CASE STUDY

6

WASTE MANAGEMENT IN ECOLOGICAL LANDFILL FOR URBAN WASTE FROM THE CITY OF BOLDESTI-SCAIENI, PRAHOVA COUNTY

Storage was initially uncontrolled. Later it was decided, due to the advantageous position in relation to the inhabited area, to transform it from an open dump into an ecological landfill. The present study presents the transformation of one open dump with uncontrolled storage into an ecological landfill. All aspects involved in the construction process and those that have an impact on the environment were taken into account.

The types of activities that take place in this ecological landfill are:

- wastewater collection and treatment;
- collection of non-hazardous waste;
- treatment and disposal of non-hazardous waste;
- recovery of sorted recyclable materials.

According to Annex No. 1 OUG No. 152/2005: category 5.4 "Landfills receiving more than 10 tonnes of waste / day or having a total capacity exceeding 25,000 tonnes of waste, excluding inert landfills"[1-5].

The activity carried out within the objective consists in the controlled storage and in conditions of conservation of the environmental factors of the household waste that come from the municipality of Ploiesti, the city of Boldesti-Scaeni and belonging localities. This waste disposal system eliminates the negative effects and falls within the modern norms used in the European Community and approved by the Ministry of Environment [6-9].

The location is located west of the town of Boldesti-Scaeni, on the left bank of the Teleajen stream, at approx. 200 m from its shore, in the immediate vicinity of the current landfill for

urban waste collected from the radius of the land and from neighboring localities. The landfill will be located on the low terrace of Fr. Teleajen, which develops on its left side, near Boldesti.

1. Description of the Installation and of the Existing Technological Flows on the Site

The storage activity is carried out in 3 compartments that occupy a total area of 7,5 ha have a storage capacity of 1 250 000 m^3 (approx. 1,450,000 tons) household waste. The first 2 compartments were temporarily covered with earth and the 3rd compartment was in operation. The activity carried out consists in the controlled storage and in conditions of conservation of the environmental factors, of the domestic waste that come from the municipality of Ploiesti, the city of Boldesti-Scaeni and the belonging localities. The storage technology is done according to the "cells" method, with periodic coating of waste with a layer of inert material.

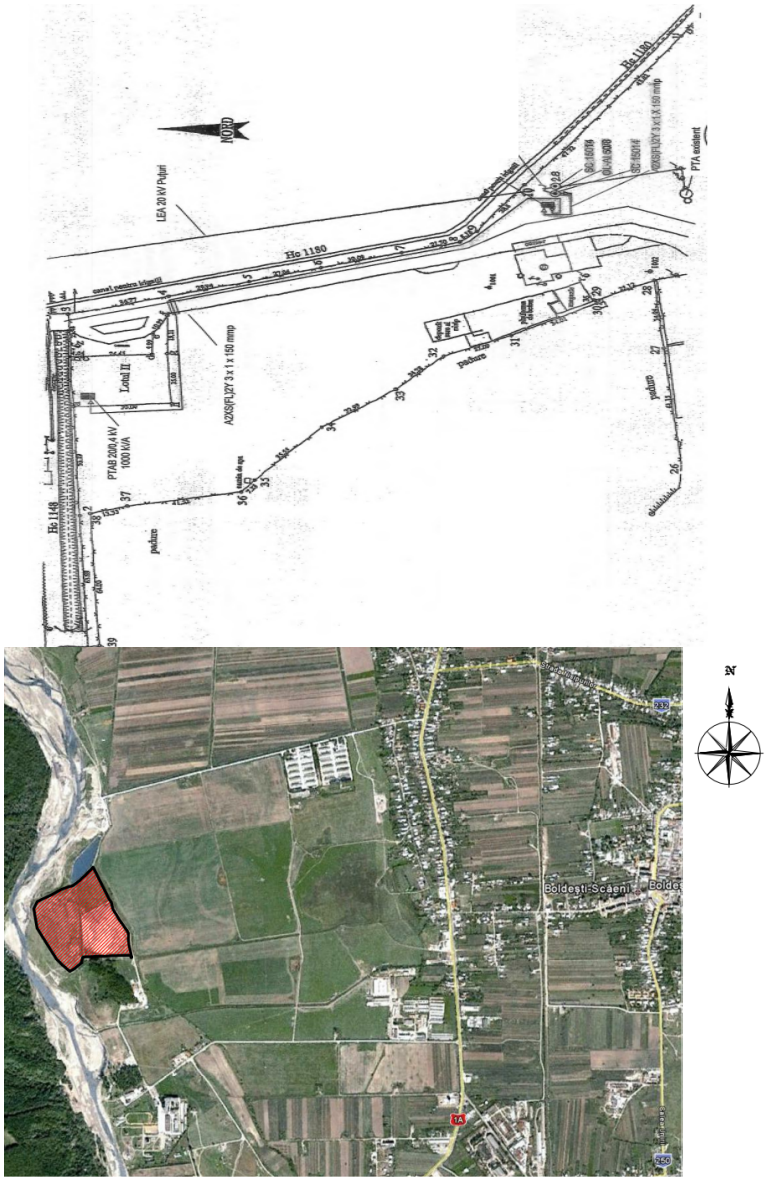

Figure 1.Location plan and details about the ecological landfill

The storage cells will have dimensions in plan of 33 x 5 and a height of 1.5 m of compacted waste, which means a volume of 248 m 3 of compacted waste. Taking into account that about 78,000 t of waste will enter the landfill annually, it results that the daily storage rate will be 244 m^3, compacted waste (η = 1.0 t / m^3). The cells will be periodically covered with a layer of 0.1 - 0.15 m with earth resulting from excavations and waste from construction and demolition. The filling technique will be done from top to bottom by advancing, up to the level of the unloading platform, after which it will be stored in the embankment.

1.1. Description of the construction system of the ecological landfill

The storage enclosure was made by excavating the higher areas, modeling the base of the depot and executing some perimeter dikes, which included the existing dams on the southern and eastern side of the storage enclosure (Figure 1).

In order to protect the enclosure from the rainwater penetration, the unclogging and re-profiling of the existing drainage channels on the west and south side of the enclosure was performed. In addition, the storage enclosure was provided with a guard channel, which is also a ditch for collecting rainwater from the technological road located on the east side of the enclosure (Figure 2).

Figure 2. Delimitation of earth dam compartments

Inside, the delimitation of the compartments is made with earthen dikes.

The waterproofing system applied to the first two cells is according to the design, consisting of:

- HDPE geomembrane with thickness of = 1,5 mm;
- protective geotextile of 800 g / m^2 - two layers.

The total area to be waterproofed will be 90.000 m^2. The geomembrane was spread over the layer of compacted natural soil and was protected by two layers of geotextile.

The waterproofing system used for cell 3 complies with the project:

-a layer of compacted clay on a thickness of 50 cm- Figure 3.

Figure 2 . Land construction of storage cells

-a layer of bentonite geocomposite NSP 4900- Figure 4.

Figure 3.Geomembrane construction of storage cells

-a layer of HDPE geomembrane with a thickness of 2mm- Figure 5.

Figure 4. Construction of storage cells

-a layer of geotextile SECUTEX 800 g/m^2

Figure 5. Final cover of storage cells

Over these was installed the drainage network made of HDPE pipes with a diameter of 200 mm laid in a layer of drainage material 50 cm thick- Figure 6.

The network was connected to the existing collector drain of cells 1 and 2.

1.2. Drainage and drainage installations

The collection of water from the storage area is done through a drainage network, made of high density polyethylene tubes, with a diameter of 200 mm- Figure 7.

Figure 6. Drainage and drainage installations-section A

The drainage pipes are laid in a layer of 40 cm thick of washed gravel sort 16- 30 mm, spread over the geotextile layer-Figure 8.

Figure 7.Drainage and drainage installations- section B

The wastewater (leachate), drained is conducted together with the leachate from compartment no. 2 to a basin lined with geomembrane with a total capacity of 150 m^3. The collection basin is connected to its own treatment plant by means of a buried pipe (made of HDPE) with DN 60 mm-Figure 9.

In order to monitor the groundwater level and quality in the storage area, 3 wells equipped for groundwater monitoring were drilled. FC1, FM2 and FM3 boreholes are currently being used for monitoring.

Figure 8. Drainage and drainage installations-section C

For the good development of the activities within the ecological landfill, a series of constructions were arranged, respectively:

- the administrative area which includes a parking lot of approx. 200 m^2 and an occupying administrative building 90 m^2;
- the administrative building is provided with:
- toilets and showers - connected to a drain;
- diesel-fired power plant;
- air conditioners;
- car access road and automatic weighing scale (one weighing for both directions of traffic);
- the recoverable waste processing area, which contains a storage space for polyethylene or PET bales and a metal shed where a press is installed;
- diesel household, for the supply of equipment and vehicles for the operation of the ecological landfill;
- waste transport vehicle washing ramp;
- maintenance workshop for equipment and vehicles, as well as a ecological landfill for materials needed for their operation and maintenance.

2. Ecological Landfill Operating Plan

The waste flow inside the landfill are:

- Access to the premises
- Verification of documents accompanying the shipment of waste ;
- Inspection for acceptance - is done visually, before weighing;

- Weighing - is performed on the platform provided with a scale of 50 tons;
- Access to the storage area inside - is made on concrete platforms and ballasted road
- Waste unloading - is done under the visual supervision of staff;

The actual storage - includes the development of several stages whose succession is dictated by the topographic position of the work front-Figure 10.

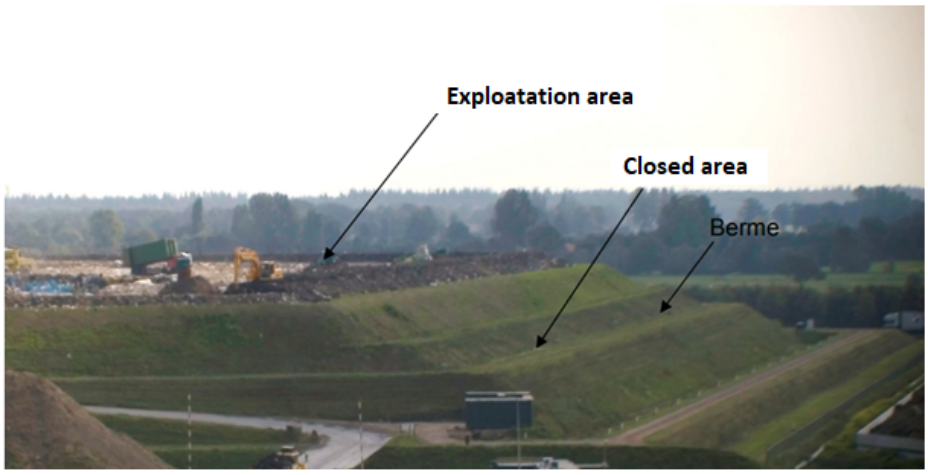

Figure 9. The actual storage

The ecological landfill will be operated on compartments, their filling being staged and divided into two main phases of operation . As the landfill develops, all full compartments will be joined and filled with waste to *the final level of the first phase of operation (220 m).*

After this first stage, the waste will be deposited on the entire surface of the landfill, in order to reach *the final level of operation (230 m)* , which will be *the closing level of the landfill.*

3. Sources of Pollutants

A. *Leaching* - The precipitation that falls on the surface of the landfill and penetrates the mass of waste turns into leachate.

In relation to water as an environmental factor, the mass of waste in the landfill can be considered to have a double behavior, namely: permeable and filtering medium, which allows passage, but retains at the same time some of the liquids and substances dissolved in them source of pollution because, crossing the mass of waste, the water entails in depth to the

groundwater the soluble substances contained in the waste or resulting from their decomposition.

4. Wastewater Collection and Treatment

The collection of wastewater resulting from the passage of precipitation through the mass of waste is done with a drainage system, located at the base of the landfill.

From the collector drain, the leachate is gravitationally discharged outside the landfill to the collector basin, ensuring a constant flow through a valve at the exit of the drain.

The rainwater, which drains from the parking platform, is collected in the guard channel which is discharged into Teleajen district. It has no pollutant charge.

4.1. Arrangements for the protection of surface and groundwater quality

The multilayer lining applied at the base of the deposit and on the slopes, comprising: two well-compacted clay layers with a total thickness of 0.50 m, HDPE geomembrane with g = 1.5 mm, geotextile with mass = 800 g/sqm.

Drainage system made of HDPE tubes with Dn 200, placed in a draining layer of sand, spread on the whole base of the deposit. Sewerage for the collection and evacuation of domestic water from the social groups of the administrative headquarters. Septic tank, drainable for domestic water

Collection and evacuation of rainwater to the natural emissary r. Teleajen

Observation drilling

- Leach storage and recirculation basin
- Air quality protection
- The sources of emissions from the activity of the deposit are fixed and mobile.
- Mobile sources of pollution

The mobile sources of air pollution are:

- vehicles running on the surface of the landfill and transporting the waste to the storage areas;
- equipment for working in the ecological landfill;

- fixed sources of pollution
- thermal power plant - a metal dispersion basket, with a height of 6 mand a diameter of 150 mm.
- extraction wells - for capturing storage gas. These wells are not equipped with shut-off systems, the gas is released freely into the atmosphere.

The designed depot can be a source of air pollution by:

- fermentation gas resulting from the process of anaerobic decomposition of waste. The main pollutants released in this case are methane gas and carbon dioxide.
- entrainment by air currents of particles produced during the operations of unloading, leveling and compacting waste.
- the exhaust gas from the vehicles transporting the waste and the bulldozer leveling the landfill.

The primary constituents of the gas released at the landfill site are methane (CH_4) and carbon dioxide (CO_2), gases produced by microorganisms in the landfill under anaerobic and aerobic conditions. CH_4 and CO_2 transformations are mediated by microbial populations adapted to material cycles in anaerobic environments.

The rate of gas generation in landfills and their composition go through 4 phases. *The first phase* is aerobic (with available oxygen) and the primary gas produced, CO_2 . *The second phase* is characterized by the destruction (disappearance) of O_2, which leads to an anaerobic environment, in which large amounts of CO_2 and hydrogen (H_2) are produced.

The third phase - begins the production of CH_4, accompanied by a reduction in the amount of CO_2 produced. The nitrogen content (N_2) in the emitted gas is initially high in the first phase and decreases sharply as the deposit passes into the second and third phases.

Phase four - gas production of CH_4 , CO_2 and N_2 becomes relatively stable- Figure 11. The total time and phase duration of gas generation varies depending on the specific conditions of the landfill (such as: waste composition, storage method, anaerobic state).

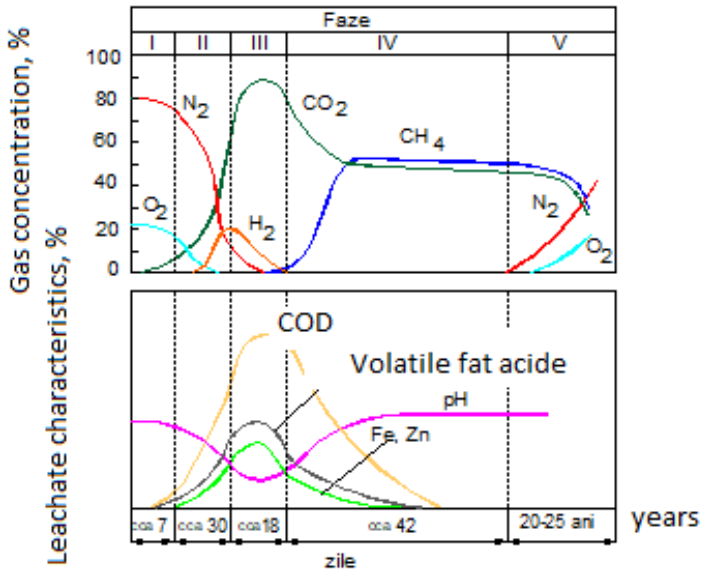

Figure 10. Phases of fermentation gas formation

The following amounts of pollutants will result:

- CO_2 396.4 kg/year
- SO_2 148.7 kg/year
- NOx 80.0 kg/year
- Aldehyde 15.2 kg/year
- Unburned hydrocarbons 247.8 kg/year

Protection against noise and vibration

Considering that the landfill is located at a sufficient distance from the locality, the noise produced by the compactor machine or by the garbage trucks that unload the waste in the landfill does not have an impact on the riparians.

Radiation protection

There are no sources of radioactive pollution in the operation phase of the landfill.

Soil and subsoil protection

The main factors that can affect the soil and subsoil are:

-sewage drained to the surface

-waste scattered by wind or intentionally.

The rainwater that falls on the outer, grassy slope of the deposit and the one on the concrete platform, are collected by the guard channels and evacuated in the Teleajen river. The water on the surface of the storage enclosure is collected with the drainage system presented and discharged into the collecting basin, from where it is then redistributed on the depot, in dry periods.

Forest fund protection

For the protection of the thrush in the vicinity of the service area, specific fire protection measures were taken on the one hand and constructive and exploitation measures on the other hand.

Ecosystem protection, biodiversity and nature protection

The operation of compartment 1 cannot cause problems for the ecosystem. The landfill is isolated from the outside in terms of pollutants and animal penetration.
The ecological landfill does not produce externalities that change the ecosystem.
Protection of the landscape and areas of traditional interest
The ecological landfill is located in the Teleajen meadow where we meet a steppe landscape.

For the protection of the landscape, the following measures will be taken:

- vegetal protection curtain formed by plantations of rows of trees of different sizes, the width of the area being 5 m. It is recommended to plant acacia and sea buckthorn which have both a landscape and anierosional role.
- wire mesh protection fence, on metal trusses with a height of 2 m;

The protective curtain is executed in stages during operation once each compartment is closed.

Protection of human settlements

The distance from the locality being large enough, they are not affected by the activity carried out at the landfill.
The ecological landfill has the following neighborhoods:
In the North - Non-agricultural land, plowed-Roman Waters
South: Agricultural land, available at Boldesti-Scaeni City Hall for the application of Law 18.
At approximately 540 m there is GPS Boldesti and at 690 m the local fire department.
West - Non-agricultural land (current landfill)

To the East - Iazul Morii Canal and agricultural land

The elements of urban discomfort that a landfill usually generates - odors, landscape changes, noise from garbage trucks, bulldozers and compactors on the landfill surface - will not be noticeable in inhabited areas.

5. Monitoring the Quantity of Waste

From the analysis of the data presented as the annual average of the waste brought to the landfill in 2020 was about 203114.92 tones of solid urban household waste, representing the total amount of household waste produced by Ploiesti, Boldesti-Scaeni and its localities.

Office waste resulting from the operation of the objective will be disposed of directly on the landfill, their quantity being insignificant in relation to the landfill capacity.

It is estimated that this should be:

0.5 kg / person / day x 16 person x 365 days = 2,920 kg / year ≅3 to / year

The activity carried out at the landfill does not result in other types of waste than those from offices, assimilated to household waste.

The burnt oils resulting from the compaction equipment will be stored in special containers and handed over to the specialized units in their collection.

Management of toxic and dangerous substances

Hospital, industrial, toxic or hazardous waste is not allowed in the landfill.

The record of the waste produced must be kept monthly, according to law 211/2011 and contains the following information:

- waste type;
- waste code;
- source of origin;
- the quantity produced;
- the date of disposal of the waste from the landfill;
- storage mode;
- date of delivery of the waste;
- the quantity delivered to the carrier;
- data on rejected shipments;

- data on any mixture of wastes.

The distribution of the total amount of waste distributed monthly is represented in the Figure 2.

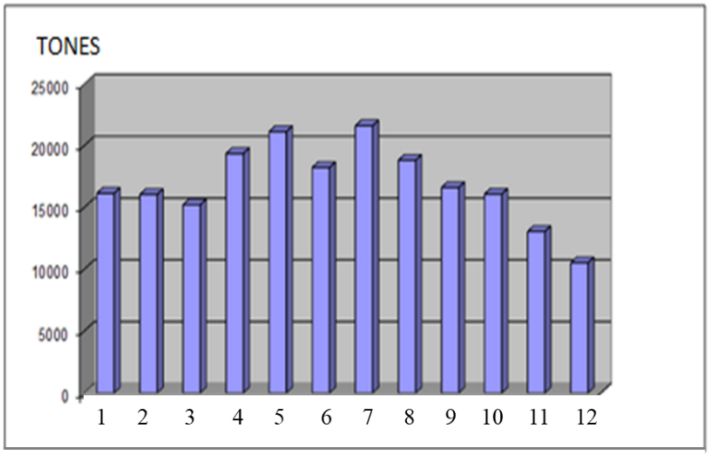

Figure 12.The distribution of the total amount of waste distributed monthly.

The amount of waste distributed monthly in 2020 in the Boldesti-Scaieni Ecological Ramp

6. Monitoring Environmental Factors

For safe operation against environmental factors, the monitoring system of the ecological landfill, and implicitly of compartment 1 aims at the following aspects:

- monitoring the quality of environmental factors
- monitoring the operation of the ecological landfill

Monitoring the quality of environmental factors takes into account the following environmental factors, with the parameters and frequency of monitoring in

The monitoring of environmental factors (water, air, soil, groundwater) will be done according to the standards in force, through accredited laboratories.

Air Quality Monitoring

The quality control and monitoring system of environmental factors must include:
The characterization of the climatic conditions of the studied area was based on the data provided by the Ploiesti weather station.
The average annual temperatures register values of 10.4 - 10.6 ºC.

The absolute maximum temperature was 39.4 ºC (August) and the absolute minimum is -30 ºC (January).

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Table 1. Monitoring the quality of environmental factors.

Monitored environmental factors	Arrangements of monitoring	The parameters of monitoring	Frequency
groundwater	-2 monitoring wells upstream and downstream ecological landfill	-level -pH, conductivity -BOD_5, DOC-Mn, NH_4^+ -total heavy metals.	2/year -1 week -1 month -1 / quarter
Surface water	-inilaborator	-pH, conductivity -BOD_5, DOC-Mn -heavy metals	-1 month -1 / quarter -1 / quarter
Gas	Blowers (exhaust pipes)	Chemical component (CH_4, CO_2, O_2, H_2S)	-1 month
Wastewater	Sewage basin	-pH, conductivity -hydrocarbons, -BOD_5, DOC-Mn, phenols, heavy metals, bacteriological ind -flow (volume)	-1 week -1 month -monthly

The period in which most precipitations are recorded is in late spring and early summer (100-150 mm / month), and the fewest are recorded in early autumn (September 35 mm) and late winter (February 20 mm).

Meteorological data collected from the nearest meteorological station, necessary to establish the water balance are presented in Table 2.

Table 2. Meteorological data

Nr. Crt.	The parameters followed	Frequency
1.	the amount of precipitation.	Monthly
2.	minimum, maximum temperature and at 15 o'clock	Daily
3.	Dominant wind direction and speed	Daily
4.	Relative air humidity at 3 p.m.	daily

Air emissions

The sources of emissions from the landfill site are open source. During the operation period, the source represented by the depot compartments will be a surface source with undirected emissions.

The main constituents of the storage gas are: CH_4, CO_2, N_2, traces of H_2S and small amounts of non-methane organic compounds (VOCnm).

The estimated amount of pollutants emitted on the surface of the non-directed storage-emission compartments in the next 50 years is presented in Table 3:

Table 3. Estimated amount of pollutants

Time (years)	CH_4 (t/year)	CO_2 (t/y)	VOCnm (kg/year)
10	2440,897	6712,466	28193,105
20	4077,079	11211,966	47091,508
30	2732,948	7515,605	31566,382
40	1831,950	5037,861	21159,578
50	1227,993	3376.979	14183,690

In the case of particulate emissions resulting from the storage of materials with the potential for excessive dust generation, the waste will be wetted during unloading or will be compacted

immediately after unloading from the vehicle and covered with a suitable material (soil or artificial cover materials), with a thickness enough.

Immission limit values

The concentrations of the pollutants discharged into the atmosphere will not exceed in the ambient air the limit values presented in Table 4, provided in the MAPM order no. 592/2002 and in STAS 12574-87, as follows:

Table 4. Limit values provided in the MAPM and STAS.

Nr. crt.	Road sign	Mediation period	Imposed limit value µg / mc	Date of VLE
1.	Nitrogen dioxide and nitrogen oxides	1 hour*	two hundred	01.01. 2020
		Annual *	40	01.01. 2020
		Annual **	30	01.01. 2020
2.	Carbon monoxide	Maximum daily value of sliding averages over 8 hours *	10,000	Present
3.	Hydrogen sulfide	30 min *	15,000	Present
		24 hours*	8,000	Present

* Protection of human health
** Vegetation protection

Water Quality Monitoring

Installations for retaining and evacuating pollutants in water consist of:
Leachate collection system - made of drainage pipes and a collector drain, made of HDPE pipes, mounted in each operational compartment of the ecological landfill and connected to the leachate storage tank.
Leach treatment plant - PALL modular installation, consisting of the following components:
- sand filters for pre-filtration and filter cartridges;

- equipment related to the leachate stage (treatment stage I), permeate stage (treatment level II), including separate local control systems;
- acid storage tank for pH adjustment (volume of 1,5 m^3);
- tanks for cleaning agents, degasser;
- container.

Underground Water

The analysis of the groundwater quality taken from the monitoring boreholes will be performed. This will follow the evolution of groundwater quality over time and the influence of the activity of the Deposit on it. The limit values for groundwater pollutants will comply with the average values determined during the construction phase and during the period of operation of the deposit (Table 5):

Table 5. The analysis of the groundwater quality.

Nr. No.	Indicator	UM	Determined concentration		
			FM 1	FM 2	FM3
1.	pH	united. pH	7.32	7.14	7.23
2.	Conductivity	mg O_2 / l	1423	1276	1354
3.	CCO-Mn	mg O_2 / l	3.24	4.24	5.56
4.	Ammonia nitrogen (NH_4)	mg / l	0.324	0.287	0.354
5	Manganese	mg / l	0.356	0.426	0.235
6.	Lead	mg / l	0.023	0.026	0.028
7	Cadmium	mg / l	0.01	0.01	0.01

Soil Quality Monitoring

1. Constructive measures adopted for storage that ensure adequate protection for the soil and subsoil.
2. Leaching and controlled evacuation of leachate.

The monitoring of the soil quality will be done in the points and for the indicators analyzed in the Site Report, once a year. The results of the analyzes will be compared with the results obtained from the investigations in the Site Report, which constitute reference data and will be related to the values included in Order 756/1997 (Table 6).

Table 6. The monitoring of the soil quality.

Nr.crt.	Road sign	Sampling frequency and analysis	Analysis method
1.	copper	Annual	SR ISO 11047/99
2.	total chrome	Annual	
3.	lead	Annual	
4.	cadmium	Annual	
5.	manganese	Annual	

Noise

The noise level at the edge of the unit will be monitored annually.

The noise level at the boundary of the unit will be within the limits provided by STAS 10009/1988, respectively 65dB.

Smell

According to National Standard 12 574/87 - Quality conditions for air in protected areas, emissions of strong odors are considered to exceed the maximum permissible concentrations when their unpleasant and persistent odor is sensed in the impact area.

Potential sources of odors and measures to reduce them are:

Biogas emissions - measures will be taken to control biogas storage gas emissions;

Collector basins - aeration of leachate storage areas;

Conclusions

Compliance with the National Waste Management Strategy, developed by the Ministry of Environment and Water Management, in accordance with its responsibilities as a result of the transposition of European legislation in the field of waste management and according to Law 211/2011, is a desideratum in the operation of this landfill [10-21].

Its transformation from uncontrolled storage to controlled storage has been a long process that has resulted in meeting the objectives of storage and those related to the minimum impact on the environment.

Since 1995, the collection and processing of information on waste types and quantities has been carried out in accordance with European classification requirements (European Waste Catalog, replaced in 2002 with the List of Wastes, including Hazardous Wastes) and reporting to

EUROSTAT, and to the European Environment Agency (via the EIONET network). Information is collected and reported on: municipal waste (household waste, waste from parks and gardens, sewage sludge), industrial waste (hazardous and non-hazardous), waste from medical activities.

In order to achieve the national and European objectives in the field of waste management, it is necessary to involve, practically, the whole society, represented by: central and local public authorities; waste generators; professional associations and research institutes; civil society.

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5. ****, Location report - Boldesti-Scaieni Ecological Ecological landfill, 2010.*

6. GEO No. 195/2005 - on environmental protection, approved by Law 265/2006;

7. GEO No. 152 / 2005- regarding the prevention, reduction and integrated control of pollution, approved by Law no. 84/2006;

8. Order of the Minister of Agriculture, Forests, Waters and Environment no. 818/2003 - for the approval of the Procedure for issuing the integrated environmental permit with the subsequent modifications and completions;

9. Order of the Minister of Environment and Water Management no. 1158/2005 for the modification and completion of the annex la Ordinul Ministruluiof Agriculture, Forests, Waters and Environment no. 818/2003 for the approval of the Procedure for issuing the integrated environmental permit;

10. HG. Nr. 349/2005 - regarding the storage of waste;

11. GD 856/2002 on the record of waste management and for the approval of the List containing waste, including hazardous waste;

12. Decision no.989 / 2005 regarding the modification and completion of GD no.166 / 2004 for the approval of the project "Development of the collection system of post-consumer PET packaging waste for recycling"

13. GD 1470/2004 on the approval of the National Waste Management Strategy and the National Waste Management Plan, including hazardous waste;

14. HG. Nr. 621 / 2005- regarding the management of packaging and packaging waste;

15. MAPM Order No. 592/2002 - for the approval of the Norm regarding the establishment of limit values, threshold values and criteria and methods for the evaluation of sulfur dioxide, nitrogen dioxide and nitrogen oxides, suspended dust (PM 10 and PM 2,5), lead , benzene, carbon monoxide and ozone in the surrounding air;

16. Law no. 655 / 2001- for the approval of the Government Emergency Ordinance No. 243/2001 on the protection of the atmosphere;

17. Order No. 462/1993 - technical conditions regarding the protection of the atmosphere;

18. Law no. 300/2002 on the legal regime of precursors illicit drug manufacturing;

19. Government Decision No. 1121/2002 for the approval of the Regulation for the application of Law no. 300/2002;

20. GEO No. 200 / 2000- regarding the classification, labeling and packaging of dangerous chemical substances and preparations;

21. Law no. 360/2003 amended and supplemented by law 263/2005 on the regime of dangerous chemical substances and preparations.