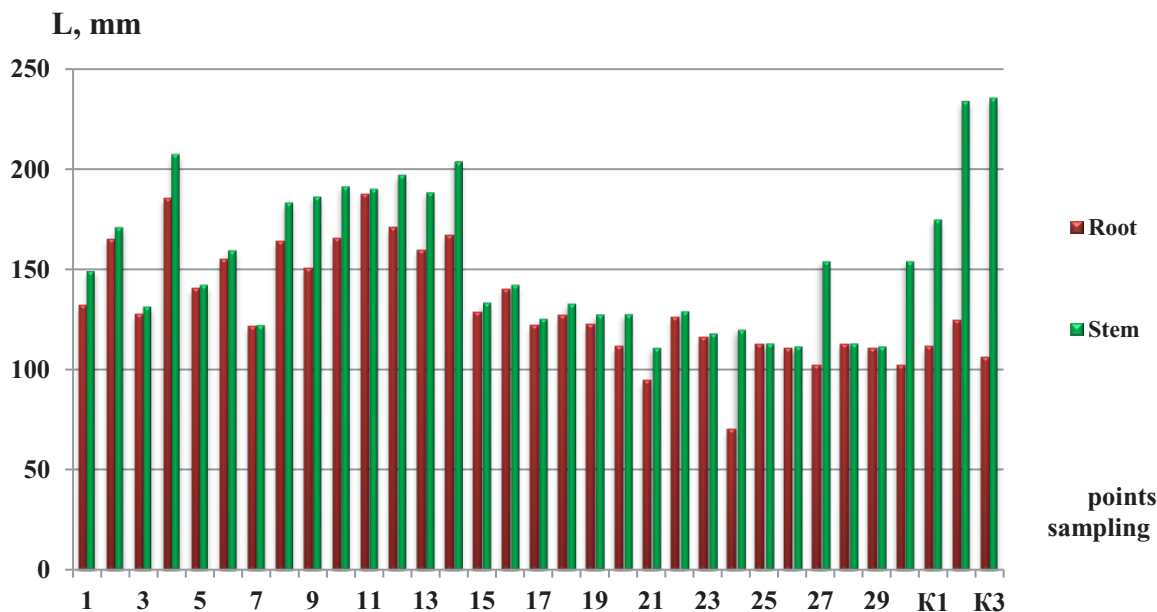


Fig. 5. Stem and root mass values of the indicator plant



**Fig. 6.** Values of the stem and root length of the indicator plant

Based on the result of the work done, it can be concluded that the shortest shoots and lower mass of the indicator plant are observed at the following points. These are No. 1 (near management), No. 15 (near litter store), No. 16 (near wood processing area), No. 17, 18 (near northern boundary of the enterprise), No. 20 (near crematorium). Points No. 21 (near fuel and lubricants store), No. 23 (near feed store), No. 26 (near slaughter house), No. 27 (near silos), No. 29 (near boiler house) indicate the highest contamination in these investigated sites.

Poultry manure accounts for a large share of the waste generated at the Novorossiysk Poultry Farm. Poultry manure itself is not dangerous to humans, but it provides a fertile environment for the development of infectious diseases, such as E. coli. E. coli is the cause of many gastrointestinal diseases such as diarrhoea and dysbacteriosis. Poultry manure is also a source of odour formation [5].

The presence of any odour in the air (pleasant or unpleasant) should be considered as a compulsive compulsion for people to use this air. As a result, the comfort of living in the area is reduced and various health problems may occur.

Hygienic assessment of the impact of odour emissions on public health, as well as the control of these emissions, due to the ever-expanding production of poultry farms and the problems of their waste disposal, are becoming increasingly important and require further study [11–14].

## 4 Conclusion

The result of the work is a list of recommended measures to improve the environmental situation on the territory of the CJSC Novorossiysk Poultry Farm and in the zone of its influence.

It is necessary to implement a set of measures aimed at reducing emissions of pollutants into the atmospheric air:

- reconstruction and repair of process equipment (dust and gas collection, gas cleaning, sealing equipment, filtration of treated gases, etc.), compliance with process parameters and elimination of product delays at intermediate stages;
- provision of necessary measures to reduce ammonia vapours from the litter store: sources of odorous and irritating substances;
- mandatory observance of the rules of manure storage;
- guidance by a substantiated list of priority impurities in the atmospheric air when organising and conducting state sanitary and epidemiological supervision and regional socio-hygienic monitoring in the area where poultry farms are located [15–19].

One of the most important factors providing protection of the air environment of settlements from industrial emissions is the greening of the area with dust and gas-tolerant tree and shrub plantings [6, 9].

Natural and artificially created green spaces and even singletree plantings have significant opportunities to change the microclimate, to give the environment comfortable conditions, high sanitary and hygienic properties. This is, first of all, the ability to absorb carbon dioxide and other pollutants coming from emission sources and enrich the air basin with oxygen, reduce the concentration of harmful impurities in the air. Air dustiness in landscaped areas is 40 % lower than that in open areas; they capture up to 70 % of aerosols and dust [7, 10].

Green spaces influence the wind regime of the green area. The air rises above more heated spaces, and cool air from the green massif rushes to replace the raised air. Therefore, there are horizontal airflows that contribute to

the ventilation of the territory and dispersion of pollutants, reducing their concentration [20–23].

When selecting green plantings for landscaping the enterprise, preference was given to the following plant species: green ash, ash maple, Caucasian hornbeam, common lilac, yellow acacia, tree caragana, crowned chubushnik, small-leaved elm, common horse chestnut, thorny gladicia [8]. The most gas-tolerant plants are located in close proximity to the source of harmful emissions. On the territory of the enterprise, trees and shrubs are recommended to be planted as solitaires (single plantings), linear plantings, hedges, as well as in the form of tree and shrub groups.

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