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MAINTENANCE OF THE FORMER MUNICIPAL LANDFILL IN POLANICA-ZDROJ

ZAGOSPODAROWANIE TERENÓW BYŁEGO SKŁADOWISKA ODPADÓW KOMUNALNYCH W POLANICY-ZDROJU

Abstract: Municipal landfill in Polanica-Zdroj was founded in 1945 and closed in 2009. It is situated within the city, next to the river Bystrzyca Dusznicka and despite the fact that it is no longer under exploitation, it is still a potential source of pollution of surface waters, especially during floods. The city is developing towards spa and tourism. The immediate vicinity of the object negatively affects its image and endangers safety of residents and patients. The facility doesn't meet current technical requirements, hence needs modernization. Maintenance is carried out to form the landfill top, protect deposited waste against the seepage of rainwater by the usage of bentomat, degassing and drainage, cover its surface with the layer of subsoil and soil, implement sod and bushes on reclamation cover. The concerned area blends into the landscape through irregular plantings of trees, including secondary succession. Conditions of after-care monitoring are also defined.

Keywords: waste, landfill, maintenance, biological reclamation

Introduction

Municipal waste is the most complex and not easy to manage waste stream [1]. Solid waste disposal sites are a danger to the environment both while being processed and after the sites are closed [2-6]. The sites are often located near residential areas.

Act of 27 April, 2001 on Environment protection laws (Dz.U. 2008, no. 28, item 150 with amendments) [7] included the obligation to review ecological waste sites, which helped classifying currently operating waste sites (basing on the technical condition and the ecological impact) in relation to the sites' capabilities as well as functioning rules. Owing to the review, the waste sites can be distinguished into sites that meet the requirements of relevant acts and performance provisions, which can be exploited after 1 January, 2010, approved for exploitation once the modernization and conversion take place, facilities which modernization is irrational due to ecological and economic issues (exploitation is allowed until 31 December, 2009), as well as waste sites that must be closed as soon as possible; the environment around such sites needs protection and the ground needs reconstruction [8].

The aim of this work is to minimize negative impacts of a closed municipal waste disposal site on the environment that are different than hazardous or neutral, in Polanica-Zdroj as well as re-shaping the terrain surface, biological soil extraction and restoring natural terrain functions.

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Waste disposal site terrain characteristics

Placement, morphology and hydrography

The waste disposal site is located within Kotlina Klodzka, near Bystrzyckie and Stolowe mountains. The mountains are covered with monocultural fern forest as well as deciduous forests with a beech domination. The site is in Polanica Zdroj, ul. Polna, in "C" protection zone of the Polanica-Zdroj health resort, however, it does not infringe the areas protected due to an act on the environment protection, including the areas of Natura 2000. The site is located 1 km from Park Zdrojowy, which is the main attraction of the whole city [9]. Height coordinates are 365-375 m [10].

The area, on which the waste has been disposed, is waterlogged, located in the lower and middle catchment area of the Bystrzyca Dusznicka river, surrounded by ditches and surface water races. The area bordering with the site is agricultural and covered with trees and shrubs.

Figure 1 shows the site location in relation to the city centre.

Fig. 1. Municipal waste disposal site in Polanica-Zdroj [9]

The climate in Polanica is typically submontane and wet, the annual average temperature is 7.0°C, while the annual range of temperature is 19.8°C. The winter time lasts for 14 up to 20 weeks, while the summer time lasts for 6 up to 10 weeks. Annual average precipitation is 622 mm [11].

Figures 2-4 show the photographs of the site area before it was rearranged into a waste disposal site.

Fig. 2. The photograph of the leachate of the municipal waste disposal site [10]

Fig. 3. The landfill slope [10]

Fig. 4. The landfill bowl [10]

Geological structure and hydrogeological conditions of the site terrain

There are normal as well as mineral and medicinal water catchments in the site's neighbourhood, however, they belong to a different geological structure. The closest underground water catchment is located approximately 100 m from the site.

The site's substrate consists mainly of quaternary formations settling on chalky sandstones of the residual soil. Deposited waste remained on clay sends with pebble and boulders as well as on clayed sands with a cumulative thickness of 1.5-3.0 m. There is a sand clay pocket on the North-West side, while on the South and East, there is peaty aggregate mud with clay sands in the substrate. There is a sandstone residual soils under the Quaternary deposits.

Free water table is located 0.1 m up to 0.3 deep, on the East and South side of the site, and 0.6 m-1.5 m on the West and South. The aquiferous layer is characterized with a low water permeability, and its permeability coefficient equals 1.348 up to 1.564 m/d. The underground water flow occurs in the Eastern direction. The underground waters flowing under the central part of the site as well as under the Northern fringe of the site are likely to be exposed to leachates [10].

The site's impact on the environment

Once the site had been closed, an examination was carried out regarding leachate waters composition, the underground water level, the underground water composition, the surface water flowrate, the surface water composition as well as biogas composition [12].

Leachate water is characterized with low values of the electrolytic conductivity and total organic carbon (TOC), with an exception of ammonia nitrogen in relation to the concentration that can be observed on the municipal waste disposal sites [13].

The results of underground eater examination showed lack of any direct negative impact of the facility on its quality (1 class underground water quality).

The concentration of heavy metals in the underground water are below detection level.

The concentration of methane in the biogas has been found to be equal to 12.8% up to 16.8%, the biogas flow intensity was 0.1 dm^3/h (reaching the analyser's detection level) [10].

Closed site's management plan

The site's management plan consists of two stages. The first stage is the site's conservation, which includes:

- site bowl formation,
- formation of the sealing and reclamation layer, degassing, drainage system,
- reinstatement of soil.

The second stage includes site's reclamation:

- barren ground fertilization,
- adopting pioneer vegetation,
- site's integration with the surroundings.

The target site bowl formation is reached by moving the waste within the site's borders without breaching stabilized top parts of the upland, with the slope of 1:3. Forming the sealing and reclamation layer (Fig. 5) allows to secure the landfill mass from rainwater infiltration. The cover creates suitable conditions for the plants' root systems to grow 2 m within the ground.

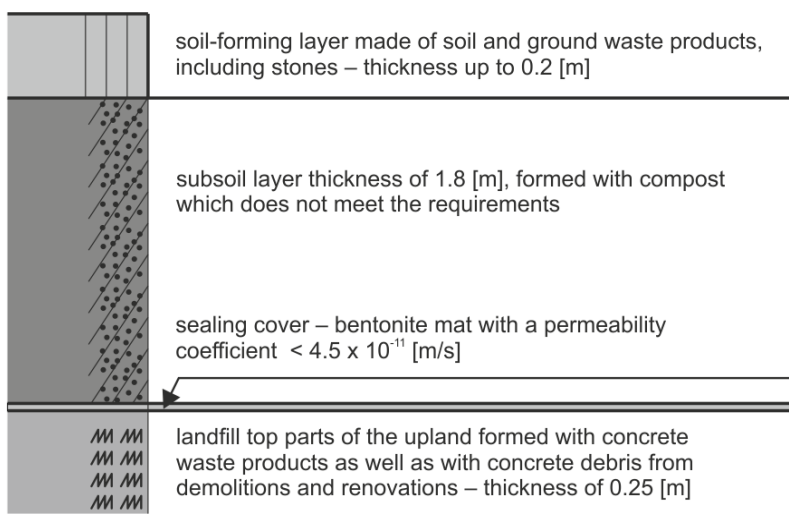

Fig. 5. Sealing and reclamation cover construction scheme [14]

The surveying surface of the landfill mass of the closed site was 2.3 ha, while after being managed, it will be equal 2.6 ha. The maximum offset after managing the site will reach 376.5 m [10].

As the biogas emission is low, which is characteristic for the fading methanogenesis, the plan includes also the commission of shallow degassing wells, with the distance of 80 m from one another, made of concrete rings with the internal diameter of 800 mm, located within the waste 1.0 m deep, with the target height of 0.7 m above the surface, filled with aggregate.

The site bowl drainage will be implemented by the natural surface runoff. Rain water in an disorganized way, will flow to the ditch system around the site base.

The reclamation layer is fertilized in the period of 4-6 weeks from the formation, and 2-3 weeks before seeding. Table 1 shows the estimated quantity and type of fertilizers.

Table 1

Fertilizers used in the biological reclamation [10]

Fertilizer type	**Quantity**
P_2O_5 - as ammonium phosphate	150 kg/ha, *i.e.* 930 kg/ha of commercial fertilizer
N - as ammonium nitrate	100 kg/ha, *i.e.* 290 kg/ha of commercial fertilizer
K_2O - as 40% potash salt	100 kg/ha, *i.e.* 200 kg/ha of commercial fertilizer 30 kg/ha $MgSO_4$

Cover seeding is to be implemented around 2-3 weeks after reclamation cover fertilization. Table 2 shows the composition of a cover mix, which should be sown 97.2 kg/ha.

Table 2

The composition of the sowable mix for site covering [10]

Type	**The mass content [%]**
Red fescue	48
Smooth-stalked meadow-grass	22
French rye-grass	19
Brome grasses	8
Dutch clover	3

Within the range of the slope and top parts of the upland, after at least of one year from covering the surface, permanent and irregular planting of shrubs (juniper, hawthorn) and trees (European white birch, poplar, red oak, beech), which will not later become a part of a forest complex with a Forrest Economy. Independent planting is allowed, with the possibility of accepting the planting succession of the surroundings.

Conservation treatments are taken into account, including among others: sowing supplements, mowing and swath removal, seeding supplement, supplementary fertilization, as well as erosion lacks and cave supplement.

In the years following the site managing, shrubs and grass are fertilized with nitrogenous and potassium fertilizers twice while with phosphoric once a year. The maximum cumulative nitrogen dose equals 20 kg/ha.

Site after-care period monitoring

In order to supervise the reclamation of the waste disposal site, it is necessary to monitor and examine the changes in surface and underground water parameters as well as in slope stability. Table 3 shows the examination schedule.

Table 3

Site after-care monitoring [8]

No.	Examined parameters	Frequency of measurement	Way of examining the measurement
1	Surface water flow capacity	every 6 months	Flow measurement
2	Surface water composition	every 6 months	pH value; total organic carbon (OWO); electrolytic conductivity; heavy metals content: Cu, Zn, Cd, Pb, Cr^{+6} Hg; polycyclic aromatic hydrocarbons sum (WWA)
3	Underground water level	every 6 months	Underground water table measurement, depth and offset in meters
4	Underground water composition	every 6 months	pH value; OWO; electrolytic conductivity; content of Cu, Zn, Cd, Pb, Cr^{+6}, Hg; WWA sum
5	Landfill gas emission and composition	every 6 months	Gas flow measurement; contents of CH_4, CO_2 and O_2
6	Settlement control	every 12 months	Monitoring: landfill site surface settlement (benchmarks); slope stability (geotechnical methods)
7	The precipitation	every day	Monitoring basing on the data collected from the Observation Network in Klodzko

Summary and conclusions

The municipal waste neutralization on the waste disposal site in Polanica-Zdroj has been carried out since 1945 until 31 December, 2009. The facility does not meet any current act or regulation requirements, while its modernization and reconstruction conducted according to The Construction Law is unfounded in both ecological and economic sense.

The examination conducted after site's shutdown have not indicated any direct negative impact on the surface and underground water. The biogas flow measurement was minimal (on the detection level), while the methane content characteristic for the fading methanogenesis.

The closed waste disposal site management in Polanica-Zdroj consists of two stages. The first stage includes the reclamation of the waste by site bowl formation with the maximum slope of 1:3, sealing and reclamation layer, degassing with shallow degassing wells, drainage through rain water offtake, streaming down from the landfill surface to the ditch system around the landfill base. All mentioned technical treatments allow to secure the landfill from rain water infiltration deep within the landfill, maximal rain water drainage out of the landfill, preventing from dusting and wind taking away light parts of the landfill, creating a biological barrier for plant root systems and rodents, erosion protection of the landfill surface. The second stage - reclamation - includes barren ground fertilization, covering the reclamation layer, site's integration with the surroundings by irregular planting of trees and shrubs. Its aim is to recover the natural functions of the terrain.

The after-care monitoring involves monitoring the level and composition of underground water, flow intensity as well as surface water composition, biogas composition and settling the landfill surface and slope, according to the schedule.

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ZAGOSPODAROWANIE TERENÓW BYŁEGO SKŁADOWISKA ODPADÓW KOMUNALNYCH W POLANICY-ZDROJU

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Abstrakt: Składowisko odpadów w Polanicy-Zdroju założono w 1945 roku, a zamknięto w 2009 roku. Zlokalizowane zostało w obrębie miasta, obok rzeki Bystrzycy Dusznickiej i, pomimo tego że nie funkcjonuje, stanowi potencjalne źródło zanieczyszczenia wód powierzchniowych, zwłaszcza w okresie powodzi. Miasto rozwija się w kierunku uzdrowiskowo-turystycznym. Bezpośrednie sąsiedztwo obiektu negatywnie wpływa na jego wizerunek, zagraża bezpieczeństwu mieszkańców i kuracjuszy. Obiekt nie spełnia aktualnych wymogów technicznych, wymaga modernizacji. Konserwację prowadzi się w kierunku uformowania wierzchowiny składowiska, zabezpieczenia zdeponowanych odpadów przed penetracją wód opadowych poprzez zastosowanie

bentomaty, odgazowanie i odwodnienie, pokrycia jego powierzchni warstwą podglebia oraz gleby, zadarnienia i zakrzewienia pokrywy rekultywacyjnej. Rozpatrywany obszar wkomponowuje się w krajobraz poprzez nieregularne nasadzenia drzew z uwzględnieniem sukcesji wtórnej. Określono warunki prowadzenia monitoringu poeksploatacyjnego.

Słowa kluczowe: odpady, składowisko, konserwacja, rekultywacja biologiczna