



LIFE12 ENV/GR/000427 LIFE reclaim "Landfill mining pilot application for recovery of invaluable metals, materials, land and energy"

**TECHNICAL REPORT - ACTION C1
FOR THE POLYGYROS LANDFILL, IN THE MUNICIPALITY OF
POLYGYROS, CHALKIDIKI**

SUBJECT:

Technical Report on the 1st Annual
Environmental Impact evaluation
of the Project

STUDY : ENVECO S.A.



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1. Introduction

1.1. Report context and Objectives

The present report is the second Deliverable of Action C1 of the Life reclaim Project “Landfill mining pilot application for recovery of invaluable metals, materials, land and energy”, which is funded by the European Union through Life+ financial instrument, under the contract with code LIFE12 ENV/GR/000427.

The objective of this report is to assess and document the performance of the indicators established in the Baseline Evaluation of the LIFE reclaim project, on an annual basis. The present report constitutes the 1st Annual Environmental Impact evaluation of the Project.

The table with the indicators set on the first deliverable of the action “Baseline environmental impact evaluation of the project” will be filled in with the values obtained during the first period after the implementation of the core action of the project (Pilot Demonstration Unit installation and implementation).

The objective of the analysis is to assess to what extend the recovery of metals, recyclable and energy materials, the land reclamation and rehabilitation and the life-time extension of the landfill have been achieved.

1.2. General information on Life+ reclaim

1.2.1. Project objectives

The Project aims at building a temporary pilot application on productive scale in order to mine parts of existing landfills, separate useful materials and produce marketable products, introducing innovative techniques from the mining industry, suggesting a new concept of waste valorization. It will also assess the viability of the proposed method as well as provide a scientific evaluation on the potential alternatives of the management of waste disposal sites. The basic objective is to introduce landfill mining (LFM) as a complementary approach of management of past landfill (controlled or uncontrolled) sites and create a useful tool for the recovery of:

- useful materials, especially ferrous and non-ferrous metals
- space, which equals to extra landfill capacity and lifetime in cases of expansion
- soil material, which has been disposed off along with the waste and which is a natural resource valuable to local ecosystems as well as to landfill industry itself
- recyclable materials, like plastic and paper products, which can be either post-processed in a suitable recycling plant or burned in modern incinerators
- land, in the case of old landfills, which will lead to a successful rehabilitation scheme with minimal environmental footprint which in turn, can be easily adapted to different waste compositions and site conditions.

At the same time the Project objectives include the familiarization of the public with the issue of post-disposal-processing of waste and with the potential of the procedure for metal recovery and site rehabilitation, resulting in a cleaner environment and rational waste management. The abovementioned objectives of material and/or energy recovery are widely known today in the waste processing industry and precede disposal, but have not been so far utilized in connection to (a) a wider program of waste post-disposal processing and (b) material beneficiation for valuable metals, by means of ore processing methods.

1.2.2. Actions and means

In order to establish LFM as a standard waste management procedure there are two basic tasks to be completed:

- LFM consolidation and application: Detailed elaboration on all technical aspects of LFM, from designing the waste mining operation to creating alternative final products (metal concentrates) that can be directly fed into metallurgical plants.
- Environmental and Social analysis: Detailed approach on the foreseeable socioeconomic impacts of adopting LFM practices.

More analytically, the Project includes the following Actions:

1. Preparation: International experience in LFM, Permitting of additional activities in Polygyros Landfill (PL), Baseline environmental and social conditions
2. Implementation: Landfill inventory, Exploitation plan, Design of production line, Sub-contracting procedures, Pilot-scale Demonstration Unit, MSW mining, operation and tests, Environment rehabilitation plan
3. Socioeconomics: EIA Study, Financial and socioeconomic analysis, Action Plan and Master Plan elaboration
4. Monitoring the environmental & socioeconomic impacts of project Actions
5. Dissemination Actions
6. Project management Actions
7. After-life communication plan

1.2.3. Expected results

According to existing literature, there is considerable experience in waste mining regarding energy and soil recovery, but not regarding non-ferrous metals, since the waste requires further processing which very few have attempted to undertake. It is expected that the Project will help consolidate knowledge, give practical experience in the field and contribute to the adaptation of an

innovative production line under, various site conditions and waste compositions. Specifically, the Project is expected to bring the following results:

- Web GIS database for operational landfills and dump-sites in Greece combined with a Website during and after the duration of the Project, connected with the web-GIS database application
- Processing of waste for the production of different separation samples
- Two field environmental economics surveys on the acceptance of LFM
- Action plan on national level for LFM and Strategic Environmental Assessment on national level
- Socioeconomic analysis of LFM
- Publication of one bilingual book/album on LFM
- Dissemination of the experience and information gained, through conferences (2 national and 1 international) as well as through proper dissemination material

All results will be supported by respective Technical Reports (one of which is the present one), with documentation on the background, methodologies, alternatives examined and relevant results. In addition, a special report regarding the carbon footprint of the Project will be submitted in order to support the footprint minimization policy of the project.

1.3. The Study Team

This Report has been elaborated by the following Life reclaim collaborators (ENVECO S.A.):

- Aristoteles Tegos, Civil Engineer (NTUA), MSc in Water Resources Management (NTUA)
- Panagiota Mprousti, Environmental Scientist (University of Aegean), MSc in Water Resources Science and Technology (NTUA)
- Alexandra Kavvadia, Biologist, MSc in Environmental Biology: Management of terrestrial and marine resources (University of Crete)

2. Environmental indicators for the RECLAIM project

2.1. Proposed environmental indicators

The environmental indicators selected are summarized in the following Table 1. Furthermore, each indicator is discussed in more detail below.

Table 1: Environmental indicators used in RECLAIM project

Impact category	Environmental Indicator	Unit
Waste minimization	Quantity of waste excavated	kg and/or m ³
Waste minimization	Waste residues	kg and/or m ³
Material resources	Recovery of hard plastic	kg and/or % of waste
Material resources	Recovery of glass	kg and/or % of waste
Material resources	Recovery of aluminum	kg and/or % of waste
Material resources	Recovery of ferrous materials	kg and/or % of waste
Material resources	Recovery of other metals in metal concentrate	kg and/or % of waste
Soil degradation	Recovery of soil	kg and/or % of waste
Climate change	Reduction in greenhouse gas of recycled materials compared to use of new materials	kg CO ₂ eq.
Energy resources	Reduction in energy consumption of recycled materials compared to use of new materials	% reduction in energy
Water resources	Reduction in water consumption of recycled materials compared to use of new materials	lt of water saved or % reduction in quantity and/or water pollution
Material resources	Reduction in raw materials consumption of recycled materials compared to use of new materials	kg of raw materials saved
Human health/Environmental quality/Quality of life	Reduction in air emissions of recycled materials compared to use of new materials	% reduction in quantity and/or air pollution
Human health/Environmental quality/Quality of life	Air emissions associated with the proposed activities in Polygyros Landfill	kg of pollutants emitted
Human health/Environmental quality/Quality of life	Noise emissions associated with the proposed activities in Polygyros Landfill	Number of people annoyed
Human health/Environmental quality/Quality of life	Wastewater emissions associated with the proposed activities in Polygyros Landfill	lt of wastewater produced
Land use	Potential land reclamation and rehabilitation	ha of land
Land use/Green space	Available landfill lifespan	years

- E.I.1. Quantity of waste excavated: This indicator refers to “Waste minimization” and its aim was to monitor and assess the waste that was excavated during the RECLAIM project. It was measured in kg.

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- E.I.2. Waste residues: This indicator is related to “Waste minimization” and its aim was to monitor and assess the waste residues that were re-disposed to Polygyros Landfill during the RECLAIM project. It was measured in kg.
 - E.I.3. Recovery of hard plastic: The aim of this indicator was to monitor and assess the impacts on “Material resources” throughout the duration of RECLAIM project and specifically the quantity of hard plastic recovered by the waste treatment process (in kg and/or % of waste processed).
 - E.I.4. Recovery of glass: The aim of this indicator was to monitor and assess the impacts on “Material resources” throughout the duration of RECLAIM project. In particular, it measured the quantity of glass recovered by the waste treatment process (in kg).
 - E.I.5. Recovery of aluminum: The aim of this indicator was to monitor and assess the impacts on “Material resources” through the duration of RECLAIM project. More specifically, it measured the quantity of aluminum recovered by the waste treatment process (in kg).
 - E.I.6. Recovery of ferrous metals: The aim of this indicator was to monitor and assess the impacts on “Material resources” throughout the duration of RECLAIM project. More specifically, the quantity of ferrous metals recovered by the waste treatment process was measured, in kg.
 - E.I.7. Recovery of other metals in metal concentrate: The aim of this indicator was to monitor and assess the impacts on “Material resources” throughout the duration of RECLAIM project. More explicitly, the aim was to measure the quantity of other metals recovered by the waste treatment process in metal concentrate (in kg and/or % of waste processed). However, no other metals recovered by the current waste management practice.
 - E.I.8. Recovery of soil: The aim of this indicator was to monitor and assess the impacts on “Soil degradation” throughout the duration of RECLAIM project. More specifically, it measured the quantity of soil recovered by the waste treatment process (in kg).
 - E.I.9. Reduction in greenhouse gas of recycled materials compared to use of new materials: This indicator is related to “Climate change” impact and its aim is to monitor and assess the reduction in greenhouse gas of recycled materials compared to use of new materials that will be achieved during the RECLAIM project. It was measured in kg of CO₂ eq. and it was estimated through existing information and data gathered by the project as regards the environmental benefits of recycling compared to use of new materials.
 - E.I.10. Reduction in energy consumption of recycled materials compared to use of new materials: This indicator refers to “Energy resources” issue and its aim is to monitor and assess the energy savings during the RECLAIM project owing to the recovery of recycled materials. It was measured in % reduction in energy consumption of recycled materials compared to use of new materials, based on existing information and data gathered by the project.
 - E.I.11. Reduction in water consumption of recycled materials compared to use of new materials: This indicator refers to “Water resources” impact and its aim is to monitor and assess the water savings during the RECLAIM project owing to the recovery of recycled

materials compared to use of new materials. It was measured in % reduction in quantity and/or water pollution, based on existing information and data gathered by the project.

- E.I.12. Reduction in raw materials consumption of recycled materials compared to use of new materials: This indicator refers to "Material resources" impact and its aim is to monitor and assess the reduction in raw materials consumption during the RECLAIM project owing to the recovery of recycled materials compared to use of new materials. It was measured in kg of raw materials saved, based on existing information and data gathered by the project.
- E.I.13. Reduction in air emissions of recycled materials compared to use of new materials: This indicator refers to "Human health/Environmental quality/Quality of life" issue and its aim is to monitor and assess the reduction in air emissions of recycled materials compared to use of new materials throughout the duration of RECLAIM project. It was measured in % reduction in quantity of pollutants and/or air pollution, based on existing information and data gathered by the project.
- E.I.14. Air emissions associated with the proposed activities in Polygyros Landfill: This indicator refers to "Human health/Environmental quality/Quality of life" issue and its aim is to monitor and assess the impacts of air emissions associated with the proposed activities in Polygyros Landfill throughout the duration of RECLAIM project. It was measured in kg of pollutants emitted, which were recorded using the TEOM PM-10 monitoring unit. The results were minor, so the value of the air emissions was zero.
- E.I.15. Noise emissions associated with the proposed activities in Polygyros Landfill: This indicator refers to "Human health/Environmental quality/Quality of life" issue and its aim was to monitor and assess the impacts of noise emissions associated with the proposed activities in Polygyros Landfill throughout the duration of RECLAIM project. It was measured in number of people annoyed, which was zero, since the waste management activities did not affect residential areas and the staff worked in the Landfill's facilities applied the necessary safety measures.
- E.I.16. Wastewater emissions associated with the proposed activities in Polygyros Landfill: This indicator refers to "Human health/Environmental quality/Quality of life" issue and its aim was to monitor and assess the impacts of wastewater emissions associated with the proposed activities in Polygyros Landfill throughout the duration of RECLAIM project. It was measured in m³ of wastewater produced, based on data gathered by the project.
- E.I.17. Potential land reclamation and rehabilitation: This indicator refers to "Land use" impacts and its aim was to monitor and assess the area of land potentially reclaimed and rehabilitated in Polygyros Landfill throughout the duration of RECLAIM project due to landfill mining process. It was measured in m² of land potentially saved.
- E.I.18. Available landfill lifespan: This indicator refers to "Land use/Green space" issue and its aim was to monitor and assess the Polygyros landfill lifespan due to landfill mining process during the of RECLAIM project. It was reported as landfill lifespan in years, calculated as available airspace/incoming volume per annum (m³/m³ per annum).

The aim is to provide indicators for the assessment of landfill mining process, which will be coherent and compatible with waste management indicators in general and will be transferable to other landfill mining projects.

3. First Annual Environmental Impact Evaluation of the RECLAIM project

Based on the collected data, a first annual report for the environmental impact evaluation was carried out to estimate the aforementioned Indicators. The results of the evaluation are summarized in Table 2 of the next page.

Table 2: First Annual Environmental Impact Evaluation for the RECLAIM project- Environmental indicators

Impact category	Environmental Indicator	Unit	Value	Comments
Waste minimization	Quantity of waste excavated	kg	580547.71	
Waste minimization	Waste residues	kg	126710.00	
Material resources	Recovery of hard plastic	kg	19470.00	
Material resources	Recovery of glass	kg	1680.00	
Material resources	Recovery of aluminum	kg	1612.00	
Material resources	Recovery of ferrous materials	kg	6220.00	
Material resources	Recovery of other metals in metal concentrate	kg and/or % of waste	0	No other metals recovered by the current waste management practice
Soil degradation	Recovery of soil	kg	371018.80	
Climate change	Reduction in greenhouse gas of recycled materials compared to use of new materials	kg CO2 eq.	56346.40	
Energy resources	Reduction in energy consumption of recycled materials compared to use of new materials	% reduction in energy	94% for aluminum 60-74% for ferrous materials 85% for hard plastic 50% for glass	

Water resources	Reduction in water consumption of recycled materials compared to use of new materials	% reduction in quantity and/or water pollution	97% for aluminum 40% for ferrous materials 13% for hard plastic 50% for glass	
Material resources	Reduction in raw materials consumption of recycled materials compared to use of new materials	kg of raw materials saved	12.89 tonnes of bauxite and 6.44 tonnes of chemical (saved from aluminum) 9.33 tonnes of iron ore and 3.11 tonnes of coking coal (saved from ferrous materials) 73.98 barrels of crude oil (saved from hard plastic) 2.01 tonnes of raw materials (saved from glass)	
Human health/Environmental quality/Quality of life	Reduction in air emissions of recycled materials compared to use of new materials	% reduction in quantity and/or air pollution	95% for aluminum 30% for ferrous materials 60% for hard plastic 20% for glass	
Human health/Environmental quality/Quality of life	Air emissions associated with the proposed activities in Polygyros Landfill	kg of pollutants emitted	0	Air emissions recorded using the TEOM PM-10 monitoring unit were minor, i.e. almost zero.

Human health/Environmental quality/Quality of life	Noise emissions associated with the proposed activities in Polygyros Landfill	Number of people annoyed	0	Waste management activities did not affect residential areas. Landfill's staff applied safety measures for the noise emissions.
Human health/Environmental quality/Quality of life	Wastewater emissions associated with the proposed activities in Polygyros Landfill	m ³ of wastewater produced	220	
Land use	Potential land reclamation and rehabilitation	m ² of land	210	
Land use / Green space	Available landfill lifespan	Days/year	2.3	This is the estimated remaining landfill lifespan, with the current rate of landfilling



ACTION C.1

Technical Report on the 1st Annual Env.Impact evaluation of the Project
