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:

Baseline evaluation of the Project
by means of the
Environmental performance indicators

STUDY : **ENVECO S.A.**

ENVECO S.A. ENVIRONMENTAL PROTECTION MANAGEMENT & ECONOMICS

HELECTOR

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1. Introduction

1.1. Report context and Objectives

This present report is the Deliverable of Action C1 of the Life reclaim Project "Landfill mining pilot application for recovery of invaluable metals, materials, land and energy", which is being funded by the European Commission through Life+ 2012 vehicle, under the contract LIFE12 ENV/GR/000427.

The objective of this report is to examine the collected data and set the Baseline Evaluation of the LIFE reclaim project according to the Environmental Monitoring Indicators which were identified at a previous stage. This evaluation serves as the basis for the project impact monitoring.

The Technical Report "Baseline environmental and social conditions report" of Action A3 will be used as an input of information about the baseline conditions of the area, along with any data gathered during this Action, via:

1. Assessment of related literature

2. Site visits in the wider area

3. Collection of primary data from relevant databases and organizations

4. Consultations with relevant authorities (land planning service, environmental services, the municipality, the regional authorities etc)

5. Final evaluation and reporting

The environmental information was collected for the Project Area and the wider region of Chalkidiki and Central Macedonia.

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 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:

- Spyros Papagrigoriou, Civil Engineer, Environmental Engineer, Dipl., MSc., MLitt
- Georgios Kotzageorgis, Biologist (University of Athens, Greece), Ph.D. in Ecology
- Nikolaos Mihas, Civil Engineer (AUTH), MSc in Environmental Engineering
- Panagiota Mprousti, Environmental Scientist (University of Aegean), MSc in Water Resources Science and Technology (NTUA)
- Alexandra Kavvadia, Biologist, MSc in Enironmental Biology: Management of terrestrial and marine resources (University of Crete)

- Xenophon Bakouras, Environmental Engineer, MSc Environmental Technology, Imperial College of London

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 paper	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 is to monitor and assess the waste that will be excavated during the RECLAIM project and it will be measured in kg and/or m^3.

- E.I.2. Waste residues: This indicator is related to "Waste minimization" and its aim is to monitor and assess the waste residues that will be re-disposed to Polygyros Landfill during the RECLAIM project. It will be measured in kg and/or m^3.

- E.I.3. Recovery of paper: This aim of this indicator is to monitor and assess the impacts on "Material resources" throughout the duration of RECLAIM project. More specifically, it will measure the quantity of paper recovered by the waste treatment process and It will be measured in kg and/or % of waste processed.

- E.I.4. Recovery of glass: This aim of this indicator is to monitor and assess the impacts on "Material resources" throughout the duration of RECLAIM project. In particular, it will measure the quantity of glass recovered by the waste treatment process and It will be measured in kg and/or % of waste processed.

- E.I.5. Recovery of aluminum: This aim of this indicator is to monitor and assess the impacts on "Material resources" through the duration of RECLAIM project. More specifically, it will measure the quantity of aluminum recovered by the waste treatment process and It will be measured in kg and/or % of waste processed.

- E.I.6. Recovery of ferrous metals: This aim of this indicator is to monitor and assess the impacts on "Material resources" throughout the duration of RECLAIM project. More specifically, it will measure the quantity of paper recovered by the waste treatment process and It will be measured in kg and/or % of waste processed.

- E.I.7. Recovery of other metals in metal concentrate: This aim of this indicator is to monitor and assess the impacts on "Material resources" throughout the duration of RECLAIM project. More explicitly, it will measure the quantity of other metals recovered by the waste treatment process in metal concentrate and It will be measured in kg and/or % of waste processed.

- E.I.8. Recovery of soil: This aim of this indicator is to monitor and assess the impacts on "Material resources" throughout the duration of RECLAIM project. More specifically, it will measure the quantity of soil recovered by the waste treatment process and It will be measured in kg and/or % of waste processed.

- 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 will be measured in kg of CO_2 eq. and will be 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 will be 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 will be measured in lt of water saved or % 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 will be 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 will be 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 will be measured in kg of pollutants emitted, based on existing emission factors and data gathered by the project.

- 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 is to monitor and assess the impacts of noise emissions associated with the proposed activities in Polygyros Landfill throughout the duration of RECLAIM project. It will be measured in number of people annoyed, based on data gathered by the project and suitable models.

- 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 is to monitor and assess the impacts of wastewater emissions associated with the proposed activities in Polygyros Landfill throughout the duration of RECLAIM project. It will be measured in lt 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 is 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 will be measured in ha of land potentially saved.

- E.I.18. Available landfill lifespan: This indicator refers to "Land use/Green space" issue and its aim is to monitor and assess the Polygyros landfill lifespan due to landfill mining process during the of RECLAIM project. It will be reported as landfill lifespan in years, calculated as available airspace/incoming volume per annum (m^3/m^3 per annum).

The above-mentioned indicators will be also expressed per m^3 of waste excavated and treated during the RECLAIM project. 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. Evaluation of the Baseline Environmental Impact for the RECLAIM project

3.1. Evaluation of the Baseline Environmental Impact with the RECLAIM project Environmental indicators

Based on the collected data, a baseline analysis was carried out to estimate the aforementioned Indicators. However, due to the fact that the operation of the pilot demonstration unit has not started yet, most of these indicators are not applicable, or are estimated to de zero at the time.

Te results of the evaluation are summarized in Table 2 of the next page.

Table 2: *Baseline Environmental Impact Evaluation for the RECLAIM project Environmental indicators*

Impact category	Environmental Indicator	Unit	Value	Comments
Waste minimization	Quantity of waste excavated	kg and/or m^3	0	No waste excavation takes place in the Polygyros Landfill
Waste minimization	Waste residues	kg and/or m^3	n/a	The indicator is related to the waste residues that will be re-disposed to Polygyros Landfill during the RECLAIM project
Material resources	Recovery of paper	kg and/or % of waste	0	The quantity of paper recovered by the current waste management practice is zero
Material resources	Recovery of glass	kg and/or % of waste	0	The quantity of glass recovered by the current waste management practice is zero
Material resources	Recovery of aluminum	kg and/or % of waste	0	The quantity of aluminum recovered by the current waste management practice is zero
Material resources	Recovery of ferrous materials	kg and/or % of waste	0	The quantity of ferrous metals recovered by the current waste management practice is zero
Material resources	Recovery of other metals in metal concentrate	kg and/or % of waste	0	The quantity of other metals recovered by the current waste management practice is zero
Soil degradation	Recovery of soil	kg and/or % of waste	0	The quantity of soil recovered by the current waste management practice is zero
Climate change	Reduction in greenhouse gas of recycled materials compared to use of new materials	kg CO_2 eq.	0	The indicator is zero provided that no recycling activities take place in Polygyros Landfill
Energy resources	Reduction in energy consumption of recycled materials compared to use of new materials	% reduction in energy	0	The indicator is zero provided that no recycling activities take place in Polygyros Landfill
Water resources	Reduction in water consumption of recycled materials compared to	lt of water saved or % reduction in quantity and/or	0	The indicator is zero provided that no recycling activities take place in Polygyros Landfill

	use of new materials	water pollution		
Material resources	Reduction in raw materials consumption of recycled materials compared to use of new materials	kg of raw materials saved	0	The indicator is zero provided that no recycling activities take place in Polygyros Landfill
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	0	The indicator is zero provided that no recycling activities take place in Polygyros Landfill
Human health/Environmental quality/Quality of life	Air emissions associated with the proposed activities in Polygyros Landfill	kg of pollutants emitted	*	* The baseline air quality will be monitored prior to conducting the landfill mining activities in Polygyros Landfill
Human health/Environmental quality/Quality of life	Noise emissions associated with the proposed activities in Polygyros Landfill	Number of people annoyed	**	** The baseline noise levels will be monitored prior to conducting the landfill mining activities in Polygyros Landfill
Human health/Environmental quality/Quality of life	Wastewater emissions associated with the proposed activities in Polygyros Landfill	lt of wastewater produced	0	No landfill mining activities take place in Polygyros Landfill
Land use	Potential land reclamation and rehabilitation	ha of land	0	The area of land saved by current waste management practice is zero
Land use / Green space	Available landfill lifespan	years	9	This is the estimated remaining landfill lifespan, with the current rate of landfilling

3.2. Findings of the Baseline Environmental Impact Evaluation

Most of the LIFE reclaim Environmental Preformance Indicators were specifically designed to measure the impacts of the Landfill Mining activities during the project pilot demonstration unit operation. Up to this point, the waste mining and processing activities of the project have not started yet. at the Polygyros landfill. Thus, most of the indicators are estimated to be zero (0).

The only indicator that has been calculated is the available landfill lifespan of the Polygyros Landfill (E.I.18): at the point of the Baseline Evaluation (March 2015), the estimated remaining lifespan of the Polygyros landfill was 9 years, if the landfilling rate remained stable.