Instrument for Pre-accession Assistance
of the European Union
Operational Programme for Regional Development 2007-2013

Preparation of necessary documents for establishing of an Integrated and Financially Self-sustainable Waste Management System in Pelagonija, Southwest, Vardar and Skopje Regions

Feasibility Study & CBA

Southwest Region

(10/11/2017)

EuropeAid/136347/IH/SER/MK

This project is funded by the European Union

A project implemented by ENVIROPLAN SA and its consortium partners

ENVIROPLAN S.A. (Leader) – LOUIS BERGER – BiPRO GmbH – EPEM S.A. – SLR Consulting Limited
23 Perikleous Str.
15344 Gerakas/Athens - Greece
Tel: +30 210 6105127 / 8
Fax: +30 210 6105138
Email: fl@enviroplan.gr

Project: **"Preparation of necessary documents for establishing of an Integrated and Financially Self-sustainable Waste Management System in Pelagonija, Southwest, Vardar and Skopje Regions"**

Reference No: EuropeAid/136347/IH/SER/MK

Document title: Southwest Region – Feasibility Study & CBA

Status: Final version

Date: 10th of November 2017

Client: Ministry of Finance-CFCD

Drafted by: Christos Tsompanidis, Team Leader

Eleni Ieremiadi-Waste Management/Feasibility Expert

Krystallia Oikonomou-Financial Expert (CBA)

Georgia Louka-SWM design/Procurement Expert

Checked by: Christos Tsompanidis, Team Leader

Approved by: Theofanis Lolos, Project Director

Table of Contents

List of Abbreviations

AD	Anaerobic Digestion
B/C	Benefit / Cost
BAT	Best Available Techniques
BaU	Business as Usual
BGM	Basic Geological Map
BMW	Biodegradable Municipal Waste
C&I	Commercial & Industrial
CAPEX	Capital Expenditure
CBA	Cost - Benefit Analysis
CCKP	Climate Change Knowledge Portal
CF	Conversion Factor
CLO	Compost Like Output
CV	Calorific Value
CWMF	Central Waste Management Facility
D&B	Design and Build
DBFO	Design, Build, Finance and Operate
DBO	Design, Build and Operate
DCF	Discounted Cash Flow
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EEC	European Economic Community
EfW	Energy from Waste
EIA	Environmental Impact Assessment
EIB	European Investment Bank
ENPV	Economic Net Present Value
EPRI	European Payment Risk Index
ERDF	European Regional Development Fund
ERR	Economic Rate of Return
ESI	European and Structural Investment
ETS	Emissions Trading System
EU	European Union
EWC	European Waste Catalogue

FDR	Financial Discount Rate
FNPV	Financial Net Present Value
FRR(C)	Financial Rate of Return of the Investment
FRR(K)	Financial Rate of Return on National Capital
GCCS	Gas Collection and Control System
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWP	Global Warming Potential
IED	Industrial Emissions Directive
IEP	Integrated Environmental Permits
IFI	International Funding Institution
IMF	International Monetary Fund
IMWMB	Intermunicipal Waste Management Board
IMWME	Intermunicipal Waste Management Enterprise
IPCC	Intergovernmental Panel on Climate Change
ISWM	Integrated Solid Waste Management
ISWMS	Integrated Solid Waste Management System
LandGEM	Landfill Gas Emissions Model
LCRS	Leachate Collection and Removal System
LEAP	Local Environmental Action Plan
LoBAWBA	Law on Batteries and Accumulators and Waste Batteries and Accumulators
LoE	Law on Environment
LoEEEWEEE	Law on Electric and Electronic Equipment and Waste Electric and Electronic Equipment
LoWM	Law on Waste Management
LSGU	Local Self-Government Units
LUC	Levelized Unit Cost
MBS	Mechanical Biostabilization System
MBT	Mechanical Biological Treatment
MCF	Methane Correction Factor
MoAFWE	Ministry of Agriculture, Food and Water Environment
MoE	Ministry of Economy
MoEPP	Ministry of Environment and Physical Planning
MoF	Ministry of Finance
MoH	Ministry of Health
MRF	Material Recovery Facility
MS	Member State
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NCCC	National Climate Change Committee

NCV	Net Calorific Value
NIR	Near Infrared
NTES	The Nomenclature of Territorial Units for Statistics
NWMP	National Waste Management Plan
NWMS	National Waste Management Strategy
O&M	Operation & Maintenance
OG	Official Gazette
OP	Operational Program
OPEX	Operational Expenditure
PCBs	Polychlorinated Biphenyls
PCC	Post-Closure Care
PCT	Polychlorinated Terphenyls
PE	Public Enterprise
PET	Polyethylene Terephthalate
PROMETHEE	Preference Ranking Organization Method for Enrichment Evaluation
PUE	Public Utility Enterprise
RDF	Refuse Derived Fuel
RES	Renewable Energy Sources
RHAS	Rapid Hazard Assessment System
RMWMC	Regional Municipal Waste Management Company
RO	Reverse Osmosis
RSS	Risk Screening System
RWMP	Regional Waste Management Plan
SAA	Stabilization and Association Agreement
SBR	Sequencing Batch Reactor
SCF	Standard Conversion Factor
SDR	Social Discount Rate
SEA	Strategic Environmental Assessment
SGEI	Service of a General Economic Interest
SILC	Survey on Income and Living Conditions
SRF	Solid Recovered Fuel
SRI	Static Respiration Index
SWM	Solid Waste Management
TC	Total Carbon
TOR	Terms Of Reference
TS	Transfer Station
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value Added Tax
WDF	Waste Disposal Facility

WEEE	Waste Electrical & Electronic Equipment
WGR	Waste Generation Rate
WM	Waste Management
WMC	Waste Management Center
WWTP	Waste Water Treatment Plant

Table of Contents

1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

The overall objective of the project "Preparation of necessary documents for establishing of an Integrated and Financially Self-Sustainable Waste Management System in Pelagonija, Southwest, Vardar and Skopje Regions" is to achieve an integrated and financially self-sustainable waste management system in those Regions.

The project's purpose is the preparation of Regional Waste Management Plans and Strategic Environmental Assessments, as well as preparation of Feasibility Studies, Cost-Benefit Analyses, Environmental Impact Assessment, Detailed Designs and assistance with preparation of Volume 3, 4 and 5 of the Tender Dossiers for works and supply contracts for construction of selected waste treatment and disposal facilities, closure of noncompliance landfills/dumpsites and for supply of equipment for waste collection and transferring of waste according to the EU standards for Pelagonija, Southwest, Vardar and Skopje Regions. There are nine (9) components to this project and the purpose of the present report is Component 3: the preparation of the Feasibility Studies for establishing of an Integrated and Financially Self-Sustainable Waste Management System for each of the Regions.

Regarding the project's context within the national waste management policy, currently the municipal waste management in the beneficiary country is undergoing a radical transformation from decentralized disposal of non-treated waste on numerous local sub-standard landfills within Regions to centralized waste management facilities serving needs of one Region or, in some cases, of several Regions. The Central Waste Management Facilities concept has been adopted by the beneficiary country in its National Waste Management Plan.

The Feasibility study demonstrates the way to select of the most acceptable taking into consideration the technical - technological, and financial - economic aspects, and is the basis for all technical solution and associated project documentation (preliminary and final design, documentation for the implementation of procedures for environmental impact assessment and documentation for the impact assessment procedure) for all facilities and equipment needed for the implementation of an integrated waste management system.

For the implementation of the feasibility study the following chapters were prepared:

- *Chapter 1: Executive Summary*. This chapter (present chapter) includes the summary of each chapter of the feasibility study taking into consideration the main conclusions, assumptions, methodologies and data used.
- *Chapter 2: Background Information and Review of the Existing Waste Management System.* This chapter includes background information summarizing and presenting key points of previous reports for the region: Assessment Report, Waste Management Report, AdHoc Report. It describes the project location regarding its environmental and infrastructure aspects, it provides an overview of current collection and treatment system, current waste generation and management, recycling and recovery industry in usage and existing waste management system costs. Finally, this chapter identifies the regional possibilities for disposal for different products of CWMF.
- *Chapter 3: Socio Economic Context of the Project*. This chapter includes the current status and future projections regarding demographics, the current status and future projections regarding tourism, the current status regarding affordability and economic aspects.
- *Chapter 4: Waste Content and Future Generation Forecast.* This chapter includes morphological composition of the mixed municipal waste, future waste generation and its content.

- *Chapter 5: Legal and Regulatory Framework*. This chapter includes EU waste management policy and directives, national policy and institutional framework, local spatial policy, the implications of the legal and policy issues on the project as well as available sources of financing.
- Chapter 6: Option Analysis. This chapter includes option analysis regarding location (as performed in AdHoc Report), collection system, Transfer Stations and technologies for CWMF.
- *Chapter 7: Proposed Investment Project*. This chapter describes the future waste management system from operational and technological point of view including an analysis of existing dumpsites and non compliant landfills in the region. This chapter describes the human resources and the promoter organization and provides detail CAPEX, OPEX and re-investment costs analysis.
- *Chapter 8: Environmental and Social Assessment*. This chapter includes all relevant information from the Environmental Impact Assessment and also includes a CO_2 footprint calculation (including without/with project scenario) and a report in climate change adaptation/resilience.
- Chapter 9: Financial and Economic Analysis. This Chapter represents the Cost Benefit Analysis of the *proposed waste management system and includes risk analysis.*
- *Chapter 10: Procurement and Implementation. This chapter provides the procurement strategy and purpose of future contract arrangements and also provides detail project implementation plan.*

1.2 BACKGROUND INFORMATION AND REVIEW OF THE EXISTING WASTE MANAGEMENT SYSTEM

The main objectives of Chapter 2 (Background Information and Review of the Existing Waste Management System) are the following:

- Study and project background in the context of national waste management strategy and objectives. This paragraph describes an overall project objective and especially of the current report.
- Project location description. This paragraph describes the selected area of the present study (***Debartsa Municipality, G2 area***).
- Environmental and infrastructure aspects. This paragraph includes a brief description of the environmental and infrastructure aspects of the future CWMF area, a brief description of the geological and hydrogeological characteristics, seismological activity, hydrology, landscape and climate characteristics, proximity to protected areas and site availability for the specific site and surrounding area.
- Current waste collection and treatment system overview. This paragraph includes information regarding organizational aspects, collection coverage, waste collection and transportation equipment. This information is presented for the whole region and is described in detail in the Assessment Report of the region.
- Current waste streams overview, waste generation and management. This paragraph presents the results Survey of existing non compliant landfills that consists the Part B of Assessment Report of the Region. Additionally, this paragraph provides information on the key problems in the current waste management system, identified through questionnaires. Finally, an overview of the generated solid municipal waste per municipality of the region.
- Recycling and recovery industry in usage. This paragraph presents the recycling companies, if existing.
- Existing waste management system costs. In this paragraph, the cost and unit costs for collection and disposal per municipality of the region are presented.
- Identification of regional possibilities for disposal for different products of CWMF. This paragraph presents the potential uses of the main outlets RDF/SRF, the marketability of CLO, compost and recyclables.

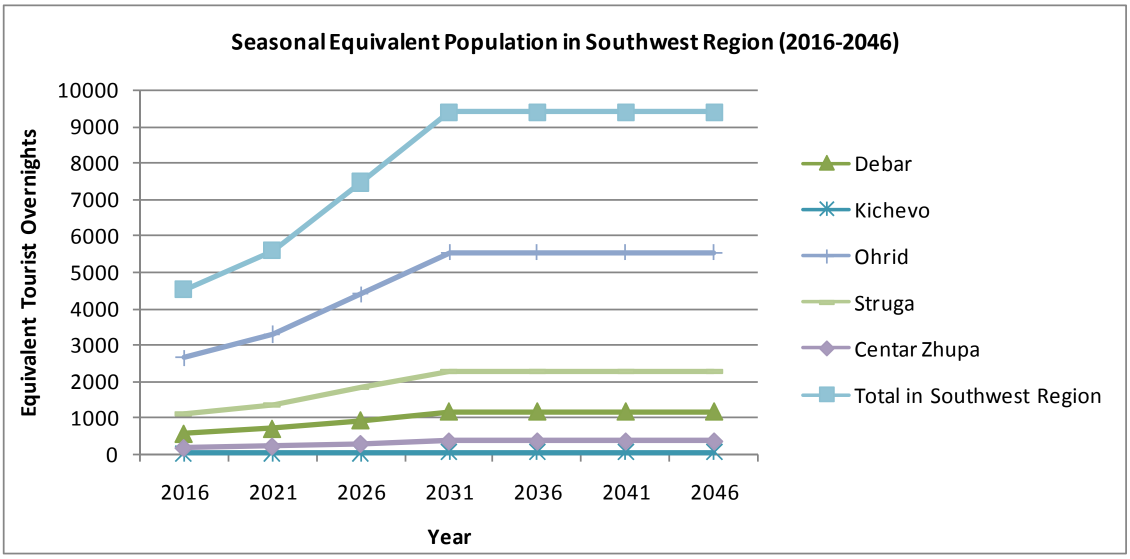
1.3 SOCIO-ECONOMIC CONTEXT OF THE PROJECT

The main objectives of chapter 3 (Socio economic context of the project) are the following:

- Permanent population-current status and future projections. This paragraph presents data regarding the population for the county according to Census 2002 and estimations for 2015 (State Statistical Office of the Republic of Macedonia) as well as a division in urban and rural population. The future projection of the permanent population until year 2046 was calculated by the project team and the average annual rate of change of urban and rural population is given according to World Bank data. The following table presents an overview of current status and future permanent population estimations according to the selected variant.

	State statistical office		Future projections of permanent population – project team						
Year	**2002**	**2015**	**2016**	**2021**	**2026**	**2031**	**2036**	**2041**	**2046**
Southwest Region	221,546	219,891	219,863	219,576	218,256	215,733	212,064	207,562	202,443

- Seasonal population - current status and future projections. This paragraph includes data regarding the seasonal population for the county (current situation) and calculations for the future projection of the seasonal population until year 2046. The following graph presents an overview of current status and future projections regarding seasonal population.



- Economic development aspects. This paragraph describes the Gross Domestic Product per capita for years 2010, 2011, 2012 and 2013 for Republic of Macedonia and for Southwest Region. GPD per capita in Southwest Region for year 2010 is lower than the average GDP per capita in the Republic of Macedonia. It also describes the available income by decile.
- The chapter also includes an analysis of Poverty and Payment indicators
- Current affordability. This paragraph includes calculations regarding the affordability level concerning the average annual income per household.
- Future economic development and affordability. This paragraph presents a brief description of the real GDP growth and contributions in the beneficiary country.

1.4 WASTE CONTENT AND FUTURE GENERATION FORECAST

The main objectives of chapter 4 (Waste content and future generation forecast) are the following:

- Presentation of the methodology, the sampling procedure and results of Morphological composition analysis of the mixed municipal waste. The analysis was analytically presented in the Annex II of the Assessment Report. The average waste composition in the region has been calculated, and presented in the following table:

Waste category	Average Mass share
Garden Waste	14.26%
Other Biodegradable waste	30.88%
Paper	6.99%
Cardboard	5.49%
Glass	5.04%
Ferrous metal packaging and other	1.57%
Aluminum (non-ferrous) metal packaging and other	1.00%
Composite Materials	1.48%
Other Plastic packaging waste	1.64%
Plastic bags	6.35%
PET Bottles	2.96%
Other plastic/Hard plastic	2.22%
Textile	6.72%
Leather	1.22%
Diapers	6.60%
Wood	1.02%
Construction and demolition material	1.18%
WEEE	0.72%
Medical Waste	0.69%
Other special waste streams (Elastic-tyres, etc)	0.33%
Fine elements <10mm	1.65%
TOTAL	**100.00%**

- Future waste generation forecast. In order to calculate the future waste generation forecast, data from the quantitative waste analysis of the municipal solid waste were used. The analysis was performed in May 2016 and presented analytically in the Part A of the Assessment Report of the region.
- The future generated quantities divided in urban and rural of MSW have been calculated after the examination of four alternative scenarios regarding the Waste Generation Rate Growth. The scenario 2- low growth-in addition to population growth, per capita generation linked to 50% of growth in GDP, followed by 2% between years 2021-2030 was selected. The future municipal waste generation per municipality resulted from calculations of the project team until the year 2046. The following table summarizes the basic calculations of this chapter.

	2016	2046
Permanent Population	219,863	202,443
Seasonal Population	4,508	9,379
Quantity of produced Municipal Waste (t)	56,224	61,450
Waste production Rate for permanent population (kg/ca/year)	247	283
Waste production Rate for seasonal population (kg/ca/year)	438	438

1.5 LEGAL AND REGULATORY FRAMEWORK

The main objectives of chapter 5 (Legal and Regulatory framework) are the following:

- EU waste management policy and directives. This paragraph describes the European Union directives that set out goals for reuse, recycling and recovery, collection and disposal for different waste categories (Municipal waste, batteries, WEEE).
- National policy and institutional framework. This paragraph provides an overview of the main waste management legal framework in the beneficiary country.
- Local spatial policy. This paragraph includes a description of waste management policy on county level, on local self-government unit level and a brief description of local spatial policy.
- Implications of the legal and policy issues on the project. This paragraph presents objectives that could be realized in the time period of this waste management plan 2009-2015 of the beneficiary country.
- Available sources of financing. The main possible sources of financing investments for the implementation of the EU waste legislation, for the execution of the variety of organizational and public relations tasks, and for elaboration of the necessary technical, spatial and investment documentation and environmental studies and capital investments are described.

1.6 OPTION ANALYSIS

The main contents of chapter 6 (Option analysis) are the following:

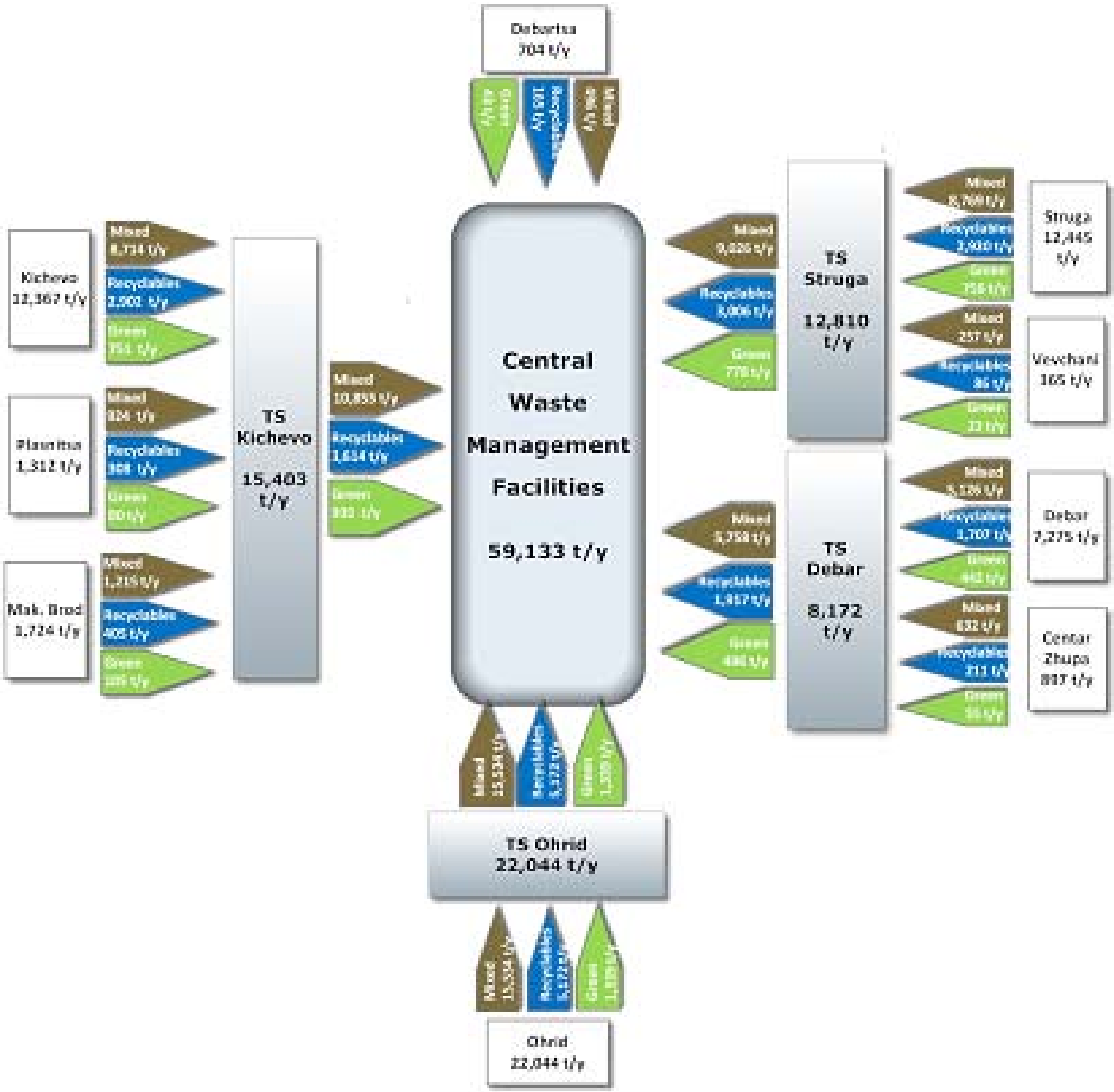
- Methodology. Firstly this chapter presents the concept of Integrated Solid Waste Management (ISWM) and the methodology followed in order to create a municipal waste management system.
- Project determination and its objectives. The general and specific objectives of the project are presented, along with the targets that must be achieved by the proposed waste management system in order to contribute to the beneficiary country's national targets.
- Option analysis for the location of CWMF. This paragraph describes the methodology used for the selection of the appropriate location of central waste management facilities in the Region (AdHoc report).
- Option analysis for the location of LWMF. The steps for the identification of the appropriate location of the Transfer Station areas are presented. Then, the three indentified areas for TSs in the Southwest region are described.

TS	Served Municipalities
Kichevo	Kichevo, Plasnitsa, Makedonski Brod
Struga	Struga, Vevchani
Debar	Debar, Centar Zhupa
Ohrid	Ohrid

- Option analysis on Transfer Stations. This paragraph describes different alternative solutions regarding transfer stations, presenting the capacity of all potential TS:
    - Business as usual (Variant 0) – no TSs: Each municipality uses its own existing means i.e. waste collection vehicles, open trucks, etc. to transport the waste to the CWMF
    - Do-something (Variant 1) – four (4) TSs: at Kichevo, Struga, Debar and Ohrid, direct transportation for the municipality of Debartsa.

  The paragraph describes the alternatives for uploading system and transportation equipment and the results of the Break Even Points calculations. Then, the investment, operational and Levelized Unit Cost were calculated for each option.

Finally, taking into consideration the objectives of the chapter and the needs of the present project such as travel distances and times the waste quantities, the optimal option is to have four (4) TSs (in Kichevo, Struga, Debar and Ohrid).



- Option analysis for Waste Management Centre Technology. In order to support decisions regarding future solutions for the Waste Management in the region, four waste management scenarios (including sub-scenarios) have been defined and examined, as presented in the Regional Waste Management Plan. The selected Scenario 3b was presented.
- Additionally, After the selection of the appropriate waste management system in Southwest region (Scenario 3) the alternatives which will be examined in this paragraph are:
  - Option 1-Business as Usual (BaU): Collection and disposal in existing landfills and dumpsites through collection trucks. Continuation of the current situation concerning recycling.
  - Option 2-Do minimum: Collection and disposal of waste through Transfer stations and/or collection trucks in a new regional landfill, continuation of the current situation concerning recycling.
  - Option 3-Do something: Scenario 3b
- Conclusively it is obvious that the current situation (Collection of waste, small recycling of packaging waste and disposal at landfills and dumpsites) and the do to minimum situation (construction of a new regional landfill according national and EU regulations) concerning waste

management are two options which do not achieve the minimum targets that should be fulfilled. For this reason a new regional waste management system, which will include (i) construction of a new regional landfill in combination with other main facilities such as MBT/MRF and windrow composting for green waste, (ii) construction of TSs and (iii) purchasing of necessary collection trucks and bins, should be established. Although the application of the new regional waste management system required capital expenditure, this is a crucial and essential task that must be implemented as it will bring only positive effects to the community. The appropriate management of solid municipal waste will eliminate adverse impacts on the environment and human health and will support economic development and improved quality of life.

1.7 PROPOSED INVESTMENT PROJECT

The main objective of chapter 7 (Proposed Investment Project) is the description of future waste management system from operational and technological point of view and the provision of detail CAPEX, OPEX and re-investment cost analysis. Also this chapter includes a description of human resources and promoter organization.

The conceptual design of the waste management system includes the description of the following:

- **Waste storage, collection, transportation and transfer**: Current equipment regarding bins and transfer vehicles were presented per municipality. Then, taking into consideration the project team assumptions, the calculations for the extra number of bins and vehicles required per municipality are presented for the three waste streams: mixed municipal, recyclables and green waste.
- **The TS sites and their characteristics:** Analytical description of the transfer station infrastructure and equipment is provided, along with description of TS operating routines and staffing. The general layout of the selected TS is also provided.
- **Analysis of existing dumpsites and non compliant landfills.** This paragraph includes relevant information from the landfills and dumpsites survey that took place for the region, in order to perform risk screening procedure and define optimal remediation and closure approach. More specifically, it includes description of the identified sites, their risk classification and closure and remediation approaches for each of the identified sites.
- **Technical Description of the new regional landfill:** The site location and the surrounding area of the selected site are described regarding the topography and the hydro-geological characteristics. Additionally, the topographic plan of the site is provided as well as the after closure topographic plan. The proposed site lay out with infrastructure and staged filling plan and the designs for bottom lining and top cover systems are provided. Then, follows a description of the landfill operating routines and interim cover systems.
  Overall earth materials balance of the site for Phase A and B is calculated.
  The net filling volume, density and efficient operational life area calculated and presented.
- The **leachate collection, treatment and disposal system** is described along with the method used for the calculations of the maximum leachate production. Leachate composition and the Effluent limits for common parameters are described. Alternative options for leachate treatment and technical description of them are provided along with the flow diagram of the proposed WWTP process. Leachate volume forecast is calculated for the lifetime of the site.
- **Gas ventilation or collection / utilization system**. Here, the typical landfill gas compositions along with potential hazards from the biogas production are presented, followed by the estimation of the landfill gas production.
- Presentation of **Surface and ground water protection works** along with calculation formulas
- **Site infrastructure**. This paragraph briefly presents each necessary infrastructure for the proper function CWMF which are also presented in the layout. Those include: access roads, fencing, weighing bridge, service and staff building, washing installation etc.

- The **equipment** paragraph describes the waste compactors, earth moving material, trucks, etc. needed for the sound everyday operations inside the landfill.
- The **staffing** paragraph presents the indicative personnel requirements for the management and the normal operation of the new regional landfill.
- Detailed description of the **environmental monitoring** is provided along with the description of closure and aftercare procedures.
- Price schedules. This paragraph presents the estimations regarding the investment cost of landfill and Infrastructures works.

Total Investment Cost of Landfill (€)	3,732,393
Total Investment Cost of Infrastructures (€)	1,434,234

- **Technical description of other proposed facilities** This section of the chapter provides analytical descriptions for the proposed waste treatment facilities, followed by flow charts, namely:
  - Mechanical biological treatment plant with AD process (MBT)
  - Material Recovery Facilities (MRF)
  - Green Waste Composting Plant

  In this paragraph, the area (m^2) for the WMF is given, along with the overall mass balance of the MBT plant and landfill site.
  Detailed Flow diagrams of the mechanical treatment plant for the residual waste bin and the recyclables waste bin are given.
  Water balance for the daily water consumption or the WMC is calculated.
  The equipment paragraph describes the waste compactors, earth moving material, trucks, etc. needed for the sound everyday operations for the treatment facilities.
  The staffing paragraph presents the indicative personnel requirements for the MBT and MRF facilities, as well as the green waste composting plant.
  Detailed description of the environmental monitoring is provided.
  Price schedules. In this paragraph, the costs of mechanical treatment, biological treatment and windrow composting for green waste are presented.

Total Investment Cost of Mechanical Treatment (€)	9,797,580
Total Investment Cost of Biological Treatment (€)	5,580,000
Total Investment Cost of windrow composting for green waste (€)	668,200

- Regarding the human resources and promoter organization issue, an organizational diagram is provided. Also personnel requirements for the central administration have been described along with the hiring procedures. Organizational scheme for project preparation, organizational scheme for project implementation and organizational scheme for project operation have also been provided for the description of promoter organization.
- **CAPEX, OPEX and reinvestments cost determination.** In this paragraph, the total project cost is presented, along with the total investment cost for collection bins and investment and operational cost for waste transport.

Total Project Cost (€)	33,698,914
Total investment cost for collection bins (€)	1,731,312
Total investment cost for collection trucks (€)	2,823,332
Total operational cost for collection trucks (€/y)	1,210,253

- Waste treatment and disposal. In this paragraph, the operating cost has been calculated for each waste treatment component: i.e. mechanical sorting plant, biological plant, landfill, infrastructure works., along with the potential revenues from the operation of WMC

1.8 ENVIRONMENTAL AND SOCIAL ASSESSMENT

The main objectives of chapter 8 (Environmental and Social Assessment) are the following:

- Sector Legislation (SEA, EIA) - Implementation of EIA Process. This paragraph describes the responsibilities of the Ministry of Environmental and Nature Protection as well as the Environmental Protection Act and the Environmental Permit Regulation that defy the EIA Study and environmental permit according to the beneficiary's country legislation. Additionally, the paragraph refers to the Environmental Impact Assessment Study for the County Waste Management Centre at the selected G2 site that is planning to be conducted and submitted to the MoEPP, according to the national and EU legislation for EIA study.
- Baseline Assessment - Environmental and Social Impact Assessment. This paragraph includes data, points and conclusions for the G2 site. Those data refer to:
  - ◊ Climate and Meteorological Data monitored at the nearest weather stations, related to temperature and precipitation.
  - ◊ Geological, Hydrogeological, Seismotectonic and Geotechnical characteristics of the site
  - ◊ Natural Features of the site, regarding land use features, nature and biodiversity, habitants and vegetation, local fauna.
  - ◊ There is also reference to areas of architectural, historical and cultural heritage and settlements in close proximity to the proposed project area.
- Potential environmental impacts, Mitigation Measures, Monitoring and Environmental Action Programme. This paragraph presents the potential environmental impacts that could occur during the construction and during the operation and after closing of CWMF, especially water, air quality, soil, noise and traffic impacts. Additionally, potential impacts of the project on biological parameters, cultural property and population are identified. Finally there is a reference to the risk of accidents.
  Then, there are analyzed the mitigation measures that should be considered during the preparation procedure, the construction and the operation of the project, as well as during and after its closure. Finally, the proper monitoring processes are presented. Those refer to: water, air, noise parameters, waste and natural values.
- GHG Footprint Calculations. This paragraph aims to calculate the Green house gases emissions that can be included within the footprint generated from activities of the proposed waste management system. GHGs include the seven gases listed in Kyoto Protocol. Total emissions of these gases are counted in units of CO_2 equivalent.
- The following table presents the total GHG emissions, in t CO_2(eq), for the different components of the waste management system in the baseline (without-project) scenario in the with-project scenario and the incremental GHG emissions that were calculated subtracting the GHG emissions in with project scenario from GHG emissions without project scenario.

Total without project scenario net GHG emissions (t Co_2(eq))	22,217
Total with project scenario net GHG emissions (t Co_2(eq))	-16,271
Total incremental GHG emissions (t Co_2(eq))	-38,488

- Climate Change adaptation/ resilience. This paragraph provides background information on climate changes and on the environmental policy in the context of mitigation climate change. Additionally, the paragraph summarizes projected changes in climate of the beneficiary country. Then, according to "The Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient forms part of the overall EU effort to mainstream climate change adaptation, following on from the White Paper on Adapting to Climate Change published by the Commission in 2009", the relevant Modules are followed in order to identify the proper Adaptation to Climate Change measures for the project.
  - Modules 1-3, Sensitivity analysis, evaluation of exposure, vulnerability analysis.
  - Module 4, Risk assessment

- Module 5, Identification of adaption measures
- Module 6, Appraisal of adaptation options

1.9 FINANCIAL AND ECONOMIC ANALYSIS

The main objectives of chapter 9 (Financial and Economic Analysis) are the following:

A. Financial Analysis

- Methodology of the Analysis. This paragraph presents the methodology of cost benefit analysis used, which is discounted cash flow (DCF) analysis.
- CAPEX overview. This paragraph describes the Total Investments schedule breakdown. The Total investment consists of two major parts. The eligible part of it and the non Eligible part. The eligible part will be subject of EU co financing with the present will derive from the Funding gap estimation.
- OPEX overview for with project scenario. This paragraph describes the Operation and Maintenance costs which were grouped in the following nine cost centers:
  - Mechanical Treatment of Mixed Municipal Waste and Mechanical Treatment of Recyclables
  - Biological treatment (Anaerobic Digestion & Biostabilization);
  - Landfill for residues (WWTP included);
  - Windrow Composting (for green waste);
  - Infrastructure Works;
  - Transfer stations;
  - Transportation costs direct to WMC and to Transfer Stations;
- OPEX overview for without project scenario. The main assumption for the "Without Project" scenario is that no investment will take place in order to change the capacity and the nature of the works that exist until now.
- Cost Implication to the Consumer, Affordability Analysis and Operating Revenue Forecast. This paragraph includes the calculations for the revenues with and without project scenario followed by the affordability analysis.
- Financial return on investment and performance indicators calculation. In this paragraph is estimated the crucial financial performance indicators which prove if the project needs financial contribution from EU Funds. These indicators are the Financial Net Present Value of the net cash flow of the investment, under financial discount of a rate 4% and the financial rate of Return.
- Funding gap calculation. The financial model developed for this project takes into account the EU grant calculation mechanism. The steps followed to determine the EU grant in accordance to the guidelines are presented in this paragraph.
- Financial return on national capital and performance indicators. This paragraph presents calculation of financial performance indicators under the proposed financing scheme.
- Financial sustainability reports. This paragraph presents Income statement and cash flow statements of the analysis period.

B. Economic Analysis

- Methodology. This paragraph refers to the objective of the economical analysis and the methodological steps for the economic evaluation of the project applied as proposed by the EU CBA Guide.
- Analysis of socioeconomic costs. This paragraph presents the calculations of conversion factors (CF), including the calculation of the contribution percentages calculation of each productive factor to the construction and O&M costs.
- Analysis of socioeconomic benefits. This paragraph includes the Revenues of the System Operation, External Benefits as well as other non-quantifiable benefits of the project that were not considered in the analysis.

- Economic performance indicators. This paragraph presents the calculations of performance indicators and concludes that he investment for this project adds to the society welfare and is worthy to be financed from National and European funds.

C. Risk Assessment

- Methodology. This paragraph presents the recommended steps for assessing the project risks.
- Sensitivity analysis. This paragraph presents the variables tested and the critical ones are identified.
- Risk analysis. This paragraph presents the results of the risk analysis performed by the Monte Carlo simulation method, concluding that the project has very high possibility (almost certainty) to be constructed and operated with low risk in financial and economic terms, as are requested by EU co-funding regulations.
- Qualitative risk analysis. Through risk matrix conducted in this paragraph, possible risk prevention and mitigation measures have been identified. It concluded that the overall level of residual risk is deemed to be fully acceptable, it can be therefore concluded that, provided that the project is awarded with EU funds.

1.10 PROCUREMENT AND IMPLEMENTATION

The main objectives of chapter 10 (Procurement and Implementation) are the following:

- Procurement Strategy: This paragraph describes definitions of terms used in procurement activities, the EU and beneficiary country's Legislation on Public Procurement, the basic principle governing the award of contracts which is competitive tendering and finally, the different types of public procurement procedures regulated by EU and the relevant national legislation.
- Tendering Strategy: This paragraph describes the stages of the Tender Process, the thresholds that apply in the case of public procurements for the estimated value and the Criteria for Grouping of Tenders. Additionally, the available contractual arrangements are described. Finally, Work, Supply and Service Contracts are described.
- Procurement Plan: This paragraph describes the recommended different contracts that should be implemented.
- Implementation Plan: This paragraph illustrates the estimated timetable for the execution of the proposed works and services.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

2. BACKGROUND INFORMATION AND REVIEW OF THE EXISTING WASTE MANAGEMENT SYSTEM

2.1 BACKGROUND INFORMATION OF THE PROJECT

The overall objective of the project "Preparation of necessary documents for establishing of an Integrated and Financially Self-Sustainable Waste Management System in Pelagonija, Southwest, Vardar and Skopje Regions” is to achieve an integrated and financially self-sustainable waste management system in those Regions.

The project’s purpose is the preparation of Regional Waste Management Plans and Strategic Environmental Assessments, as well as preparation of Feasibility Studies, Cost-Benefit Analyses, Environmental Impact Assessment, Detailed Designs and assistance with preparation of Volume 3, 4 and 5 of the Tender Dossiers for works and supply contracts for construction of selected waste treatment and disposal facilities, closure of non compliant landfills/ dumpsites and for supply of equipment for waste collection and transferring of waste according to the EU standards for Pelagonija, Southwest, Vardar and Skopje Regions.

During the elaboration of Southwest region’s Assessment report (part of Component 1 of the project), the development of suitable questionnaires took place, along with the creation of an inventory of existing dumpsites - risk assessment - prioritization - preparation of program for remediation, and qualitative and quantitative analysis of municipal solid waste. Review and analysis of existing documentation was performed at an earlier stage of the project.

The information collected, verified, analyzed and presented in the Assessment Report, served as an input for the elaboration of the Regional Waste Management Plan (RWMP) for Southwest region. The RWMP was additionally drafted on the basis of EU and national waste legislation and strategies, which include objectives. Within the RWMP different waste management scenarios regarding treatment and collection of waste were examined, analytical calculations regarding the achievement on national targets for Recycling of packaging waste and reduction of Biodegradable Municipal Waste being landfilled, according to the minimum requirements set by the national waste management legislation were made, and also calculations of financial and economic indices for the examination of the feasibility of each scenario. At a next stage, evaluation of the alternative proposed scenarios took place by using the method of multicriteria analysis and one scenario was finally proposed for the regional waste management system.

The purpose of the present report is the preparation of the Feasibility Study and the Cost-Benefit Analysis (CBA), in which alternative locations for placing the CWMFs and the TSs, respectively, will be analysed and the Conceptual Design of the selected scenario will be presented. Furthermore, a justification of the project design against alternative scenarios, i.e. ‘Business as Usual’, ‘Do minimum’ and ‘Do something’, will be performed.

Brief description of the region

The Southwest Region is located in the western part of the country and it borders Albania. Internally, it borders the Polog, Skopje, Vardar and Pelagonija regions. Southwest Region is divided into nine (9) municipalities, (1) Vevchani, (2) Debar, (3) Debarca, (4) Kichevo, (5) Makedonski Brod, (6) Ohrid, (7) Plasnica, (8) Struga and (9) Centar Zhupa.

The current population of the Southwest Statistical Region is 221,546 citizens or 11.0% of the total population of the country, according to the last population Census in 2002. According to population estimates on 30.06.2015 from the State Statistical Office, the overall population of Southwest Region has slightly decreased (219,891 inhabitants), approximately -0.75%. The Southwest region takes up 13.4% of the total area of the country and has population density of 65.8 people per km^2.

The terrain of Southwest region is characterized by alternately switching the high hills and deeply incised valleys and gullies with elevations on hills with very steep sides toward streams and gullies. Most of the route is represented by a flat - hilly terrain with occasional valleys and ravines. In Southwest region there are one (1) National Park, thirteen (13) Natural Monuments and two (2) areas with important characteristics that belong to the National Emerald Network of the Republic of Macedonia. In Southwest Region the protected areas with internationally recognized status are: The Monument of Nature "Ohrid Lake" – World Natural Heritage (UNESCO), the Monument of Nature "Slatinski izvor" (The Springs of Slatino) – World Natural Heritage (UNESCO's Tentative List) and the Biosphere Ohrid - Prespa Reserve – World Natural Heritage (UNESCO) (2014).

2.2 CURRENT WASTE MANAGEMENT SYSTEM

In the following paragraphs the existing situation regarding the waste management in Southwest region will be analysed. Currently, all collected waste streams are directed to dumpsites and non compliant municipal landfills and the coverage of the collection system is not 100% in all municipalities. Moreover, (currently) no treatment of waste takes place and the sorting at source of recyclable waste is either at a primary stage or is not performed at all.

2.2.1 Current institutional framework

The Municipalities hold the overall responsibility for waste management and the Public Utility Enterprises (PUEs) are the main service provider of waste management services conducting the daily operation of waste collection services and landfill of waste. The Municipalities retain the responsibility for overall planning of waste management, tariff setting and the oversight of the PUEs up to the TSs, if will be constructed, or up to the CWMF, if the waste transported directly to the Center.

Description of the way for the delivery of waste management services in the future will be presented on Chapter 7 of the present study.

Currently, the municipalities hold the overall responsibility for waste management and the PUEs are the main service providers of waste management services conducting the daily operation of waste collection services and landfill of waste. The table below presents the PUEs per municipality.

Table 2-1: Public Utility Enterprises (PUEs) Southwest Region

#	Municipality	Name of administrative structure	Scope	% of population serviced	Employees	Transportation equipment
1	Centar Zhupa	PUE Kale	Collection	45%		-
2	Debar	PUE Standard	Collection, Transportation	80%	34	3 compaction vehicles, 3 tractors
3	Debarca	PUE Debrca	Collection, Transportation	80%	17	-
4	Kichevo	PUE Komunalec Kichevo	Collection, Transportation	65%	66	4 compaction vehicles, 1 open truck, 2 other type
5	Makedonski Brod	PUE "Komunalna Higiena"	Collection, Transportation		15	1 compaction vehicle, 1 other type
6	Ohrid	PE Ohridski Komunalec Ohrid	Collection, Transportation,	99%	162	15 compaction vehicles, 3 open trucks

#	Municipality	Name of administrative structure	Scope	% of population serviced	Employees	Transportation equipment
			partly Treatment			
7	Plasnica	PE Komunalec		40%		-
8	Struga	PE "Komunalno"	Collection, Transportation	30%-100%	23	4 compaction vehicles, 1 open truck
9	Vevchani	PUE Kale	Collection	100%		-

As can be observed from the table above, the coverage of the collection system is not 100% in all municipalities. Furthermore, regarding transportation equipment (which is briefly presented at the last column of the above table), a more detailed listing of it is given in the paragraph that follows.

2.2.2 Current equipment for collection and transportation

Regarding storage facilities (collection of waste), the information for existing bins was taken from the questionnaires and was presented in the Assessment Report of the region and in the following tables.

Table 2-2: Current Collection bin equipment for mixed waste and the collection frequency (per week) per municipality

Current Collection Equipment for Mixed Waste										
Household premises		Centar Zhupa	Debar	Debartsa	Kichevo	Mak. Brod	Ohrid	Plasnitsa	Struga	Vevchani
5 m^3	metal			45						
	plastic			80						
	others									
	frequency			1						
1.1 m^3	metal	7	55	30	196	20	385		200	
	plastic		12		40				20	
	others									
	frequency	2		1	1-3	2	2			
240 lt	metal									
	plastic	5	12	15						
	others									
	frequency	2	5	1						
120 lt	metal									
	plastic	53	800	65	740					
	others	2								
	frequency		2	1						
Collection Company		Municipality of Centar Zhupa			PUE Komunalec Kichevo		Pe Ohridski komunalec			

Table 2-3: Current Collection bin equipment for recyclable waste per municipality

Current Collection Equipment for Recyclable Waste										
Household premises		Centar Zhupa	Debar	Debartsa	Kichevo	Makedonski Brod	Ohrid	Plasnitsa	Struga	Vevchani
1.1 m^3	Glass						1			
	Paper/Cardboard		12			4	59			
	Plastic		12			4	20			
	Metals									
	Combined									
240 lt	Glass									
	Paper/Cardboard									
	Plastic		24							
	Metals									
	Combined									
120 lt	Glass									
	Paper/Cardboard									
	Plastic				14					
	Metals									
	Combined									

Likewise, regarding collection, transportation and transfer equipment, the information provided by the municipalities through the questionnaires was obtained and evaluated, in order to determine the suitable number of transportation trucks. The respective data are presented in the Assessment Report of the region and are summarized in the following table:

Table 2-4: Current transportation equipment per municipality

Municipality	Vehicle type	Capacity (m^3)	Age (years)	Age <8 years
Centar Zhupa	Compaction vehicle	5	10	1
	Compaction vehicle	10	4	
Debar	Compaction vehicle	7	15	0
	Compaction vehicle	3	19	
	Compaction vehicle	4	20	
Debartsa	Compaction vehicle	8	1	1
	Compaction vehicle	18	18	
Kichevo	Compaction vehicle	16	5	2
	Compaction vehicle	16	5	
	Compaction vehicle	14	-	
	Compaction vehicle	-	-	
	Open truck	6	18	
Makedonski Brod	Compaction vehicle	8	34	0
Ohrid	Compaction vehicle	3	2	4
	Compaction vehicle	3	2	
	Compaction vehicle	3	14	
	Compaction vehicle	3	14	
	Compaction vehicle	7	10	
	Compaction vehicle	7	10	
	Compaction vehicle	9	2	
	Compaction vehicle	12	30	
	Compaction vehicle	12	26	
	Compaction vehicle	13	32	
	Compaction vehicle	13	26	
	Compaction vehicle	14	33	
	Compaction vehicle	16	19	

Municipality	Vehicle type	Capacity (m^3)	Age (years)	Age <8 years
	Compaction vehicle	18	2	
	Compaction vehicle	18	35	
	Compaction vehicle	20	18	
	Open truck	3	2	
	Open truck	3	2	
	Open truck	6	2	
	Open truck	9	2	
Plasnitsa	Compaction vehicle	-	37	0
Struga	Compaction vehicle	5	21	1
	Compaction vehicle	5	30	
	Compaction vehicle	7	5	
	Compaction vehicle	10	25	
	Compaction vehicle	12	25	
	Open truck	5	28	
Vevchani	Compaction vehicle	5	-	
Total Vehicles in Southwest Region: 41				
Total number of new vehicles in Southwest Region: 9				

2.2.3 Existing landfills

In order to fully investigate current waste management status, special focus was placed on investigation on waste disposal practices and full extension of their environmental impacts. Identification of all waste disposal facilities (landfills and dumpsites) within project area was the first step in the process.

Data collected include information for waste disposal facility information, location, land property, PUE or other entity entitled to manage facility (if any) and other administrative information, period of waste disposal, protective technologies and controls used (if any) and disposed waste composition. Additional information regarding the local conditions including climate (rain, wind), geological and hydrogeological settings, hydrology, land cover and usage, sensitive areas and demographic data were collected with additional desk top research using official sources of data. The aforementioned data were analytically presented in Survey of existing non compliant landfills that consists the Part B of Assessment Report of the Region.

The identified active non-compliant municipal landfills in Southwest Region are ten (10), eight of them active, and two closed in the last 20 years. The identified dumpsites in Southwest Region are 85.

Out of 95 landfills and dumpsites, 5 (5%) are evaluated as a high risk and 90 (95%) as medium risk sites. Most of the sites (86) can be reclaimed with waste removal (cleaning), 7 will be capped without gas control installation and 2 capped with gas control installation.

More information on the 'Existing landfills' status will be given at Chapter 7 of the present study.

2.2.4 Key Problems

The key problems in the current waste management system were identified through questionnaires that were distributed to the municipalities from the project team. In the following table are presented the problems encountered in Solid Waste Management Service in Southwest Region as they were identified through the relevant sections of the filled questionnaires.

Table 2-5: Problems encountered in Solid Waste Management Service in Southwest Region

Problems Encountered in solid Waste Management Service in Southwest Region	Municipalities answered %	No problem %	Not so serious %	Serious %	Very serious %
Inadequate service coverage	18%	67%	0%	33%	0%
Lack of service quality (not frequent enough, etc.)	24%	75%	25%	0%	0%
Lack of financial resources	35%	0%	0%	67%	33%
Lack of trained personnel	29%	20%	40%	20%	20%
Lack of vehicles	35%	17%	17%	17%	50%
Lack of collection equipment	29%	0%	60%	20%	20%
Old vehicle equipment	35%	0%	0%	33%	67%
Difficulty to find spare parts	29%	0%	60%	20%	20%
Lack of capability to maintain/repair vehicle/equipment	29%	0%	100%	0%	0%
No standardization of vehicle equipment	29%	20%	60%	20%	0%
No proper institutional set-up for solid waste management service	35%	33%	50%	0%	17%
Lack of legislation	24%	100%	0%	0%	0%
Lack of planning (short, medium and long term plan)	29%	40%	60%	0%	0%
Rapid urbanization outstripping service capacity	29%	80%	20%	0%	0%
Lack of separate collection of recyclables	35%	0%	50%	33%	17%
Lack of separate collection of biowaste	24%	25%	50%	0%	25%
Poor response to waste minimization (reuse/recycling)	29%	0%	40%	40%	20%
Lack of control on hazardous waste	12%	50%	0%	50%	0%

The key problems that the municipalities face are evident from the results, and those regard the age and the lack of the transportation equipment, lack of financial resources, lack of separate collection of waste streams and waste minimization in general and the lack of control on hazardous waste.

2.2.5 Overview of Existing/ Current Waste Streams, Waste Generation and Waste Management

A waste quantity analysis was performed during the elaboration of the Assessment Report. The collection of data about the total mass of generated waste was carried out by weighing the mass of fully-laden garbage trucks which collect waste in the territory of a municipality.

The most populated Municipality of the region is Kichevo Municipality and covers the 22% of the overall waste production in Southwest Region, closely followed by Struga Municipality (21%). Ohrid Municipality although having less permanent population thn Kichevo, covers the 35% of the overall waste production in the region. The average waste production per capita of the Southwest Region is 247 kg/capita/yr.

Taking into consideration the seasonal population, Ohrid Municipality covers 36% of the overall waste production in Southwest Region and is closely followed by Kichevo Municipality (22%). The average daily waste generation per habitant of the Southwest Region is 251 kg/ca/yr.

An overview of main calculations for annual produced quantities of municipal waste in Southwest Region with the contribution of waste from seasonal population is given in the following table:

Table 2-6: Overview of produced waste in the municipalities of Southwest Region for 2016

Municipalities *(Southwest Region)*	**Permanent population 2016**	**Waste generation for permanent population (kg/ca/yr)**	**Generated waste from permanent population (t)**	**Generated waste from tourists, 2016 (t)**	**Weighted Waste generation rate (kg/ca/yr)**
Kichevo	**57,088**	**214**	**12,197**		
Kichevo urban	*32,065*	*233*	*7,479*	11	214
Kichevo rural	*25,024*	*189*	*4,718*		
Ohrid	**52,257**	**361**	**18,886**		
Ohrid urban	*40,648*	*377*	*15,344*	1,161	365
Ohrid rural	*11,609*	*305*	*3,542*		
Debar	**20,630**	**315**	**6,503**		
Debar urban	*15,396*	*331*	*5,101*	246	318
Debar rural	*5,234*	*268*	*1,402*		
Struga	**65,202**	**174**	**11,352**		
Struga urban	*39,065*	*189*	*7,368*	481	178
Struga rural	*26,137*	*152*	*3,985*		
Vevchani	**2,449**	**170**	**417**		
Vevchani urban	*0*	*0*	*0*	-	170
Vevchani rural	*2,449*	*170*	*417*		
Centar Zhupa	**6,995**	**125**	**872**		
Centar Zhupa urban	*0*	*0*	0	75	125
Centar Zhupa rural	*6,995*	*125*	872		
Debarca	**4,066**	**198**	**805**		
Debarca urban	*0*	*0*	*0*	-	198
Debarca rural	*4,066*	*198*	*805*		
Makedonski Brod	**6,328**	**271**	**1,717**		
Makedonski Brod urban	*3,324*	*298*	*992*	-	271
Makedonksi Brod rural	*3,004*	*241*	*725*		
Plasnica	**4,848**	**309**	**1,500**		
Plasnica urban	*0*	*0*	*0*	-	309
Plasnica rural	*4,848*	*309*	*1,500*		
TOTAL	**219,863**	**247**	**54,250**	**1,975**	**251**

2.2.6 Current status on recycling

In the municipality of Ohrid, PE "Ohridski Komunalec" has conducted a contract with PAKOMAK DOO – Skopje for use of the bins for packaging waste collection with (plastic, paper and glass) and with DOOEL Nutrivet for collection of baled waste paper and plastic. Additionally, the Contract with "Nutrivet" is semi-annual (renewable) and the income in 2015 from paper was 830,046 MKD and from plastic- 88,620 MKD.

There were no data provided from rest of the municipalities regarding other companies working in waste management.

Regarding Recycling, which should be done according to the Law on packaging and packaging waste, the companies-partners that performed collection of packaging waste for the system of PAKOMAK, concerned, in 2015, the municipalities of Ohrid, Kichevo and Struga, in which bin equipment (bins) for recyclable waste was given. Collective scheme Pakomak is a non-profit company, founded on 03/12/2010, whose main activity is management of packaging waste.

2.2.7 Existing waste management system costs

Costs of the current waste management system are divided into:

- Collection costs - consists of:
  - ***Capital costs*** of the service, which include the following costs land; purchase of machinery and equipment (special utility vehicles, trailers, tippers, construction machinery, etc.); equipment; waste containers.
  - ***Operating costs*** of the service include costs of daily operation and maintenance of the waste management. Operating costs are divided into fixed and variable. Fixed costs do not depend on the quantity of collected waste. Variable costs depend on the quantity of collected waste.
- Landfill disposal costs

The following tables present the cost for waste management system for municipalities of the region (data derived from questioners). The unit cost per ton of collected waste has been calculated, using the data for total collected waste from quantitative analysis, which are presented in the following paragraph. Collection operational costs and unit waste collection cost per collected residual waste are presented in the table below:

Table 2-7: Collection and Disposal unit costs

Municipality	Costs for collection, MKD		Collection unit cost (MKD/t)	
	2014	2015	2014	2015
Kichevo	18,972,869	14,033,730	2,063	1,526
Ohrid	45,426,766	45,171,109	2,266	2,253
Debar	12,269,956	14,521,440	2,129	2,520
Struga	8,159,147	8,548,212	926	970
Debarca	804,000	786,000	1,873	1,831
Makedonski Brod		415,738		351
Plasnica				
Centar Zhupa				
Vevchani	1,143,466	1,112,417	81	79

Disposal operational costs and unit waste disposal cost per collected residual waste are presented in the table below:

Table 2-8: Disposal costs (MKD) and disposal cost per ton collected waste (MKD/t)

Municipality	Disposal cost, MKD		Disposal cost per ton collected waste (MKD/t)	
	2014	2015	2014	2015
Kichevo	4,743,217	3,508,433	516	381
Ohrid	6,526,445	6,829,818	326	341
Debar				
Struga	2,998	10,013	0.3	1.1
Debarca	804,000	786,000	1,873	1,831
Makedonski Brod		178,174		150
Plasnica				
Centar Zhupa				
Vevchani				

2.3 PROJECT DESCRIPTION

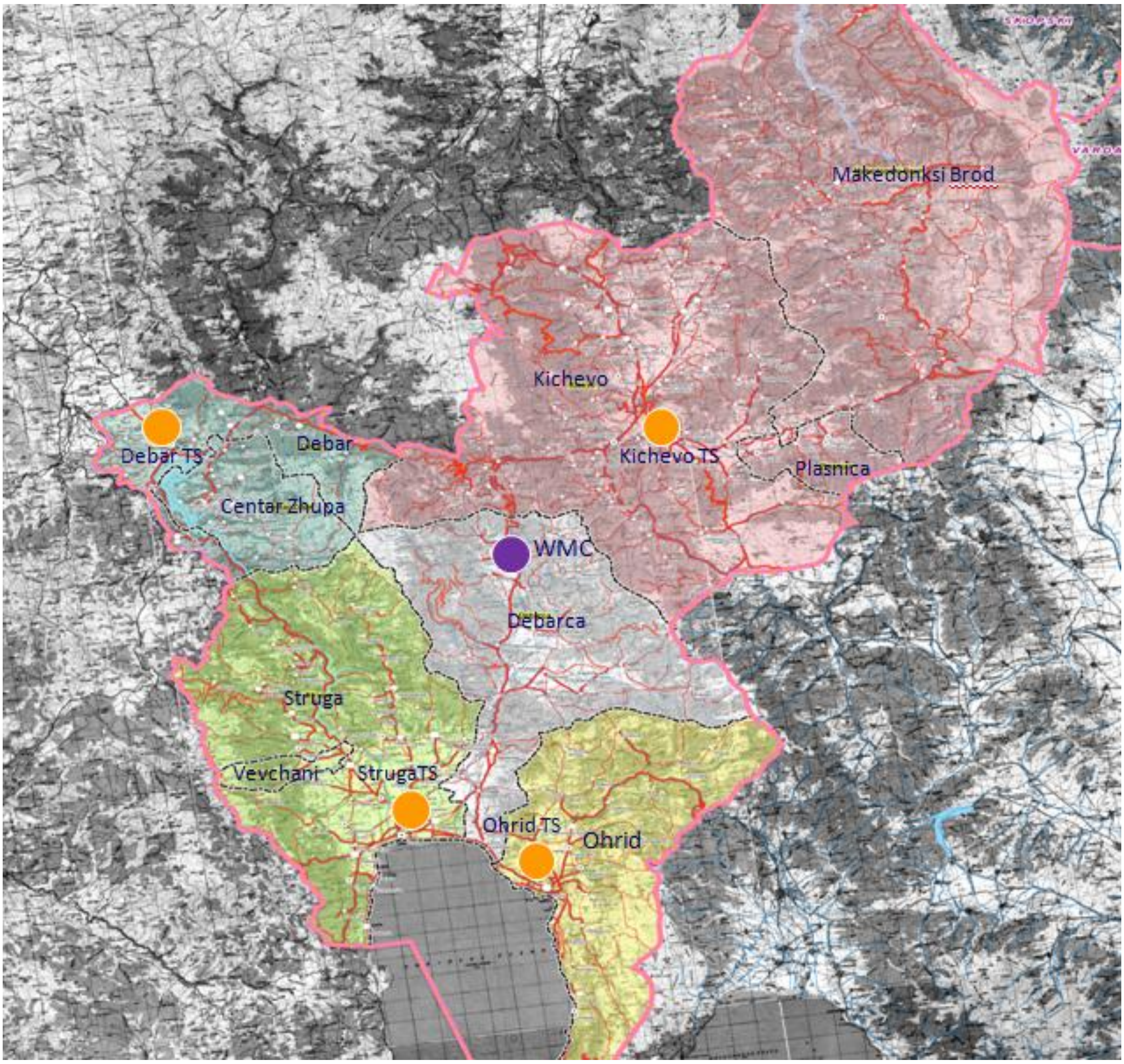
The Central Waste Management Facilities (CWMFs) in Southwest region are going to be located in site G2, which administratively belongs to the municipality of Debartsa. The selection methodology for the selection of the most appropriate location for placing the Central Waste Management Facilities in Southwest region is described in detail in Chapter 6 of the present study.

The municipalities in which Transfer Stations will be constructed are the municipalities of (i) Debar, (ii) Struga, (iii) Kichevo and (iv) Ohrid, serving the municipalities of (i) Debar, Centar Zhupa, (ii) Struga, Vevchani, (iii) Kichevo, Plasnitsa, Makedonski Brod and (iv) Ohrid, respectively.
The municipality of Debartsa will transfer its waste directly to the CWMFs.

The option analysis for selecting the appropriate location(s) for the construction of Transfer Stations is also included in the same chapter (Chapter 6 of the present study). The sustainability of potential TSs was examined through the Break Even Point Calculations.

The following map illustrates the locations of each proposed TS, in a municipality level, and the municipalities which will be served from each (proposed TS), as well as the location of CWMFs. Municipalities that transport their waste directly to CWMF are presented too.

Figure 2-1: Locations of CWMFs and proposed Transfer Stations with their respective served municipalities



During the elaboration of the Regional Waste Management Plan for Southwest Region, four waste management scenarios (including sub-scenarios) have been defined and examined. For all the aforementioned scenarios flow diagrams have been created, the targets according to the Law on management of packaging and packaging waste and according to the LoWM Article 8 for biodegradable municipal waste landfilled have been quantified and financial-economic analysis has been implemented.

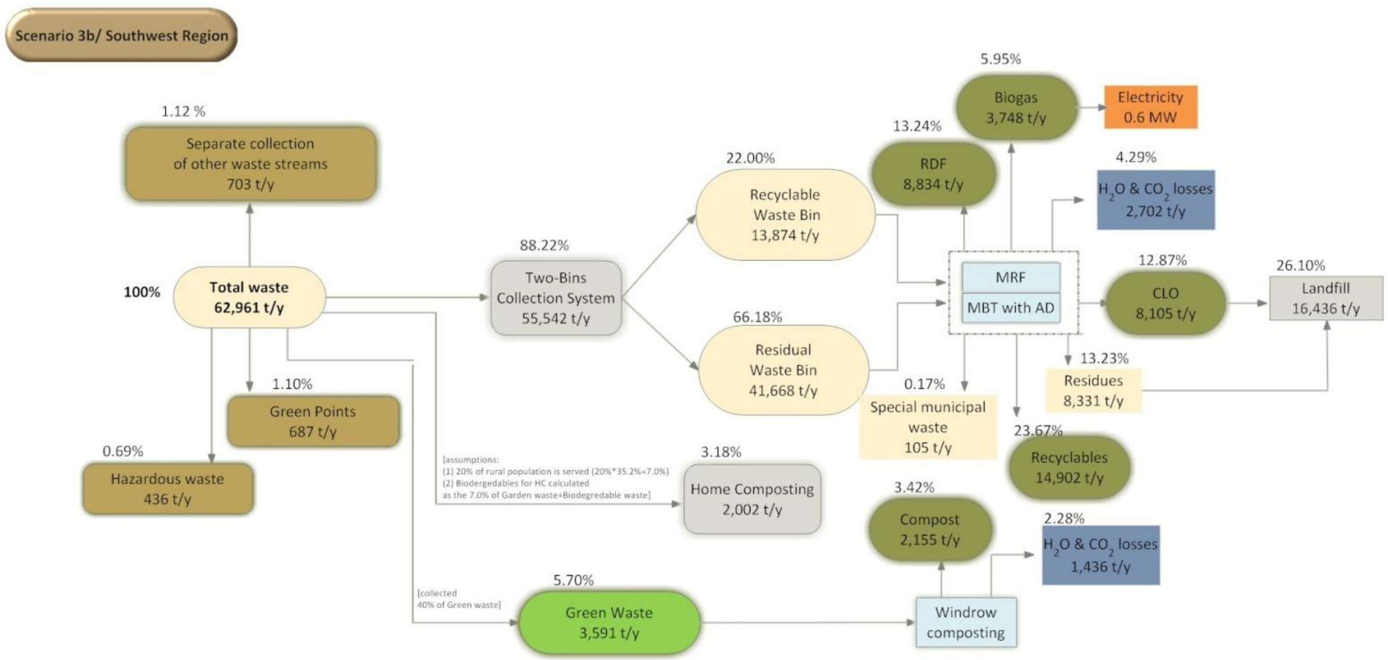
The selected scenario concerning Waste Management System for Southwest Region is Scenario 3b. The waste management system includes:

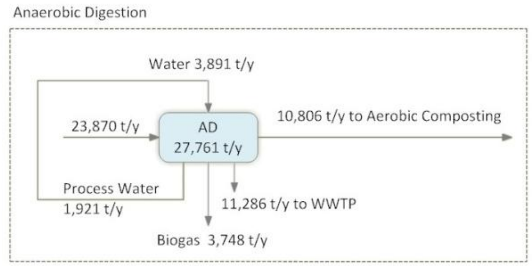
- Separate collection of recyclable materials and wood packaging fraction in green points,
- Separate collection of hazardous materials in municipal waste
- Separate collection of other waste fraction, i.e. other special waste streams (elastic-tires), WEEE and construction and demolition waste.
- Home composting actions,

- Separate collection of green waste which will be diverted to windrow composting process for the production of high quality compost.
- Recyclable waste bin which will be diverted to a Material Recovery Facility (MRF) for the recovery of recyclables (glass, paper, plastic, metals)
- Residual waste bin which will be diverted to a Mechanical Biological treatment plant (MBT) with anaerobic digestion (Biogas/Electricity production) and aerobic composting of digestate. Recyclables and RDF will be recovered from mechanical treatment of residual waste bin.
- Landfill which will accept residues from MRF/MBT and CLO.

The next figure illustrates the total waste management system which was examined and selected during the implementation of RWMP in Southwest Region:

Figure 2-2: Waste Management System in Southwest Region/ Selected option in RWMP



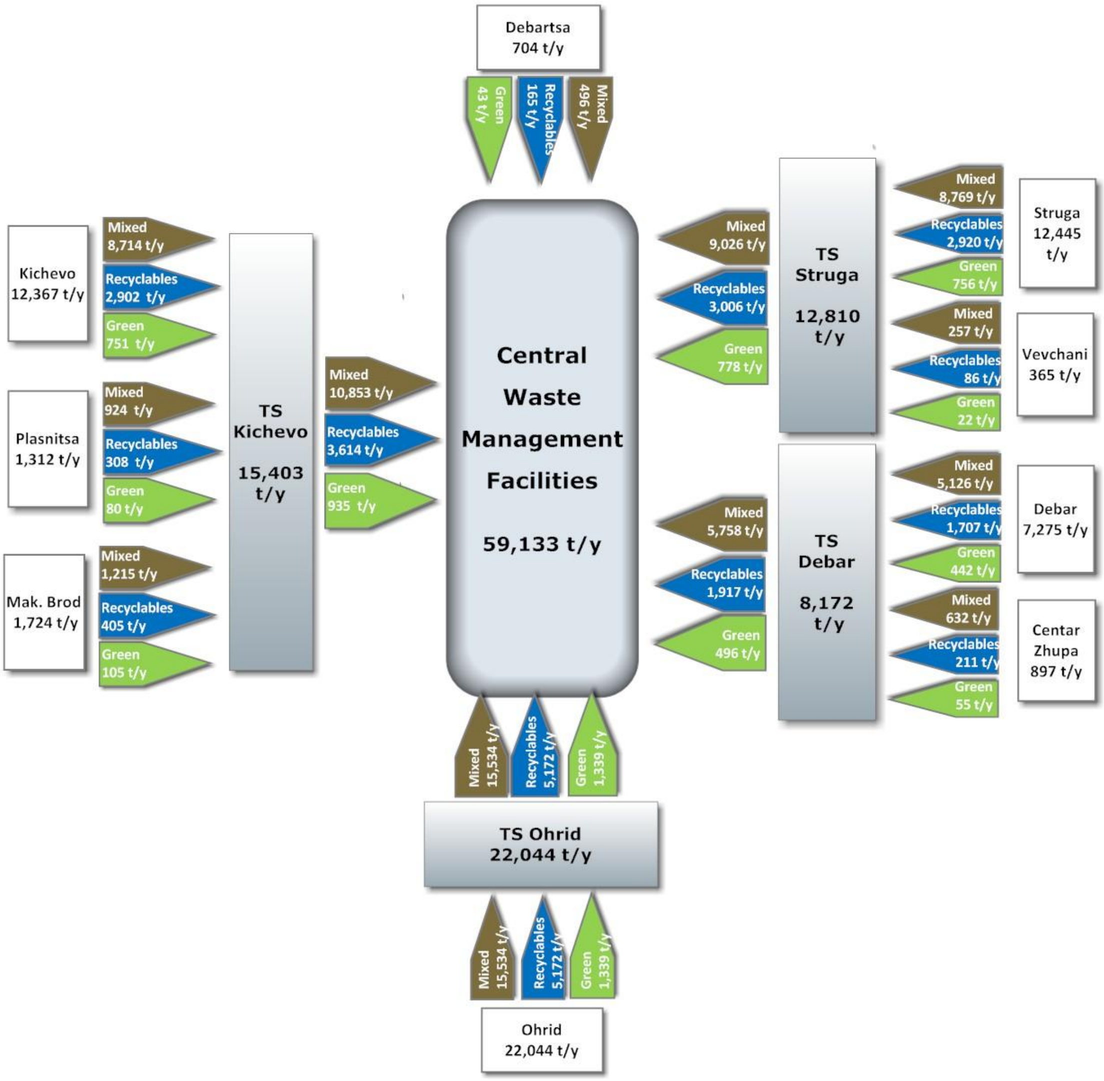


Scenario 3b	
Collection	✓Two Bins Collection System (Recyclable Waste Bin and Residual Waste Bin) ✓Green Points ✓Separate Collection of Green waste
Treatment of Recyclable Waste Bin	✓MRF
Treatment of Residual Waste Bin	✓MBT with Anaerobic Digestion and aerobic composting of digestate
Treatment of Green Waste	✓Aerobic composting
Treatment at the Source	✓Home Composting
Products	✓Compost ✓Recyclables ✓Biogas
Landfill	✓Residues from MRF Facility and MBT

The alternative scenarios were examined in relation to the minimum requirements based on national legislation according to the Law on management of packaging and packaging waste and to the Law in relation to reduction of the quantity of Biodegradable municipal waste landfilled. The table below presents the quantification of targets for all scenarios in Southwest Region. From the quantification of targets, scenario 1c does not achieve the targets for the recycling of packaging waste and scenario 4 does not achieve the targets for Biodegradable Municipal Waste landfilled in 2021. All the other scenarios, including the selected scenario 3b, achieve the targets.

Furthermore, the following diagram illustrates the proposed Transfer Stations, the municipalities which will be served from them, the municipality in which these will be located, the quantities which will be transferred through them and the municipalities and their quantities which will transfer their waste directly to CWMF.

Figure 2-3: Overall transportation system in Southwest region



Regarding the environmental and infrastructure aspects of project (i.e. geological and hydrogeological characteristics of the area, seismological activity of the area, hydrology, protected areas, etc.), these will be analytically described in Chapter 8 of the present study.

2.4 IDENTIFICATION OF NATIONAL POSSIBILITIES FOR UTILISATION FOR DIFFERENT PRODUCTS OF CWMF

2.4.1 Identification of immediate national possibilities for CWMF products

Waste derived fuels generally refer to the production of refuse derived fuels (RDF) and solid recovered fuels (SRF). The terms RDF and SRF are often used interchangeably but there is a significant difference between RDF and SRF which determines its ultimate destination. The preparation of RDF requires a basic level of treatment to remove recyclables from predominantly an MSW waste stream, while SRF requires a higher standard of preparation to produce a fuel. RDF is typically destined for standard Energy from Waste (EfW) facilities which also accept unprepared mixed waste streams. SRF on the other hand are solid fuels prepared from non-hazardous waste and are typically utilised for energy recovery in incineration or co-incineration plants (within cement kilns, power stations, etc.) as an alternative to fossil fuels also meeting the classification and specification requirements laid down in the CEN15359 European standard.

These differences can be summarised as follows:
- RDF is a "crude fuel" typically derived from Municipal Solid Waste (MSW) or commercial and industrial waste with similar properties to MSW with a Net CV (Calorific Value) of 8-14 MJ/kg (Mega Joules per kilogram). It is typically pre-sorted and shredded residual waste with recyclables removed where practical, or the reject fraction of a MRF (Materials Recycling Facility) operation;
- SRF is produced to a fuel standard specified by the receiving plant and can be produced to the European standard specifications set out in CEN15359:2011. It is typically derived from pre-sorted commercial & industrial (C&I) waste or rejects from MRF activities, and from MSW, typically having a Net CV or >15 MJ/kg.

The development in the production and therefore also use of waste fuels is driven by several factors, these mainly being summarised as:
- the EU Landfill Directive 1999/31/EC, which requires diversion of biodegradable waste from landfill. This led several states to implement a complete ban for organic waste in landfill,
- the Waste Incineration Directive 2000/76/EC as now superseded by 2010/75/EC,
- the Renewable Energy Sources (RES) Directive 2001/77/EC,
- the Emission Trading Directive 2003/87/EC,
- rising energy costs and the consequent interest to substitute expensive primary fuels, and
- the development of European Standards (i.e. CEN15359).

RDF and SRF can be used in a variety of ways to produce electricity, heat or a combination of both. It is often used alone or together (as a partial substitute) with traditional sources of fuel in the following industries:
- power plants for energy generation
- industrial power plants
- cement kilns
- incineration plants (R1 –status)
- pyrolysis plants
- steel mills, etc.

The main outlets of RDF/SRF are currently found in the cement industry as well as paper manufacturing. The European countries where RDF/SRF production is already well established are Germany but also Austria, Finland, Italy, the Netherlands, and Sweden. Countries where RDF/SRF production and energy recovery is currently being developed are Belgium, the United Kingdom and ever more increasingly the eastern European countries for example Slovenia, Serbia, and Croatia. In various countries several waste derived fuels are produced as different forms of appearance (fluff, pellets, chips, powder).

Regarding the current European market activity, there are cases of importing SRF to Austria or to Germany, some of these being at zero costs at the gate or even with a positive Gate fee (income to the SRF producer) which helps to offset transport costs to these facilities.

A major proportion of the international requirement for SRF utilization (mainly in cement kilns) remains outside of Europe, for example in India and China, these two countries being of the largest producers of cement globally. Any consideration for the export of SRF materials to these regions brings with it other costs (road, port storage/handling, shipping) and regulatory issues. China in particular is globally recognised as a dominating force in global manufacturing specifications and the treatment of recyclables due to being the largest importer of recyclables, also from Europe. Shipments however of SRF from Europe to China or India are not almost non existent due mainly to their relatively low (in comparison to recyclables) market value in relation to their transportation costs. No notable figures for exports of SRF from European countries to Eastern and South Eastern markets were established.

It must be noted that quality management for RDF/SRF plays a key role in efforts to establish viable market outlets, not least by creating confidence in suppliers, end-users, and regulators. However, standardization in isolation cannot guarantee increased market share. The European market for SRF/RDF is developing and remains unpredictable. The RDF/SRF contaminant properties and combustion behavior critically affect its potential applications. Problems with low-quality RDF characteristics, particularly high chlorine and trace metals content, have led to a decline in co-combustion applications.

Within the context of the present study, the produced SRF could be given to existing cement industry. Only one (1) cement plant is in operation in the Beneficiary country (Usje Cementarnica, which is a 94.8% subsidiary of Titan Cement Company of Athens).

Not all kinds of SRF are suited for all types of installations. The classes have determined as a tool for identifying and pre-selecting SRF. However, the performances of the plant where SRF is used are depending on the properties of the SRF and more significantly on the design and operating condition of such a plant.

The classification system for SRF, based on the EN 15359:2011 is presented at the following table:

Table 2-9: Classification System for SRF

Classification characteristic	Statistical measure	Unit	Classes				
			1	2	3	4	5
Net calorific value (NCV)	Mean	MJ/kg (ar)	≥ 25	≥ 20	≥ 15	≥ 10	≥ 3
Classification characteristic	**Statistical measure**	**Unit**	**Classes**				
			1	**2**	**3**	**4**	**5**
Chlorine (Cl)	Mean	% (d)	≤ 0,2	≤ 0,6	≤ 1,0	≤ 1,5	≤ 3
Classification characteristic	**Statistical measure**	**Unit**	**Classes**				
			1	**2**	**3**	**4**	**5**
Mercury (Hg)	Median	mg/MJ (ar)	≤ 0,02	≤ 0,03	≤ 0,08	≤ 0,15	≤ 0,50
	80^{th} percentile	mg/MJ (ar)	≤ 0,04	≤ 0,06	≤ 0,16	≤ 0,30	≤ 1,00

The price of produced product depends on the quality. SRF of class 2 or higher, based on the above mentioned classification system, could be cost -5€/tn (that means the producer should pay 5€/tn to a cement plant). SRF of lower classe could be cost up to -20€/tn.

Additionally the material must not contain pieces of metal or stone that can damage the conveyor systems and must not contain dioxins, furans, PCBs and other hazardous organic components. SRF must be declared with the category 191210, according to the European Waste Catalogue (EWC).

Other barriers identified for the promotion of production and use of SRF includes the following:

- *SRF classified as a waste fuel.*
- Governed by Waste Incineration Directive 2010/75/EC
- Likelihood of *public opposition*
- Increased combustion requirements for existing facilities – i.e. higher temperatures, longer incineration residence times
- High costs associated with transport. SRF products being relatively low in density in relation to calorific value as compared with fossil fuels, increases their relative transport cost, since transport costs are largely based on volume.
- Ash disposal costs.

Finally, the produced RDF for the Mechanical treatment can be treated using advanced thermal treatment facilities like pyrolysis or gasification.

2.4.2 Identification of national possibilities for compost / CLO

Compost Like Output (CLO)

The marketability of Compost-like outputs (CLO) is affected by the concentration of contaminants. Some facilities in Europe are processing mixed waste (composting and anaerobic digestion) with the intent of recovering a product suitable for landscaping and for use by the agricultural sector. Compost-like outputs (CLOs) are treated differently across Member States. For example, Germany uses MBT mostly as a pre-treatment prior to landfill, partially to stabilize biodegradable municipal solid waste, and does not use CLO on land. In France there are 70 plants processing 1.9 million tons per annum (tpa) of MSW with CLO used on land. Other countries also have substantial MBT capacities and use some of the CLO output on land, including agricultural land, such as Spain which has treatment capacity of 3 million tpa and Italy which has treatment capacity of 11.7 million tpa. In the UK the current regulatory position precludes the use of CLO from mixed waste sources for any agricultural land.

CLO derived from mixed waste is of lower quality and value compared to compost derived from source-segregated materials, largely due to higher contamination levels. Trials on mixed waste derived materials have reported large amounts of physical contaminants (e.g. glass) and potentially levels of other elements above limits.

Potential uses of the produced CLO can be:

a) As the fill material or material for soil remediation for the following tasks in projects or activities:
   - To active mining operations, for filling and rehabilitation of trenches whose operation has been completed,
   - In road works and particularly in concrete trenches on slopes or embankments in closed highways for vegetation growth,
   - As material for landscaping, provided that the final surface sealing of the new waste surface will be consisted of planting of at least one (1) meter thickness,
   - As daily and final cover material in landfills,
   - In backfilling operations - soil remediation in inactive, for rehabilitation mines and quarries.
   - As a top soil material for recovery of waste Dumpsites.

For the aforementioned uses, the compost like output (CLO) may be used in mixture with other materials to the extent that the required soil and mechanical characteristics are achieved as well as the protection of groundwater and surface water.

b) As a biofilter material for absorbing odors from industrial plants with smelly waste gas vents in municipal sewage treatment plants, mechanical sorting, and composting, mass conservation animals, etc.

In the following table, potential CLO end users are presented.

Table 2-10: Potential compost-like-output (CLO) end-users

Potential compost end-user	Description
State Government	For example, transportation projects
Regional Government	Road, bridge and transportation protects, compost is also used in open space, parks etc.
Landscape (contractor, design, maintenance)	Landscape contractors, designers, and maintenance – significant potential users
Construction (road and reclamation)	Contracted by the County or municipalities to undertake public works, road, erosion control, and reclamation projects.
Sports Complexes	Covered in the above categories (State, county. Municipal)
Landscape Architects	Design landscaping plans most often include soil amendment

Compost

For compost, there are two main uses as a product: as a soil improver/organic fertilizer and as a component of growing media. [1]

a) Compost as a soil improver/organic fertilizer:

Regarding the consideration of *compost as a multifunctional soil improver*, it is therefore used in agriculture and horticulture. The application of compost usually improves the physical, biological and chemical properties of soil. Repeated application of compost leads to an increase in soil organic matter, it often helps to reduce erosion, it increases the water retention capacity and pH buffer capacity, and it improves the physical structure of soil (aggregate stability, density, pore size). Composts may also improve the biological activity of the soil.

Regarding the often consideration of *compost as an organic fertilizer*, that function of compost (supply of nutrients) is, in many cases, less pronounced than the general soil improvement function.

The quality parameters that characterize the usefulness of compost in agricultural applications include:

- organic matter content;
- nutrient content (N, P, K, Mg, Ca);
- dry matter;
- particle size;
- bulk density;
- pH.

b) Compost as a component of growing media:

The second main use of compost is as a component of growing media. Growing media are materials, in which plants are grown. The total volume of growing media consumed in the EU is estimated to be about

[1] Hans Saveyn & Peter Eder, "End-of-waste criteria for biodegradable waste subjected to biological treatment (compost & digestate): Technical Proposals", Joint Research Centre/ITPS, Sevilla, Spain, Final Report, (December 2013)

20–30 million m^3 annually. Worldwide, peat-based growing media cover some 85–90 % of the market. The market share of compost as a growing medium constituent is below 5 %.

The suitable uses of compost depend on source material type, compost class and quality. Application areas like agriculture just require standard quality. Landscaping and, even more so, the growing media sector need an upgraded and more specialized product. Here, further requirements have to be met and it is up to the marketing strategy of the compost plant to decide whether to enter into this market segment.

An important factor determining compost use is the national environmental and fertilizing policy.

In Europe, more than 50 % of the compost goes to mass markets which require standard quantities. Twenty to thirty per cent of the market volumes are used in higher specialized market areas which require an upgrade and mixing of the compost in order to meet the specific requirements of the customers.

The following table presents the surface area (ha) of utilized agricultural and other land, by categories in Southwest Region (data from Census of Agriculture 2007), where compost could be utilized.

Table 2-11: Surface area of utilized agricultural and other land, by categories in project area (Census of Agriculture 2007)

Type of land	Surface area (ha)
Total utilized agricultural land, ha*	19,924.12
Utilized agricultural land, arable land and gardens and kitchen gardens, ha	12,356.74
Utilized agricultural land, meadows, ha	4,795.01
Utilized agricultural land, pastures, ha	1,532.12
Utilized agricultural land, orchards-total, ha	878.13
Utilized agricultural land, vineyards-total, ha	355.85
Utilized agricultural land, nurseries and osier for basket-weaving etc., ha	6.27
Other land, total, ha	266
Other land, of that unutilized agricultural land, ha	3,415
Other land, of that wooded area, ha	1,592

*Total utilized agricultural land, ha: Include arable land and gardens + kitchen garden + meadows + pastures + orchards (total) + vineyards (total) + nurseries

Compost classifications

The classification system for compost, based on the EU regulation on by-products and end-of-waste status is presented at the following table:

Table 2-12: Classification System for compost

Parameter	Limit values in compost		
	Class I	Class II	Class III
	mg / kg dry matter		
Cadmium (Cd)	0.7	1	3
Chromium (Cr)	70	150	250
Mercury (Hg)	0.4	0.7	3
Nickel (Ni)	25	60	100
Lead (Pb)	45	120	200
Copper (Cu)	70	150	500
Zinc (Zn)	200	500	1800
PAU	-	-	6
PCB	-	-	1

Permitted uses of the produced compost according to the class belonging is the following:

Compost Class I: is designed for use in organic production in accordance with the special regulations for organic production and use in agriculture in accordance with the special regulations for fertilizers and soil improvers;
Compost Class II: is designed for use in agriculture in accordance with the special regulations for fertilizers and soil;
Compost Class III: is designed for use on the ground that is not used for food production, the forest and decorated park land, for the purposes of planning and land reclamation and for the final layer for landfills recultivation.

Finally, when choosing technical and technological solutions such as mechanical-biological treatment of mixed municipal waste and non-hazardous waste (input material in the mechanical-biological treatment) in which the process produce compost, is necessary to consider the following:

- ✓ Compost produced after a. biological treatment of source separated biodegradable waste, b. biological treatment of mixed municipal waste.
- ✓ Criterion for processing is the AT4 respiration index: The AT4 is a static respiration index (SRI) test, also used to calculate the oxygen consumption of a sample over a period of time. The index determines the biological stability of compost or other organic materials, and is an additional test to prove the maturity of the material being tested. For the landfill disposal procedure D1 (disposal of waste in or on the ground) must be ensured that:
  - AT4 ≤ 10 mg O2 / g dry mater by 31 December 2019
  - AT4 ≤ 7 mg O2 / g dry mater from 01 January 2020

Waste that has been stabilized to this standard is assigned a BMW factor of zero.
Note: AT4 is an analytical method that needs to be carried out according to BS EN 15590: 2011 Solid recovered fuels - Determination of the current value of aerobic bacterial activity using the real dynamic respiration index (BS EN 15590: 2011).

2.4.3 Identification of immediate national possibilities for recyclables

The processing of quality secondary materials is needed to ensure the sustainability of the recycling sector i.e. through source separated collection and imposing standards for the processing of packaging waste. Pakomak is the first company in the Beneficiary country, licensed by the Ministry of environment for selection and processing of packaging waste.

The recyclables derived from the recovery of mechanical treatment of mixed waste can add benefit to the recycling industry and used as a substitute for raw materials to reinforce the local manufacturing industry, as well as the financial conditions of the area. Industrial activities that use recyclables as raw materials in their processes regard paper manufacturing, glass manufacturing and steel manufacturing.

In particular, other indicative applications of recyclables in industry refer to:

- ✓ Installations for the production of iron or steel
- ✓ Ferrous metal foundries and melting installations
- ✓ Installations for surface treatment of metal and plastic materials electrolytic or chemical process
- ✓ Installations of Mineral industry
- ✓ Wood and paper industries
- ✓ Other facilities

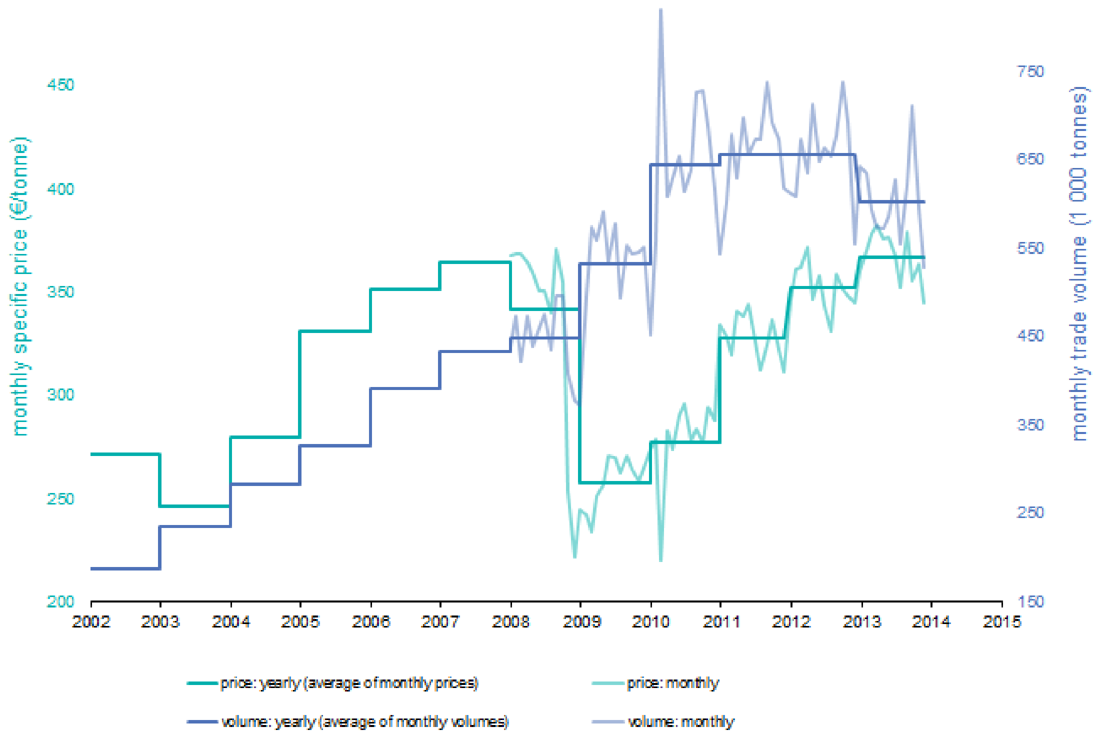
The conditions exist for an increased use of secondary raw materials in the manufacture of new packaging due to the good quality and sufficient quantities available.

The graph below shows annual averages of monthly prices and volumes of plastic waste in the EU28 countries, given from 2002 to 2013, according to the website www.letsrecycle.com. From 2009 only, the data is also displayed on a monthly basis to highlight fluctuations in the data (transparent lines).

The traded volume (blue line) tripled over the reported period from the year 2002 to 2012 from approximately 180 000 tons/month to nearly 650 000 tons/month. The monthly data (transparent blue line) show a volatile steady increase until 2011/2012. 2013 was the first year since 2002 in which the annual trade volume did not grow and the trade volume 2013 was lower than the year before. Within a year the volatility is also significant. For 2013 the monthly average for the whole year is approximately 600 ktons. We observe a spike in September 2013 of approximately 710 ktons and a drop to 523 ktons in December 2013.

The price of plastic waste depends on one hand on the supply and demand of plastic waste material and on the other hand on crude oil price which strongly influences the price of the virgin (primary) material. The indicator (turquoise line) shows a decrease in the price of plastic waste between 2003/2004. Since 2004 the price has increased to levels above 350 €/t. In 2009 the indicator shows a sharp decline down to 234€/t in March 2009. Afterwards the price recovered with the exception of March 2010 when the lowest price in the decade with 220€/t is shown (monthly data in transparent turquoise line). Finally, the price recovered to the price level of 2007 with around 370€/t.

Figure 2-4: Price developments of plastic waste EU-28 (€ / ton).

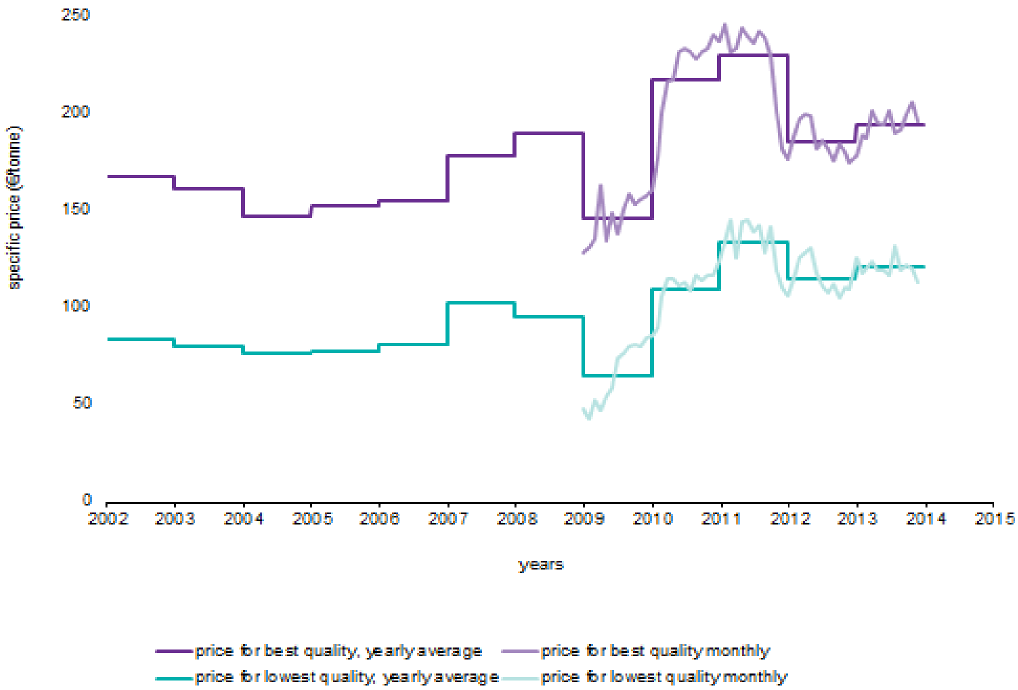


(Source:http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Price_indicator_and_trade_volume_for_plastic_waste_in_EU-28_till_December2013_update3.PNG)

For paper and plastics more than one foreign trade statistics code is used for the calculation of the price indicator. The different codes describe secondary materials, which may include industrial residues of high quality or separately collected waste. Next Figure illustrates the difference in price and the corresponding development over time. As an example the trade positions of paper waste with the highest (code 47072000) and lowest (code 47079010) price were chosen.

The difference in price between the lowest and highest quality remains fairly constant. In other words, both prices appear to develop in parallel. The observation of trade volumes gives a similar picture. Therefore it is reasonable to calculate only one price indicator for paper.

Figure 2-5: Price development of low and high quality paper waste in EU-28 until December 2013



(Source:http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Price_development_for_low_and_high_quality_paper_waste_in_EU-28_till_December2013_update4.PNG)

Overall, local separation of the recyclable stream and delivery to a commercial buyer will remain only opportunistic in nature and cannot be relied upon in terms of stability of revenues or cost. Another factor to consider is that buyers need large consistent amounts of recyclables to be viable; they want guarantees that the materials will always be available in the quantities required.

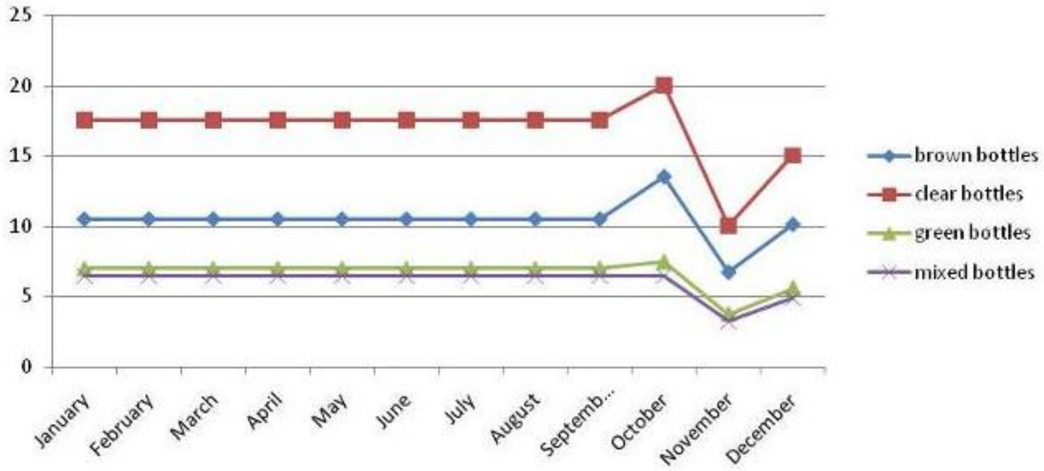
Local Authorities cannot guarantee this. Setting up public private partnerships, or making contracts with private companies can help local authorities achieve 100% waste collection. However municipalities may need assistance to ensure appropriate contracts are established and are supported by legislation.

Development in the sectors of collection and recycling create business and employment opportunities. Development of the local market to take recyclables is a key opportunity to help support the establishment of a viable recycling sector.

The following graph presents the fluctuation of glass prices in UK for the year 2016, according to the website www.letsrecycle.com. It must be noted that the prices shown are for tonnages of container glass (essentially bottles and jars) delivered to a cullet collector who will clean and sort the glass ready for use, or for further checking, by a glassmaker. The guide price for mixed glass typically reflects the sum that may be paid at the weighbridge by the aggregates sector and some glass industry recyclers for the mixed material. It must also be taken into account that the quality of mixed glass varies.

According to the website, some believe that including glass in commingled collections makes it harder to separate from other materials at MRFs, meaning for some that MRF glass is not of such a high quality compared to separated mixed glass.

Figure 2-6: Average Glass prices, £ per tonne, 2016



(Source: http://www.letsrecycle.com/prices/glass/glassprices2016/)

According to the site www.letsrecycle.com, UK glass manufacturers prize clear glass most highly because, while most glass made in the UK is clear, by far the largest proportion of the glass waste stream is green. For this reason, green is prized the least. Completely mixed glass cannot be used in the container re-melt industry, where colour purity is vital, and must instead go to alternative uses such as aggregates. However, companies abroad in wine-producing countries such as Italy, Spain and Portugal are willing to import mixed glass to process green container glass. These countries are the main recipients of exported UK glass, which is then used to create wine bottles. For mixed and clear glass, comparative prices are presented in the table below for years 2016 and 2015.

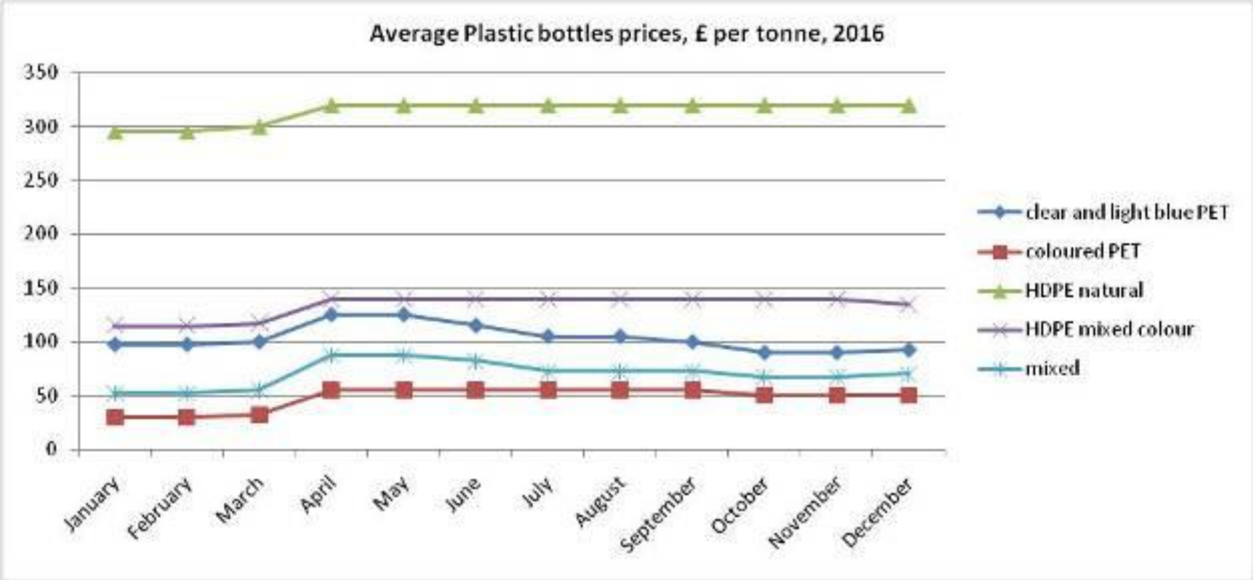
Table 2-13: Mixed and Clear Glass prices, £ per ton, 2016-2015

	2016				2015			
MONTH	**MIXED GLASS**		**CLEAR GLASS**		**MIXED GLASS**		**CLEAR GLASS**	
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
J	0	13	10	25	-10	10	14	23
F	0	13	10	25	-15	10	16	25
M	0	13	10	25	-30	10	16	25
A	0	13	10	25	-30	10	16	25
M	0	13	10	25	-30	10	16	25
J	0	15	12	25	-25	10	16	25
J	0	15	13	23	-30	15	16	25
A	0	15	15	25	-33	15	16	25
S	0	13	15	25	-33	15	16	25
O	0	13	15	25	-35	11	14	22
N	0	13	15	25	-31	9	14	22
D	4	17	17	27	-30	10	15	23
AVERAGE	0	14	13	25	-28	11	15	24

(Source: http://www.letsrecycle.com/prices/glass/glass-prices)

The following graph presents the fluctuation of plastic bottle prices for the year 2016, according to the website www.letsrecycle.com. According to the site, reprocessors will normally only accept material in baled form. The current preferred bale form is 1.8m x 1.2m x 1m, with larger bales too big to be handled by reprocessors' bale-breaking equipment and smaller balers difficult to store. Bales should be compacted to a density which ensures safe stacking, loading and transport and allows for separation of the bales once the strapping is removed. There is variation in bale weights depending on polymer type. Based on the specified bale dimensions, bales should weigh between 200- 325 kg. There are limitations to the maximum bale density which some reprocessors can accept. Only plastic bottle materials shall be baled. Other materials such as cardboard end pieces or plastic film wrapping should not be used.

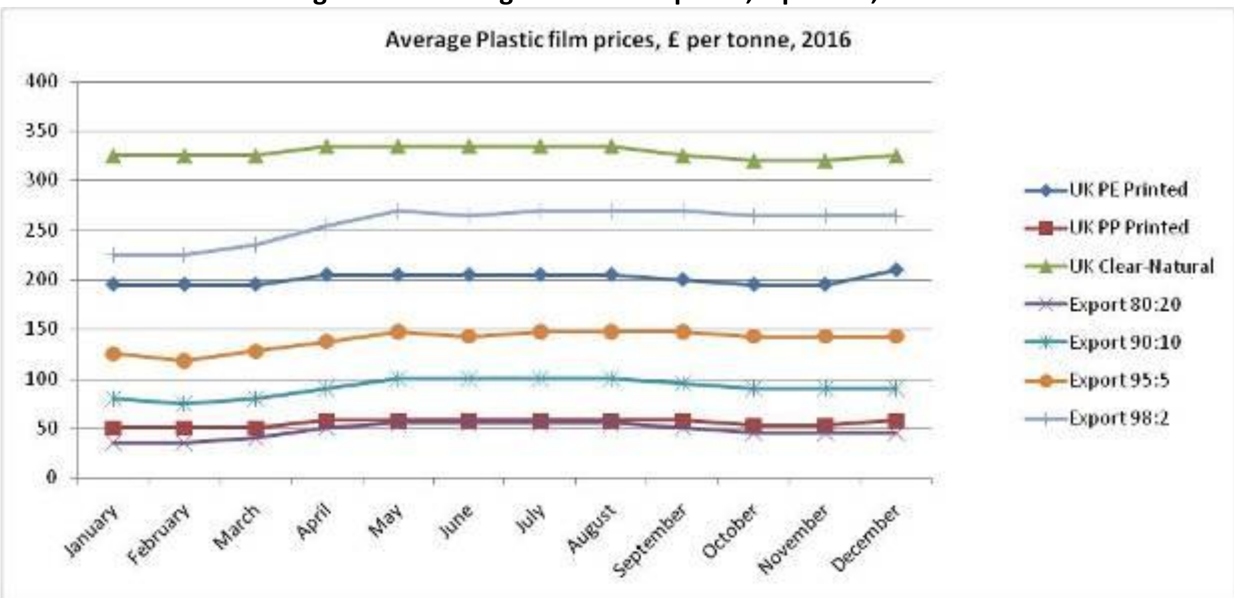
Figure 2-7: Average Plastic bottle prices, £ per ton, 2016



(Source: http://www.letsrecycle.com/prices/plastics/plasticbottles/plasticbottles2016/)

Regarding plastic films, two main types of plastic film are traded within the UK and most of the film is exported for processing, and in particular to China. While hand-sorting and processing is carried out overseas and some contaminated material will still be recycled, the general principle for plastic film recycling is that the material should be as clean and contaminant-free as possible. Material is usually expected to be baled in various grades, including natural and jazz; weights are either light or heavy; and in various grades of contamination, from little through to heavily contaminated.

Figure 2-8: Average Plastic film prices, £ per ton, 2016



(Source: http://www.letsrecycle.com/prices/plastics/plasticfilm/plasticfilm2016/1/)

For mixed plastic bottles and plastic film (PP-PE printed), comparative prices are presented in the table below for years 2016 and 2015.

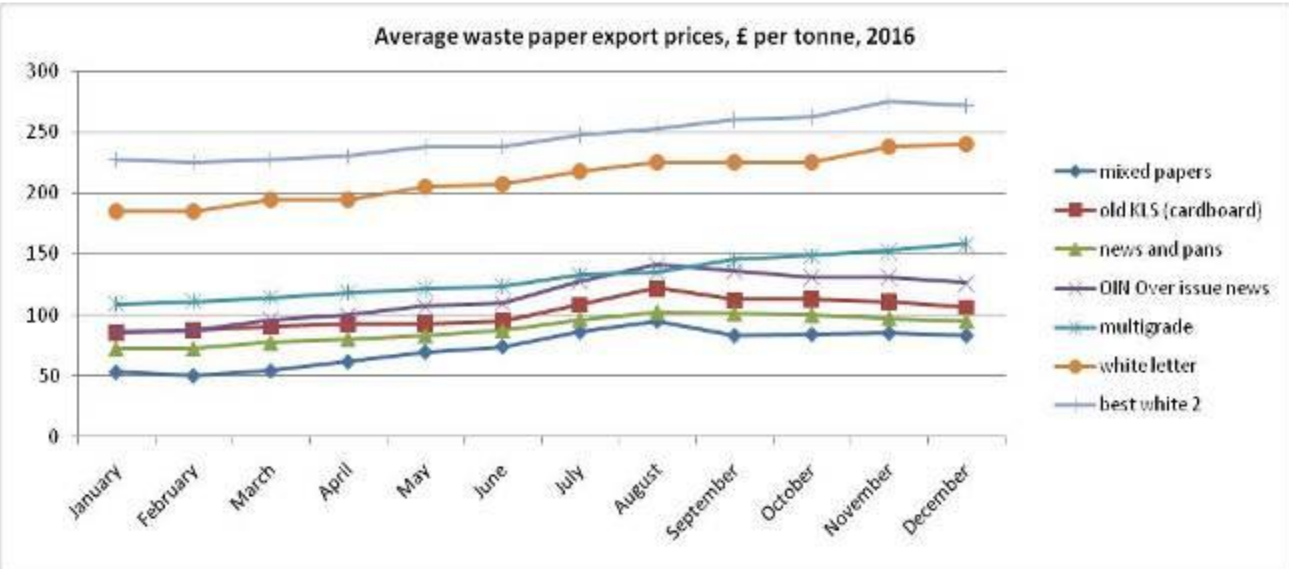
Table 2-14: Plastic bottles and PP-PE printed prices, £ per ton, 2016-2015

MONTH	2016						2015					
	PLASTIC BOTTLES (MIXED)		PE Printed		PP Printed		PLASTIC BOTTLES (MIXED)		PE Printed		PP Printed	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
J	30	75	180	210	35	65	65	105	210	230	65	85
F	30	75	180	210	35	65	70	110	210	240	65	85
M	30	80	180	210	35	65	70	110	210	240	65	85
A	55	120	190	220	45	70	70	110	210	240	65	85
M	55	120	190	220	45	70	80	120	220	250	75	95
J	50	115	190	220	45	70	80	120	225	255	80	100
J	40	105	190	220	45	70	80	120	225	255	80	100
A	40	105	190	220	45	70	50	90	210	235	60	85
S	40	105	185	215	45	70	35	75	200	230	45	65
O	35	100	180	210	40	65	35	75	200	230	45	65
N	35	100	180	210	40	65	35	75	200	230	45	65
D	40	100	195	225	45	70	35	75	200	230	45	65
AVERAGE	**40**	**100**	**186**	**216**	**42**	**68**	**59**	**99**	**210**	**239**	**61**	**82**

(Source: http://www.letsrecycle.com/prices/plastics)

The following waste paper export guide prices, compiled by letsrecycle.com, – in £ per ton – indicate what may be paid for material but are not guaranteed. Price indicators are for material ex work, usually baled or supplied to a mill specification. In January 1999 UK paper mills and suppliers started to adopt the new European Standard grade list compiled by the Confederation of European Paper Industries (CEPI) which was used as the basis for the revision of the European Standard EN 643. There was much discussion in the UK in 2003 over the use of material collected on a commingled basis from households. By 2010 it appeared that most UK paper mills using material from the domestic stream were taking in some material from commingled collections.

Figure 2-9: Average Waste paper export prices, £ per ton, 2016



(Source: http://www.letsrecycle.com/prices/wastepaper/exportprices/2016exportprices/)

For mixed paper and cardboard, comparative prices are presented in the table below, for years 2016 and 2015.

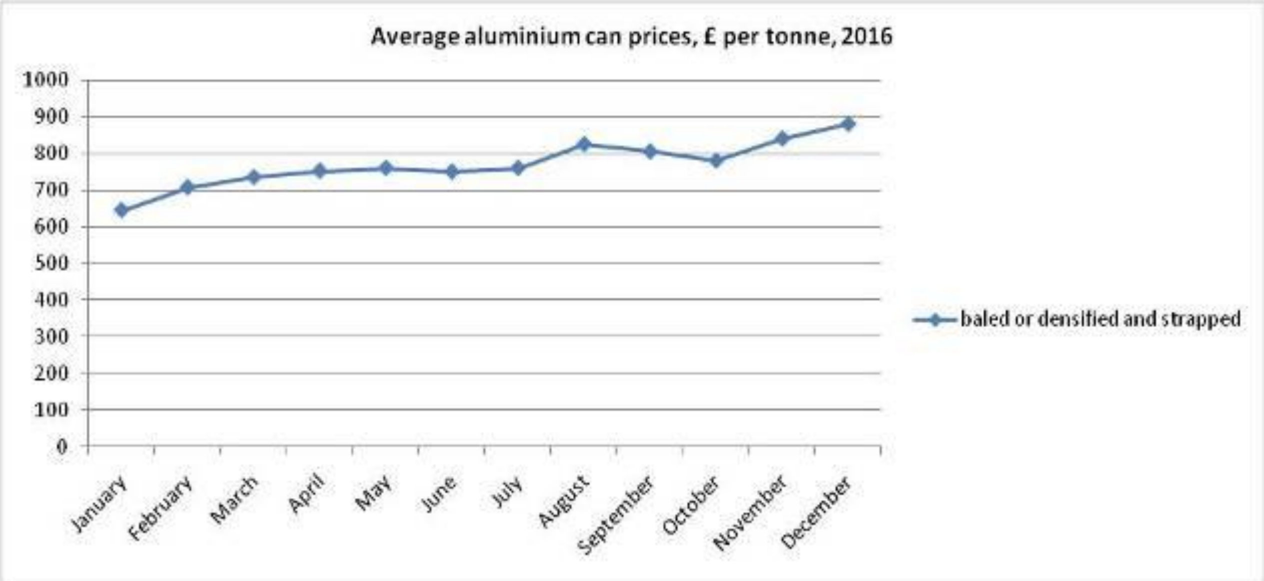
Table 2-15: Mixed paper and cardboard prices, £ per ton, 2016-2015

MONTH	2016				2015			
	MIXED PAPER		CARDBOARD		MIXED PAPER		CARDBOARD	
	Low	High	Low	High	Low	High	Low	High
J	50	56	83	88	47	55	77	80
F	46	54	85	90	46	52	74	78
M	48	60	87	94	45	50	78	80
A	56	67	90	95	46	53	79	82
M	65	74	90	96	47	57	82	90
J	70	78	94	96	55	66	86	92
J	80	92	105	112	60	73	83	91
A	90	100	119	125	60	68	82	87
S	78	88	110	115	55	67	81	86
O	80	88	111	115	55	71	80	85
N	80	90	108	114	55	69	80	84
D	78	88	102	111	55	62	81	84
AVERAGE	**68**	**78**	**99**	**104**	**52**	**62**	**80**	**85**

(Source:http://www.letsrecycle.com/prices/waste-paper/export-prices)

The following aluminum cans prices, compiled by letsrecycle.com, – in £ per ton, serve as an indicator to current markets, but are not guaranteed. The following graph presents aluminum can prices for year 2016.

Figure 2-10: Average Aluminum cans prices, £ per tonne, 2016



(Source: http://www.letsrecycle.com/prices/metals/aluminium-cans/aluminium-can-prices-2014)

For aluminum cans, comparative prices are presented in the table below, for years 2016 and 2015.

Table 2-16: Aluminum cans prices, £ per ton, 2016-2015

MONTH	2016		2015	
	Low	High	Low	High
J	620	670	740	810
F	675	740	720	810
M	700	770	740	820
A	730	775	740	820
M	740	780	755	835
J	730	770	700	770
J	740	780	640	680
A	800	850	625	660
S	780	830	580	640
O	760	800	590	630
N	820	860	610	660
D	860	900	620	670
AVERAGE	**746**	**794**	**672**	**734**

Table of Contents

List of tables

List of figures

3. SOCIO-ECONOMIC CONTEXT OF THE PROJECT

3.1 Permanent population - current status and future projections

According to the data from the last Census of Population, Households and Dwellings in 2002, the Southwest Region had 221,546 inhabitants. According to the sixth edition of "Regions of the Republic of Macedonia, 2016" population estimates from the State Statistical Office, the overall population of Southwest Region has decreased (219,891 inhabitants), while the overall population of the country has slightly increased.

Table 3-1: Population of Southwest Region per municipality (Census 2002 and state statistical office estimation for 2015)

	Population 2002 (*)	Estimated population 2015
Vevchani	2,433	2,458
Debar	19,542	20,613
Debarca	5,507	4,082
Kichevo	56,734	57,107
Makedonski Brod	7,141	6,331
Ohrid	55,749	52,204
Plasnica	4,545	4,866
Struga	63,376	65,208
Centar Zhupa	6,519	7,022
Total	**221,546**	**219,891**

(*) The Nomenclature of Territorial Units for Statistics (NTES) has been followed

Table 3-2: Share (in %) of the urban and rural population per municipality, Census 2002 and 2015 estimation

	Population 2015	
	Share Urban %	Share Rural %
Vevchani	0.0%	100.0%
Debar	74.5%	25.5%
Debarca	0.0%	100.0%
Kichevo	56.0%	44.0%
Makedonski Brod	52.4%	47.6%
Ohrid	77.7%	22.3%
Plasnica	0.0%	100.0%
Struga	59.8%	40.2%
Centar Zhupa	0.0%	100.0%
Total	**59.2%**	**40.8%**

In order to proceed with the forecasting of the permanent population the indicators regarding urban and rural population from the United Nations have been taken into consideration.

Table 3-3: Average annual Rate of Change of the Urban and Rural population

	2016-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2046
Urban	0.24%	0.35%	0.41%	0.33%	0.20%	0.09%	0.00%
Rural	-0.38%	-0.79%	-1.23%	-1.50%	-1.62%	-1.73%	-1.82%

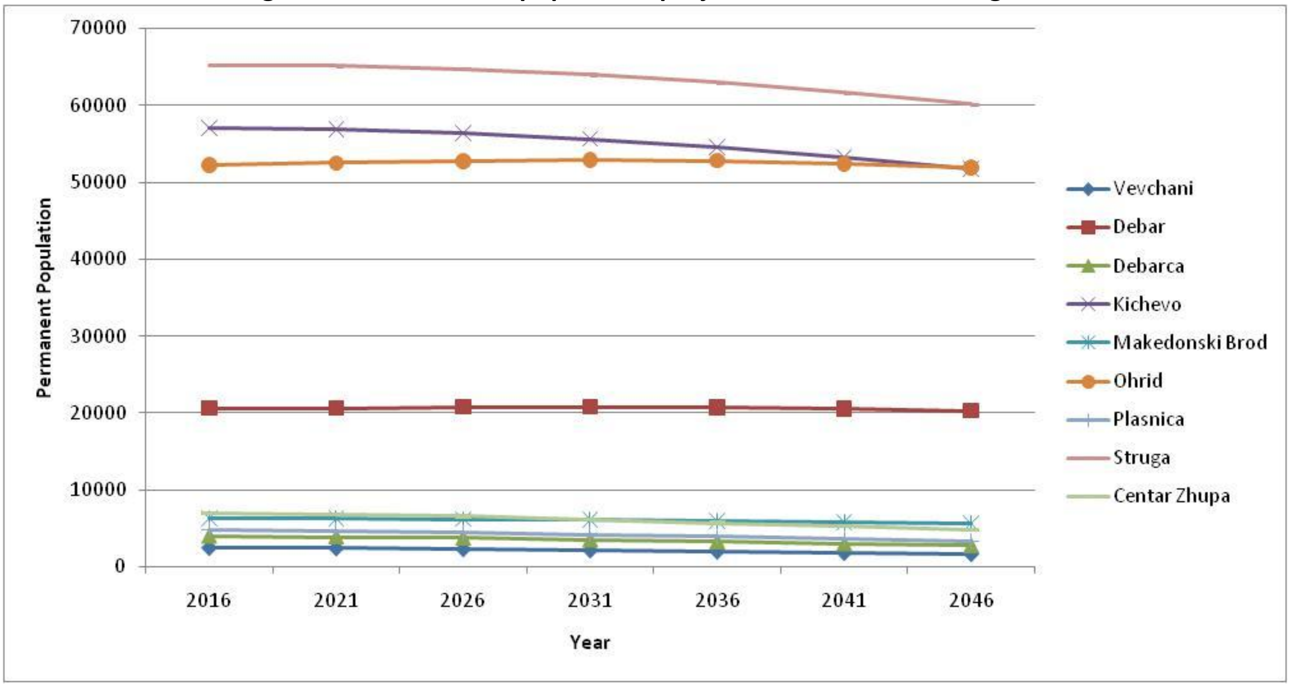
Source: United Nations, Department of Economic and Social Affairs, Population Division (http://esa.un.org/unpd/wup/DataQuery/)

The following table and figure present the forecast for the permanent population in each Municipality.

Table 3-4: Permanent population projection in Southwest Region (2016 - 2046)

Municipality	2016	2021	2026	2031	2036	2041	2046
Vevchani	2,449	2,393	2,289	2,146	1,987	1,830	1,675
Debar	20,630	20,699	20,773	20,802	20,731	20,558	20,300
Debarca	4,066	3,973	3,802	3,564	3,301	3,038	2,782
Kichevo	57,088	56,938	56,475	55,668	54,563	53,255	51,802
Makedonski Brod	6,328	6,303	6,237	6,130	5,989	5,827	5,650
Ohrid	52,257	52,527	52,788	52,941	52,843	52,483	51,909
Plasnica	4,848	4,737	4,532	4,249	3,935	3,622	3,316
Struga	65,202	65,118	64,738	64,009	62,944	61,631	60,135
Centar Zhupa	6,995	6,890	6,622	6,224	5,771	5,319	4,874
Total Southwest Region	**219,863**	**219,576**	**218,256**	**215,733**	**212,064**	**207,562**	**202,443**

Figure 3-1: Permanent population projection in Southwest Region



3.2 Seasonal population - Current state and projections

According to the data from the State Statistical Office of the Republic of Macedonia, the total number of overnights per municipality in Southwest Region for the year 2015, is presented at the following table.

Table 3-5: Total Number of Overnights in 2015 for Southwest Region

Municipality	Number of Nights spent (2015)
Vevchani	-
Debar	196,618
Debarca	-
Kichevo	9,141
Makedonski Brod	-
Ohrid	926,396
Plasnica	-
Struga	383,957
Centar Zhupa	60,000
Total	**1,576,112**

In order to calculate the forecasting of the seasonal population of Southwest Region, the indicators from the "National Tourism Strategy in Macedonia 2009-2013 (Realistic Scenario)" were taken into consideration (i.e. the average annual rate of change was calculated to be 4.40% from 2015 to 2021, 5.92% from 2021 to 2030 and constant from 2031 to 2046).
The following table and figure present the forecast of overnights.

Table 3-6: Overnight projection in Southwest Region (2016 - 2046)

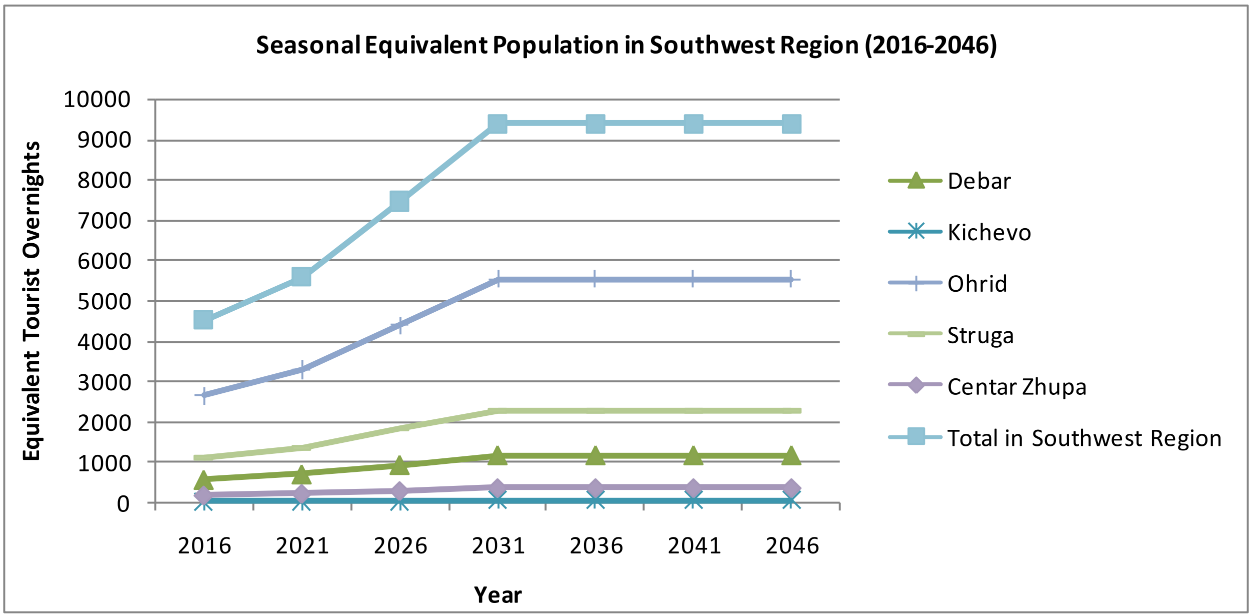
Municipality/tourists overnights	2016	2021	2026	2031	2036	2041	2046
Centar Zhupa	62,641	77,694	103,559	130,326	130,326	130,326	130,326
Debar	205,272	254,602	339,362	427,074	427,074	427,074	427,074
Debarca	0	0	0	0	0	0	0
Kichevo	9,543	11,837	15,777	19,855	19,855	19,855	19,855
Makedonski Brod	0	0	0	0	0	0	0
Ohrid	967,170	1,199,593	1,598,950	2,012,221	2,012,221	2,012,221	2,012,221
Plasnica	0	0	0	0	0	0	0
Struga	400,857	497,188	662,707	833,992	833,992	833,992	833,992
Vevchani	0	0	0	0	0	0	0
Total	**1,645,483**	**2,040,914**	**2,720,356**	**3,423,469**	**3,423,469**	**3,423,469**	**3,423,469**

The seasonal equivalent population that corresponds to the estimated nights spent is presented in the following table and figure.

Table 3-7: Seasonal equivalent population projection (2016 - 2046)

Municipality	2016	2021	2026	2031	2036	2041	2046
Centar Zhupa	172	213	284	357	357	357	357
Debar	562	698	930	1,170	1,170	1,170	1,170
Debarca	0	0	0	0	0	0	0
Kichevo	26	32	43	54	54	54	54
Makedonski Brod	0	0	0	0	0	0	0
Ohrid	2,650	3,287	4,381	5,513	5,513	5,513	5,513
Plasnica	0	0	0	0	0	0	0
Struga	1,098	1,362	1,816	2,285	2,285	2,285	2,285
Vevchani	0	0	0	0	0	0	0
Total in Southwest Region	**4,508**	**5,592**	**7,453**	**9,379**	**9,379**	**9,379**	**9,379**

Figure 3-2: Seasonal equivalent population projection in Southwest Region (2016 - 2046)



3.3 Households statistics

In the tables that follow, the Households statistics as well as the Households revenues are depicted.

Table 3-8: Households statistics, Southwest region, Census 2002 & Estimation 2016

	Total number of individual households (According to Census 2002)	Total number of household members (According to Census 2002)	Average size of household (Census 2002)	Total number of individual households (According to estimation 2016)
Vevchani	593	2,433	4.1	597
Debar	3,916	19,538	5.0	4,126
Debarca	1,995	5,507	2.8	1,452
Kichevo	8,330	30,138	3.6	15,858
Makedonski Brod	2,391	7,138	3.0	2,109
Ohrid	16,010	55,705	3.5	14,931
Plasnica	1,125	4,545	4.0	1,212

	Total number of individual households (According to Census 2002)	Total number of household members (According to Census 2002)	Average size of household (Census 2002)	Total number of individual households (According to estimation 2016)
Struga	14,485	63,376	4.4	14,819
Centar Zhupa	1,444	6,519	4.5	1,555
TOTAL	**50,289**	**194,899**	**3.9**	**56,659**

**Source: Project team estimations, Census 2002*

Table 3-9: Household revenues (MKD/HH)

Household revenues/ Covered Households	MKD/HH 2014	MKD/HH 2015
Vevchani	2,113	1,889
Debar	1,231	1,058
Debarca	2,403	2,584
Kichevo	2,242	2,162
Makedonski Brod	0	51
Ohrid	4,455	4,504
Plasnica	1,209	2,103
Struga	1,757	2,094
Centar Zhupa	0	0

3.4 Gross Domestic Product (GDP)

The following table presents the GDP per capita in denars for years 2010, 2011, 2012 and 2013 for Republic of Macedonia and for Southwest Region.

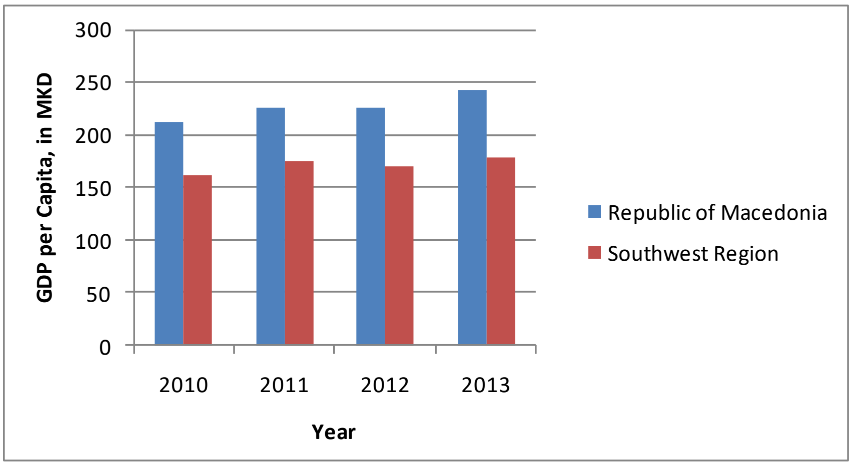
Table 3-10: GDP per Capita in MKD 2010-2013

Year	Republic of Macedonia	Southwest Region	
2010	212,795	161,492	75.9%
2011	225,493	174,509	77.4%
2012	226,440	170,493	75.3%
2013	243,161	178,726	73.5%

Source: State statistical office, Regions of the Republic of Macedonia 2015 and 2016

According to the data in the above table GPD per capita in Southwest Region for year 2010 is lower than the average GDP per capita in the Republic of Macedonia.

Figure 3-3: Gross domestic product per capita (in thousant MKD) for Republic of Macedonia and Southwest region



The GDP in million denars in the Republic of Macedonia and Southwest Region is presented in the following table:

Table 3-11: GDP in million denars 2010-2013

Year	Republic of Macedonia	Southwest Region	
2010	437,296	35,828	8.2%
2011	464,187	38,657	8.3%
2012	466,703	37,652	8.1%
2013	501,891	39,378	7.8%

Source: State statistical office of the Republic of Macedonia

Figure 3-4: Gross domestic product in million denars for Republic of Macedonia and Southwest region

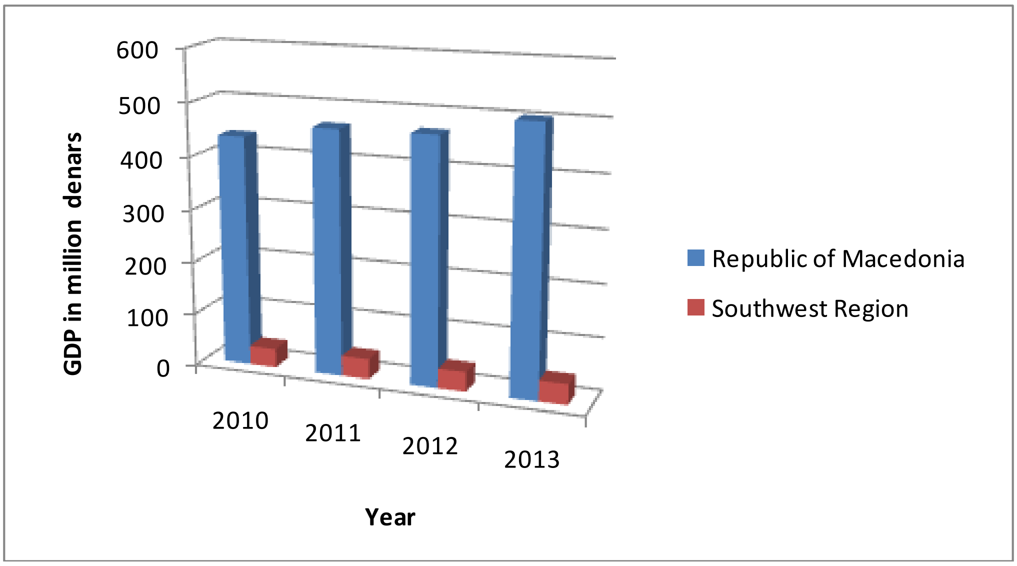


Table 3-12: Gross value added, by Sector of activity, by year, in million MKD (% of total for the year)

	Republic of Macedonia			Southwest region		
	2011	2012	2013	2011	2012	2013
Total	**399,376**	**403,684**	**436,706**	**33,259**	**32,568**	**34,264**
Agriculture, forestry and fishing	43,405	42,493	50,327	2,505	1,864	2,241
Mining, manufacturing, electricity, gas and water supply, sewerage, waste management, remediation activities	76,013	71,689	75,397	6,872	6,163	5,172
Construction	24,215	26,695	35,725	2,310	2,264	3,076
Wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage; accommodation and food service activities	79,423	78,150	92,403	7,178	7,405	8,681
Information and communication	15,942	16,167	16,177	240	116	89
Financial and insurance activities	11,327	13,542	13,863	521	677	692
Real estate activities	56,665	59,862	60,259	6,764	7,267	7,355
Professional, scientific and technical activities; administrative and support service activities	14,371	14,852	16,058	874	652	605
Public administration and defence; compulsory social security; education; human health and social work activities	66,496	69,317	64,277	5,307	5,458	5,455
RSTU Arts, entertainment and recreation, repair of household good and other services	11,518	10,917	12,221	689	702	897

Source: State Statistical Office, regional yearbook 2016

Available income by income decile

The annual publication "Household Consumption in the Republic of Macedonia" provides data for the average household income and the ten decile groups of the Republic of Macedonia.

According to the State Statistical Office the average annual income per household in the Republic of Macedonia for 2014 and 2015 is 336,289 MKD and 360,198MKD respectively. Data concerning the income in Southwest region are not provided from the State Statistical Office. In order to estimate the average annual income per household for years 2014 and 2015 in this region, the proportion of Southwest Region GDP in country's GDP was used.

Table 3-13: Total available assets on average, per household for 2014, MKD

		Decile groups by available assets						
	average	first	third	fourth	fifth	sixth	eighth	tenth
AVAILABLE ASSETS	**336,289**	**65,864**	**163,881**	**210,946**	**250,712**	**303,662**	**449,582**	**853,714**
Monetary income	320,318	63,534	155,338	195,626	237,658	288,378	431,615	817,852
Income on the basis of regular work	205,646	5,307	54,377	77,902	148,055	188,140	330,959	593,119
Income on the basis of part-time work	11,413	14,293	15,746	14,718	14,870	3,319	16,323	5,647
Income on the basis of pension scheme	68,308	25,936	65,011	73,499	52,516	72,198	62,144	105,423

		Decile groups by available assets						
	average	first	third	fourth	fifth	sixth	eighth	tenth
Other income on the basis of social insurance	5,002	12,151	1,914	6,828	1,895	3,442	4,258	3,550
Income from abroad	8,637	2,038	10,245	10,090	11,626	3,967	5,165	28,097
Net income from agriculture	16,180	585	2,997	4,604	3,250	11,473	8,894	80,113
Property renting and selling	883	342	-	313	1,366	944	-	1,538
Donations, gifts and similar contributions	560	1,419	33	294	344	508	-	-
Loans (Borrowings)	290	11	299	9	-	-	-	-
Savings decrease	3,398	1,452	4,715	7,368	3,737	4,388	3,871	365
Other incomes	3	100	-	-	-	-	-	-

Source: State statistical office of the Republic of Macedonia

Figure 3-5: Household income in Republic of Macedonia and Southwest region in 2014 by decile groups

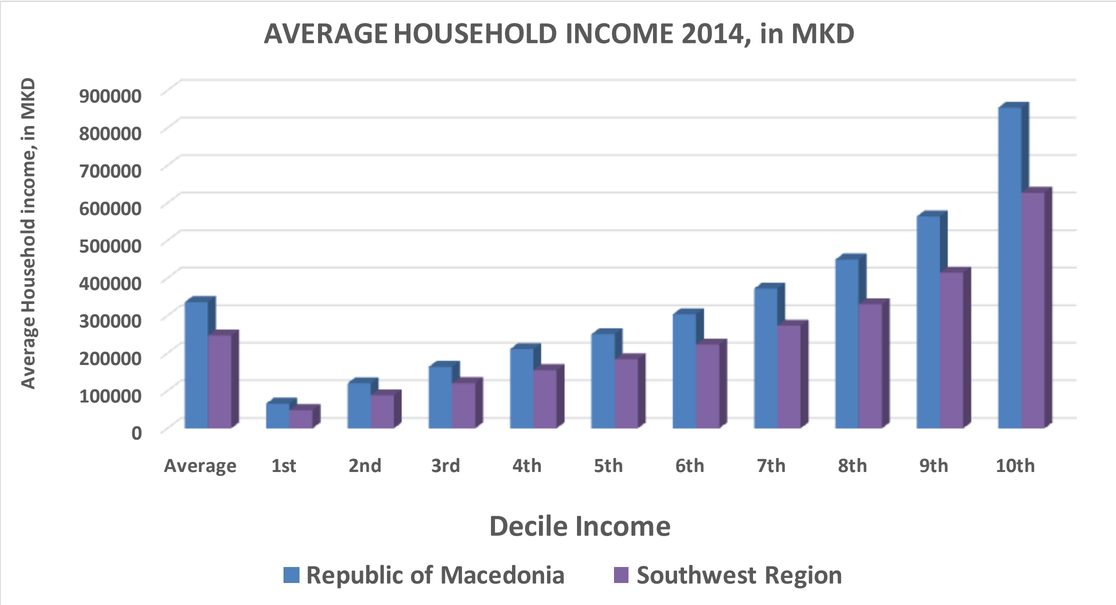
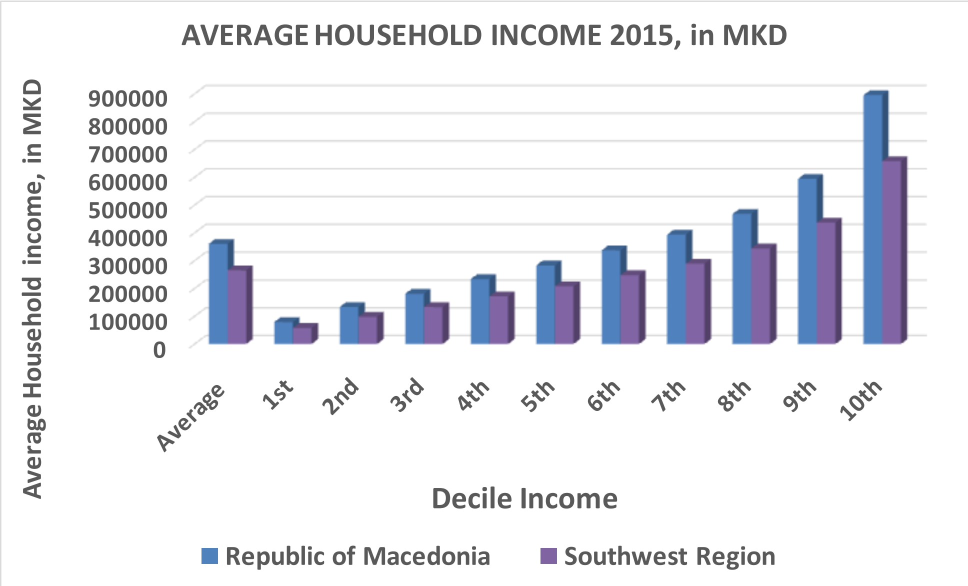


Table 3-14: Total available assets on average, per household for 2015, MKD

		Decile groups by available assets						
	average	**first**	**third**	**fourth**	**fifth**	**sixth**	**eighth**	**tenth**
AVAILABLE ASSETS	**360,198**	**78,654**	**180,524**	**233,329**	**282,486**	**336,780**	**467888**	**895,162**
Monetary income	349,430	77,065	172,689	228,908	273,561	326,705	455,419	862,925
Income on the basis of regular work	225,129	11,606	57,195	120,692	167,038	210,664	317,511	650,728
Income on the basis of part-time work	10,762	7,357	21,318	14,956	15,052	7,212	11,900	10,990
Income on the basis of pension scheme	71,774	34,913	63,879	75,097	56,686	76,934	83,245	89,642

		Decile groups by available assets						
	average	first	third	fourth	fifth	sixth	eighth	tenth
Other income on the basis of social insurance	6,413	11,379	7,041	4,145	4,774	5,009	5,580	6,749
Income from abroad	8,848	4,805	7,522	5,662	15,252	7,036	11,500	9,395
Net income from agriculture	16,648	344	5,357	2,481	5,676	8,932	15,356	80,495
Property renting and selling	1,947	-	506	1,323	29	566	3,573	7,772
Donations, gifts and similar contributions	1,687	2,455	3,778	411	2,323	2,904	1,291	596
Loans (Borrowings)	393	567	935	40	91	280	923	905
Savings decrease	5,769	3,638	5,158	4,100	6,271	7,169	4,540	5,652
Other incomes	60	-	-	-	370	-	-	-
Source: State Statistical Office								

Figure 3-6: Household income in Republic of Macedonia and Southwest region in 2015 by decile groups



Poverty indicators

In 2015, the State Statistical Office conducted the Survey on Income and Living Conditions 2015[1], which represents a source of data on poverty and social exclusion. Statistics on income and living conditions are an instrument for presenting comparable data on incomes, poverty, social exclusion and living conditions. The survey was the basis for calculating structural indicators for comparative analysis at the EU level, as well as for calculating the redistribution of income and the manifestation of poverty and social exclusion.

The "Survey on Income and Living Conditions", or EU SILC, was conducted under the regulations of the European Parliament and the Council (Regulation EC No. 1177/2003 as basis). These regulations include definitions, rules for the frame of the survey, sample, rules for monitoring households, lists of main and secondary variables, variables in terms of housing conditions, social and financial exclusion, material deprivation and other rules applied by all European countries. The survey was also conducted in

[1] http://www.stat.gov.mk/Publikacii/2.4.16.15.pdf

accordance with international classification systems. The main classifications used are ISCED 2001 for levels of education, ISCO 08 and NACE Rev.2 for economic activity. In the Republic of Macedonia, the survey was carried out based on Article 26 of the Law on State Statistics (Official Gazette of the Republic of Macedonia No. 54/97, 21/07, 51/11, 104/13 and 42/14) and the Programme for Statistical Surveys 2013-2017 (Official Gazette of the Republic of Macedonia No. 20/13, 24/14 and 13/15). Consequently, all work related to the SILC project was coordinated by Eurostat, which, in particular, provides guidelines on the methodology that is implemented in order to ensure comparability among countries.

Following Eurostat's recommendations, the State Statistical Office conducted the survey for the first time in 2009 as a pilot, and since 2010 has continued with the regular survey planned in the Work Programme of the State Statistical Office. Using data from SILC, the State Statistical Office produces the Laeken set of common European poverty indicators, so called after they were established at the European Council of December 2001.

The at-risk-of-poverty threshold, referred to as the at-risk-of-poverty line, is equivalent to 60 percent of the median national equivalised income of the persons living in the households. The main indicator, the at-risk-of-poverty rate, reflects the percentage of persons with an equivalised disposable income below the at-risk-of-poverty threshold. The "at-risk-of-poverty rate before social transfers" shows the percentage of persons with an equivalised disposable income before social transfers excluding also old-age benefits below the "at-risk-of-poverty threshold". Another indicator, the severe material deprivation rate is defined as the percentage of the population with an enforced lack of at least four out of nine material deprivation items in the "economic strain and durables" dimension.

As shown at the table below, according to the Survey data, on national level, the at-risk-of-poverty rate before social transfers and before pensions (in % of population) was 41.7 and 40.5 for years 2014 and 2015, respectively. The at-risk-of-poverty rate (in % of population) was 22.1 and 21.5 for years 2014 and 2015, respectively.

Table 3-15: Laeken Poverty Indicators - Poverty and social exclusion indicators, 2014-2015

	2014	2015
At-risk-of-poverty rate, % of population	22.1	21.5
Number of persons below at-risk-of-poverty threshold, in thousand persons	457.2	445.2
At-risk-of-poverty threshold of single-person household - annual equivalent income in denars	71,925	78,362
At-risk-of-poverty threshold of four-person household (2 adults and 2 children aged less than 14) - annual equivalent income in denars	151,043	164,560
At-risk-of-poverty rate before social transfers and before pensions, % of population	41.7	40.5
Inequality of income distribution S80/S20	7.2	6.6
Inequality of income distribution Gini coefficient	35.2	33.7

Furthermore, in 2015, there were 30.0% of persons living in households that made ends meet with great difficulty, 29.9% of persons living in households that made ends meet with some difficulty (only 0.7% of persons living in households that made ends meet very easily). Additionally, the severely materially deprived persons (in % of population) were 35.7 and 30.4 for years 2014 and 2015, respectively.

Table 3-16: Distribution of households according to the subjective opinion about the ability to make ends meet in urban and rural areas, 2014-2015 - structure

2014			2015			
All house-holds	Urban area	Rural area	All house-holds	Urban area	Rural area	
100.0	100.0	100.0	100.0	100.0	100.0	All households
32.9	31.0	35.3	30.0	30.5	29.3	With great difficulty
28.6	29.9	26.8	26.8	27.5	25.8	With difficulty
27.0	27.2	26.9	29.9	30.3	29.4	With some difficulty
7.6	8.5	6.4	9.0	8.5	9.8	Fairly easily
3.2	2.8	3.7	3.6	2.8	4.6	Easily
0.7^{U}	:	:	0.7^{U}	:	:	Very easily

Table 3-17: Severely materially deprived persons or percentage of population lacking at least 4 of 9 items in the economic strain and durables dimension, by age, 2013 - 2015

in percent			
	2013	2014	2015
Total	37.7	35.7	30.4
0-17	38.0	38.1*	31.6
18-64	37.4	35.3	30.0
65 and over	38.8	34.4*	30.8

3.5 Current tariffs

In this section are presented the current tariffs for residential and commercial users and then the residential tariffs are expressed as % of the average household income.

The following table present the tariffs for residential and commercial users for years 2014-2015.

Table 3-18: Current tariffs (MKD/t) for Southwest Region

Municipality	Tariffs for Household users, (MKD/t)		Tariffs for Commercial users, (MKD/t)	
	2014	2015	2014	2015
Kichevo	3.934	3.794	8.396	7.814
Ohrid	3.493	3.531	31.979	32.545
Debar	1.150	989	1.194	1.256
Struga	2.409	2.871	-	-
Debarca	6.189	6.655	2.950	3.137
Makedonski Brod	-	69	-	1.348
Plasnica	1.086	1.889	752	940
Centar Zhupa				
Vevchani	100	89	145	153

The following table presents the tariffs for residential users as the cost per Household (for years 2014-2015).

Table 3-19: Household tariffs MKD/HH

Municipality	MKD/HH 2014	MKD/HH 2015
Kichevo	2.242	2.162
Ohrid	4.455	4.504
Debar	1.231	1.058
Struga	1.757	2.094
Debarca	2.403	2.584
Makedonski Brod	-	51
Plasnica	1.209	2.103
CentarZhupa	-	-
Vevchani	2.113	1.889

Next, these costs are expressed as a percentage of average household income in Southwest Region.

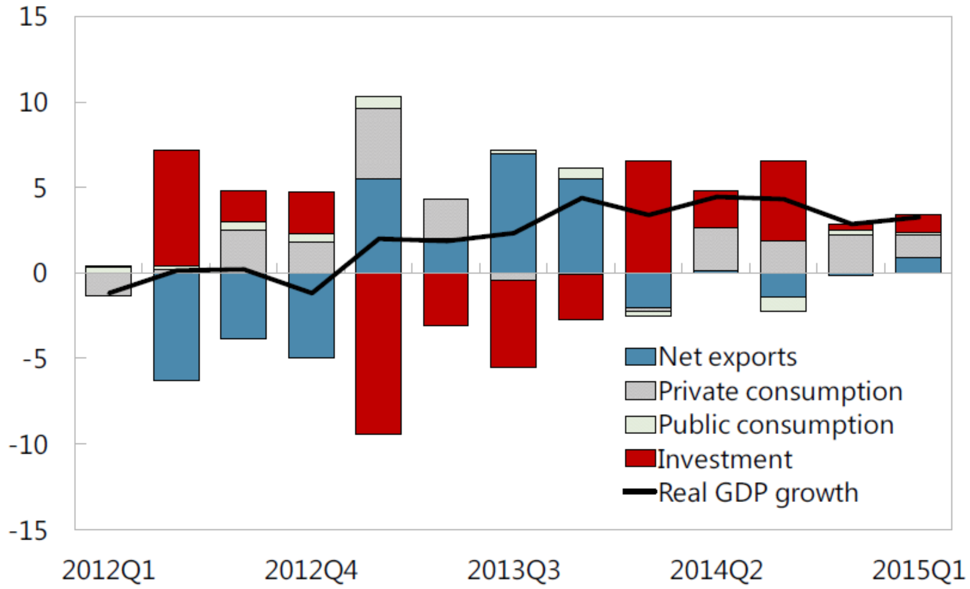
Table 3-20: Tariffs as a % of the average household income in Southwest region for the years 2014 and 2015

Municipality	Tariffs as a % of the average household income	
	2014	2015
Kichevo	0,91%	0,82%
Ohrid	1,80%	1,70%
Debar	0,50%	0,40%
Struga	0,71%	0,79%
Debarca	0,97%	0,98%
Makedonski Brod	-	0,02%
Plasnica	0,49%	0,79%
Centar Zhupa	-	-
Vevchani	0,85%	0,71%

3.6 Future economic development and affordability

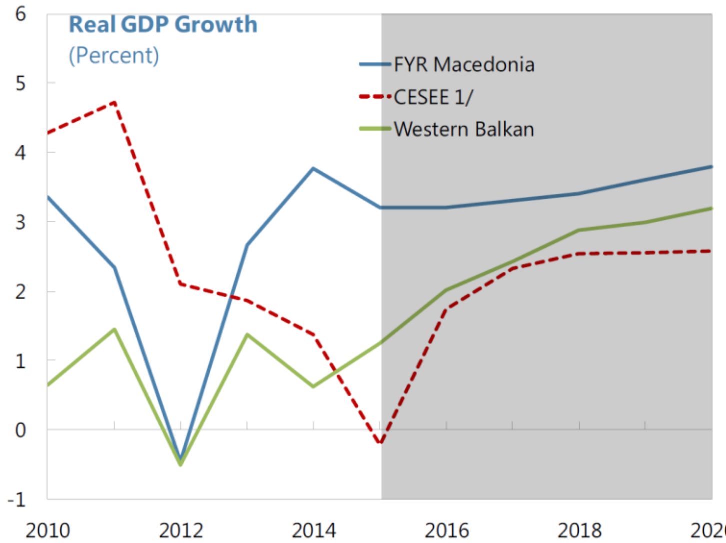
Real GDP growth accelerated in 2014 to 3.8% and strong growth continued in 2015-Q1. Double-digit growth in investment, and strong private consumption supported by credit growth and improved labour market conditions, boosted output. Favourable developments in exports, domestic demand and credit continued through the first quarter, but there are some incipient signs of slowdown since May. GDP growth was expected to remain broad-based but moderate to 3.2% in 2015, before gradually improving over the medium term. Some private investment plans, both domestic and foreign, are reportedly on hold until new elections, while private consumption is being affected by negative confidence effects. A projection of the Real GDP Growth is presented at Figure 3-8, for the years until 2020; growth seems to continue in the forthcoming years, until 2020.

Figure 3-7: Republic of Macedonia: Contribution to Real GDP Growth (Percent)



Source: IMF Country Report No. 15/242, International Monetary Fund

Figure 3-8: Republic of Macedonia: Real Sector Developments, 2010-2015



Source: IMF Country Report No. 15/242, International Monetary Fund

Table 3-21: Republic of Macedonia: Macroeconomic Framework, 2011-2020; (Year-on-year change, unless otherwise indicated)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
					Proj.					
Real GDP	2.3	-0.5	2.7	3.8	3.2	3.2	3.3	3.4	3.6	3.8
Real domestic demand	0.4	3.5	-2.6	4.2	3.8	3.5	3.1	3.1	3.2	3.2
Private consumption	-5.4	1.2	2.1	2.3	2.0	2.1	2.2	2.4	2.6	2.6
Gross investment	17.9	10.2	-16.6	13.5	7.5	6.5	5.6	5.4	5.0	5.0
Exports (volume)	16.1	2.0	-2.7	17.0	7.7	6.7	8.8	8.2	7.6	6.9
Imports (volume)	8.0	8.2	-10.0	14.5	7.7	6.5	7.1	6.7	6.1	5.3
Contributions to growth 1/										
Domestic demand	0.5	4.0	-3.1	5.1	4.3	4.0	3.5	3.6	3.7	3.6
Net exports	1.7	-3.9	5.0	-0.9	-1.1	-0.8	-0.2	-0.2	-0.1	0.2
Output gap (percent of potential GDP)	1.1	-2.1	-2.2	-1.4	-1.1	-0.8	-0.5	0.0	0.7	1.7
General government operations (percent of GDP)										
Revenues	29.4	29.4	28.0	27.6	29.1	29.1	28.9	28.9	28.9	28.9
Expenditures	31.9	33.3	31.8	31.8	33.1	33.0	32.4	32.4	32.4	32.4
Of which: capital	3.8	4.0	3.3	3.4	3.9	4.1	3.9	3.9	3.9	3.9
Balance	-2.5	-3.8	-3.9	-4.2	-4.0	-3.8	-3.5	-3.5	-3.5	-3.5
Savings and investment (percent of GDP)										
Domestic saving	24.4	26.0	26.7	29.2	30.2	30.6	31.0	31.4	31.3	31.0
Public	2.5	0.2	-0.5	-0.9	-0.1	0.2	0.4	0.4	0.4	0.4
Private	19.2	25.8	27.2	30.1	30.3	30.4	30.6	31.0	30.9	30.6
Foreign saving	2.5	2.9	1.8	1.3	3.2	4.4	4.3	3.8	3.6	3.5
Gross investment	26.9	28.9	28.5	30.6	33.4	35.0	35.3	35.2	34.9	34.5
Consumer prices										
Period average	3.9	3.3	2.8	-0.3	0.1	1.3	1.8	1.9	2.0	2.0
End-period	2.8	4.7	1.4	-0.4	0.8	1.7	1.8	2.0	2.0	2.0
Private sector credit growth	7.7	5.2	6.3	9.8	7.6	6.4	7.5	7.4	7.3	7.1
Memorandum items:										
Current account balance (percent of GDP)	-2.5	-2.9	-1.8	-1.3	-3.2	-4.4	-4.3	-3.8	-3.6	-3.5
Gross official reserves (millions of euros)	2,069	2,193	1,993	2,434	2,277	2,476	2,704	2,789	2,859	2,998
in percent of ST debt	112	101	107	116	111	121	118	121	134	133
in months of prospective imports	4.9	5.3	4.3	4.9	4.1	4.0	4.0	3.8	3.5	3.7
Gross general government debt (percent of GDP)	27.7	33.7	34.1	38.1	37.0	39.5	41.0	42.5	43.8	44.8
Public and publicly guaranteed debt (percent of GDP) 2	30.1	36.3	38.2	43.5	44.2	48.3	50.9	52.9	53.8	54.1
Foreign direct investment (percent of GDP)	4.6	1.5	3.3	3.3	3.1	3.1	3.4	3.6	3.7	3.8
External debt (percent of GDP)	64.2	68.2	64.3	69.8	68.3	72.2	75.6	76.1	75.9	75.6
Nominal GDP (billions of denars)	464	467	500	526	549	574	602	633	668	708
Nominal GDP (millions of euros)	7,544	7,585	8,112	8,533	8,912	9,322	9,776	10,278	10,844	11,481
GDP per capita (PPP, constant USD 2005)	9,356	9,323	...	...	...	...	...	...	...	...
Gini coefficient	39.2	...	...	...	...	...	...	...	...	...

Source: IMF Country Report No. 15/242, International Monetary Fund
Note: 1/ The inconsistency between Real GDP growth and contributions to growth results from discrepancies in the official data on GDP and its components.
Note: 2/ Including general government and public sector non-financial enterprises.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

4. WASTE CONTENT AND FUTURE GENERATION FORECAST

4.1 Morphological composition of the mixed municipal waste

Methodology

The waste quantity and composition directly influence the functioning of and the capacity required for all stages of an integrated MSW Management System (waste generation, temporary storage, collection, treatment, and disposal). Detailed information is provided in the Annex II "Morphological Composition of Waste" of the Assessment report of the Region.

The existing methodologies of waste quality evaluation can be divided in two categories:

- Direct evaluation methods: the waste quality evaluation takes place through sampling and analysis of the samples
- Indirect evaluation methods: the waste quality evaluation takes place indirectly through calculations, based either on macroeconomics (i.e. production and consumption of goods) or on micro economics (i.e. consumption of goods per house) etc.

The quantitative characteristics of waste are equally important to the qualitative characteristics, as the viability of all management systems is directly connected to waste quality and quantity data.

In the case of the current study, the direct evaluation method was used for the qualitative analysis. In the following paragraphs the methodology applied is described in more detail. The standards used for the determination of waste composition analysis are presented in the following table.

Table 4-1: Standards for waste composition analysis

CEN/TR 15310-1: 2008	Characterization of waste - Sampling of waste materials - Part 1: Guidelines for selection and application of criteria for sampling under various conditions (CEN / TR 15310-1: 2006)	The standard was published in the Journal of the CSI No.6 / 2008 dated 31.12.2008.
CEN/TR 15310-2: 2008	Characterization of waste - Sampling of waste materials - Part 2: Guidance on sampling techniques (ISO / TR 15310-2: 2006)	The standard was published in the Journal of the CSI No.6 / 2008 dated 31.12.2008.
CEN/TR 15310-3: 2008	Characterization of waste - Sampling of waste materials - Part 3: Guidance on procedures for sub field (CEN / TR 15310-3: 2006)	The standard was published in the Journal of the CSI No.6 / 2008 dated 31.12.2008.
CEN/TR 15310-4: 2008	Characterization of waste - Sampling of waste materials - Part 4: Guidance on procedures for packaging, storage, preservation, transport and delivery of samples (ISO / TR 15310-4: 2006)	The standard was published in the Journal of the CSI No.6 / 2008 dated 31.12.2008.
CEN/TR 15310-5: 2008	Characterization of waste - Sampling of waste materials - Part 5: Guidelines for the Preparation of the sampling plan (CEN / TR 15310-5: 2006)	The standard was published in the Journal of the CSI No.6 / 2008 dated 31.12.2008.
EN 14899: 2007	Characterization of waste - Sampling of waste materials - Framework for the preparation and implementation of a sampling plan (EN 14899: 2005)	The standard is published in the official bulletin of the CSI 1/2007 of 28.2.2007.

Sampling areas

Each sampling area was selected in such way, that the samples collection procedure was easy to be implemented due to the existence of common waste producing sources (houses, stores etc).

For the purpose of sampling and analysis of morphological composition of waste on municipality level in the region, it was necessary to bring waste samples of approximately 300 kg in weight to the site for analysis. Local representatives in cooperation with technical supervisors determined that samples will be taken from two types of urban zone (individual and collective housing) as well as rural part of the regions:

- urban zone I –collective housing and commercial areas (settlements with blocks of residential buildings);
- urban zone II – individual houses (settlements with houses that own yard /garden, situated in the urban zone), and
- rural zones – within the municipalities (settlements with houses that own yard / garden, situated in a rural zone of the municipality).

Sampling procedure

Waste sampling and sorting was carried out in two seasons, to capture seasonal variations in consumption and waste generation. Events, such as Christmas and other festivities, leading to abnormal waste generation patterns were avoided.

At least two samples were taken and sorted/analysed in each sampling area for each one of the sampling period analysis. One of these samples was from waste collected during a week day and the other during a weekend day.

Samples were collected either in the landfill area, or from another area indicated from municipality. The collection method was determined in such way, that the sample was really “representative” of the respective “sampling area”.

The collected data were recorded in a sampling protocol, which included information such as: Date and time of sampling, Name of sampling area, Comments. The collected samples after sampling procedure were delivered to sorting.

Figure 4-1: Southwest Region/Qualitative analysis

Sorting equipment

The equipment needed for the properly conduct the process of waste sorting included:

- ✓ Electronic scale.
- ✓ Waste bins
- ✓ One level grid.
- ✓ Support tools (shovels, brooms, rakes, plastic, scissors, knives for cutting bags, etc.).

Health and Safety equipment

Employees on sorting process were provided with special training and special attention to their care during work. All personnel health protection and safety standards are according to ISO 10831-3:2001.

Comprehensively, the following safety equipment was used: Gloves, Eye protection, Masks, Boots, and Overalls.

Sorting procedure

The desired mass of approximately 300 kg was reached by collecting waste from bins of 60 l volume. For the operations of sorting and analysis of morphological composition of waste no more than 3-5 workers needed, one technical staff, and an engineer who was in charge for supervision of the process. Waste was separated manually in different fractions. The results of waste amounts divided into categories, were listed in kg, as the total quantity of the sample and the share of each type of waste in the total amount (given in percentages).

More analytically, after the necessary conditions were met and the all necessary equipment was provided, sampling and sorting process and determining the composition of waste started as follows:

- Samples from each zone within municipality had a mass of approximately 300 kg.
- There was a selection of streets that best represent each living sector.
- In the street, bins/containers were randomly chosen, and their contents were emptied into the truck.
- After collecting the required samples, waste trucks from all sectors were brought to location for sorting and analysis.
- Total amount of sample collected waste in one truck was analysed.
- All samples were manually sorted, according to provided waste catalogue.

After discharging the waste load on the discharging area (either paved floor or plastic membrane), where mixing with other waste cannot take place, the waste bags were opened, the waste released from the bags and then mixed thoroughly. To facilitate the sorting, a representative sub-sample of about 300 kg was selected from the mixed waste using the coning and quartering technique. The sorting categories are defined clearly and are explained to the sorting staff.

After sorting, the weight and volume of each fraction were measured, and the share in the total subsample determined. After this procedure, the residual wastes were disposed of in the landfill.

The structure of waste separation categories is presented below:

Table 4-2: Waste separation categories

Waste category	Examples
Garden Waste	Cut grass, weeds, flowers, twigs, branches, leaves, remnants of hedges etc.
Other Biodegradable waste	Food waste - all kinds (bread, meat, vegetables, fruits, pastries...),
Paper	Old newspapers, advertisements on paper, envelopes, computer prints, diaries, posters, books, notebooks, bus tickets, receipts, letters etc.
Cardboard	All kinds of cardboard boxes, electrical equipment packaging, food packaging, beer packaging carton, boxes of biscuits, toys, flat card etc.
Composite Materials	Carton of yogurt, milk, juice, cream etc.
Glass	Bottles (wine, beer, spirits, mineral water, juices, etc.), jars (for pickles, jams, etc.), flat glass, light bulbs, mirrors etc.
Ferrous metal packaging and other	Canned food (sardines, pasta, canned meat), tools, metal car parts, kitchen accessories, items of iron etc.
Aluminum (non-ferrous) metal packaging and other	Beverage cans (beer, coca-cola, energy drinks) etc.
PET Bottles	Bottles made of polyethylene terephthalate (PET) for water, soft drinks, beer, oil, vinegar, etc.
Other Plastic packaging waste	Plastic packaging for milk, juice, water bottles, yogurt containers, margarine tubs, take away containers, soft drinks, plates, etc.
Plastic bags	Bags from stores, garbage bags, plastic bags (black, green, gray), bags of chips, sandwich bags, bags of frozen vegetables, bags of cookies, etc.
Other plastic/Hard plastic	"Plastic toys, rulers, pencils, toilet lids, toothbrushes, plastic boxes, cleaning supplies, Flower pots etc.

Waste category	Examples
Textile	Natural and man-made fibres: clothing made of natural fibres (cotton, wool, flax) and synthetic fibres (pants, socks, canvas bag, canvas) etc.
Diapers	Baby diapers, sanitary diapers, sanitary napkins etc.
Construction and demolition material	Waste generated as a result of construction works (bricks, stones, etc.)
WEEE	All kinds of discarded electrical and/or electronic equipment or its components
Medical Waste	Waste materials generated at health care facilities (blood-soaked bandages, discarded needles, culture dishes and other glassware, etc.)
Leather	Leather clothing, wallets, belts, shoes, bags, leather balls etc.
Wood	All wooden items, wooden packaging, parts of furniture etc. except garden waste
Other special waste streams (Elastic - tires etc)	Other special waste streams that are not in this table such as car tires, etc.
Fine elements <10mm	All waste residues, which undergo the last of the 10mm sieve - soil, dust, ash, sand, glass fragments, etc.

Results

The Quality Analysis Survey in Southwest Region was performed in different sampling areas in the periods of June 2016 and October 2016 in the following municipalities: Kichevo, Ohrid, Struga, Debar, Centar Zhupa and Makedonski Brod.

For the municipalities that no measurements took place, assumptions concerning their composition analysis have been made, based on their geomorghological and population characteristics. No measurements took place in the Municipalities of Vevchani, Debarca and Plasnica. These Municipalities have similar geomorphological and population characteristics with the Municipality of Centar Zhupa regarding the rural sector. For that reason, data measurements of the waste morphological composition have been used for the aforementioned municipalities. Detailed information is provided in the Annex II "Morphological Composition of Waste" of the Assessment report of the Region.

The following table illustrates the average morphological waste composition for each Municipality of Southwest region.

Table 4-3: Average waste composition for each municipality of Southwest region

Waste category	Centar Zhupa	Debar	Debartsa	Kichevo	Makedonski Brod	Ohrid	Plasnica	Struga	Vevchani
Garden Waste	16.64%	13.04%	16.64%	20.21%	22.90%	18.78%	16.64%	4.30%	16.64%
Other Biodegradable waste	32.67%	36.65%	32.67%	25.15%	31.16%	28.43%	32.67%	35.51%	32.67%
Paper	0.81%	2.39%	0.81%	3.15%	1.76%	4.13%	0.81%	4.33%	0.81%
Cardboard	6.29%	6.11%	6.29%	2.83%	2.82%	6.28%	6.29%	7.00%	6.29%
Glass	1.58%	3.29%	1.58%	6.94%	2.42%	3.50%	1.58%	6.41%	1.58%
Ferrous metal packaging and other	1.14%	1.34%	1.14%	1.89%	0.47%	1.87%	1.14%	1.34%	1.14%
Aluminum (non-ferrous) metal packaging and other	0.89%	1.18%	0.89%	0.58%	0.51%	0.94%	0.89%	1.44%	0.89%
Composite Materials	1.05%	2.35%	1.05%	1.66%	1.16%	1.45%	1.05%	1.21%	1.05%
Other Plastic packaging waste	0.63%	1.49%	0.63%	1.56%	0.83%	2.04%	0.63%	1.81%	0.63%
Plastic bags	2.87%	4.95%	2.87%	3.42%	4.37%	7.59%	2.87%	9.53%	2.87%
PET Bottles	3.10%	3.22%	3.10%	2.94%	1.03%	3.77%	3.10%	2.41%	3.10%
Other plastic/Hard	1.52%	2.23%	1.52%	1.59%	3.84%	2.29%	1.52%	2.75%	1.52%

Waste category	Centar Zhupa	Debar	Debartsa	Kichevo	Makedonski Brod	Ohrid	Plasnica	Struga	Vevchani
plastic									
Textile	10.53%	5.10%	10.53%	7.28%	2.70%	4.68%	10.53%	7.70%	10.53%
Leather	0.39%	0.22%	0.39%	1.23%	0.73%	1.82%	0.39%	1.31%	0.39%
Diapers	16.30%	11.96%	16.30%	14.43%	6.75%	7.45%	16.30%	6.64%	16.30%
Wood	1.58%	1.61%	1.58%	0.96%	1.68%	1.34%	1.58%	0.39%	1.58%
Construction and demolition material	0.06%	1.36%	0.06%	0.53%	8.83%	0.91%	0.06%	1.50%	0.06%
WEEE	0.21%	0.55%	0.21%	0.76%	0.09%	0.43%	0.21%	1.16%	0.21%
Medical Waste	1.20%	0.09%	1.20%	1.40%	0.39%	0.33%	1.20%	0.44%	1.20%
Other special waste streams (Elastic-tyres etc.)	0.02%	0.09%	0.02%	0.21%	0.47%	0.79%	0.02%	0.23%	0.02%
Fine elements <10mm	0.50%	0.78%	0.50%	1.28%	5.11%	1.19%	0.50%	2.59%	0.50%
TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

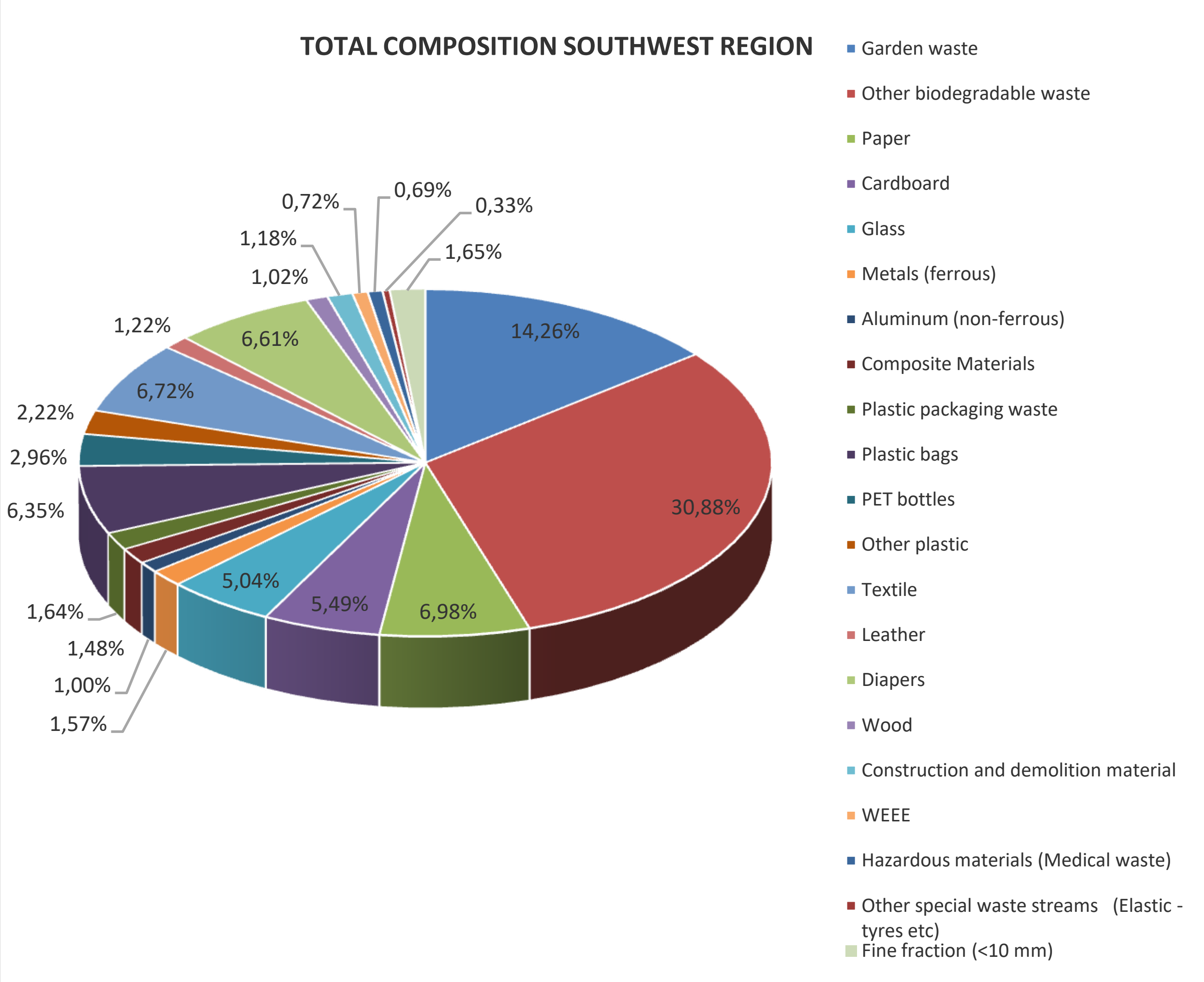
Overall data of waste composition at regional level

The average waste composition in the region has been calculated, and presented in the following table. Analytical calculations are shown in Annex II of Assessment Report of Southwest Region.

Table 4-4: Weighted average morphological waste composition for Southwest region

Waste category	Average Mass share
Garden Waste	14.26%
Other Biodegradable waste	30.88%
Paper	6.99%
Cardboard	5.49%
Glass	5.04%
Ferrous metal packaging and other	1.57%
Aluminum (non-ferrous) metal packaging and other	1.00%
Composite Materials	1.48%
Other Plastic packaging waste	1.64%
Plastic bags	6.35%
PET Bottles	2.96%
Other plastic/Hard plastic	2.22%
Textile	6.72%
Leather	1.22%
Diapers	6.60%
Wood	1.02%
Construction and demolition material	1.18%
WEEE	0.72%
Medical Waste	0.69%
Other special waste streams (Elastic-tires, etc.)	0.33%
Fine elements <10mm	1.65%
TOTAL	**100.00%**

Figure 4-2: Weighted average waste composition for Southwest region



4.2 Future waste generation forecast

In municipal environmental management, it is very important to be able to forecast the amount of municipal solid wastes generated. This information is needed not only to formulate environmental standards and assess environmental impacts of the wastes, but also to evaluate the potential quantity of re-usable energy and material resources in wastes. Accurate data of quantities of municipal solid waste generated and collected are of critical importance in selecting specific equipment and in designing treatment facilities and disposal facilities. Also they can be used for budget preparation and operation optimization. The data on solid waste quantity are also an essential foundation for environmental economy programs and can greatly influence final environmental management targets and strategy.

4.2.1 Current generated quantities of MSW – Quantitative waste analysis

The collected data about the total mass of generated waste was carried out by weighing the mass of fully – loaded garbage trucks which collect waste in the territory of a municipality. The mass of fully – loaded trucks was weighed using a weighbridge of a utility company or other business entities in the territory of local self – government unit where the produced is performed.

The municipal waste quantities were weighed during a period of one week. The procedure included standard circumstances.

Public utility companies provided all necessary conditions for implementation of quantitative analysis (weighbridge, supervision over the weighing procedure, result recording, etc.).

In order to calculate the produced waste for each Municipality of Region the following steps have been followed:

- The waste which produced from seasonal population have been estimated taking into consideration the assumption that an average tourist in Europe generates approximately 1,2 kg of waste per bed night (CREM, 2000).
- Segregation of the quantity of collected waste which derived from permanent and from seasonal population has been done.
- The percentage of collection coverage regarding household waste and commercial waste for each municipality has been estimated taking into consideration data from Questionnaires.

The obtained results for each municipality are presented analytically in the Assessment Report of the Region and are summarized in the following tables.

Kichevo Municipality

The actual waste quantity measurements took place in Kichevo Municipality from 09-15 May 2016. The data is summarized in the following table.

Table 4-5: Waste weighting (t) in Kichevo Municipality for the period 09 – 15 May 2016

Vehicle type	Date of measurements (Municipal waste, t)							Total
	9/5/16	10/5/16	11/5/16	12/5/16	13/5/16	14/5/16	15/5/16	
Press container	26.7	26.8	25.2	22.3	22.0	13.0	12.3	**148.2**
Open truck	3.2	5.0	2.5	3.0	2.6	0.0	0.0	**16.3**
Tractor	4.2	2.2	2.9	1.4	1.8	0.0	0.0	**12.4**
Total	**34.0**	**34.1**	**30.6**	**26.6**	**26.4**	**13.0**	**12.3**	**176.9**

During the period of measurements, a total 176.9 t of waste were collected and the annual collected waste has been calculated to 9,199 t. The following table presents the calculation of the waste generation rate (kg/cap/y).

Table 4-6: Waste Generation Rate (kg/cap/y) for Kichevo Municipality

Permanent population of Kichevo Municipality (2016)	**57,088**
Urban population	**32,065**
Rural population	**25,024**
Collection coverage for house premises % (Source questionnaires)	
Urban population	100%
Rural population	30%
Weighted collection coverage for house premises %	**69.3%**
Collection coverage for commercial premises % ***(Source questionnaires)***	**100%**
Generated Waste from Seasonal Population (t)	
Total annual generation for tourists, 2016(t/y)	**11**
Number of tourists overnight, 2016	9,543

"Waste Generation for tourists (kg/night)"	1.2

Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**9,187**
Collected waste derived from house premises (t) 74% of the total collected waste *(source questionnaires)*	6,799
Collected waste derived from industrial premises (t) 26% of the total collected waste *(source questionnaires)*	2,389

Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**12,197**
Produced waste derived from house premises (t)	9,808
Produced waste derived from industrial premises (t)	2,389
Waste Generation Rate (kg/ca/year)	**214**

Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**12,197**
Generated municipal waste (t) (urban areas)	7,479
Generated municipal waste (t) (rural areas)	4,718
Waste Generation Rate (kg/ca/year) for urban areas	233
Waste Generation Rate (kg/ca/year) for rural areas	189
Waste Generation Rate (kg/ca/year)	**214**

Ohrid Municipality

The actual waste quantity measurements took place in Ohrid Municipality from 09-15 May 2016. The data is summarized in the following table.

Table 4-7: Waste weighting (t) in Ohrid Municipality for the period 09 – 15 May 2016

Vehicle type	**Date of measurements (Municipal waste, t)**							**Total**
	9/5/16	**10/5/16**	**11/5/16**	**12/5/16**	**13/5/16**	**14/5/16**	**15/5/16**	
Press container	60.9	86.4	57.9	54.6	61.6	41.3	22.8	**386**
Total	**60.9**	**86.4**	**57.9**	**54.6**	**61.6**	**41.3**	**22.8**	**386**

During the period of measurements a total 386 t of waste were collected and the annual collected waste has been calculated to 20,047 t. The following table presents the calculation of the waste generation rate (kg/cap/y).

Table 4-8: Waste Generation Rate (Kg/cap/y) for Ohrid Municipality

Permanent population of Ohrid Municipality (2016)	**52,257**
Urban population	**40,648**
Rural population	**11,609**
Collection coverage for house premises % (Source questionnaires)	
Urban population	100%
Rural population	100%
Weighted collection coverage for house premises %	**100%**

Collection coverage for commercial premises % ***(Source questionnaires)***	**100%**

Generated Waste from Seasonal Population (t)	
Total annual generation for tourists, 2016(t/y)	**1,161**
Number of tourists overnight, 2016	967,170
"Waste Generation for tourists (kg/night)"	1.2

Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**18,886**
Collected waste derived from house premises (t) 95% of the total collected waste *(source questionnaires)*	17,942
Collected waste derived from industrial premises (t) 5% of the total collected waste *(source questionnaires)*	944

Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**18,886**
Produced waste derived from house premises (t)	17,942
Produced waste derived from industrial premises (t)	944
Waste Generation Rate (kg/ca/year)	**361**

Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**18,886**
Generated municipal waste (t) (urban areas)	15,344
Generated municipal waste (t) (rural areas)	3,542
Waste Generation Rate (kg/ca/year) for urban areas	377
Waste Generation Rate (kg/ca/year) for rural areas	305
Waste Generation Rate (kg/ca/year)	**361**

Debar Municipality

The actual waste quantity measurements took place in Debar Municipality from 09-15 May 2016. The data is summarized in the following table.

Table 4-9: Waste weighting (t) in Debar Municipality for the period 09 – 15 May 2016

Vehicle type	Date of measurements (Municipal waste, t)							Total
	9/5/16	10/5/16	11/5/16	12/5/16	13/5/16	14/5/16	15/5/16	
Press container	11.5	9.8	5.1	8.8	9.2	0.0	5.8	**50.1**
Tractor	12.4	13.1	5.1	12.5	11.8	3.9	2.0	**60.7**
Total	**23.8**	**23.0**	**10.1**	**21.3**	**21.1**	**3.9**	**7.7**	**110.8**

During the period of measurements a total 110.8 t of waste were collected and the annual collected waste has been calculated to 5,763 t. The following table presents the calculation of the waste generation rate (kg/cap/y).

Table 4-10: Waste Generation Rate (Kg/cap/y) for Debar Municipality

Permanent population of Debar Municipality (2016)	**20,630**
Urban population	**15,396**
Rural population	**5,234**

Collection coverage for house premises % (Source questionnaires)	
Urban population	100%
Rural population	15%
Weighted collection coverage for house premises %	**78,4%**
Collection coverage for commercial premises % ***(Source questionnaires)***	**100%**

Generated Waste from Seasonal Population (t)	
Total annual generation for tourists, 2016(t/y)	**246**
Number of tourists overnight, 2016	205,272
"Waste Generation for tourists (kg/night)"	1.2

Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**5,517**
Collected waste derived from house premises (t) 65% of the total collected waste *(source questionnaires)*	3,586
Collected waste derived from industrial premises (t) 35% of the total collected waste *(source questionnaires)*	1,931

Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**6,503**
Produced waste derived from house premises (t)	4,572
Produced waste derived from industrial premises (t)	1,931
Waste Generation Rate (kg/ca/year)	**315**

Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**6,503**
Generated municipal waste (t) (urban areas)	5,101
Generated municipal waste (t) (rural areas)	1,402
Waste Generation Rate (kg/ca/year) for urban areas	331
Waste Generation Rate (kg/ca/year) for rural areas	268
Waste Generation Rate (kg/ca/year)	**315**

Struga Municipality

The actual waste quantity measurements took place in Struga Municipality from 09-15 May 2016. The data is summarized in the following table.

Table 4-11: Waste weighting (t) in Struga Municipality for the period 09– 15May 2016

Vehicle type	Date of measurements (Municipal waste, t)							Total
	9/5/16	10/5/16	11/5/16	12/5/16	13/5/16	14/5/16	15/5/16	
Press container	28.2	9.7	24.0	27.2	17.4	3.2	30.2	**139.88**
Open truck	5.3	1.2	6.1	2.7	2.0	0.0	1.1	**18.56**
Tractor	5.9	0.0	0.0	2.6	2.5	0.0	0.0	**11.08**
Total	**39.5**	**10.9**	**30.1**	**32.5**	**22.0**	**3.2**	**31.3**	**169.52**

During the period of measurements a total 169.52 t of waste were collected and the annual collected waste has been calculated to 8,815 t. The following table presents the calculation of the waste generation rate (kg/cap/y).

Table 4-12: Waste Generation Rate (Kg/cap/y) for Struga Municipality

Permanent population of Struga Municipality (2016)	**65,202**
Urban population	**39,065**
Rural population	**26,137**
Collection coverage for house premises % (Source questionnaires)	
Urban population	100%
Rural population	30%
Weighted collection coverage for house premises %	**71,9%**
Collection coverage for commercial premises % *(Source questionnaires)*	**90%**

Generated Waste from Seasonal Population (t)	
Total annual generation for tourists, 2016(t/y)	**481**
Number of tourists overnight, 2016	400,857
"Waste Generation for tourists (kg/night)"	1.2

Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**8,334**
Collected waste derived from house premises (t) 90% of the total collected waste *(source questionnaires)*	7,501
Collected waste derived from industrial premises (t) 10% of the total collected waste *(source questionnaires)*	833

Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**11,352**
Produced waste derived from house premises (t)	10,426
Produced waste derived from industrial premises (t)	926
Waste Generation Rate (kg/ca/year)	**174**

Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**11,352**
Generated municipal waste (t) (urban areas)	7,368
Generated municipal waste (t) (rural areas)	3,985
Waste Generation Rate (kg/ca/year) for urban areas	189
Waste Generation Rate (kg/ca/year) for rural areas	152
Waste Generation Rate (kg/ca/year)	**174**

Vevchani Municipality

The actual waste quantity measurements took place in Vevchani Municipality from 09 -13 May 2016. The data are summarized in the following table.

Table 4-13: Waste weighting (t) in Vevchani Municipality for the period 09 – 13 May 2016

Vehicle type	**Date of measurements (Municipal waste, t)**					**Total**
	9/5/16	**10/5/16**	**11/5/16**	**12/5/16**	**13/5/16**	
Press container	1.9	1.5	1.6	1.3	1.7	**8.0**
Total	**1.9**	**1.5**	**1.6**	**1.3**	**1.7**	**8.0**

During the period of measurements a total 8 t of waste were collected and the annual collected waste has been calculated to 416 t. The following table presents the calculation of the waste generation rate (kg/cap/y).

Table 4-14: Waste Generation Rate (Kg/cap/y) for Vevchani Municipality

Permanent population of Vevchani Municipality (2016)	**2,449**
Urban population	**0**
Rural population	**2,449**
Collection coverage for house premises % (Source questionnaires)	
Urban population	-
Rural population	100%
Weighted collection coverage for house premises %	**100%**
Collection coverage for commercial premises % ***(Source questionnaires)***	**100%**
Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**417**
Collected waste derived from house premises (t) 90% of the total collected waste *(source questionnaires)*	375
Collected waste derived from industrial premises (t) 10% of the total collected waste *(source questionnaires)*	42
Total Generated municipal waste (t)	**417**
Produced waste derived from house premises (t)	375
Produced waste derived from industrial premises (t)	42
Waste Generation Rate (kg/ca/year)	**170**
Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**417**
Generated municipal waste (t) (urban areas)	0
Generated municipal waste (t) (rural areas)	417
Waste Generation Rate (kg/ca/year) for urban areas	0
Waste Generation Rate (kg/ca/year) for rural areas	170
Waste Generation Rate (kg/ca/year)	**170**

Centar Zhupa Municipality

The actual waste quantity measurements took place in Centar Zhupa Municipality on 10th and 13th of May 2016. The data is summarized in the following table

Table 4-15: Waste weighting (t) in Centar Zhupa Municipality for the period 10, 13 May 2016

Vehicle type	Date of measurements (Municipal waste, t)		Total
	10/5/16	13/5/16	
Press container	2.2	4.1	**6.4**
Total	**2.2**	**4.1**	**6.4**

During the period of measurements a total 6.4t of waste were collected and the annual collected waste has been calculated to 332t. The following table presents the calculation of the waste generation rate (kg/cap/y).

Table 4-16: Waste Generation Rate (Kg/cap/y) for Centar Zhupa Municipality

Permanent population of Centar Zhupa Municipality (2016)	**6,995**
Urban population	**0**
Rural population	**6,995**
Collection coverage for house premises % (Source questionnaires)	
Urban population	30%
Rural population	30%
Weighted collection coverage for house premises %	**30%**
Collection coverage for commercial premises % ***(Source questionnaires)***	**25%**
Generated Waste from Seasonal Population (t)	
Total annual generation for tourists, 2016(t/y)	**75**
Number of tourists overnight, 2016	62,641
"Waste Generation for tourists (kg/night)"	1.2
Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**257**
Collected waste derived from house premises (t) 90% of the total collected waste *(source questionnaires)*	231
Collected waste derived from industrial premises (t) 10% of the total collected waste *(source questionnaires)*	26
Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**872**
Produced waste derived from house premises (t)	770
Produced waste derived from industrial premises (t)	102
Waste Generation Rate (kg/ca/year)	**125**
Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**872**
Generated municipal waste (t) (urban areas)	0
Generated municipal waste (t) (rural areas)	872
Waste Generation Rate (kg/ca/year) for urban areas	0
Waste Generation Rate (kg/ca/year) for rural areas	125
Waste Generation Rate (kg/ca/year)	**125**

<u>Debarca Municipality</u>

The actual waste quantity measurements took place in Debarca Municipality on 12 of May 2016. The data is presented in the following table:

Table 4-17: Waste weighting (t) in Debarca Municipality on 12 May 2016

Vehicle type	Date of measurements (Municipal waste, t)	Total
	12/5/16	
Press container	8.26	**8.26**
Total	**8.26**	**8.26**

During the period of measurements a total 8.26 t of waste were collected and the annual collected waste has been calculated to 430 t. The following table presents the calculation of the waste generation rate (kg/cap/y).

Table 4-18: Waste Generation Rate (Kg/cap/y) for Debarca Municipality

Permanent population of Debarca Municipality (2016)	**4,066**
Urban population	**0**
Rural population	**4,066**
Collection coverage for house premises % (Source questionnaires)	
Urban population	-
Rural population	80%
Weighted collection coverage for house premises %	**80%**
Collection coverage for commercial premises % ***(Source questionnaires)***	**30%**
Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**429**
Collected waste derived from house premises (t) 70% of the total collected waste *(source questionnaires)*	301
Collected waste derived from industrial premises (t) 30% of the total collected waste *(source questionnaires)*	128
Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**805**
Produced waste derived from house premises (t)	376
Produced waste derived from industrial premises (t)	429
Waste Generation Rate (kg/ca/year)	**198**
Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**805**
Generated municipal waste (t) (urban areas)	0
Generated municipal waste (t) (rural areas)	805
Waste Generation Rate (kg/ca/year) for urban areas	0
Waste Generation Rate (kg/ca/year) for rural areas	198
Waste Generation Rate (kg/ca/year)	**198**

Makedonski Brod Municipality

The actual waste quantity measurements took place in Makedonski Brod Municipality from 09-13 May 2016. The data is summarized in the following table.

Table 4-19: Waste weighting (t) in Makedonski Brod Municipality for the period 09 – 13 May 2016

Vehicle type	Date of measurements (Municipal waste, t)					Total
	9/5/16	10/5/16	11/5/16	12/5/16	13/5/16	
Press container	4.0	3.3	2.9	0.0	4.5	**14.7**
Tractor	2.3	1.1	1.7	2.3	0.7	**8.1**
Total	**6.3**	**4.4**	**4.6**	**2.3**	**5.2**	**22.8**

During the period of measurements a total 22.8 t of waste were collected and the annual collected waste has been calculated to 1,186 t. The following table presents the calculation of the waste generation rate (kg/cap/y).

Table 4-20: Waste Generation Rate (Kg/cap/y) for Makedonski Brod Municipality

Permanent population of Makedonski Brod Municipality (2016)	**6,328**
Urban population	**3,324**
Rural population	**3,004**
Collection coverage for house premises % (Source questionnaires)	
Urban population	100%
Rural population	30%
Weighted collection coverage for house premises %	**66,8**
Collection coverage for commercial premises % ***(Source questionnaires)***	**100%**
Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**1,186**
Collected waste derived from house premises (t) 90% of the total collected waste *(source questionnaires)*	1,067
Collected waste derived from industrial premises (t) 10% of the total collected waste *(source questionnaires)*	119
Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**1,717**
Produced waste derived from house premises (t)	1,598
Produced waste derived from industrial premises (t)	119
Waste Generation Rate (kg/ca/year)	**271**
Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**1,717**
Generated municipal waste (t) (urban areas)	992
Generated municipal waste (t) (rural areas)	725
Waste Generation Rate (kg/ca/year) for urban areas	298
Waste Generation Rate (kg/ca/year) for rural areas	241
Waste Generation Rate (kg/ca/year)	**271**

<u>Plasnica Municipality</u>

The actual waste quantity measurements took place in Plasnica Municipality from 09-13 May 2016. The data is summarized in the following table:

Table 4-21: Waste weighting (t) in Plasnica Municipality for the period 09 – 13 May 2016

Vehicle type	Date of measurements (Municipal waste, t)					Total
	9/5/16	10/5/16	11/5/16	12/5/16	13/5/16	
Open truck	2.48	2.44	2.47	2.48	2.41	**12.28**
Total	**2.48**	**2.44**	**2.47**	**2.48**	**2.41**	**12.28**

During the period of measurements a total 12.3 t of waste were collected and the annual collected waste has been calculated to 638 t. The following table presents the calculation of the waste generation rate (kg/cap/y).

Table 4-22: Waste Generation Rate (Kg/cap/y) for Plasnica Municipality

Permanent population of Plasnica Municipality (2016)	**4,848**
Urban population	**0**
Rural population	**4,848**
Collection coverage for house premises % (Source questionnaires)	
Urban population	-
Rural population	40%
Weighted collection coverage for house premises %	**40%**
Collection coverage for commercial premises % ***(Source questionnaires)***	**100%**
Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**638**
Collected waste derived from house premises (t) 90% of the total collected waste *(source questionnaires)*	575
Collected waste derived from industrial premises (t) 10% of the total collected waste *(source questionnaires)*	64
Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**1,500**
Produced waste derived from house premises (t)	1,436
Produced waste derived from industrial premises (t)	64
Waste Generation Rate (kg/ca/year)	**309**
Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**1,500**
Generated municipal waste (t) (urban areas)	0
Generated municipal waste (t) (rural areas)	1,500
Waste Generation Rate (kg/ca/year) for urban areas	0
Waste Generation Rate (kg/ca/year) for rural areas	309
Waste Generation Rate (kg/ca/year)	**309**

Overall data at regional level

The measurements of waste quantities took place in the Municipalities of Southwest Region from 9th of May 2016 till 15th of May 2016. The actual measured waste quantities per day are summarized in the following table.

Table 4-23: Measured waste quantities (in t) in the municipalities of Southwest Region, 09 – 15 May 2016

	MON	TUE	WED	THR	FRI	SAT	SUN	Total
Kichevo	34.0	34.1	30.6	26.6	26.4	13.0	12.3	177.0
Ohrid	60.9	86.4	57.9	54.6	61.6	41.3	22.8	385.5
Debarca	-	-	-	8.3	-	-	-	8.3
Struga	39.5	10.9	30.1	32.5	22.0	3.2	31.3	169.5
Vevchani	1.9	1.5	1.6	1.3	1.7	-	-	8.0
Centar Zhupa	-	2.2	-	-	4.1	-	-	6.3
Debar	23.8	23.0	10.1	21.3	21.1	3.9	7.7	110.9
Makedonski Brod	6.3	4.4	4.6	2.3	5.2	-	-	22.8
Plasnica	2.5	2.4	2.5	2.5	2.4	-	-	12.3
Waste (t)	**169.0**	**164.9**	**137.3**	**149.3**	**144.5**	**61.3**	**74.2**	**900.5**

During the period of measurements 901 t of waste were collected and the annual waste collected has been calculated to 46,852 t. The following table presents the calculation of the waste generation rate (kg/ca/year).

The following table presents an overview of main calculations for annual produced quantities of municipal waste in Southwest Region, without the contribution of waste from seasonal population.

Table 4-24: Overview of produced waste data for permanent population in the municipalities of Southwest Region

Municipalities (Southwest Region)	Weekly measurements for permanent population (t) (1)	Permanent Population 2016 (2)	Collected Waste, 2016 (t) (3)=(1)*52	Generated waste from permanent population (t) (4)	Generated Waste, 2016 (kg) (5)	Collection coverage % (6)=(3)/(4)	Waste generation (kg/ca/yr)	Waste generation (kg/ca/d)
Kichevo	176.67	57,088	9,187	12,197	12,196,767	75%	214	0.59
Ohrid	363.19	52,257	18,886	18,886	18,886,463	100%	361	0.99
Debar	106.1	2,063	5,517	6,503	6,502,782	85%	315	0.86
Struga	160.27	65,202	8,334	11,352	11,352,311	73%	174	0.48
Vevchani	8.02	2,449	417	417	417,040	100%	170	0.47
Centar Zhupa	4.94	6,995	257	872	872,409	29%	125	0.34
Debartsa	8.25	4,066	429	805	804,960	53%	198	0.54
Makedonski Brod	22.81	6,328	1,186	1,717	1,716,587	69%	271	0.74
Plasnica	12.27	4,848	638	1,500	1,500,249	43%	309	0.85
TOTAL	862.52	219,863	44,852	54,250	54,249,541	83%	**247**	**0.68**

Table 4-25: Overview of waste data in the municipalities of Southwest Region

Municipalities (Southwest Region)	Population Estimation 2016 (Project team)	Number of tourists nights	Equivalent Seasonal population 2016	Waste Generation for tourists (kg/night)	Waste generation for permanent population (kg/ca/yr)	Generated waste from permanent population, 2016 (t)	Generated waste from tourists, 2016, (t)	Total Generated waste, 2016 (t)	Total Collected waste, 2016 (t)	Coverage	Weighted Waste generation (kg/ca/y)
Kichevo	57,088	9,543	26	1.2	214	12,197	11	12,208	9,199	75%	214
Ohrid	52,257	96,717	2650	1.2	361	18,886	1,161	20,047	20,047	100%	365
Debar	2,063	205,272	562	1.2	315	6,503	246	6,749	5,763	85%	318
Struga	65,202	400,857	1,098	1.2	174	11,352	481	11,833	8,815	74%	178
Vevchani	2,449	-	-	1.2	170	417	-	417	417	100%	170
Centar Zhupa	6,995	62,641	172	1.2	125	872	75	948	332	35%	125
Debartsa	4,066	-	-	1.2	198	805	-	805	429	53%	198
Makedonski Brod	6,328	-	-	1.2	271	1,717	-	1,717	1,186	69%	271
Plasnica	4,848	-	-	1.2	309	1,500	-	1,500	638	43%	309
TOTAL	**219,863**	**1,645,483**	**4,508**	1.2	**247**	**54,250**	**1,975**	**56,224**	**46,826**	**83%**	**251**

Figure 4-3: Waste production (kg/ca/yr) in the municipalities of Southwest Region
(Source: Calculations)

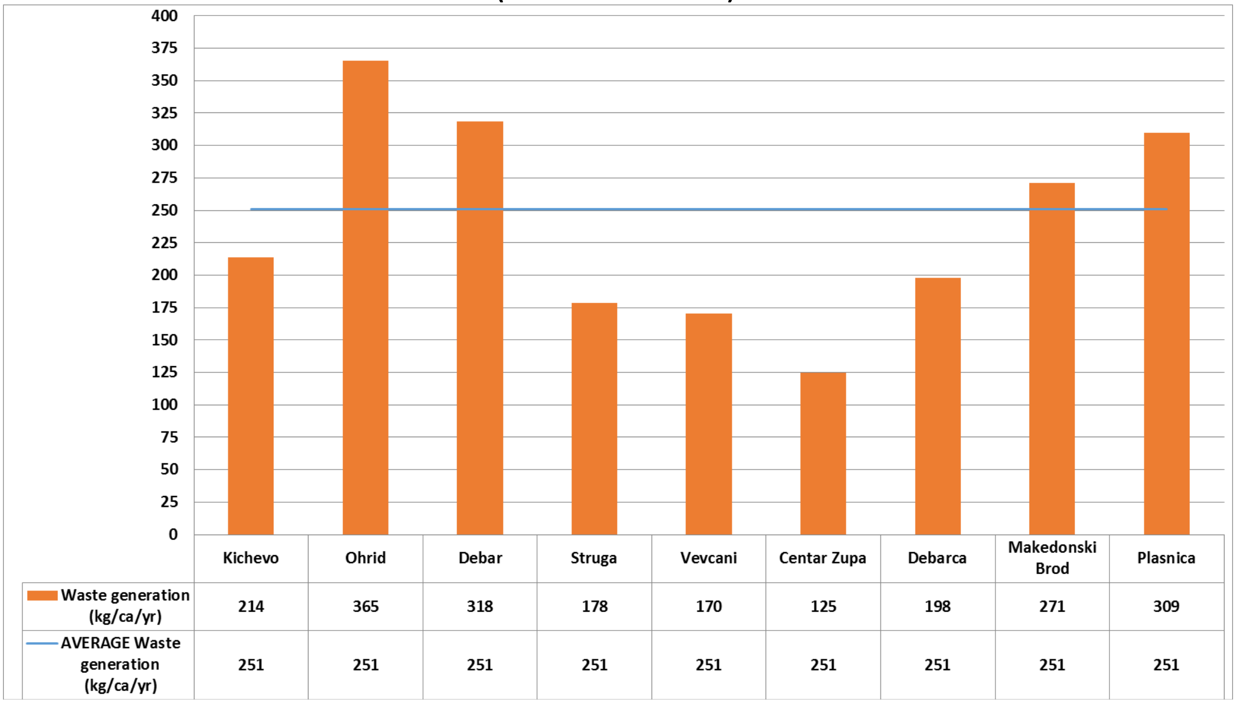
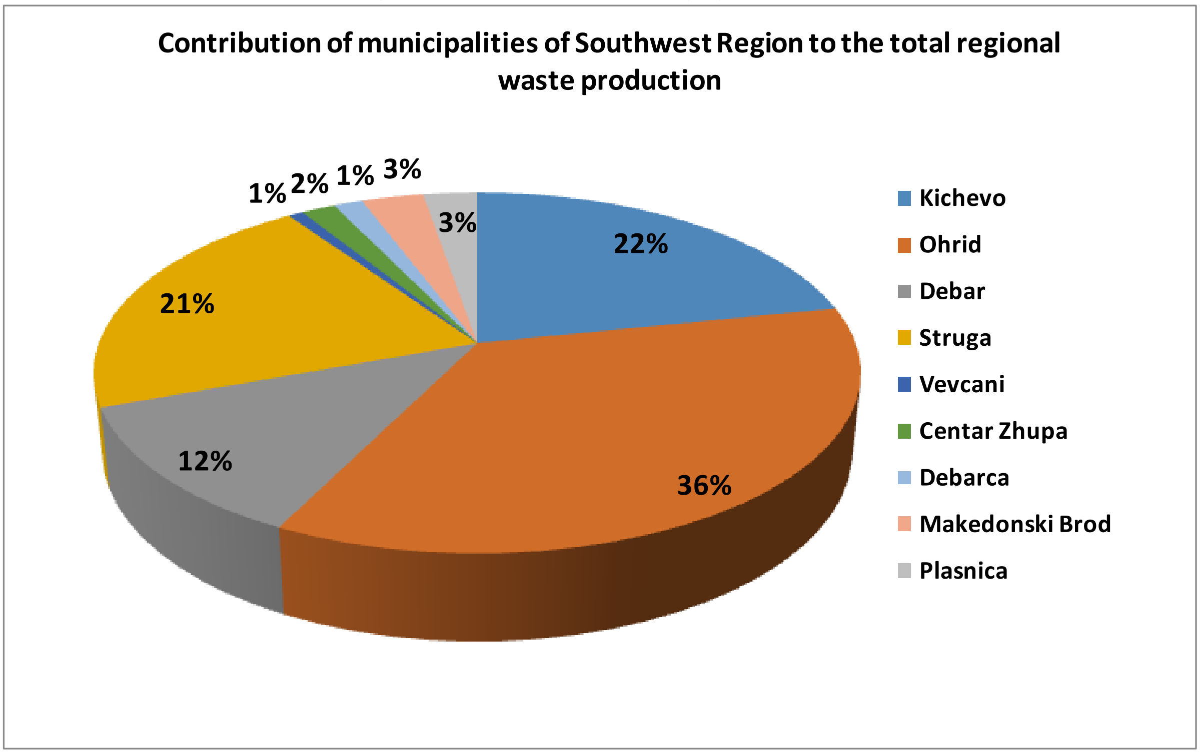


Figure 4-4: Participation of the municipalities of Southwest Region in regional waste production from permanent and seasonal population



As shown in the figure 4-4, Ohrid Municipality covers the 36% of the overall waste production in Southwest Region and is followed by Kichevo Municipality (22%). The average waste production per capita of the Southwest Region is 247 kg/capita/yr.

4.2.2 Future generated quantities of MSW

Future generated rate of the permanent population

The following four proposed scenarios for the projection of the Waste Generation Rate (WGR) of the permanent population have been examined, based on the National Waste Management Plan 2009-2015.

- Scenario 1: Zero growth-no growth in per capita generation, waste generation grows proportionally to population
- Scenario 2: Low growth-in addition to population growth, per capita generation linked to 50% of growth in GDP, followed by 2% between years 2021-2030.
- Scenario 3: Medium growth-as Scenario 2 but assume GDP growth of 5% for 10 years after EU membership (projected to be in 2020)
- Scenario 4: High growth-as Scenario 3 but 100% linkage to GDP growth

The scenarios have been quantified in regional level and will be applied per municipality of Southwest Region. For all these scenarios analytical calculations have been done concerning the produced waste until year 2046 and graphs were created to illustrate the four scenarios aggregated. Finally scenario 2 has been selected as the more realistic scenario in comparison with scenario 1 and scenario 4.
Scenario 1 (zero growth sc.) is a very theoretical approach which according the international experience has not been applied in any European country. On the other hand Scenario 4 (high growth sc.) is a scenario which does not follow prevention and circular economy policies as it is directly connected with GDP growth. Regarding scenario 3, this is almost the same with scenario 2 and it was examined as it was proposed in the national waste management plan of RM.
Analytical description for each scenario is presented in Chapter 3 of Regional Waste Management Plan of Southwest region.

According to the 2nd Scenario which finally was chosen, the % Change in Waste Generation rate is *low*, i.e. in addition to population growth, the ‘per capita’ generation is linked to 50% of growth in GDP (projected at 3% p.a.).

Table 4-26: Change in per capita Waste Generation rate (%) - Scenario 2

Year	2017	2018	2019	2020	2021 - 2030	2021 - 2046
% Change in Waste Generation rate (kg/ca/year)	1.56%	1.52%	2.94%	2.78%	0.20% per year	-

The waste production forecast for Scenario 2 was calculated as presented in the following table and diagram:

Table 4-27: Waste Generation rate for permanent population, Scenario 2

WGR for Permanent Population (kg/ca/year) per year per Municipality in Southwest Region	2016	2021	2026	2031	2036	2041	2046
Vevchani	**170**	**186**	**188**	**189**	**189**	**189**	**189**
Vevchani urban	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Vevchani rural	*170*	*186*	*188*	*189*	*189*	*189*	*189*

WGR for Permanent Population (kg/ca/year) per year per Municipality in Southwest Region	2016	2021	2026	2031	2036	2041	2046
Debar	**315**	**345**	**349**	**353**	**354**	**354**	**355**
Debar urban	*331*	*362*	*366*	*369*	*369*	*369*	*369*
Debar rural	*268*	*293*	*296*	*298*	*298*	*298*	*298*
Debarca	**198**	**216**	**219**	**220**	**220**	**220**	**220**
Debarca urban	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Debarca rural	*198*	*216*	*219*	*220*	*220*	*220*	*220*
Kichevo	**214**	**234**	**237**	**240**	**241**	**242**	**243**
Kichevo urban	*233*	*255*	*257*	*260*	*260*	*260*	*260*
Kichevo rural	*189*	*206*	*208*	*210*	*210*	*210*	*210*
Makedonski Brod	**271**	**297**	**301**	**305**	**306**	**308**	**309**
Makedonski Brod urban	*298*	*326*	*329*	*332*	*332*	*332*	*332*
Makedonski Brod rural	*241*	*264*	*266*	*268*	*268*	*268*	*268*
Ohrid	**361**	**396**	**400**	**405**	**406**	**407**	**408**
Ohrid urban	*377*	*413*	*417*	*420*	*420*	*420*	*420*
Ohrid rural	*305*	*333*	*337*	*339*	*339*	*339*	*339*
Plasnica	**309**	**338**	**342**	**344**	**344**	**344**	**344**
Plasnica urban	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Plasnica rural	*309*	*338*	*342*	*344*	*344*	*344*	*344*
Struga	**174**	**191**	**193**	**195**	**196**	**197**	**198**
Struga urban	*189*	*206*	*208*	*210*	*210*	*210*	*210*
Struga rural	*152*	*167*	*168*	*170*	*170*	*170*	*170*
Centar Zhupa	**125**	**135**	**136**	**137**	**137**	**136**	**136**
Centar Zhupa urban	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Centar Zhupa rural	*125*	*136*	*138*	*139*	*139*	*139*	*139*
Weighted Average WGR for Permanent Population (kg/ca/year) for Southwest Region	**247**	**270**	**274**	**278**	**280**	**282**	**283**

Figure 4-5: Waste Generation Rate projection for permanent population for Scenario 2, per Municipality

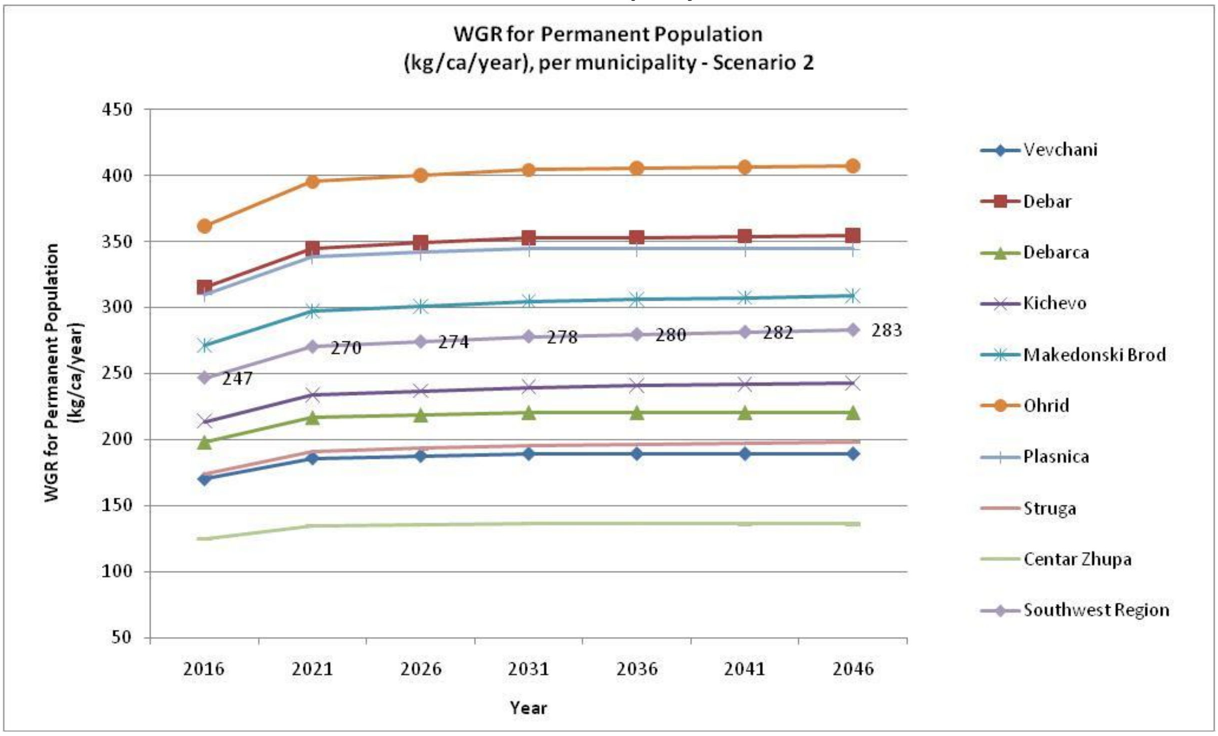


Table 4-28: Total Produced Waste from Permanent Population for the municipalities of Southwest region (t) for Scenario 2

Year	2016	2021	2026	2031	2036	2041	2046
Vevchani	417	445	430	407	377	347	317
Debar	6,503	7,146	7,256	7,338	7,329	7,282	7,206
Debarca	805	860	831	785	727	669	613
Kichevo	12,197	13,320	13,386	13,356	13,150	12,890	12,592
Makedonski Brod	1,717	1,872	1,877	1,868	1,833	1,792	1,745
Ohrid	18,886	20,775	21,129	21,417	21,436	21,345	21,163
Plasnica	1,500	1,602	1,548	1,463	1,355	1,247	1,142
Struga	11,352	12,414	12,503	12,510	12,355	12,148	11,900
Centar Zhupa	872	932	900	851	788	725	664
Total Produced Waste from Permanent Population in Southwest Region	**54,250**	**59,366**	**59,861**	**59,994**	**59,349**	**58,445**	**57,342**

Future generated waste of the seasonal population

The waste generated from seasonal population has been estimated taking into consideration the assumption that an average tourist in Europe generates approximately 1.2 kg of waste per bed night (CREM,2000). Taking into account the overnights’ projection in Southwest region, the Waste Generation Rate of the seasonal population was considered stable and equal to 438 kg/ca/year for all years within the examined period of time (2016-2046), and for all municipalities within Southwest region.

Table 4-29: Total Produced Waste from Seasonal Population for the municipalities of Southwest region (t) for Scenario 2

Year	2016	2021	2026	2031	2036	2041	2046
Vevchani	0	0	0	0	0	0	0
Debar	246	306	407	512	512	512	512
Debarca	0	0	0	0	0	0	0
Kichevo	11	14	19	24	24	24	24
Makedonski Brod	0	0	0	0	0	0	0
Ohrid	1161	1440	1919	2415	2415	2415	2415
Plasnica	0	0	0	0	0	0	0
Struga	481	597	795	1001	1001	1001	1001
Centar Zhupa	75	93	124	156	156	156	156
Total Produced Waste from Seasonal Population in Southwest Region	**1975**	**2449**	**3264**	**4108**	**4108**	**4108**	**4108**

Forecast of Waste Production

Based on the previous calculations, a Forecast of Waste generation for the years 2016-2046 was made, for each municipality, and accordingly for the whole region. The results are presented in the following table.

Table 4-30: Forecast of Waste Production for municipalities of Southwest region (t) for Scenario 2

Year	2016	2021	2026	2031	2036	2041	2046
Vevchani	417	445	430	407	377	347	317
Debar	6,749	7,451	7,663	7,851	7,841	7,795	7,718
Debarca	805	860	831	785	727	669	613
Kichevo	12,208	13,335	13,405	13,380	13,173	12,914	12,616
Makedonski Brod	1,717	1,872	1,877	1,868	1,833	1,792	1,745
Ohrid	20,047	22,214	23,048	23,831	23,851	23,759	23,577
Plasnica	1,500	1,602	1,548	1,463	1,355	1,247	1,142
Struga	11,833	13,011	13,298	13,511	13,356	13,148	12,901
Centar Zhupa	948	1,025	1,025	1,007	944	882	820
Total Produced Waste (t) in Southwest Region	**56,224**	**61,815**	**63,125**	**64,103**	**63,457**	**62,553**	**61,450**

TABLE OF CONTENTS

LIST OF FIGURES

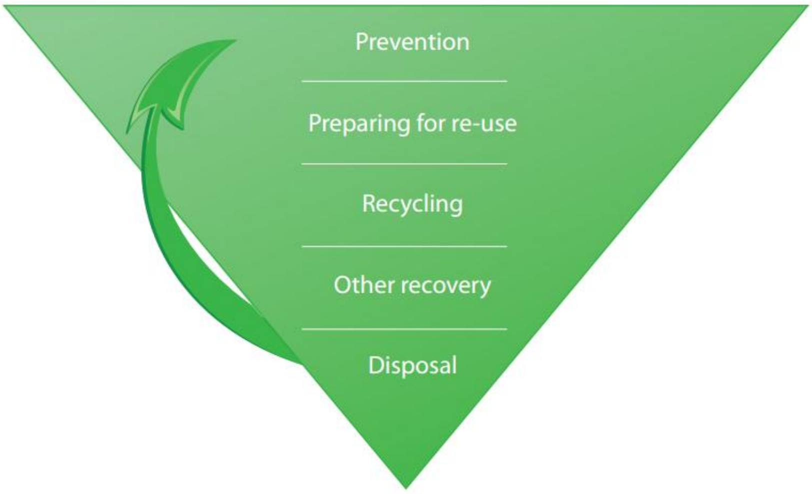
5. LEGAL AND REGULATORY FRAMEWORK

5.1 EU WASTE MANAGEMENT POLICY AND DIRECTIVES

Transposition of the EU legislation on waste management into the national legislation framework is one of the main and priority tasks in the establishing process of the proper waste management system in the beneficiary country, as well in the accession process to EU. The full ***transposition of the Waste Framework Directive*** shall be carried into the Law on Waste Management within the short-term schedule as ***the first priority***, as both directives set the basic rules, principles and the structure for the proper operation of the waste management system. However, the primary legislation shall, in the best possible manner, incorporate the definitions, main principles, planning, general obligations like permits and allocation of responsibilities. The Law on Waste Management shall also enact the mechanisms for reflection of full costs of environmental damage, enacting the mechanisms for encouraging economic instruments in preference to legislative instruments as the cost recovery measure, enacting financial mechanisms that enable implementation of the "producer's responsibility principle" and environmental liability.

Turning waste into a resource is one key to a circular economy. The objectives and targets set in European legislation have been key drivers to improve waste management, stimulate innovation in recycling, limit the use of landfilling, and create incentives to change consumer behavior. If we re-manufacture, reuse and recycle, and if one industry's waste becomes another's raw material, countries can move to a more circular economy where waste is eliminated and resources are used in an efficient and sustainable way. Improved waste management also helps to reduce health and environmental problems, reduce greenhouse gas emissions (directly by cutting emissions from landfills and indirectly by recycling materials which would otherwise be extracted and processed), and avoid negative impacts at local level such as landscape deterioration due to landfilling, local water and air pollution, as well as littering. The European Union's approach to waste management is based on the "waste hierarchy" which sets the following priority order when shaping waste policy and managing waste at the operational level: prevention, (preparing for) reuse, recycling, recovery and, as the least preferred option, disposal (which includes landfilling and incineration without energy recovery).[1]

Figure 5-1: Waste hierarchy



Waste legislation in European Union can be divided in 3 main parts:

[1] http://ec.europa.eu/environment/waste/index.htm

1. FRAMEWORK WASTE LEGISLATION

- **Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Waste Framework Directive) -** The Directive establishes a legal framework for the treatment of waste in the EU. It sets the basic concepts and definitions related to waste management and lays down waste management principles for all other EU legislation related to waste, such as the "polluter pays principle" and the "waste hierarchy". It sets the framework for waste management in Member States, including the extended producer's responsibility.
- **Decision 2000/532/EC establishing a list of wastes -** This Decision establishes the classification system for wastes, including a distinction between hazardous and non-hazardous wastes. It is closely linked to the list of the main characteristics which render waste hazardous contained in Annex III to the Waste Framework Directive.
- **Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste -** This Regulation aims at strengthening, simplifying and specifying the procedures for controlling waste shipments to improve environmental protection. It sets out a system of control for the movement of waste. The Regulation specifies the documentation to be provided and the security measures to be taken during transportation. The system must take into account the principles of self-sufficiency, proximity of waste for disposal and prior informed consent. This should reduce the risk of waste shipments not being controlled. The Regulation concerns almost all types of waste shipped, including national and transit transports, except radioactive waste and a few other types of waste. It is based on the International Basel Convention.

2. LEGISLATION ON WASTE MANAGEMENT OPERATIONS

- **Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste** - The Directive is intended to prevent or reduce the adverse effects of the landfill of waste on the environment. It defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies to all landfills. Landfills are divided into three classes: landfills for hazardous waste; landfills for non-hazardous waste and landfills for inert waste. The Directive also defines wastes which are not to be accepted in any landfill and sets up a system of operating permits for landfill sites.
- **Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste (WID)** - The European Union imposes strict operating conditions and technical requirements on waste incineration plants and waste co-incineration plants to prevent or reduce air, water and soil pollution caused by the incineration or co-incineration of waste. The directive requires a permit for incineration and co-incineration plants, and emission limits are introduced for certain pollutants released to air or to water.
- **Directive 2000/59/EC of the European Parliament and of the Council on port reception facilities for ship-generated waste and cargo residues** - It addresses in detail the legal, financial and practical responsibilities of the different operators involved in delivery of ship-generated waste and cargo residues in European Union ports. A waste reception and handling plan must be drawn up in each port following consultations with the relevant parties, and it must be approved and assessed by the Member States.[2]

[2] http://www.municipalwasteeurope.eu/summary-current-eu-waste-legislation

3. LEGISLATION ON SPECIFIC WASTE STREAMS

- **Council Directive 75/439/EEC of 16 June 1975 on the disposal of waste oils** - This directive deals with the necessary measures which the Member States have to take to ensure the safe collection and disposal of waste oils. It specifies procedures for recycling waste oils, rules with regard to stocking waste oils, rules that have to be observed by those who dispose of waste oils and the responsibilities of Member States towards the European Commission in the matter of disposal of waste oils.[3]
- **Council Directive 78/176/EEC of 20 February 1978 on titanium dioxide industrial waste –** This Directive regulates that the Member States take steps to ensure that waste-disposal procedures take due account of human-health and environmental considerations. Member States must actively encourage waste prevention and recycling and the re-use of waste as raw materials. Any discharge, dumping, storage, accumulation or injection of waste requires prior authorization, for a limited but renewable period, by the competent Member State authority.[4]
- **Council Directive 96/59/EC of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCB/PCT) –** This Directive regulates necessary measures which Member States must take to ensure that: used PCBs are disposed of; PCBs and equipment containing PCBs are decontaminated or disposed of. It also regulates that Inventories must be compiled of equipment with PCB volumes of more than 5 dm3 and that any equipment which is subject to inventory must be labeled.[5]
- **Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture** - The Directive regulates the use of sewage sludge in agriculture to prevent harmful effects on soil, vegetation, animals and humans. In particular it sets maximum values of concentrations of heavy metals and bans the spreading of sewage sludge when the concentration of certain substances in the soil exceeds these values. Sludge from small sewage-treatment plants, which treat primarily domestic waste water, can represent danger to the environment.
- **Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive** - The Directive prohibits the placing on the market of most batteries and accumulators with a certain mercury or cadmium content and establishes rules for the collection, recycling, treatment and disposal of batteries and accumulators. The aim is to cut the amount of hazardous substances, in particular, mercury, cadmium and lead, dumped in the environment; this should be done by reducing the use of these substances in batteries and accumulators and by treating and re-using the amounts that are used.
- **European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste** - The Directive sets out measures and requirements for the prevention re-use and recovery of packaging wastes in Member States. It seeks to harmonize national measures concerning the management of packaging and packaging waste to provide a high level of environmental protection and ensure the functioning of the internal market. Member States must ensure that packaging placed on the market complies with the essential requirements**.**
- **Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicles -** The Directive aims to limit the production of waste arising from end-

[3] http://www.hdm-stuttgart.de/printing-green/directiv.html#6
[4] http://europa.eu/legislation_summaries/environment/waste_management/l21203_en.htm
[5] http://europa.eu/legislation_summaries/environment/waste_management/l21201_en.htm

of-life vehicles and to increase re-use, recycling and recovery of end-of-life vehicles and their components. The generation of waste from vehicles should be avoided as much as possible.

- **Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (ROHS Directive)** - This Directive covers the same scope as the WEEE Directive (except for medical devices and monitoring and control instruments). This Directive requires the substitution of various heavy metals by other substances in new electrical and electronic equipment entering the market. Every four years the Commission undertakes an assessment of the exemptions in order to check whether the exemptions are still justified in light of technical and scientific progress. Member States are to determine the penalties applicable to breaches of this Directive. This is a product Directive, not a waste Directive.
- **Directive 2012/19/EC of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE Directive) -** This Directive aims to provide incentives to improve the design of electrical and electronic equipment to facilitate recycling. It was introduced to prevent the generation of electrical and electronic waste and to promote reuse, recycling and other forms of recovery in order to reduce the quantity of such waste. It shifts responsibility for WEEE to the producers, giving them the obligation to recycle electrical and electronic equipment that consumers return to them.
- **Directive 2010/75/EU on industrial emissions (IED)**[6] **-** It concerns the minimization of pollution from industrial activities, defined in Annex I of the Directive. Operators of these industrial installations are required to obtain an integrated permit from the authorities in the EU countries and meet certain basic obligations. [7]

5.2 NATIONAL POLICY AND INSTITUTIONAL FRAMEWORK

On a national level, the general waste management policy was established in the Law on Environment ("Official Gazette" No.53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/2013, 44/2015), in the National Environmental Programmes (NEAP 1996/2007) and particularly in the Law on Waste Management ("Official Gazette" No.68/04, 71/04, 107/07, 102/08, 134/08, 124/10, 08/11, 51/11 and 123/12, 147/13 and 163/13). The Law on Waste Management has important links to other Laws related to tasks and responsibilities regarding administrative, organizational and operational issues in waste management, in particular to the Law on the Environment, which includes basic provisions on environmental permitting, EIA procedure and greenhouse gas emissions.

The issue related to the management of sludge from urban wastewater treatment is regulated in the Law on Water. Moreover, separate laws have been adopted for packaging and packaging waste, WEEE and batteries and accumulators, namely:

- The Law on Packaging and Packaging Waste (2009) (LoPPW) ("Official Gazette" No. 161/09, 17/11, 47/11, 136/11, 6/12 and 163/13),
- the Law on Batteries and Accumulators and Waste Batteries and Accumulators (2010) (LoBAWBA) ("Official Gazette" No. 140/10, 47/11, 148/11, 39/12 and 163/13),
- the Law on Electric and Electronic Equipment and Waste Electric and Electronic Equipment (2012) (LoEEEWEEE) ("Official Gazette" No. 6/12 and 163/13)

Secondary legislation based on these laws has been adopted as well

[6] http://ec.europa.eu/environment/waste/legislation/index.htm
[7] http://www.municipalwasteeurope.eu/summary-current-eu-waste-legislation

Law on Environment (“Official Gazette” No.53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/2013, 44/2015) (LoE)

The national LoE is the framework legal act setting out the main requirements for environmental protection in the country and regulates the SEA, EIA and Integrated permits being horizontal issues for all sectors. It contains the fundamental environmental protection principles, which provide a basis for determining procedures for management of the environment and which are common to all laws regulating specific environmental media. It also defines the roles and responsibilities of the state administrative bodies, municipal authorities and legal and physical persons in the implementation of the legal provisions.

The LoE, which owing to its extension and scope can be almost considered as a Code for the Environment, replaces the previous Law of 1996 with a completely new approach. The new Law contains provisions on all sectors covered by EU legislation on the environment transposing it into national legislation, namely, access to environmental information, public participation in environmental decision-making, environmental monitoring, procedures for environmental assessment, integrated pollution, prevention and control, prevention and control of accidents involving hazardous substances and environmental liability. In addition, the Law contains provisions with regard to monitoring the work of the local self-government units (LSGU) from the aspects of LSGU jurisdiction and organizational set-up, particularly that of the inspection authorities. Finally, the Law also contains the legal basis for adoption of the subsidiary legislation needed to implement the Law’s provisions and thus necessary for the direct harmonization and implementation of EU environmental legislation.

Including several aspects of environmental protection in a single Law is definitely a valid approach, as it helps ensure coherence within the system and facilitate access to legislation for citizen who do not have to read several documents but can find most of the information in one. The Law is complemented by and further specified in several thematic rulebooks and by-laws relating to the different topics covered[8].

According to the LoE:

- The waste management plans at national and regional level are subject to obligatory SEA;
- The construction of the elements of the integrated waste management infrastructure requires following EIA procedures.
    - The waste management facilities require ‘A’ - integrated environmental permits (A-IEP) or ‘B’ - integrated environmental permits (B – IEP).

The installations subject to A-IEP and B-IEP are determined by a Decree of the Council of Ministers of 13 October 2005.

Regarding waste management the activities requiring A-IEP are:

- Installations for the disposal, recovery and/or co-incineration of hazardous waste with a capacity exceeding 10 tons per day
- Installations for the incineration of communal waste with a capacity exceeding 3 tons per hour
- Installations for disposal of non-hazardous waste a capacity exceeding 50 tons per day
- Landfills receiving more than 10 tons per day or with a total capacity exceeding 25000 tons, excluding landfills of inert waste

[8] United Nations Economic Commission for Europe (2011) “2nd Environmental performance review” Environmental Performance Reviews Series No. 34 (http://www.unece.org/fileadmin/DAM/env/epr/epr_studies/the_former_yugoslav_republic_of_macedonia_II.pdf)

- Installations for incineration of animal carcases

Installations for managing mining waste

Law on Waste Management ("Official Gazette" No.68/04, 71/04, 107/07, 102/08, 134/08, 124/10, 08/11, 51/11, 123/12, 147/13 and 163/13) (LoWM)

The legal framework for waste management has been established by the 2004 Law on Waste Management. Relevant EU directives have been transposed in the Law on Waste Management (LpWM), also taking into consideration the local conditions. The Law regulates issues concerning the framework Policy on Waste; on Hazardous Waste; on Landfills; Waste Oils; PCB/ PCT; on Incineration of Non-hazardous Waste; on Incineration of Hazardous Waste; on Hazardous Substances Containing Batteries and Accumulators; on Packaging and Packaging of Waste; on End-of life Vehicles; and on Waste from the Titanium Dioxide Industry. The Law on Waste Management also provides grounds for the adoption of several secondary legislation acts. The LoWM defines in details the responsibilities with regards to waste management planning, waste management activities, permitting and licensing system, rules for specific waste streams, monitoring, data collection and reporting, and financing.

Other main relative laws to waste management are:

- Law on Packaging and Packaging Waste ("Official Gazette" No. 161/09, 17/11, 47/11, 136/11, 6/12 and 163/13)
- Law on Batteries and Accumulators and Waste Batteries and Accumulators ("Official Gazette" No. 140/10, 47/11, 148/11, 39/12 and 163/13)
- Law on Electric and Electronic Equipment and Waste Electric and Electronic Equipment ("Official Gazette" No. 6/12 and 163/13) (LoEEEWEEE)
- Law on Communal Activities (1997, as amended)
- Law on the public cleanliness (2008, as amended)
- Law on Market Inspection (2007)
- Law on the Sanitary and Health Inspection (2006, as amended)

The EU recognises seven over-arching principles for waste management, which should be considered in the waste management plan[9]:

- **Waste Management Hierarchy**. Waste management strategies must aim primarily to prevent the generation of waste and to reduce its harmfulness. Where this is not possible, waste materials should be reused, recycled or recovered, or used as a source of energy. As a final resort, waste should be disposed of safely (e.g. by incineration or in landfill sites);
- **Self-Sufficiency** at Community and, if possible, at Member State level. Member States need to establish, in co-operation with other Member States an integrated and adequate network of waste disposal facilities;
- **Best Available Technique Not Entailing Excessive Cost (BATNEEC)**. Emissions from installations to the environment should be reduced as much as possible and in the most economically efficient way;
- **Proximity**. Wastes should be disposed of as close to the source as possible;
- **Precautionary Principle**. The lack of full scientific certainty should not be used as an excuse for failing to act. Where there is a credible risk to the environment or human health of acting or not acting with regard to waste, a cost-effective response to the risk identified should be pursued;

[9] Regional Environmental Center, Umweltbundesamt GmbH (2008) Handbook on Implementation of EU Environmental Legislation. (http://ec.europa.eu/environment/enlarg/handbook/handbook.pdf).

- **Producer Responsibility**. Economic operators, and particularly manufacturers of products, have to be involved in the objective to close the life cycle of substances, components and products from their production throughout their useful life until they become a waste;
- **Polluter pays**. Those responsible for generating or for the generation of waste, and consequent adverse effects on the environment, should be required to pay the costs of avoiding or alleviating those adverse consequences. A clear example can be seen in the EU Directive 99/31/EC on landfill of waste, Article 10.

Most of the above principles are incorporated in the Law on Waste Management, for example Article 7 on priorities in waste management, Article 9 on the precautionary principle, Article 10 on the proximity principle and Article 12 on the polluter-pays. Therefore, the Law incorporates the basic principles of waste management. Waste management, as a public service, is based on the principle of service universality (non-discrimination, sustainability, quality and efficiency, transparency, affordable price and full coverage of the territory).

The Law of the beneficiary country on Waste Management includes the following provisions concerning preparation of waste management strategies and plans under Section II:

- Article 15, Planning in waste management
- Article 16, Strategy on Waste Management
- Article 17, Waste Management Plan of the Republic of Macedonia
- Article 18, Waste Management Plans of the Municipalities and the City of Skopje according to the latest amendment, October 2012
- Article 18-a, Regional Plans
- Article 19, Waste Management Programmes

Distribution of responsibilities for implementation of waste management legislation

The key institution for implementing the national waste management legislation is the Ministry of Environment and Physical Planning (MoEPP) having the overall responsibility in that respect.

Regarding waste management issues, the Ministry of Economy (MoE), Ministry of Finance and MoEPP are responsible for common preparation of several regulations related to packaging and packaging waste and other end-of-life products. Inspection of the fulfilled requirements related to the products on the market is the obligation of the State Market Inspectorate (within MoE). The Ministry of Finance (MoF) plays an important role in decision making/taking and in implementation of available and effective financial/economic instruments and funds to encourage the development of waste management, in particular on approval of setting fees/charges/surcharges/earmarked taxes, management of earmarked funds, and on the cost recovery mechanisms for MSW investments and executed services. MoF is in charge of the allocation of annual budgets for all Ministries and local communities, and executes expenditure monitoring, provides co-financing for projects under international financial support (grants, loans, warranties, etc) and finally, it approves the appointment of new employees in the State institutions.

The Ministry of Health (MoH) and the MoEPP are obliged to prepare and to adopt regulations as well as to inspect the implementation of medical waste management. Collection, treatment and final disposal of animal by-products and survey on active substances for plant protection are the responsibility of the Ministry of Agriculture, Food and Water Environment (MoAFWE). The Ministry of Transport and Communication (MTC) is responsible is responsible for International regulations and required documentation for hauliers transporting dangerous or hazardous goods by road or by vehicles on ships (ADR licences).

National Waste Management Strategy (2008 - 2020)

The National Waste Management Strategy of the beneficiary country (2008 - 2020)[10] defined the directions and principles of waste management in the country, whereas the National Waste Management Plan 2009-2015, based on the NWMS, laid out the technical work and timeline needed to harmonize with the standards of the European Union. The NWMS sets out the following strategic goals and objectives:

- Harmonisation of the policy and legislation on waste management regarding the political agreement in the society and requirements of the co-operating economic environment;
- Establishment of effective institutional and organisational arrangements in all phases of implementation of the new integrated waste management system: planning, permitting, financing, operating and enforcement;
- Strengthening human resources and capacity in the public and private sector involved in the establishment process of the waste management system, as well as encouragement and engagement of knowledge, technical know-how and economic potential available in the country;
- Introduction of stable financial resources and adequate economic mechanisms to assure the full cost recovery of providing for the integrated waste management system according to the "polluter pays" principle and to the maximum effects regarding investment and operational activities;
- Raising public awareness and awareness of all stakeholders in the society from the viewpoint of understanding their roles, responsibilities and obligations in the waste management process and in the protection of the environment in order to accept significant changes of the waste management practice from collection to the final disposal;
- Establishing the data collection/ information system on the sources, nature, quantities and fate of waste streams as well as on the facilities for material/ energy recovery and final disposal of waste and assuring necessary public access;
- Establishing the contemporary technical waste management system which takes into account different technical options regarding waste avoidance, lowering their hazardous potential and reduction at sources, material/ energy recovery and utilisation of waste and safe final disposal of stabilised residues according to "best practicable environmental option" with the aim of preservation of non-renewable natural resources and minimal emissions and adverse effect of the waste treatment/ disposal processes on the living and natural environment as well as on public health;
- Application of efficient and cost-effective techniques for the management of segregated waste streams by means of private sector participation to achieve a 100% waste collection rate and optimal level for material/ energy recovery of waste;
- Introduction of landfills for hazardous and non-hazardous waste and other facilities for final disposal of waste compliant with contemporary standards to prevent the appearance of new environmental burdens;
- Progressive closing down and/ or remediation of existing municipal dumpsites and/or industrial "hot-spots" according to the inventory of environmental burdens and corresponding criteria that particularly take into account adverse effects and risks to the environment, future utilisation of physical space, costs of rehabilitation, and acceptability by the population.

The basic principles for development of the country's waste management are defined as follows:

- Solving waste problems at source;
- Separate collection of waste streams:

[10] http://www.moepp.gov.mk

- according to their hazardous characteristics;
- according to their point-source or dispersed-source generation; and
- according to the intention of further management, which shall be acceptable from an environmental and economic aspect.

- Waste utilisation as substitute of natural resources;
- Rational network of treatment and disposal facilities;
- The rationality of space management and preservation of natural and cultural heritage;
- Landfill of the stabilised and low volume waste residues;
- Remediation of contaminated sites -"hot-spots".

The NWMS introduces the concept of waste management on a regional level. The preparation of the priority policy and planning documents on establishment and operation of the new regional waste collection/treatment/disposal system of municipal and other non-hazardous waste is a central part of actions executed by the waste management unit/department in the first 5 years of the implementation of the waste management strategy.

According to the NWMS, the Government, in particular MoEPP shall encourage political decisions and organise the establishment of new regional bodies - enterprises and institutions - to carry out the tasks leading towards a contemporary regional waste management system, and assist in the execution of key political, re-organisation, financial, public relation and other operational activities.

It is stated that in order to achieve adequate economic thresholds for management with the municipal waste and acceptable prices for executed services, the majority of pre-treatment operations and landfill of residues shall be carried out on the regional level with more than 200000 habitants. The central complex of the infrastructure facilities for the final disposal of residual municipal waste shall be represented by the network of landfills on the regional level of waste management, which shall be built, equipped and in operation according to the EU standards on landfill of waste. Waste management regions shall represent the obligatory association of communities for the common solving of municipal waste issues; the size of the waste management regions shall be of such a range that enables the installation of financially optimal economy of scale of regional or inter-municipality landfills and of other accompanying waste material & energy recovery and treatment plants.

Regional municipal waste management systems shall represent a link between the state and local communities and they shall take over the majority of their responsibilities and tasks, like planning, leading investments, public relations and organisation of other activities related to the municipal waste management originally addressed to municipalities, on behalf of the joint municipalities and their inhabitants with the consent or participation of MoEPP. From the administrative/organisational and financial side, such systems shall be managed by the inter-municipal boards as political representative bodies of the joint municipalities and of the managing board of the regional waste management companies (RMWMC) which provide the municipal management operations, collection, recovery and final disposal services; RMWMC may also function as the central regional agency carrying out various expert tasks like planning, investments, local regulation, organisation, cost recovery and financing executed municipal waste management operations and environmental monitoring.

National Waste Management Plan (2009-2015)

In addition to the Strategy, in 2009 MoEPP adopted the National Waste Management Plan for the period 2009 - 2015[11], which represents an amendment and supplement of the National Waste Management Plan for the period 2006-2012 as based on the National Waste Management Strategy.

[11] http://www.moepp.gov.mk/WBStorage/Files/NWMP_2009-2015_%20of%20RM_finaL.pdf

The National Waste Management Plan has been developed to gradually implement the required improvements of the present problematic solid waste management system in the country by setting main goals, objectives and targets in the process of establishing the waste management system, and by defining the main activities and tasks in the legal, institutional, organizational, technical, and economic fields in the over six-year period. The purpose of the National Waste Management Plan is to provide an adequate environmental policy, decision-making framework, economic basis, public participation and gradual establishment of the technical infrastructure for carrying out waste management operations in order to implement the waste management system in compliance with EU legislation and with the EU Sixth Environmental Action Programme (2002-2012), taking into account its priority in waste management, i.e. the thematic strategy on sustainable use of resources and thematic strategy on waste prevention and recycling.

The Plan foresees a complex of measures in order to eliminate or mitigate environmental impacts caused by the existing improper waste management operations, and to carry out the preparation and implementation of an integral, cost-effective and sustainable waste management system, taking into account key EU principles of waste management.

The establishment of regional waste management regions to coordinate waste management activities and operations on behalf of the member municipalities is a key recommendation of the National Waste Management Plan 2009-2015 (NWMP). The organisational concept of regional cooperation in waste management is widely established in the EU although there are many approaches to the specific legal setup, shareholding, decision-making and the division of tasks and responsibilities for waste management between the regional level and the individual member municipalities. The involvement of private companies in such organisations can also be found, although essentially municipal waste management is a public service and public supervision and control is essential[12].

The amendments to the LoWM established that Regional Waste Management Plans could be adopted and implemented jointly for several municipalities for establishing a regional integrated waste management system. The RWMPs have to be approved by MoEPP and adopted by all of the municipal councils of the municipalities involved and.

It must be noted that according to the Law amending the Law on Waste Management (Official Gazette No. 123/12-02.10.12, article 2), the Waste Management Plan shall be issued for a period of ten years, instead of six.

The National Waste Management Plan (2009 - 2015) provides a series of targets for specific activities and waste streams.

Regional Waste Management Plan for Southwest region

Regional Waste Management Plan (RWMP) plays a key role in achieving sustainable municipal waste management. The main purpose is to give an outline of waste streams and treatment options.
More specifically, it provides a planning framework for the following issues:
- Compliance with waste policy and target achievement
- Outline of municipal waste characteristics and sufficient capacity for managing waste
- Outline of actions, including measures for achieving objectives:
    - collection systems
    - municipal solid waste management facilities

[12]United Nations Economic Commission for Europe (2011) "2nd Environmental performance" Environmental Performance Reviews Series No. 34 (http://www.unece.org/fileadmin/DAM/env/epr/epr_studies/the_former_yugoslav_republic_of_macedonia_II.pdf)

- Outline of financial requirements concerning current and future status for sustainable municipal waste management

The RWMP for Southwest region was prepared in the framework of the project '*Preparation of necessary documents for establishing of an Integrated and Financially Self sustainable Waste Management System in Pelagonija, Southwest, Vardar and Skopje Regions*' (EuropeAid/136347/IH/SER/MK).
The RWMP was drafted on the basis of: a) EU and national waste legislation and strategies; and b) the analysis and evaluation of the current situation, which was the outcome of the elaborated Assessment Report. Apart from the EU and national waste legislation and strategy, a number of significant parameters which influence the regional planning were taken into account: (1) Waste quantity and composition, (2) Geographic origin of waste and (3) Current situation regarding waste collection and treatment, including waste tariffs and affordability.
The minimum requirements set by the national waste management legislation for packaging and packaging waste, and, additionally, a set of targets for biodegradable municipal waste (BMW) that should be diverted from landfills were taken into consideration during the preparation of the RWMP in order these to be covered by the RWMP.
To fulfill the objectives of waste management, alternative waste management scenarios have been proposed, examined and presented within the RWMP, all of which including some common elements, like (i) green points that will be a collection point for recyclables and wood packaging fraction, (ii) separate collection of hazardous municipal waste, (iii) separate collection of construction and demolition waste, (iv) separate collection of WEEE and (v) separate collection of other special waste streams (elastic-tires). Also all proposed scenarios included separate collection of garden waste and sorting at source of recyclables or packaging waste. Finally the alternative scenarios included a collection system with the use of either 1 or 2 or 3 bins.

Followingly, by using a Multi-Criteria Analysis (MCA), PROMETHEE, the characteristics of the various alternative proposed scenarios were simultaneously analyzed through the evaluation and rating of all the different criteria for the extraction of the optimal solution, i.e. the recommended scenario. The evaluated criteria are classified into four major groups, incorporating financial, technical, environmental and social-institutional parameters.

Having quantified and set the regional targets of recycling of packaging waste and reduction of BMW which will be landfilled for the proposed scenario, and, additionally, having set the objectives as well as the measures via which these targets will be achieved, an action plan was prepared. This action plan focuses on the priority measures and the respective main infrastructure investments, but also gives an indication of all future activities (reinvestment on other activities) that will need to be implemented. The Action Plan was divided into the following periods: (1) Priority measures for a period of up to three years (2018-2020), (2) Short-term measures for a period of up to five years (-2022), (3) Medium-term measures for a period of six to ten years (-2027) and (4) Long term measures for a period longer than ten years (-2046).

5.3 LOCAL SPATIAL POLICY

According to the Waste Management Strategy 2008-2020 physical planning on the national and local level regarding acceptable locations for waste management facilities shall take into account the topographic, geological, hydro-geological characteristics and current use of land, locations of the settlement expanding, ownership of land and identified sensitive areas regarding water resources and natural habitats. On a national and local level, environmentally sensitive areas shall be identified as important inputs in the preparation of physical plans.

Waste treatment and incineration facilities shall be placed on locations with the predominance of industrial, energy and transport facilities where no general limitations for technologies regarding the quality of living environment may be expected.

Locations for the landfill facilities shall be chosen primarily according to the criteria related to the characteristics and protection of the natural environment, to the ownership of land, to the prevailing utilization of locations as well as to the economic and social effects. However, the priority shall be given to the location of existing or abandoned landfills of waste where reconstruction of a landfill may be economically acceptable and alternative utilization may not be practicable, and where environmental criteria regarding landfill can be met, or new locations for landfills may be selected where environmental and economic criteria can be met in the frame of the social acceptance.
Locations selected according to the set criteria and intended for a new long-term function on the waste treatment/landfill facility shall be prepared and adopted as an integral part of physical plans on the national and local level taking into account possible expansion of waste management operations on those locations in the future.

In a local level concerning the strengthening of institutions Municipalities are in principle responsible to provide for the proper management and disposal of municipal waste on behalf of their inhabitants. By accepting the regional level of solving the municipal waste issues, municipalities shall appoint and train responsible persons for activities related of the establishment and operation of regional systems of the municipal waste management from the legal, organizational and financial viewpoint.
Regional municipal waste management companies (RMWMC) shall be established by the consortiums of municipalities with the consent and/or participation of the MoEPP and they shall take over the majority of responsibilities and tasks on planning, leading investments, public relations and on the organization of other activities related to municipal waste management originally addressed to municipalities, and on organising municipal waste management and final disposal of residues on behalf of the joint municipalities and their inhabitants. Involvement of the private sector, through concession or public private partnership shall be encouraged as mechanism for provision of economically optimal solution that shall be also acceptable from environmental point of view.

The 2004 Spatial Plan incorporates emphasized strategic development connotation and defines and establishes the basis and at the same time feasible goals and directions for development, especially with regard to the necessary qualitative and quantitative structural changes and the relevant and adaptable spatial planning solutions and options. This document constitutes a foundation for the organization, development, use and protection of space in the country, covering a 20-year period. The Study on the Environment and Nature Protection, carried out within the framework of the Plan, specifies the goals and planning guidelines for environment protection, as part of the overall activities in the field of spatial planning.

As of May 2016, 29 local environmental action plans from municipalities form the four regions of the project, including the City of Skopje, had been developed. Most of the four larger municipalities have greater economic and human capacity and have developed their LEAPs, while smaller municipalities are lagging behind in the preparation of this document. There are a number Plans prepared in the last three years, after the adoption of the Methodology for the preparation of LEAPs by MoEPP, based on Article 64 of the Law on Environment, such as LEAP for the municipalities within the City of Skopje, for example Aerodrom, Ilinden, Gjorce Petrov, and other municipalities, such as Novaci, Vasilevo, Brvenica. Twenty LEAPs prepared by 1998 are particularly outdated since they were developed prior to the preparation of the MoEPP Methodology for the Preparation of LEAPs, based on the DPSIR approach.

The Government and in particular MoEPP is financially supporting the municipalities in the preparation of the LEAPs. In addition to these national resources, the international donor community is active in this field. MoEPP has prepared a methodology for LEAP preparation based on the DPSIR approach (Driving forces, Pressures, States, Impacts and, Responses). The methodology is used by municipalities in preparing the LEAP, and it can be seen that in recent years, the quality of LEAPs has improved and they are becoming increasingly relevant.

Spatial planning measures represent a complex of projects on the proper assessment of possible placing of the waste treatment plants and disposal facilities in intended areas, taking into account the present use of land, proximity of settlements and manufacturing/service zones, availability of transport communication and utilities, the geological and hydro-geological situation, areas with protected living species and habitats. Spatial planning activities shall take into consideration the possible direct/indirect, cumulative, synergic, short-, medium and long-term, constant or temporary impacts on the natural and living environment, cultural heritage and landscaping, in particular in relation to other development plans of the considered area and especially protected natural resources.
The regions were obliged to prepare waste management plans which should have defined the waste management system consisting of not more than one WMC in each region. For construction of integral waste management system, regions should adopt required physical plans.

Planned construction works are compatible with Waste Management Strategy of the beneficiary country and the Waste Management Plan for period 2009-2015 and physical planning on local and national level.

5.4 LEGAL AND POLICY ISSUES RELATED TO THE PROJECT

Preparation and implementation of an integral and cost effective and sustainable waste management system requires interrelated and simultaneous changes in the policy and legislation, in institutional and organizational arrangements, in strengthening of human resources and capacity building, in financing investments in infrastructure and in assuring the cost recovery of the waste management operation, in the stakeholder /public awareness and participation in waste management projects and in establishment of an easy accessible and transparent information system.

The beneficiary country has adopted the general and long-term policy on waste management in the Law on Waste Management and in the National Waste Management Strategy, i.e. the principles of the sustainable development of the waste management system, general framework of the technical waste management scheme and general measures to overcome existing environmental issues and to assure a rational and efficient network of facilities for the waste collection, material/energy recovery and for disposal of residues.

Objectives that could be realized in the time period of the waste management plan 2009-2015 are presented in the following table.

Area /activity	Principal objective and sub-objectives
Policy and legislation structure	***• Alignment of legislation with acquis communautaire*** • National level: Transposition of EU legislation and accomplishment of the basic legal WM framework • Completion of regulations indirectly related to WM (asbestos, emissions to air & water, water & soil environment, environmental liability) • Local & regional level: Upgrading of the municipal SWM regulations, physical planning acts and regulations living environment, sensitive areas, water environment and natural/cultural heritage;
Institutional/organisational structures & arrangements	***Division of obligations, tasks, responsibilities & organisational reforming, raising capacities of all stakeholders in WM*** • Division of tasks/responsibilities and effective co-operation of the interministerial committee; • Strengthening of the role and capacities of the central WM body in MoEPP to carry out the planning, reporting, monitoring, administration (permitting, licensing) and project coordination activities; • Strengthening and reforming the enforcement bodies; • Set-up the institutional links between state institutions, local institutions and manufacturing/service sector and vertical co-operation; • Bringing under control the industrial non-hazardous and hazardous waste streams by setting-up a feasible and economically acceptable and licensed organisational system, complementary to the adaptation to IPPC requirements and to the introduction of environmental standards (ISO 14000, EMAS) in companies. • Diverting special waste streams and end-of-life products from landfills by setting-up a linked collection/recovery/disposal system (public services/enterprises) according to the "producer's responsibility principle". • Strengthening human resources and waste management capacities of WM operators and generators.
Technical infrastructure facilities	***Reduction of environmental impact by establishment of the network of the technical infrastructure waste management facilities*** • Gradual establishment of the regional MSWM infrastructure facilities with the corresponding efficient & cost effective collection system and transport logistics for different waste fractions: - in the transition period by improvement of collection, transport and landfill of waste on the existing low risk landfills after conditioning, on new landfills and by diversion of waste from non-legal landfills, - in the follow-up phases, the construction of the landfill facilities with the supplemental infrastructure facilities for material/energy recovery and final disposal operations fully compliant with EU standards. • Closure of landfills non-compliant with EU standards (presumably 40 high /medium risk landfills according to the programme of the MSW transition period). • Establishment of the collection and material/energy recovery facilities for special waste streams and end-of-life products according the "producer's responsibility • Establishment of the hazardous waste management infrastructure according to the technological adaptation programmes to the IPPC directive (application of BAT) and according to other feasible technical/logistical solutions for small HW generators. • Remediation/upgrading of landfills on premises of hazardous and nonhazardous waste generators; remediation of at least one priority "hot spot".

Area /activity	Principal objective and sub-objectives
	• Establishment of the network for the animal by-product management infrastructure compliant with EU standards. • Establishment of the logistics system and treatment/disposal infrastructure for medical waste and for the selected groups of combustible hazardous waste fractions from different sources. • Establishment of the network for the recovery/disposal facilities for construction/demolition waste compliant with EU standards, including safe disposal of asbestos waste.
Cost recovery and financing investment	***Assuring revenue flows to cover full cost for executed services provided by the gradually developing waste management system*** • Assuring the cost recovery system for MSWM services based on the “polluter pays” principle; • Assuring earmarked taxes and payment mechanisms for executed services in the frame of the" compliant" scheme according to the “producer’s & importer’s responsibility for packaging waste and for other special waste streams / end-of-life products; • Assuring cost more efficient waste management by involvement of private sector in execution of waste management operations. ***Assuring revenues of funds for financing investments*** • Assuring funds for investments in the WM infrastructure facilities and in closure/remediation of landfills by means of earmarked charges/ surcharges / taxes, collected on the national & local level. • Assuring funds for investments in the infrastructure facilities for management of special waste streams & end-of-life products, and in remediation/reactivation of “hot spots” by means of local and international private investors, funds, banks and donations.
Stakeholder & public awareness and communication system	***Understanding of waste issues and role of all stakeholders and inevitable policy/structural changes, positive public participation supporting the waste management projects*** • General and constant public information and raising awareness on waste issues • Understanding legal requirements, constrains and technical options of waste generators and WM sector with regard to waste management operations and impacts on environment. • Raising public awareness and positive participation in implementation of regional MSW and other waste management projects.

5.5 AVAILABLE SOURCES OF FINANCING

According to the National Waste Management Plan 2009-2015 the main possible sources of financing investments for the implementation of the EU waste legislation, for the execution of the variety of organizational and public relations tasks, and for elaboration of the necessary technical, spatial and investment documentation and environmental studies and capital investments, are:

- waste producers (measures they take themselves);
- public sources consisting of:
    - charges paid by waste producers to waste management service providers;
    - fees for licenses and other services,
    - State or municipal budgets, and
    - investment funds (established on the regional/inter-municipality level)
- private capital (through direct private investments, through the Public Private Partnership arrangements, CO_2 credit lines), and

- international funds and financial institutions providing grants (IPA fund, ERDF, international donors) and loans (different IFI, bilateral financing institutions, commercial bank, bonds issued by the central or local government authorities

By means of the earmarked addition to the selling price of waste-generating products levied by the producer or importer, the producers or importers may fund a system organized by themselves to collect, recover and dispose of waste (end-of-life products) according the "producer’s and or importer’s responsibility principle".

There is also another option available: earmarked taxes levied by the state or other public authority on waste-generating products (end-of-life products) are collecting in the environmental fund (in principle in the State budget); these taxes are used for organization and execution of collection, recovery and disposal of waste residues in the organization form of the joint public services. Such a system also represents one of the economical/financial instruments.
Some of these main, various sources are considered below:

<u>Waste producers (measures they take themselves)</u>
For example producers of some high volume hazardous wastes will be required either to take measures to reduce the volume of hazardous waste being produced or to store or dispose of that waste in a manner which meets EU standards. This will be done at their own expense.

<u>Charges paid by waste producers to waste management service providers</u>
These will mainly be charges for waste collection and disposal. Waste producers are already paying such charges to local authorities and to transport contractors who transport their waste, but these charges are likely to rise to reflect the costs of complying with EU legislation.

<u>Fees for licenses and other services</u>
The costs of a competent authority for issuing and maintaining a waste management license or for carrying out an inspection could be met by levying a fee for that activity.

<u>State or municipal budgets</u>
This may be either part of the regular budget or a special allocation earmarked to deal with a one-off or special situation. Earmarked taxes as well as surcharges on improper waste management practices may also become a significant resource of regional funds established on inter-municipality level and intended for regional investments in the MSWM infrastructure facilities. Establishment of the investment funds from earmarked sources on the State and regional level is very important for a country developing a new waste management system almost from the very beginning.
There are a lot of tasks on the national and local level with regard to elaboration of the variety of documentation which need their own financial sources; the majority of international investment institutions also require a determined part of the co-investment.

<u>Grants from other international donors</u>
A variety of bilateral development cooperation organizations provide grants to middle income countries preparing for accession to the EU such as the Republic of Macedonia. These include US-AID, GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit), Danida (Danish International Development Aid), SIDA (Swedish International Development Aid), DfID (Department for International Development of UK), SDC (Swiss Agency for Development and Cooperation), ADA (Austrian Development Agency), JICA (Japan International Cooperation Agency). Such funding is of course likely to dry up after the Republic of Macedonia accedes to the EU.

Loans from international funding institutions

The international funding institutions (IFIs) are development banks such as the World Bank, the European Bank for Reconstruction and Development (EBRD) and the European Investment Bank (EIB), which offer loans at a relatively low rate of interest for investments (amongst others) intended to establish or improve environmental facilities or infrastructure. In general, applications for financing to an IFI will need to have the official approval and a supporting guarantee from the government of the beneficiary country.

An exception to this general rule is the EBRD, which may require a sovereign guarantee. However, the interest rates charged by the EBRD tend to be higher than those typically offered by other international (or bilateral) financing institutions (for example LIBOR + 2 to 4%, say 6 to 8% at the time of writing).

The World Bank will only lend to a government body but the EBRD and the EIB will also lend to private companies. Most of the international financing institutions will only lend to companies or to corporate entities having clearly defined objectives, management and decision-making structure, which are operated along commercial lines. Also, some institutions have a minimum size of loan. For example, the EBRD will only directly finance loans of 5 million US or greater. These constraints tend to limit the scope for IFI participation in financing capital investments to projects of a fairly substantial size. In addition, significant resources and time are usually needed to develop and negotiate an IFI loan.

The World Bank recently finalized its Country Partnership Strategy 2007-2010 for the beneficiary country. The total funding for 2007-2010 shall be 230 million US $. Of this, perhaps 10% will go to municipal development. The World Bank at present is not enthusiastic about investing in wastewater treatment in the beneficiary country (doubts about sustainability due to high operating costs), but thinks the time is ripe for the development of modern waste management facilities.

Loans from commercial banks

Local authorities may be able to obtain loans from commercial banks, but the terms are likely to be much less favorable than from international and bilateral funding institutions. The banking sector in the Republic of Macedonia is presently hampered by a relatively uncompetitive banking climate low banking efficiency and difficulties in assessing the credit risks of potential borrowers.

Bonds issued by local government authorities

Most local authorities, with the possible exception of the City of Skopje, are probably not yet at a stage where they can envisage issuing bonds as a means of raising finance. This is because of their small size, lack of an independent audit of their accounts, low quality of financial data, the need for obtaining a credit rating from organizations such as Standard and Poor, Moody's, etc.

Private capital

The private sector could play a role in financing the development of the waste management infrastructure in the country. There are many different arrangements by which the private sector could participate, for example private contractors could operate a sanitary landfill as a concession or the landfill might be the subject of a BOT (Build - Operate - Transfer) contract. Such constructions will require a number of developments before they can be envisaged in the beneficiary, including reform of accounting in municipalities and communal enterprises, clear evidence that the state is willing to enforce the new laws and that municipalities are willing to allow the real waste management costs to be charged to waste producers and the emergence of credible operators of the new facilities.

TABLE OF CONTENTS

Annex 6-I: Transfer Stations

List of tables

LIST OF FIGURES

6. OPTION ANALYSIS

6.1 Methodology

An integrated waste management system needs to be a sustainable system which is economically affordable, socially acceptable and environmentally effective.

- Economic affordability requires that the costs of waste management systems are affordable to all sectors of the community served, including householders, commerce, industry, institutions, and government.
- Social acceptability requires that the waste management system meets the needs of the local community, and reflects the values and priorities of that society.
- Environmental effectiveness requires that the overall environmental burdens of managing waste are reduced, both in terms of consumption of resources (including energy) and the creation of environmental impacts.

Integrated Solid Waste Management (ISWM) takes an overall approach to this, involves the use of a range of different treatment options, and deals with the entire solid waste stream.

The following figure represents the concept of an Integrated Solid Waste Management System (ISWM). The ISWM scheme demonstrates that collection and sorting are at the centre of any successful waste management system. The four main waste management technologies surrounding the collection and sorting system are shown as equal sized quadrants to illustrate that they must be considered equally when developing a waste management strategy for any location. Flexibility in technology application for a specific location is also an essential component of the ISWM concept. Data based decision support using Life Cycle Assessment tools facilitates the selection of the most appropriate waste management technologies (not necessarily all four) needed to deliver an environmentally optimized ISWM system for a specific location. In combination with economic and social considerations, this approach helps for the design of a more sustainable solid waste management system.

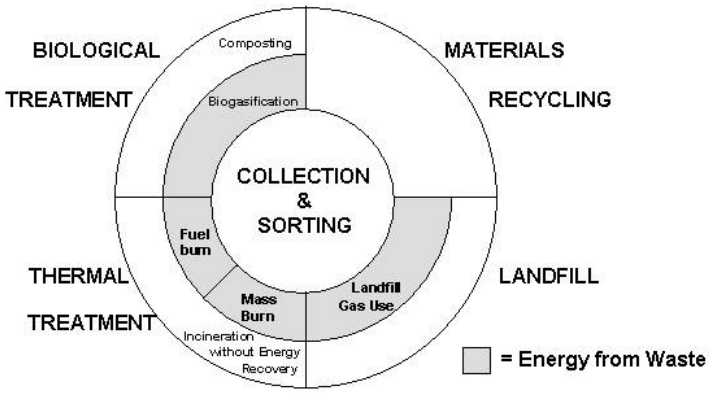


Figure 6-1: The Elements of Integrated Waste Management

Along with the overall need for sustainable waste management, it is clear that no one single treatment method can manage all materials in Municipal Solid Waste (MSW) in an environmentally effective way. Following a suitable collection system, a range of treatment options will be required. These include materials recovery, biological treatment (composting, anaerobic digestion, biodrying etc.), thermal treatment (mass-burn incineration with energy recovery and/or burning of Refuse Derived Fuel - RDF) and landfilling. Together these or some of these form an Integrated Solid Waste Management (ISWM) system.

Effective management schemes need the flexibility to design, adapt, and operate systems in ways which best meet current social, economic, and environmental conditions. These are likely to change over time and vary by location. The need for consistency in quality and quantity of recycled materials, compost or energy, the need to support a range of disposal options, and the benefit of economies of scale, all suggest that ISWM systems should be organized on a large-scale, regional basis. Any scheme incorporating recycling, composting or energy from waste technologies must be market-orientated.

Whilst it uses a combination of options, the defining feature of an ISWM system is that it takes an overall approach to manage all materials in the waste stream in an environmentally effective, economically affordable, and socially acceptable way.
An integrated waste management system consists in general of the following stages:

- Waste collection (one / two / three or more bin collection system)
- Waste transportation and transfer (to transfer station, recovery and recycling facility, treatment plant or landfill)
- Locations of waste management facilities i.e. transfer stations and integrated waste management centre
- Waste treatment (thermal, physical, chemical or biological treatment)
- Waste disposal to landfill

In particular in this study the methodology that is followed in order to create a municipal waste management system includes the following steps:

- Step 1: Collection and elaboration of data for the current situation of waste management in area of interest. Those data have been deeper analyzed in the Assessment report of the current project.
- Step 2: Estimation of the forecast of future population (urban, rural and seasonal) and future municipal waste production using different scenarios concerning the change of urban/rural population, seasonal population and the change of Waste Generation Rate (WGR) for each population category.
- Step 3: Detailed presentation via a flow chart on waste streams that will be collected separately
- Step 4: Analytical calculations of the quantities of waste stream that will remain and will be transferred in future CWMF for further treatment through Transfer Stations or directly.
- Step 5: Analysis of alternative technologies that can be used in CWMF (calculation of legislative targets, mass balances, investment costs, operational costs, LUC, ENPV, ERR, B/C ratio), according to the New Guide to cost – benefit analysis of investment project by European Commission 2014-2020.
- Step 6: Multi-criteria analysis of alternative solutions - scenarios in order to conclude which solution - scenario is the preferable for waste management in area of interest.

6.2 Project determination and its objectives

Within the main text of the RWMP of Southwest region, a gap analysis is also included. The purpose of gap analysis was to comment on the gaps and weak spots identified within the assessment carried out.

Already since 2008 the European Waste Framework Directive has set specific requirements for waste management, among which the most notable is the waste hierarchy. Following the waste hierarchy, waste prevention is the worthwhile goal, followed by preparing for re-use, recycling, other recovery, e.g. energy recovery, and lastly disposal as the last resort for waste that cannot be further recovered. Therefore, a shift away from landfill in the current waste management system is crucial. The necessary changes will require the development of an appropriate infrastructure to provide an integrated network of separate waste collection, transportation, recycling facilities, recovery installation and EU conform disposal facilities. The proposed changes in the next phase should reduce the amount of waste being landfilled.

Identified gaps and measures to be taken within the current waste management system, already presented in the respective RWMP, concerned the following topics:

A. EU and national targets/ Local Policy

- Diversion of biodegradable municipal waste

- Target for collection and treatment of packaging waste: paper and cardboard packaging, metal packaging, plastic packaging and glass packaging from households and other sources, if possible, when such waste streams are similar to household waste.

- Waste prevention

- Landfill restoration and/ or landfill closure

B. Financial mechanisms

- Tariffs

C. Technology and infrastructure

- Collection - Transportation

D. Stakeholder participation - Public awareness

Upgrading with its long-term goal of becoming a 'Recycling Society', the European Union's waste policy aims at preventing waste generation and optimizing the use of waste as a resource. The key actors concretely implementing this concept are regional and local authorities as waste management falls into their responsibility[1].

For the establishment of a waste management system, the **Waste Management Strategy of the Republic of Macedonia (2008 - 2020)**[2] (OG 39/08) and the **National Waste Management Plan (2009 - 2015) of the Republic of Macedonia**[3] (OG 77/09) envision the construction of improved and new waste management infrastructure for collection, treatment and final disposal of municipal solid waste on the regional level. Among the general goals and objectives of the waste management Strategy of the Republic of Macedonia, 3 of the main are:

-to bring under control all generated waste streams

-decrease the quantities of waste generated

-recovery of the material and energy value of waste

The overall project objective is to establish an integrated waste management system in the Region. The actions will contribute to the protection of the environment and human health.

The general objectives are:

- Minimization of negative impacts on the environment and human health caused by the generation and management of waste.
- Minimization of negative social and economic impacts and maximization of social and economic opportunities.

---

[1] http://www.regions4recycling.eu/R4RTheProject/background_and_objectives

[2]http://www.moepp.gov.mk/wp-content/uploads/2014/09/Strategija%20za%20upravuvanje%20so%20otpad%20na%20RM%20(2008-2020).pdf

[3]http://www.moepp.gov.mk/wp-content/uploads/2014/09/Nacionalen%20Plan%20za%20upravuvanje%20so%20otpad%20(2009-2015)%20na%20RM%20.pdf

- Conformity with the legislative requirements, targets, principles and policies set by the European and National legal and regulatory framework.

The specific objectives of the project are to:

- close and rehabilitate of non-compliant municipal landfills
- increase the percentage of separately collected waste (the system will include sorting at source for recyclables),
- increase recycling and re-use of waste,
- achieve the recycling of a minimum of 55% and a maximum of 80% of the weight of packaging waste, by the end of the year 2020, according to the article 35 of the Law on management of Packaging and Packaging waste[4]
- achieve the reduction of the amount of biodegradable waste in municipal waste,
- achieve the reduction of the amount of biodegradable waste disposed in landfill, in order to fulfill the article 87 of the LoWM of the Republic of Macedonia
- reduce the harmful effects of waste on the environment,
- plan and implement waste prevention measures, through public awareness campaigns,
- enable a sustainable municipal waste management system.

Article 15, par. (1) of the Law on Waste Management (LoWM)[5], states that "*the competent authorities of the Republic of Macedonia, municipalities and the City of Skopje, as well as legal and natural persons managing waste in accordance with this Law shall adopt and implement strategic, planning and program documents for waste management in order to:*
1) provide environmental protection, life and health;
2) achieve the objectives and guidelines laid down in the National Environmental Action Plan;
3) apply the general principles and guidelines for waste management;
4) establish an integrated national network of facilities and installations for processing and disposal of waste
5) fulfill the obligations related to waste management, which the Republic of Macedonia has undertaken at international level."

Furthermore, Article 16, par. (2) of the LoWM, states that "*the Strategy for waste management shall:*
1) determine basic guidelines for managing all types of waste;
2) improve the general situation in waste management;
3) determine the necessary legal measures for the implementation of the plan for waste management;
4) term needs of the Republic of Macedonia in the field of waste management;
5) determine the strategic approach to the development of public awareness and education regarding waste management and
6) determine other issues of importance for the development of waste management."

The following targets must be achieved by the proposed waste management system in order to contribute to Republic of Macedonia's national targets:

[4]http://www.moepp.gov.mk/wp-content/uploads/2014/10/%D0%97%D0%90%D0%9A%D0%9E%D0%9D-%D0%97%D0%90-%D0%A3%D0%9F%D0%A0%D0%90%D0%92%D0%A3%D0%92%D0%90%D0%8A%D0%95-%D0%A1%D0%9E-%D0%9F%D0%90%D0%9A%D0%A3%D0%92%D0%90%D0%8A%D0%95-%D0%98-%D0%9E%D0%A2%D0%9F%D0%90%D0%94-%D0%9E%D0%94-%D0%9F%D0%90%D0%9A%D0%A3%D0%92%D0%90%D0%8A%D0%95.pdf
[5]http://www.moepp.gov.mk/wp-content/uploads/2014/09/Zakon%20za%20Upravuvanje%20so%20Otpadot.pdf

As already briefly mentioned above, according to the article 35 (National aims for treatment of packaging waste), paragraphs (1) b, (1) c & (1) d of Law on management of Packaging and Packaging waste the following should be fulfilled:

- By the end of the year 2020, a minimum of 55% and a maximum of 80% of the weight of packaging waste created on the territory of the Republic of Macedonia needs to be recycled

- By the end of the year 2020, the following percentages of materials from the packaging waste produced need to be recycled:

(i) 60% by weight for glass; ii) 60% by weight for paper and cardboard;

(iii) 50% by weight for metals;

(iv) 15% by weight for wood

- Also, by the end of the year 2018, 22.5% by weight for plastic, considering only the recyclable materials in the plastic.

Also, article 87 of the LoWM of the Republic of Macedonia specifies the reduction of the quantity of Biodegradable Municipal Waste (BMW) landfilled, expressed as a percentage reduction of the BMW generated at 1995:

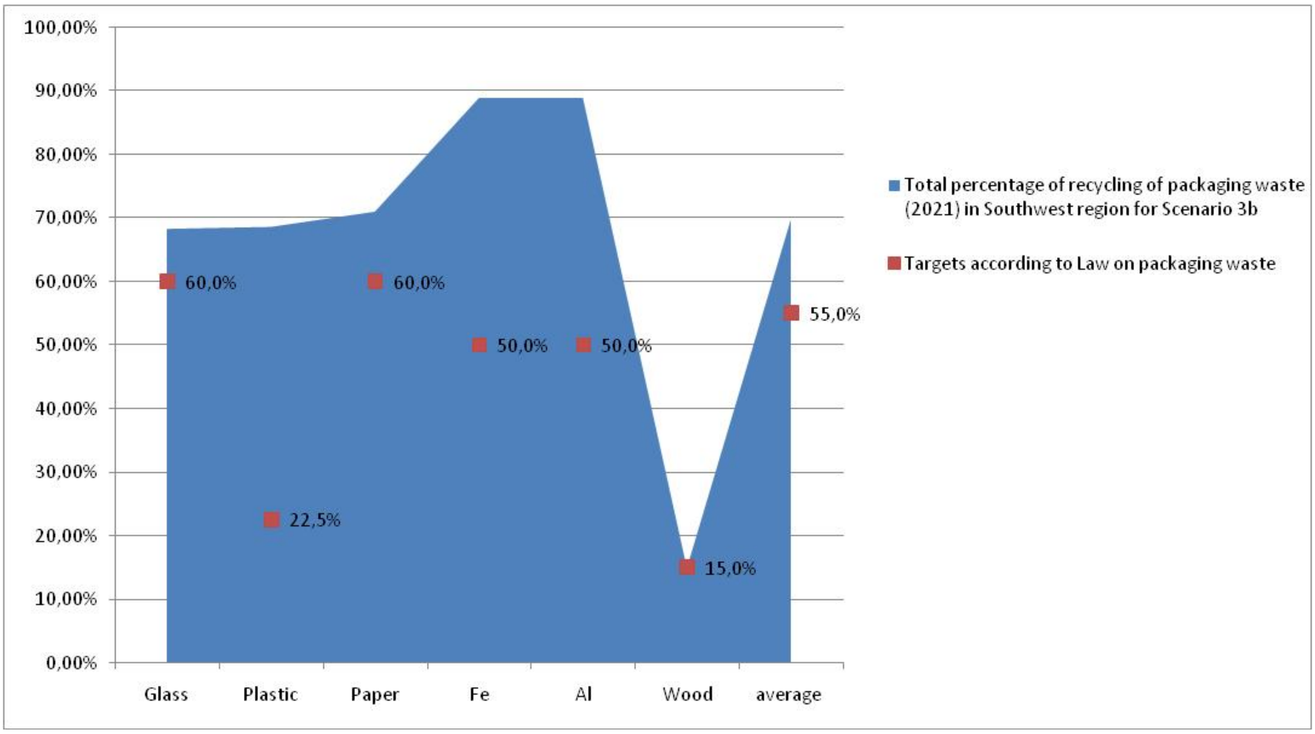
1. *by 31st December 2016 the reduction must be 25%, that is a maximum allowable mass of 228,750 t BMW*
2. *by 31st December 2019 the reduction must be 50%, that is a maximum allowable mass of 152,500 t BMW*
3. *by 31st December 2026 the reduction must be 65%, that is a maximum allowable mass of 106,750 t BMW*

Especially for Southwest Region the maximum allowable mass of BMW which may be deposited annually in landfill shall be:

- *25,057 t* by 31st December 2016
- *16,705 t* by 31st December 2019
- *11,693 t* by 31st December 2026

The quantification of the aforementioned targets is presented in the following figures and tables.

Figure 6-2: Quantification of Law on Management of Packaging and Packaging waste for selected scenario



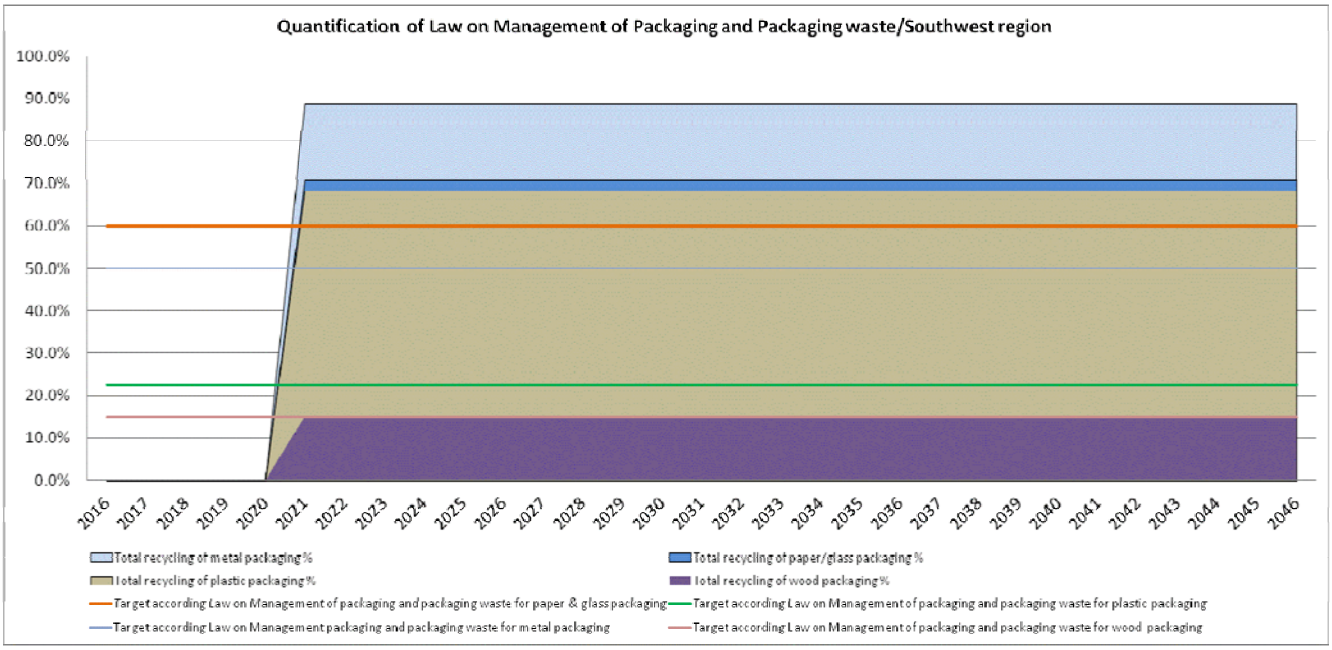
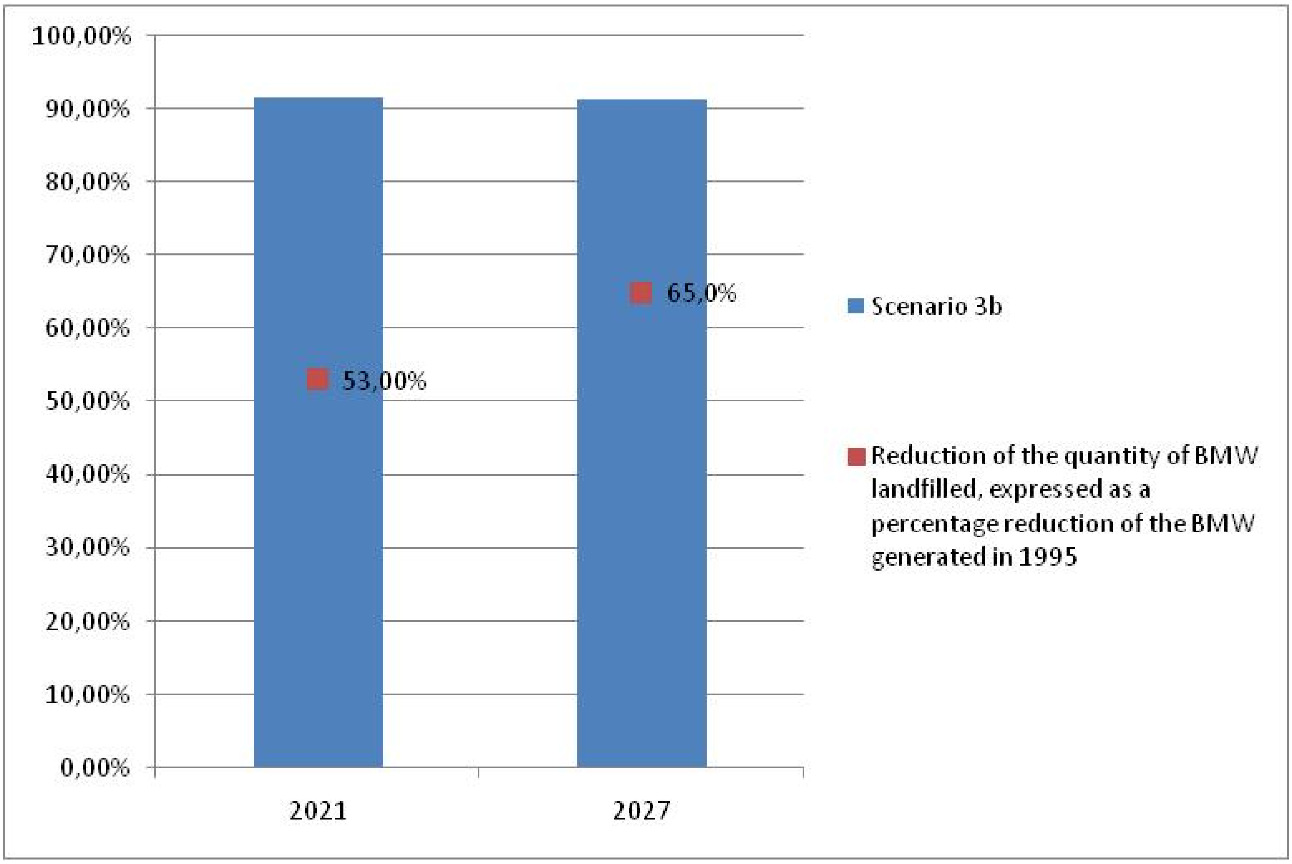


Table 6-1: Quantification of Law on Management of Packaging and Packaging waste

YEAR	Total Packaging Waste Produced in Southwest region (t)	Total recycling of packaging waste (t)	Target that must be fulfilled according to the Law on Management of Packaging and Packaging waste (t)	Total recycling of packaging waste (%)
2016	14,676		8,072	
2017	14,925		8,209	
2018	15,172		8,345	
2019	15,632		8,598	
2020	16,081		8,845	
2021	16,136	11,182	8,875	69.3%
2022	16,201	11,228	8,911	69.3%
2023	16,270	11,275	8,948	69.3%
2024	16,341	11,324	8,988	69.3%
2025	16,415	11,376	9,028	69.3%
2026	16,478	11,419	9,063	69.3%
2027	16,544	11,465	9,099	69.3%
2028	16,614	11,513	9,137	69.3%
2029	16,688	11,565	9,178	69.3%
2030	16,766	11,619	9,221	69.3%
2031	16,733	11,596	9,203	69.3%
2032	16,701	11,574	9,185	69.3%
2033	16,670	11,552	9,168	69.3%
2034	16,640	11,532	9,152	69.3%
2035	16,611	11,512	9,136	69.3%
2036	16,564	11,479	9,110	69.3%
2037	16,518	11,447	9,085	69.3%
2038	16,473	11,416	9,060	69.3%
2039	16,429	11,386	9,036	69.3%
2040	16,387	11,356	9,013	69.3%
2041	16,328	11,316	8,981	69.3%
2042	16,271	11,276	8,949	69.3%
2043	16,215	11,237	8,918	69.3%
2044	16,160	11,199	8,888	69.3%
2045	16,106	11,162	8,858	69.3%
2046	16,040	11,116	8,822	69.3%

Figure 6-3: Quantification of LoWM Article 8 regarding biodegradable municipal waste landfilled for selected scenario 3b



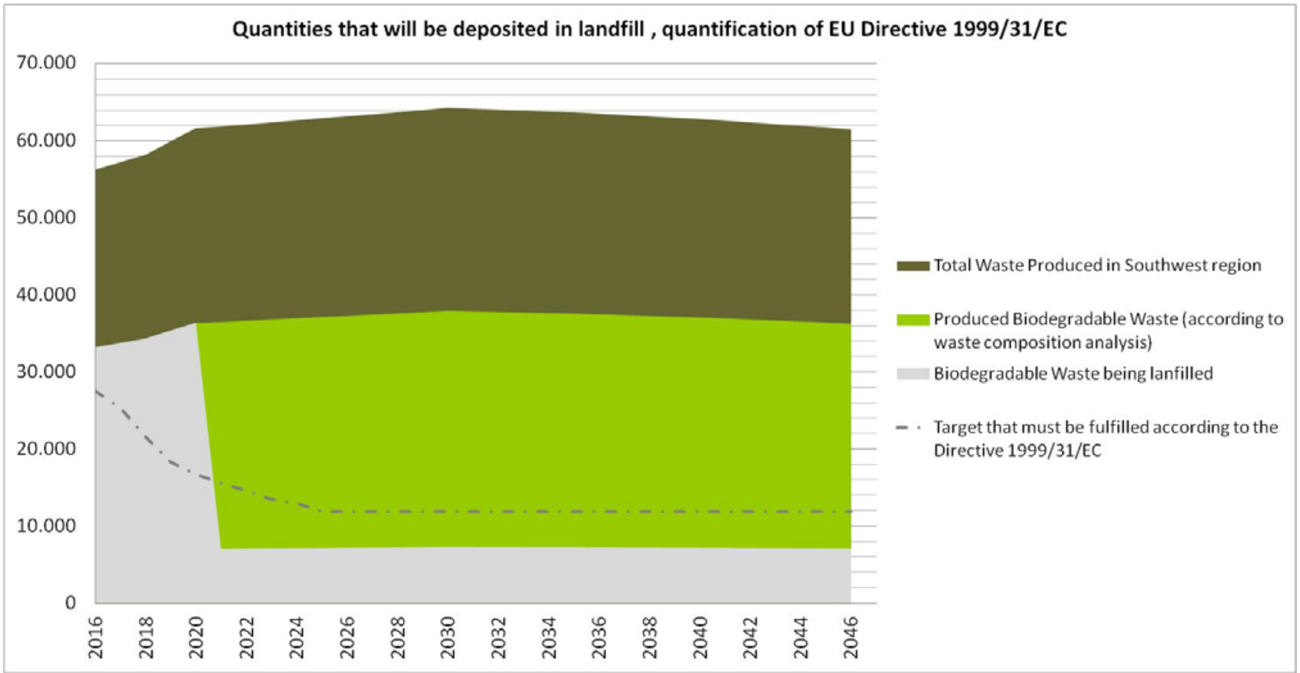


Table 6-2: Quantification of LoWM Article 8 regarding biodegradable municipal waste landfilled for selected scenario

YEAR	Total Waste Produced in Southwest region (t)	Produced Biodegradable Waste (according to waste composition analysis) (t)	Target that must be fulfilled according to the Directive 1999/31/EC	Biodegradable Municipal Waste being landfilled (t)
2016	56,224	33,222	27,482	33,222
2017	57,178	33,786	25,326	33,786
2018	58,123	34,345	21,554	34,345
2019	59,885	35,386	18,321	35,386
2020	61,607	36,403	16,705	36,403
2021	61,815	36,526	15,627	7,073
2022	62,067	36,675	14,549	7,104
2023	62,329	36,830	13,471	7,136
2024	62,602	36,991	12,933	7,170
2025	62,887	37,159	11,855	7,205
2026	63,125	37,300	11,855	7,235
2027	63,378	37,450	11,855	7,267
2028	63,646	37,608	11,855	7,301
2029	63,930	37,776	11,855	7,337
2030	64,230	37,953	11,855	7,374
2031	64,103	37,878	11,855	7,363
2032	63,980	37,805	11,855	7,352
2033	63,862	37,735	11,855	7,342
2034	63,748	37,668	11,855	7,332
2035	63,638	37,603	11,855	7,323
2036	63,457	37,496	11,855	7,305
2037	63,281	37,392	11,855	7,288
2038	63,109	37,290	11,855	7,272
2039	62,941	37,191	11,855	7,256
2040	62,777	37,095	11,855	7,240
2041	62,553	36,962	11,855	7,217
2042	62,334	36,833	11,855	7,195
2043	62,119	36,706	11,855	7,173
2044	61,909	36,582	11,855	7,152
2045	61,703	36,460	11,855	7,131
2046	61,450	36,310	11,855	7,105

The target derived from Directive 2008/98/EC also quantified for Southwest region and the results are presented in the following figure and table.

Figure 6-4: Quantification of Dir. 2008/98/EC for selected scenario 3b in Southwest region

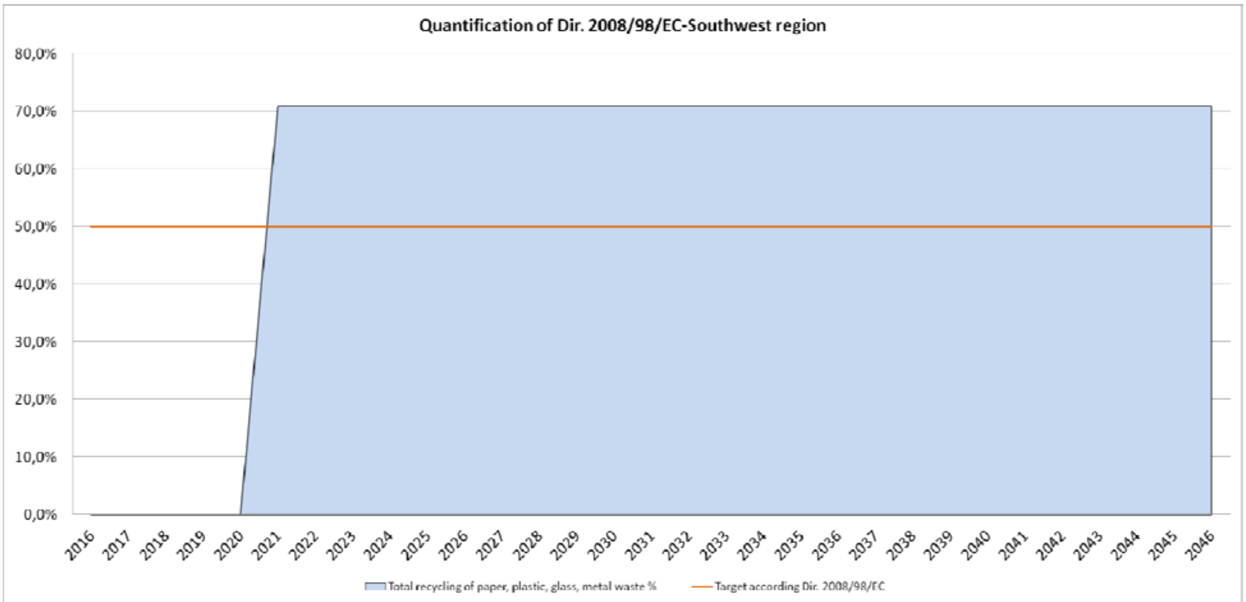


Table 6-3: Quantification of Dir. 2008/98/EC for selected scenario 3b, Southwest region

	Total Produced Recyclable waste (t)	**Total recycling of paper, plastic, glass, metals (t)**	**Total recycling of paper, plastic, glass, metals derived from Green points and MRF (t)**	**Total recycling of paper, plastic, glass, metals derived from MBT (t)**	Total recycling of paper, plastic, glass, metals %	Total recycling of paper, plastic, glass, metals derived from Green points and MRF %	Total recycling of paper, plastic, glass, metals derived MBT %	Target according Dir. 2008/98/EC
2016	19,527	0	0	0	0.0%	0.0%	0.0%	50%
2017	19,858	0	0	0	0.0%	0.0%	0.0%	50%
2018	20,187	0	0	0	0.0%	0.0%	0.0%	50%
2019	20,798	0	0	0	0.0%	0.0%	0.0%	50%
2020	21,397	0	0	0	0.0%	0.0%	0.0%	50%
2021	21,469	15,230	12,177	3,052	70.9%	56.72%	14.22%	50%
2022	21,556	15,292	12,227	3,065	70.9%	56.72%	14.22%	50%
2023	21,647	15,356	12,278	3,078	70.9%	56.72%	14.22%	50%
2024	21,742	15,423	12,332	3,091	70.9%	56.72%	14.22%	50%
2025	21,841	15,493	12,388	3,105	70.9%	56.72%	14.22%	50%
2026	21,924	15,552	12,435	3,117	70.9%	56.72%	14.22%	50%
2027	22,012	15,615	12,485	3,130	70.9%	56.72%	14.22%	50%
2028	22,105	15,681	12,538	3,143	70.9%	56.72%	14.22%	50%
2029	22,203	15,750	12,594	3,157	70.9%	56.72%	14.22%	50%
2030	22,307	15,824	12,653	3,172	70.9%	56.72%	14.22%	50%
2031	22,263	15,793	12,628	3,165	70.9%	56.72%	14.22%	50%
2032	22,221	15,763	12,604	3,159	70.9%	56.72%	14.22%	50%
2033	22,179	15,734	12,580	3,153	70.9%	56.72%	14.22%	50%
2034	22,140	15,706	12,558	3,148	70.9%	56.72%	14.22%	50%
2035	22,102	15,679	12,536	3,142	70.9%	56.72%	14.22%	50%
2036	22,039	15,634	12,501	3,133	70.9%	56.72%	14.22%	50%
2037	21,978	15,591	12,466	3,125	70.9%	56.72%	14.22%	50%
2038	21,918	15,548	12,432	3,116	70.9%	56.72%	14.22%	50%
2039	21,860	15,507	12,399	3,108	70.9%	56.72%	14.22%	50%

	Total Produced Recyclable waste (t)	Total recycling of paper, plastic, glass, metals (t)	Total recycling of paper, plastic, glass, metals derived from Green points and MRF (t)	Total recycling of paper, plastic, glass, metals derived from MBT (t)	Total recycling of paper, plastic, glass, metals %	Total recycling of paper, plastic, glass, metals derived from Green points and MRF %	Total recycling of paper, plastic, glass, metals derived MBT %	Target according Dir. 2008/98/EC
2040	21,803	15,467	12,367	3,100	70.9%	56.72%	14.22%	50%
2041	21,725	15,411	12,323	3,089	70.9%	56.72%	14.22%	50%
2042	21,649	15,357	12,279	3,078	70.9%	56.72%	14.22%	50%
2043	21,574	15,304	12,237	3,067	70.9%	56.72%	14.22%	50%
2044	21,501	15,253	12,196	3,057	70.9%	56.72%	14.22%	50%
2045	21,430	15,202	12,155	3,047	70.9%	56.72%	14.22%	50%
2046	21,342	15,139	12,105	3,034	70.9%	56.72%	14.22%	50%

In case of inadequate finance of the Project, it is proposed to be implemented in three stages, following the next list of investment priorities:

a. The first priority investments are the construction of the new Sanitary Landfill, the closure and rehabilitation of non-compliant municipal landfills and dumpsites and the supply of collection bins and trucks.
b. The second priority investments are the development of sorting at source (supply of bins for mixed waste and recyclable waste) and the construction of Mechanical Treatment Facility of the MBT plant for mixed waste bin.
c. The third priority investments are the construction of biological treatment of MBT plant for mixed waste bin and the windrow composting process for green waste.

6.3 Option analysis for location of Central and Local Waste Management Facilities – description of selected site

6.3.1 Option analysis for location of CWMF-Methodology

For the selection of the appropriate location of central waste management facilities in Southwest Region an AdHoc report was prepared and submitted. The scope of the report was to result in the most appropriate site for the future waste management facilities with the following characteristics:

- To maximize the contentment of the needs of the region
- To minimize environmental impact
- To ensure greater social acceptance for the project
- To minimize the cost of construction and operation of the project.

The site selection methodology procedure was carried out in the following stages:

- Data collection
- Development of exclusion – selection criteria
- Site visit – Application of exclusion – selection criteria for the site under investigation – Identification of alternative sites
- Development of evaluation criteria - Multiple Criteria Decision Analysis for the comparative evaluation of the sites – Selection of the most appropriate site

For the identification of the alternative sites, exclusion criteria are applied. They are indented to reflect minimum acceptable sitting practice. Exclusion criteria for the sitting of waste management infrastructure (treatment & disposal) are mainly related to the distances from settlements, roads, cultural monuments, areas of high ecological interest, etc.

Exclusion criteria proposed in accordance with guidelines of the World Health Organization
Unstable or weak soils (organic, swelling, delicate sands etc.)
Areas where there are or potential subsidence.
Saturated soils (eg wetlands, coastal zones)
Groundwater recharges area.
Areas that flood.
Areas upstream concentration of surface waters, eg reservoirs, water points for drinking or irrigation water or anywhere can decline due to rapid surface water contaminant transport.
Atmospheric conditions not conducive to safe dispersion of pollutants from escaping after extraordinary event.
Major natural hazards: landslides, increased seismic movements.
Natural ecosystems: Habitat endangered species, parks, forests, nature protection areas.
Areas of economic or cultural significance.
Historical and archaeological sites and buildings or areas associated with local traditions.
Sensitive locations, such as airports, warehouses flammable or explosive materials etc.
Location of special population concentrations eg hospitals, prisons.
Occupying space that leads to inequality between population groups due to the destruction of cultural traditions or relationships with the area.

Moreover it is prohibited to install WM facilities within the following areas:

- Areas of archaeological cultural interest, i.e. officially proclaimed and statutory archaeological sites.
- Traditional Settlements
- Statutory protection areas and individual elements of nature and landscape
- Residential areas
  1. Areas within the project boundaries and within city limits settlements
  2. Areas private urbanization for residential use.
- Areas for which a special or general prohibitory provision, and National Defense and Security.

Exclusion Areas

In order to identify suitable areas for sitting waste treatment and disposal works of solid waste throughout the area of interest, conditions and limitations of suitability will be laid down in accordance with international practice and the requirements of national legislation.

The basic terms and restrictions placed are:

- **Geologic constraints:** Firstly there must be effort to avoid areas dominated geological Permeability. In case of difficulty finding areas which geologically constructed of impermeable formations, selecting areas with impermeable bedrock not a criterion for exclusion.
- **Hydrological constraints:** Avoid principle areas which are watersheds where dams exist, but this is not an exclusion criterion.
- **Nature Protected areas:** Excluded Strict Nature Reserve areas, Natural Monuments with important characteristics and Emeralds areas.
- Any other protected area under national legislation.
- **Archaeological sites:** areas declared as archaeological sites are excluded.
- **Settlements:** Statutory settlement boundaries are forbidden

Criteria for selecting locations for central waste management facilities

The selection process began with the identification of suitable sites using maps at appropriate scale and content (geological, hydrogeological, topographical etc.) and with the determination of the form of terrain (flat, valley, and slope), geology sites, distance from settlements, the region's road network, as well as the water resources of the region. Afterwards, data from charts, studies (eg. hydrogeological, regulators) or reports (eg. archaeology, forest inspections, etc.) were obtained and site visits were performed.

A number of criteria were taken under consideration for the identification of suitable locations are as follows:

1 Capacity: It is important to ensure that the selected areas provide the necessary capacity for the landfill.
2 Distance from settlements and visual concealment: This criterion takes into account for each site the distance and concealment of a settlement.
3 Topography and covering material: The morphology of the terrain significantly affects the type of construction and operating procedures. Additionally, the possibility of finding cover material in situ minimizes the operating cost.
4 Geology – Hydrogeology: Better groundwater protection is ensured by compact rock, clay and soil material with clay.
5 The hydrological and climate conditions: The local hydrological conditions are important for calculation and design of drainage works. The climatic conditions could also affect works operation.
6 Ownership: This criterion examines the cost effectiveness for the acquisition of land, if it is not state land or the alternative cost of a possible different exploitation.
7 Construction -operating-restoration of the site and transport costs: This criterion involves all the relevant costs of the projects in relation to each particular alternative location.

Alternative sites' description

Based on all the above mentioned about exclusion and selection criteria, a "Significant / Protected Areas Map" for Southwest Region was prepared, indicating the areas not included in exclusion areas. Within those areas, after site visits and taking under consideration the proposals of the local authorities, the following twelve (12) alternative site locations for Southwest Region Central Waste Management Facilities were identified.

- Alternative site Belchishta (B1) – Debartsa Municipality
- Alternative site Zlesti (Z1) – Debartsa Municipality
- Alternative site Trebenishta (T1) – Debartsa Municipality
- Alternative site Arbinovo (A1) – Debartsa Municipality
- Alternative site Arbinovo (A2) – Debartsa Municipality
- Alternative site Laktinje (L1) – Debartsa Municipality
- Alternative site Godivje (G1) – Debartsa Municipality
- Alternative site Godivje (G2) – Debartsa Municipality
- Alternative site Vraneshtitsa (V1) – Kichevo Municipality
- Alternative site Rashtani (R1) – Kichevo Municipality
- Alternative site Orlantsi (OR1) – Kichevo Municipality
- Alternative site Oslomej (OS1) – Kichevo Municipality

The basic characteristics of the twelve (12) proposed site locations for Central Waste Management Facilities in Southwest Region, are presented as follows:

Alternative site Belchishta (B1) – Debartsa Municipality	
Geographical site location	• The site is located southwest of the settlement of Belchishta in proximity to the settlement borderlines. • Regarding the approx. direct distance from the nearby settlements, the B1 site is: in the northwest of the settlement of Zlesti in a distance of approx. 1.0km and in the northeast of the settlement of Botun in a distance of approx. 1.2km.
Access road	• The access to the site is easy and takes place through an existing paved local road that connects Belchishta with Botun settlements. The local road crosses the regional road E-65 for approx. 2.2 km (road distance) at Botun settlement.
Spatial characteristics	• The site is in proximity to Belchista settlement borderlines. • The optical isolation is low from the closest settlements and from the access local road that connects the settlements of Belchishta and Botun. • There is no archaeological site under a distance of 3km
Environmental characteristics	• The site is located within the emerald protected area "Belchishko Blato" with code MK0000014. • The wider area is characterized as non irrigated arable land and broad leaved forest, according to Corine land cover 2012.
Geological – Hydrogeological characteristics	• The site is situated within proluvial sediments of small thickness, made by clays, gravel and sand. The proluvial sediments are with good water permeability and with expressed porosity). • There are no significant tectonic structures within site area. • There are no hydrant points within or near the site. River Golema flows at about 1.3 km north of the site. There are no wells for groundwater pumping within or near the site. • Closest recipients are rural settlement Belcista located about 1.3 km of the site. River Golema flows near of the settlement and after 2.5 km this river flows into the Sateska, which is the main drainage artery of the region. • The wider area of the location is wavelike creased without dominant slopes. The catchment area is estimated at less than 40 ha (0.4km2). • As the site is located proluvial sediments, the borrow pit can be formed within the site.
Technical and Operational characteristic	• The altitude of the site ranges from 775 to 815 meters (mean average 795 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 15.5 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it could be characterized as mainly private. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The access to the site takes place through an existing paved local road that connects the Belchishta and Botun settlements. There is no need for major road access works. • Diversion works in order to avoid access through Botun settlement could possibly be needed. • The site could be connected to the public utility networks through the nearby settlement.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 37km.
Conclusion	***No Further Evaluation*** The site is situated within the borders of the Emerald site "Belchishko Blato" (MK0000014).

Figure 6-5: Geographical location, utilization area and site photos of the alternative site Belchishta (B1)

Alternative site Zlesti (Z1) – Debartsa Municipality	
Geographical site location	• The site is located in the northwest of the settlement of Zlesti in a distance of approx. 0.5km, southwest of the settlement of Belchishta in a distance of approx. 0.6km and in the east of the settlement of Botun in a distance of approx. 1.2km. The above mentioned distances refer to approximate straight line/direct distance, and from the establishment borders of the settlements.
Access road	• The access to the site is easy and takes place through the regional road E-65. For the final access, an existing paved local road that connects Botun and Belchishta settlements for approx. 1.7 km must be followed and the existing paved local road that connects to Zlesti settlement for approx. 0.1 km (road distance).
Spatial characteristics	• The closest settlement to the site is the settlement of Zlesti in a distance of approximately 0.5km. • The optical isolation is low from the closest settlements and low from the access local road that connects the settlements of Botun and Belchishta. • There is no archaeological site in a distance of 3km
Environmental characteristics	• The site is located very close to the borderlines of the emerald protected area "Belchishko Blato" with code MK0000014, in a distance of approx. 60m. • The site is characterized by land principally occupied by agriculture with sighnificant areas of natural vegetation and by non irrigated land, according to Corine land cover 2012.. In the wider area broad –leaved forest could also be found.
Geological – Hydrogeological characteristics	• The site is situated within proluvial sediments of small thickness, made by clays, sand and slightly rounded pieces of schist from Paleozoic metamorphic complex. The proluvial sediments are with good water permeability and with expressed porosity. • There are no significant tectonic structures within the site area, but rock masses are estimated as non-coherent. The area is divided into two parts, flat area near the road and a steep slope in the southern parts. • Surface flow is not observed within site boundaries, but it should be noted that Sateska River passes about 1000 meters west of the site. Sateska River is the largest river in the region and therefore the main drainage artery. There are no wells for groundwater pumping within or near the site. • The main recipients are relatively large rural settlements (Botun, Meseista and Trebenishte) and closest of them is Botun in a distance of 1.2 km downstream from the site. • As the site is located within proluvial sediments, the borrow pits can be formed within the site areas rich with clay materials. Pliocene sediments rich with clays are located few kilometers north of the site (left of the road Ohrid - Kichevo) and present nice area for borrow pit design.
Technical and Operational characteristic	• The altitude of the site ranges from 785 to 809 meters (mean average 797 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 16.4 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it could be characterized as mainly private. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The access to the site is easy and takes place through the regional road E-65, then following an existing paved local road that connects Botun and Belchishta settlements for approx. 1.7 km (road distance), and finally following the existing paved local road that connects to Zlesti settlement for approx. 0.1 km (road distance). There is no need for major road access works. • Diversion works in order to avoid access through Botun settlement could possibly be needed. • The site could be connected to the public utility networks through the nearby settlement.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 37 km.
Conclusion	***Further Evaluation*** The site site Z1 in Municipality of Debartsa, is an appropriate site because: o It is not located in an excluded area o There is available space to implement the Central Waste Management Facilities. o In general it has appropriate characteristics for the aimed purpose

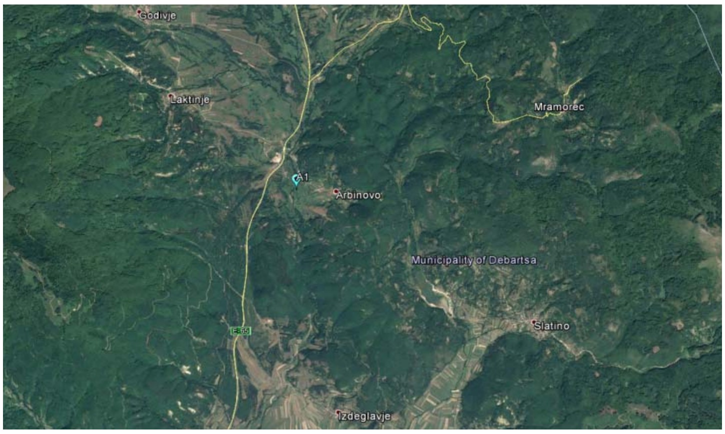
Figure 6-6: Geographical location, utilization area and site photos of the alternative site Zlesti (Z1)

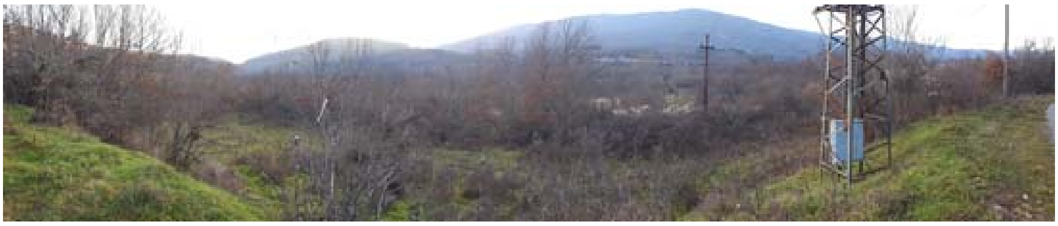
Alternative site Trebenishta (T1) – Debartsa Municipality	
Geographical site location	• The site is located in the east of the settlement of Trebenishta in a distance of approx. 1.3km and south of the settlement of Mesheishta in a distance of approx. 2.8km. The above mentioned distances refer to approximate straight line/direct distance, and from the establishment borders of the settlements.
Access road	• The access to the site takes place through the road E-65, which connects Ohrid with Kichevo settlement and then moving in east direction passing through Trebenishta settlement and under a narrow bridge. The final access road is with gravel for a distance of 1.5Km.
Spatial characteristics	• The closest settlement to the site is the settlement of Trebenishta in a distance of approximately 1.3km. • The optical isolation is high from the closest settlements and low from the final access local road. • A recreation lagoon is identified in a distance of 0.75Km. • There is no archaeological site in a distance of 3km. • The area is used for recreation in some specific periods (e.g. during spring).
Environmental characteristics	• There are no protected areas in a distance under 3km from the site. The closest emerald protected area is "Ohrid Lake" (MK0000024) in a distance of approx. 5.5km south from the site. In addition, the Ohrid region which is characterized by UNESCO as Natural and cultural heritage area, is in a distance of approximately 6.0km south. • The site is characterized as non irrigated arable land and broad leaved forest and the wider area is non-irrigated arable land with mixed forest, according to Corine land cover 2012.
Geological – Hydrogeological characteristics	• Most of the area is covered with thin diluvia sediments and only in the south parts the underlying Pliocene complex appears on the surface of the the field. Site considered is situated within diluvial sediments of small thickness, made by clay, gravels and sands with good water permeability and with expressed porosity. • There are no significant tectonic structures within the site area. The site is built by not coherent or slightly coherent rock masses. The site is located far from any active seismic structure. • Occasional water-flow is formed in rainy seasons, but it is completely dried in largest part of the year. At about 800 meters downstream from the site a small dam for recreational activities is build. This flow and other small streams in the vicinity of site inflow to Sateska River that passes about 2.5 kilometers west from the site. Sateska River is the largest river in the region and therefore the main drainage artery. • The main recipients are relatively large rural settlements (Trebenishta, Gorenci and Orovnik) and closest settlement is Trebenishta (2 km downstream from our location). • A highly permeable alluvial environment is located about 2500 meters west from the site. • As the site is located within diluvia clay sediments and Pliocene clay, the borrow pit can be formed within the site, or in its immediate vicinity.
Technical and Operational characteristic	• The altitude of the site ranges from 768 to 781 meters (mean average 775 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 19 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it could be characterized as mainly private. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The access to the site takes place passing through Trebenishta settlement and under a narrow bridge through an existing gravel local road. There is need for road access improvement works and improvement works for the narrow bridge. • Diversion works in order to avoid access through Trebenishta settlement could possibly be needed. • The site could be connected to the public utility networks through the nearby settlement.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 34km.
Conclusion	***No Further Evaluation*** The site T1 in Municipality of Debartsa, has the following main disadvantages: o It is located in a small distance from a recreation lake (0.75Km). o In general, this area is used for recreation. o The road network which connects the site needs improvement works, including the improvement works for the narrow bridge.

Figure 6-7: Geographical location, utilization area and site photos of the alternative site Trebenishta (T1)

Alternative site Arbinovo (A1) – Debartsa Municipality	
Geographical site location	• The site is located in the west borders of the settlement of Arbinovo, southeast of the settlement of Laktinje in a distance of approx. 2.0km, north of the settlement of Izdeglavje in a distance of approx. 3.8km and southwest of the settlement of Mramorec in a distance of approx. 5km. The above mentioned distances refer to approximate straight line/ direct distance, and from the establishment borders of the settlements.
Access road	• The access to the site is easy, through the road E65 which connects Ohrid settlement with Kichevo settlement, and then following the local paved road to Arbinovo settlement.
Spatial characteristics	• The closest settlement to the site is the settlement of Arbinovo in a distance of approximately 0.2km. • The optical isolation is low from the closest settlement and also from the access road E-65. • There are some facilities of tourist interest under construction, located northwest of the site at 0.4 km (direct line distance). • There is no archaeological site in a distance of 3km.
Environmental characteristics	• The site is located north of the emerald protected area "Belchishko Blato" with code MK0000014 in a distance of approx. 5km and east of the protected area "Pesoschanska Reka" in a distance of approx. 4.5km. • The wider area is characterizes as Broad leaved forests and transitional woodland-shrub , according to Corine land cover 2012, and the site is characterized by land principally occupied by agriculture, with significant areas of natural vegetation and complex cultivation patterns.
Geological – Hydrogeological characteristics	• The site includes alluvium and slab limestone with Triassic age. Alluvial sediments occupy narrow belts around river flow (Sateska river), while the rest is composed of limestone. Site is situated within alluvial sediments of small thickness, made by gravels and sands with good water permeability and with expressed porosity. • As per the Hydrogeological map of the Republic of Macedonia (1:200,000) limestone sediments fall into water bearing environments with cavern porosity. • There are no significant tectonic structures within the site area. • In the proximity of the area, Sateska river flows. This is the largest water body in the region and therefore the main drainage artery. There are no wells for groundwater pumping within or near the site. • The main recipients are relatively large rural settlements (Pesochani, Botun and Trebenishte) but the distance along the stream is more than 10 km from the site. At the location there is a highly permeable alluvial environment (alluvium of the river Sateska). • Just across the regional road Kichevo - Ohrid (1 km distance from the site) clayish Pliocene sediments are found. This site is accounted as very good for borrow pit construction.
Technical and Operational characteristic	• The altitude of the site ranges from 832 to 851 meters (mean average 842 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 15.4 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it could be characterized as mainly private. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The access to the site takes place through an existing paved local road, which connects the road E-65 (Kichevo settlement with Ohrid settlement) with Arbinovo. There is no need for major road access works. • The site could be connected to the public utility networks through the nearby settlement.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 41km.
Conclusion	***No Further Evaluation*** The site A1 in Municipality of Debartsa, has the following main disadvantages: o It is located by the borders of Arbinovo settlement. o It is in a small distance from tourist facilities under construction (0.4 km).

Figure 6-8: Geographical location, utilization area and site photos of the alternative site Arbinovo (A1)





Alternative site Arbinovo (A2) – Debartsa Municipality	
Geographical site location	• The site A2 administratively belongs to Municipality of Debartsa. Regarding the approximate direct distance from the nearby settlements, the proposed site is: 0.2 km northwest of Arbinovo, 0.8 km southeast of Laktinje, 2.3 km southeast of Godivje, 3.5 km southwest of Slivovo. The above mentioned distances refer to approximate straight line/direct distance, and from the establishment borders of the settlements.
Access road	• The access to the site is easy, through the road E65 at the part which connects Ohrid settlement with Kichevo settlement, and then following the local paved road to Laktinje settlement .
Spatial characteristics	• The closest settlement to the site is the settlement of Arbinovo in a distance of approximately 0.2km. • The optical isolation is low from the closest settlement and also from the access local road and E-65. • The wider area is characterized by complex cultivation patterns (to the north). • There are some facilities of tourist interest under construction, located east –northeast of the site at 0.2 km (direct line distance). • There is no archaeological site in a distance of 3km.
Environmental characteristics	• The site is located north of the emerald protected area "Belchishko Blato" with code MK0000014 in a distance of approx. 5.5 km and east of the protected area "Pesoschanska Reka" in a distance of approx. 3.7km. • The site is characterized by land principally occupied by agriculture, with significant areas of natural vegetation with a part of transitional woodland-shrub, according to Corine land cover 2012.
Geological – Hydrogeological characteristics	• The site is situated within Pliocene sediments of small thickness, made by clays, gravel and sand. These sedimentary rocks are transgressive deposit on metamorphic phyllites which can be seen on the surface of the ground near the settlement Laktinje. The Pliocene sediments are considered as semi permeable. • There are no significant tectonic structures related with the site area. Those are not coherent or slightly coherent rock masses, of limited unconfirmed thickness, overlaying metamorphic rocks. • Sateska River is the largest river in the region and therefore the main drainage artery. • The area is represented by a relatively steep slope which is cut by a shallow river valley. In the south-eastern parts of the terrain some slopes can be seen which are probably caused by human activity because nearby there are some facilities of tourist interest under construction. • Near the observed area (at 100 meters) a highly permeable zone appears in the alluvium of river Sateska like). • As mentioned, the terrain is relatively steep which is cut by a shallow river valley and it has a large catchment area (over 280 ha). • The site is situated within clayish Pliocene sediments which are ideal for the design of borrow pits clay in them.
Technical and Operational characteristic	• The altitude of the site ranges from 860 to 878 meters (mean average 878 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 17 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it could be characterized as mainly private. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The access to the site takes place through an existing paved local road, which connects the road E-65 with Laktinje settlement. There is no need for major road access works. • The site could be connected to the public utility networks through the nearby settlement.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 41km.
Conclusion	***No Further Evaluation*** The site A2 in Municipality of Debartsa, has the following main disadvantages: o It is located in a small distance from Arbinovo settlement (0.2km) and from the tourist facilities under construction (0.2 km).

Figure 6-9: Geographical location, utilization area and site photos of the alternative site Arbinovo (A2)

Alternative site Laktinje (L1) – Debartsa Municipality	
Geographical site location	• The site L1 administratively belongs to Municipality of Debartsa. • Regarding the approximate direct distance from the nearby settlements, the proposed site is: 0.1 km northwest of Arbinovo, 1.0 km south-southeast of Laktinje, 2.4 km southeast of Godivje, 3.0 km southwest of Slivovo. The above mentioned distances refer to approximate straight line/direct distance, and from the establishment borders of the settlements.
Access road	• The access to the site is easy, through the road E65 at the part connecting Ohrid settlement with Kichevo settlement, and then following the local paved road to Laktinje settlement.
Spatial characteristics	• The closest settlement to the site is the settlement of Arbinovo in a distance of approximately 0.1km. • The optical isolation is low from the closest settlement and also from the access local road and E-65. • There are some facilities of tourist interest under construction, located south of the site at 0.2 km (direct line distance). • There is no archaeological site under a distance of 3km.
Environmental characteristics	• The site is located east of the protected area "Pesoschanska Reka" in a distance of approx. 4.0km and north of the emerald protected area "Belchishko Blato" with code MK0000014 in a distance of approx. 6.0 km. • The wider area and the site are characterized by land principally occupied by complex cultivation patterns and land occupied by agriculture, with significant areas of natural vegetation
Geological – Hydrogeological characteristics	• The site includes Pliocene sediments with significant thickness which are transgressive deposited on the metamorphic rocks of Paleozoic age (phyllites). Pliocene is built by clay, clayish sands and gravels accounted as semi permeable. After a short geological prospection can be concluded that the surface parts of the terrain are built of clay materials with sub capillary porosity. • As per Hydrogeological map of the Republic of Macedonia (1:200.000) those areas fall into waterless terrains. • There are no significant tectonic structures within or near the site, and rock masses are estimated as non coherent or slightly coherent. The site is located far from any active seismic structure. • There are no hydrant points within or near the site. Stream Sateska passes 200 m east of the site, and Sateska River is the largest river in the region and therefore the main drainage artery. There are no wells for groundwater pumping within or near the site. • The main recipients are relatively large rural settlements (Pesocani, Botun and Trebenishte) but mostly all are more than 10km from the site. A highly permeable alluvial environment is located about 200 meters east from the site. • As the site is located within Pliocene clay, the borrow pit can be formed within the site, or in its immediate vicinity.
Technical and Operational characteristic	• The altitude of the site ranges from 848 to 886 meters (mean average 867 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 18 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it could be characterized as mainly private. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The access to the site takes place through an existing paved local road, which connects the road E-65 with Laktinje settlement. There is no need for major road access works. • The site could be connected to the public utility networks through the nearby settlement.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 41km.
Conclusion	***No Further Evaluation*** The site L1 in Municipality of Debartsa, has the following main disadvantages: o It is located in a small distance from Arbinovo settlement (0.1km) and from tourist facilities under construction (0.2 km).

Figure 6-10: Geographical location, utilization area and site photos of the alternative site Laktinje (L1)

Alternative site Godivje (G1) – Debartsa Municipality	
Geographical site location	• The site G1 administratively belongs to Municipality of Debartsa. • The site is located in the southwest of the settlement of Slivovo in a distance of approx. 1.7km, northwest of the settlement of Arbinovo in a distance of approx. 1.7km, northeast of the settlement of Laktinje in a distance of approx. 1.8km and southeast of the settlement of Godivje in a distance of approx. 2.0km. The above mentioned distances refer to approximate straight line/direct distance, and from the establishment borders of the settlements.
Access road	• The access to the area of the site is very easy. The site is located sideways of the road E-65, which connects Kichevo settlement with Ohrid settlement.
Spatial characteristics	• The closest settlements to the site are the settlements of Slivovo and Arbinovo in a distance of approx. 1.7km. • The site is visible from the access regional road E-65. Also the optical isolation from the settlement of Godivje is very low. • There are some facilities of tourist interest under construction, located south – southwest of the site at 2.0 km (direct line distance). • There is no archaeological site in a distance of 3km. • Exactly in front of the site, a pay toll station is planned to be constructed, in the national road E65.
Environmental characteristics	• There are no protected areas in a distance under 3km from the city. Regarding the closest protected areas, the site is located: ✓ north of the closest emerald protected area "Belchishko Blato" with code MK0000014, in a distance of approx. 8km and ✓ east of the protected area "Pesoschanska Reka" in a distance of approx. 5.0km. • The land occupation of the site and the wider area is characterized as agricultural land and according to the site visit, the proposed site can be characterized as occupied by ordinary ecological features.
Geological – Hydrogeological characteristics	• The site includes alluvium and Pliocene sediments. Alluvial sediments occupy narrow belts around small stream flow (Vrbjanska), while the rest of the site is composed of Pliocene. Site is situated within alluvial sediments of small thickness, made by gravels and sands with good water permeability and with expressed porosity. • As per Hydrogeological map of the Republic of Macedonia (1:200,000), those sediments fall into water-bearing areas. • There are no significant tectonic structures related with the site area. Surface rocks include no coherent or slightly coherent masses. Pliocene sediments have very low thickness without appearance of dominant structures of crimping. • Stream Vrbjanska passes through the site, and Sateska River flows in vicinity. Sateska River is the largest river in the region and therefore the main drainage artery. There are no wells for groundwater pumping within or near the site considered. • The terrain is flat and only in eastern there is elevation of the terrain and appearance of slopes is noted. The hills are built of Pliocene material. The slopes are stable (20-30 degrees) and mostly forested. • The main recipients are relatively large rural settlements (Pesochani and Trebenishte) but the distance along the stream is more than 10 km from the site. • Terrain is flat and without significant slopes, but due to the central position in the valley it has a large catchment area (over 400ha or 4km2). • As the site is located within Pliocene clay, the borrow pit can be formed within the site, or in its immediate vicinity.
Technical and Operational characteristic	• The altitude of the site ranges from 857 to 872 meters (mean average 862 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 15 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it could be characterized as mainly private. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The access to the site takes place through regional road E-65, which connects the settlement of Kichevo with the settlement of Ohrid. There is no need for extra road access works. • The site could be connected to the public utility networks through the nearby settlement.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 41km.
Conclusion	***No Further Evaluation*** The site G1 in Municipality of Debartsa, has the following main disadvantages: o it is located by the national road E65 and o it is designed to be constructed a toll station in that location.

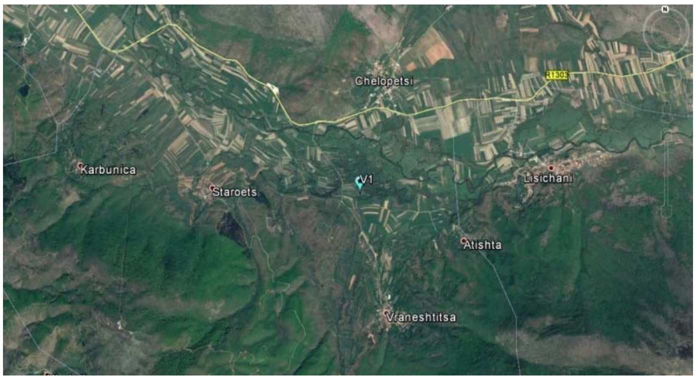
Figure 6-11: Geographical location, utilization area and site photos of the alternative site Godivje (G1)

Alternative site Godivje (G2) – Debartsa Municipality	
Geographical site location	• The site G2 administratively belongs to Municipality of Debartsa. • The site is located northeast of the settlement of Laktinje in a distance of approx. 1.0km, in the southeast of the settlement of Godivje in a distance of approx. 1.3km, northwest of the settlement of Arbinovo in a distance of approx. 1.5km and northeast of the settlement of Vrbjani in a distance of approx. 2.4km. The above mentioned distances refer to approximate straight line/direct distance, and from the establishment borders of the settlements.
Access road	• The access to the site is easy, through the road E65 which connects Ohrid settlement with Kichevo settlement, and then following the local paved road to Godivje settlement.
Spatial characteristics	• The closest settlement to the site is the settlement of Laktinje, in a distance of approximately 1.0km. • The optical isolation is in a good level from the road E65 (connects Ohrid with Kichevo settlement) and is in a moderate level from the nearby settlements. • There are some facilities of tourist interest under construction, located south – southwest of the site at 1.8 km (direct line distance). • There is no archaeological site in a distance of 3km.
Environmental characteristics	• There are no protected areas in a distance under 3km from the city. Regarding the closest protected areas, the site is located: ✓ north of the closest emerald protected area "Belchishko Blato" with code MK0000014, in a distance of approx. 7.3km and ✓ east of the protected area "Pesoschanska Reka" in a distance of approx. 4.3km. • The land occupation of the site and the wider area is characterized as land principally occupied by agriculture, with significant areas of natural vegetation and complex cultivation patterns and according to the site visit, the proposed site can be characterized as occupied by ordinary ecological features.
Geological – Hydrogeological characteristics	• The site includes Pliocene sediments that appear west of the alluvial sediments of the river Vrbjanska. Pliocene includes clay, clay-sands and gravels accounted as semi permeable. After a short geological prospection, it can be assumed that the surface parts of the terrain are built of clay materials with sub capillary porosity. • As per Hydrogeological map of the Republic of Macedonia (1:200,000), those sediments fall into waterless terrains. • There are no significant tectonic structures within or near the site area, and rock masses are estimated as non-coherent or slightly coherent. Pliocene sediments have very low thickness without the appearance of dominant structures of crimping. The site area is flat with the presence of a gentle valley in its central parts. • Vrbjanska stream passes 500 m east of the site and Sateska River flows in vicinity. Sateska River is the largest river in the region and therefore the main drainage artery. There are no wells for groundwater pumping within or near the site. • The main recipients are relatively large rural settlements (Pesocani, Botun and Trebenishte), but all at a distance more than 10 km from the site. Highly permeable alluvial environment, which is an integral part of Sateska River alluvium, is located 500 meters east from the site. • The site is flat and without significant slopes, but due to the central position in the valley it has a large catchment area (over 400ha or 4Km2). • As the site is located within Pliocene clay, the borrow pit can be formed within the site or in its immediate vicinity.
Technical and Operational characteristic	• The altitude of the site ranges from 886 to 908 meters (mean average 897 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 21.5 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it could be characterized as mainly private. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The access to the site is easy, through the road E65 which connects Ohrid settlement with Kichevo settlement, and then following the local paved road to Godivje settlement. For the final access to the site about 100m needs improvement works. • The site could be connected to the public utility networks through the nearby settlement.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 42km.
Conclusion	***Further Evaluation*** The site G2 in Municipality of Debartsa, is an appropriate site because: o It is not located in an excluded area o There is available space to implement the Central Waste Management Facilities. o In general it has appropriate characteristics for the aimed purpose.

Figure 6-12: Geographical location, utilization area and site photos of the alternative site Godivje (G2)

Alternative site Vraneshtitsa (V1) – Kichevo Municipality	
Geographical site location	• The site V1 administratively belongs to Kichevo Municipality and it is situated southeast of Kichevo settlement at approx. 7.8 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the V1 proposed site is: 1 km northwest of Atishta, 1.1 km south-southwest of Chelopetsi, 1.2 km north of Vraneshtitsa and 1.6 km east of Staroets.
Access road	• The site can be accessed from Kichevo municipality which is connected to the main road network though E-65 and regional road R-1303. The access to the site takes place through the regional road R-1303, deriving from Kichevo settlement, exiting right before Chelopetsi and following a paved road network to Vraneshtitsa for approximately 1km (road distance).
Spatial characteristics	• The closest settlement to the site is the settlement of Atishta in a distance of approximately 1 km. • The optical isolation from the road is low, since the area of the site is situated in the crossroads of the local roads connecting the settlements Staroets, Chelopetsi and Atishta. Also, there is medium optical isolation from the regional road R-1303. • According to the site visit, livestock activities were observed in the wider area of the proposed site. • There is no archaeological site in a distance of 3km.
Environmental characteristics	• The wider area as well as the proposed site is non-irrigated arable land with a part of land principally occupied by agriculture, with significant areas of natural vegetation, according to Corine land cover 2012.
Geological – Hydrogeological characteristics	• The area includes alluvial and proluvial sediments. Alluvial sediments occupy the belt around river Treska, while the rest of the area is built of proluvial sediments in form of mild slopes above the river valley. The site is situated within alluvial and proluvial sediments of small thickness made by gravels, sands and clays sands with good water permeability and with expressed porosity. • As per the Hydrogeological map of the Republic of Macedonia (1:200,000) these sediment fall into water-bearing areas. • There are no significant tectonic structures within or near the site area. There are no-coherent or slightly coherent rock masses. • The site does not include hydrant points (existence of hydrant points is not marked on the map or observed during the site visit). At 1 km north of the site, the Treska River flows (the main drainage artery in the area). There are no wells for groundwater pumping within or near the site. • The main recipients are rural settlements, and the closest is Lisichani at about 2.5 km away from the site. • The terrain is located in the lowland area where there are no morphological forms with the presence of slopes. The site is located far from any active seismic structure. • Site catchment area is estimated at 120 -200 ha (1.2 -2 km2), but may be noted that in the southern part of the site there is dry river bed, probably filled during the rainy season. • At about 500 meters before Vranestica (according to geological map) there is an old clay quarry. This site can be used as a borrow pit.
Technical and Operational characteristic	• The altitude of the site ranges from 585 to 594 meters (mean average 588 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 15.6 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it could be characterized as private. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The access to the site takes place through a paved road (approximately 1 km) that can be accessed through regional road R1303 deriving from Kichevo. There is no need for improvement road works. • The site could be connected to the public utility networks through the nearby settlement. • However due to the biggest distance of the waste production center as well as due to the fact that almost 2/3 of the waste are generated in the Southern part of the Region, remarkable additional cost will rather be needed for construction and operation of more Transfer Stations.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 57 km.
Conclusion	***No Further Evaluation*** The site V1 in Municipality of Kichevo, has the following main disadvantages: o The site has no social acceptance. o It is located in a big road distance (more than 57km) from the waste production center of the region. o The road network which connects the site is in a quite good condition, but with difficult geomorphological characteristic, taking into consideration the meteorological conditions of the region. o Significant additional construction and operation cost will be needed.

Figure 6-13: Geographical location, utilization area and site photos of the alternative site Vraneshtitsa (V1)

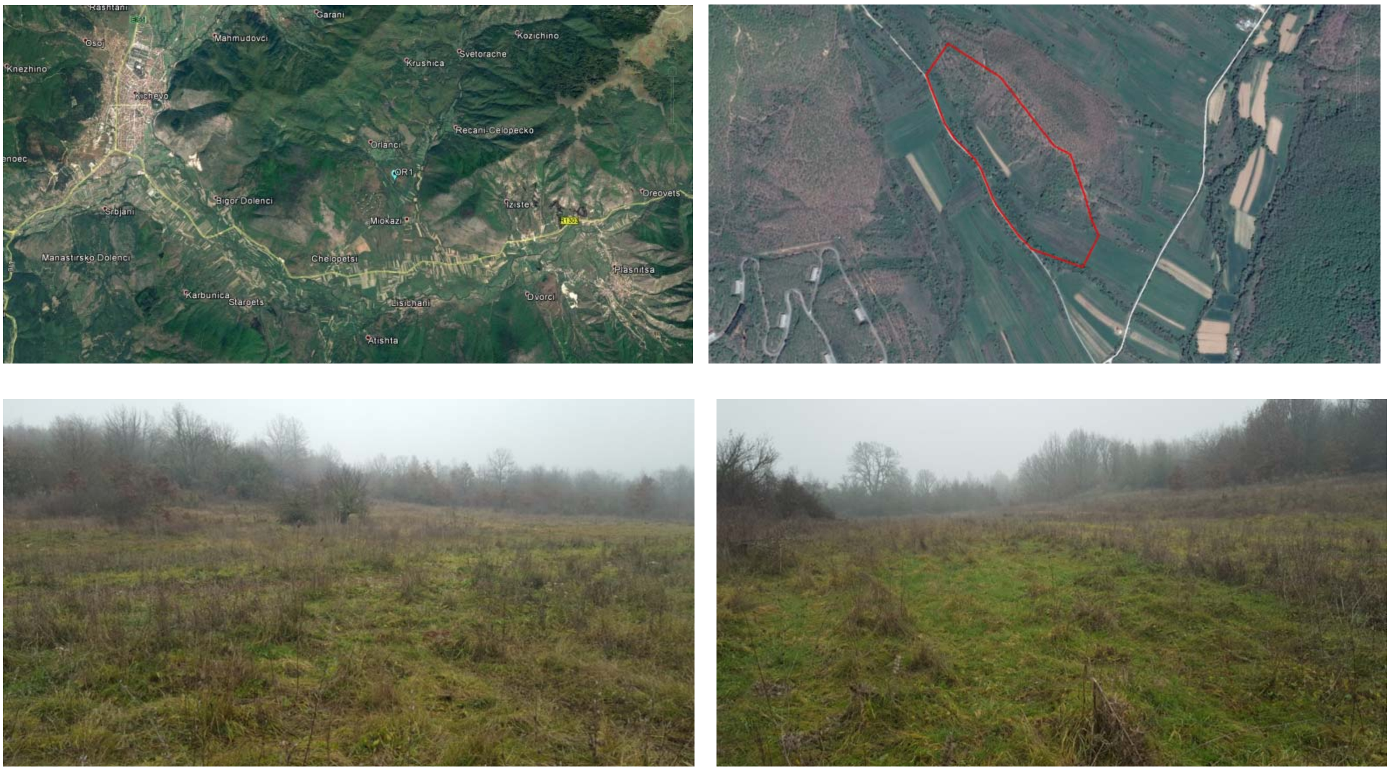


Alternative site Rashtani (R1) – Kichevo Municipality	
Geographical site location	• The proposed site R1 administratively belongs to Kichevo Municipality and it is situated north-northwest of Kichevo settlement at approximately 3.2 km direct distance (1 km from the outskirts of Kichevo). • Regarding the approximate direct distance from the nearby settlements, the R1 proposed site is: 0.3 km east of Rashtani, 1.6 km north-northeast of Osoj and 3.3 km north east from Knezhino. The above mentioned distances refer to approximate straight line/direct distance, and from the establishment borders of the settlements.
Access road	• The access to the area takes place through Kichevo that is connected to the road network with E-65. The final access to the site can be achieved exiting Kichevo to the northeast directing to Rashtani at approximately 0.3 km before arriving to the settlement (road distance).
Spatial characteristics	• The closest settlement to the site is the settlement of Rashtaniin a distance of approximately 0.3 km. • The optical isolation from Rashtani as well as the road connecting it to Kichevo is very low. The site is also visible from E-65. • There is no archaeological site in a distance of 3km.
Environmental characteristics	• The wider area is situated on agricultural land with complex cultivation patterns and parts of transitional woodland shrub and mixed forest, according to Corine land cover 2012.
Geological – Hydrogeological characteristics	• The site is situated within Pliocene sediments of small thickness, made by clays, gravel and sand. The Pliocene sediments are considered as semipermeable. • There are no significant tectonic structures within or near the site area. Rocks under the Pliocene sediments do have rare cracks, tight and not filled. • There are no hydrant points within or near the site. River Zajaska flows at about 2 km east of the site. • There are no wells for groundwater pumping within or near the site. • Closest recipients are urban settlement (Kichevo) located about 1 km south from the site. River Zajaska flows at about 1 km east of the settlement. Main usage is irrigation and recreation). • The site in its largest part the site is located within flat lowlands. • The wider area of the location is wavelike creased with dominant slopes located in the north part of the site. The slopes have not very steep sides (greater than 30 degrees). The catchment area is estimated at more than 40 ha (0.4 km2). • As the site is located within Pliocene clay, the borrow pit can be formed within the site.
Technical and Operational characteristic	• The altitude of the site ranges from 660 to 742 meters (mean average 694 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 15.5 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it could be characterized as private. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The final access to the site can be achieved exiting Kichevo to the northeast directing to Rashtani at approximately 0.3 km before arriving to the settlement. There is no need for major improvement road works. • The site could be connected to the public utility networks through the nearby settlement. • However due to the biggest distance of the waste production center as well as due to the fact that almost 2/3 of the waste are generated in the Southern part of the Region, remarkable additional cost will rather be needed for construction and operation of more Transfer Stations.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 53 km.
Conclusion	***No Further Evaluation*** The site R1 in Municipality of Kichevo, has the following main disadvantages: o The site has no social acceptance. o It is located in a big road distance (more than 53km) from the waste production center of the region. o The road network which connects the site is in a quite good condition, but with difficult geomorphological characteristic, taking into consideration the meteorological conditions of the region. o Significant additional construction and operation cost will be needed.

Figure 6-14: Geographical location, utilization area and site photos of the alternative site Rashtani (R1)

Alternative site Orlantsi (OR1) – Kichevo Municipality	
Geographical site location	• The proposed site OR1 administratively belongs to Kichevo Municipality and it is situated southeast of Kichevo settlement at approximately 7.0 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the OR1 proposed site is: 0.6 km southeast of Orlantsi, 0.7 km northwest of Miokazi, 2.0 km southwest of Rechani – Chelopechko, 2.0 km northeast of Chelopetsi. The above mentioned distances refer to approximate straight line/ direct distance, and from the establishment borders of the settlements.
Access road	• The proposed site can be accessed from Kichevo municipality which is connected to the main road network though E-65 and regional road R-1303. • The access to the site takes place through the regional road R-1303, deriving from Kichevo settlement, exiting at Chelopetsi and following a paved road to Orlantsi for approximately 2.8km).
Spatial characteristics	• The closest settlement to the site is the settlement of Orlantsi in a distance of approximately 0.6 km. • The optical isolation of the site from Orlantsi settlement as well as the road deriving from the settlement is very low. • The site is situated in close vicinity of military establishments. • There is no archaeological site in a distance of 3km.
Environmental characteristics	• The site is not located in the vicinity of protected areas or points of interest (direct distance >3 km) • The wider area as well as the site is situated on non-irrigated arable land with a part of land principally occupied by agriculture, with significant areas of natural vegetation, according to Corine land cover 2012.
Geological – Hydrogeological characteristics	• The site is built of none permeable clays and clay sands with sub capillary porosity (Pliocene), where weakly coherent clays predominantly appear. • According to the hydrogeological map of the Republic of Macedonia (1:200,000) these areas fall into waterless. • There are no significant tectonic structures within or near the site area. There are no-coherent or slightly coherent rock masses. • The site does not include hydrant points (existence of hydrant points is not marked on the map or observed during the site visit). At 0.5 km east of the site river Radetinska flows. • The site is located on a mild slope (5-10 degrees), constructed from poorly coherent clayish and sandy materials. • The main recipients are rural settlements, and the closest is Miokazi, about 1 km away from the site. • Borrow pits can be formed within the area.
Technical and Operational characteristic	• The altitude of the site ranges from 613 to 652 meters (mean average 631 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 15 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it could be characterized as private. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The final access to the site takes place through a paved road that connects Chelopetsi with Orlantsi. There could be the need for improvement works. The distance of the site from the paved road deriving from Chelopetsi is 0.5 km approximately. • The site could be connected to the public utility networks through the nearby settlement. • However due to the biggest distance of the waste production center as well as due to the fact that almost 2/3 of the waste are generated in the Southern part of the Region, remarkable additional cost will rather be needed for construction and operation of more Transfer Stations.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 60 km.
Conclusion	***Further Evaluation*** The site OR1 in Municipality of Kichevo, is an appropriate site because: o It is not located in an excluded area o It has available space to implement the Central Waste Management Facilities. o In general it has appropriate characteristics for the aimed purpose.

Figure 6-15: Geographical location, utilization area and site photos of the alternative site Orlantsi (OR1)



Alternative site Orlantsi (OS1) – Kichevo Municipality	
Geographical site location	• The proposed site OS1 administratively belongs to Kichevo Municipality and it is situated north-northeast of Kichevo settlement at approximately 7 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the OS1 proposed site is: 0.5 km southwest of Oslomej, 1.8 km north-northeast of Crvivtsi, 2.2 km east of Kolibari, 2.5 km Southeast of Dolno Strogomishte and 2.7 km northeast of TrapchinDol. The above mentioned distances refer to approximate straight line/direct distance, and from the establishment borders of the settlements.
Access road	• The proposed site can be accessed from E-65, exiting Kichevo to the north directing to Oslomej. • The final access to the site can be accessed from the paved road connecting Oslomej and Crvivtsi (approximately 1.4 km from both settlements, road distance).
Spatial characteristics	• The closest settlement to the site is the settlement of Orsomej in a distance of approximately 0.5 km. • The optical isolation from Orsomej as well as the road connecting it to Kichevo is very low. • Currently, at the limits of the proposed site to the south, a non-compliant municipal landfill site exists. • The site is situated in close proximity of the existing "Oslomej" lignite mining field. • There is no archaeological site in a distance of 3km.
Environmental characteristics	• There are no protected areas in the vicinity of the proposed site, in a distance of 3 km. • According to Corine land cover 2012, the site is situated on mine excavation site with a part of transitional woodland-shrub.
Geological – Hydrogeological characteristics	• The site is situated in close proximity of the existing Oslomej lignite mining field, where mining activities are ceased for long period (roof sediments and productive lignite layer are excavated). The plateau formed after the excavations is made up of Pliocene siltstones and clay sediments which are characterized by sub capillary pores and constitute poorly permeable zones. • There are no significant tectonic structures within or near the site area. Rock masses on the surface are not coherent or slightly coherent. • The site does not include hydrant points. Temnica River flows at 1 km east from the location and flows into the river Zajaska (main drainage artery for whole area). There are no wells for groundwater pumping within the site. • The site is located on a large plateau and there are large quantities of barren material (lignite overburden). Those piles are not very high but do have steep slopes consisted of disintegrated materials susceptible to surface erosion. It should be noted that in the north-eastern part of this area are the final parts of the current landfill of Kicevo. The landfill area is in the same level with steep slopes. • The main recipients are rural settlements, and the closest are Crvica and Strelci at a distance 2 and 2.5 km from the location receptively. • The mere presence of lignite within the site, offers a choice of excellent materials to cover the landfill and these materials are in huge quantities.
Technical and Operational characteristic	• The altitude of the site ranges from 670 to 700 meters (mean average 684m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 15.6 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, it belongs to the JSP company. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The final access to the site can be achieved through 1.4 km of paved road that needs improvement works. • The site could be connected to the public utility networks through the nearby settlement. • However due to the biggest distance of the waste production center as well as due to the fact that almost 2/3 of the waste are generated in the Southern part of the Region, remarkable additional cost will rather be needed for construction and operation of more Transfer Stations.
Transportation costs – Distance from waste production center of the region	• Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 58 km.
Conclusion	***No Further Evaluation***

	The site OS1 in Municipality of Kichevo, has the following main disadvantages: o The site has no social acceptance, which is very critical parameter for the selection of a site o It is located in a big road distance (more than 55km) from the waste production center of the region. o The road network which connects the site is in a quite good condition, but with difficult geomorphological characteristic, taking under consideration the meteorological conditions of the region. o Significant additional construction and operation cost will be needed**.**

Figure 6-16: Geographical location, utilization area and site photos of the alternative site Oslomej (OS1)

Selection of the appropriate site

Based on the conclusions of those descriptions, three alternative sites were selected for further evaluation through the PROMETHEE II (Preference Ranking Organization Method for Enrichment Evaluation). This is one of the most efficient multi-criteria methods, based on the outranking relations concept. In the area of Southwest Region four (4) alternative potential sites were selected finally for evaluation from the multi-criteria analysis procedure. These sites are:

- Alternative site Z1 - Debartsa Municipality
- Alternative site G2 - Debartsa Municipality
- Alternative site OR1 - Kichevo Municipality

The steps followed for the selection of the most appropriate solution for site are presented below:

Step 1: Choose, classify and calibrate the evaluation criteria;
Step 2: Estimate the criteria weight factors;
Step 3: Set alternative potential sites;
Step 4: Grade alternative potential sites – Determine indifference and preference thresholds;
Step 5: Use a multi-criteria software tool;
Step 6: Rank alternative potential sites.

The setting or selection of the criteria was made according to experience from similar applications to:

(1) Ensure all parameters were used to examine each alternative potential site
(2) Ensure a representation of each potential site’s characteristics
(3) Avoid the over-lapping of criteria

The criteria were classified into five groups, each including a number of individual criterions, as given below:

Table 6-4: Groups of criteria and individual criteria

Criteria	Sub-Criteria
A. Geological-Hydrogeological	A1: Permeability of the underground layer
	A2: Tectonic structure of the area
	A3: Existence of hydrant points
	A4: Existence and use of underground water
	A5: Ground erosion-Stability of the slope
	A6: Seismicity and seismik risk of the area
	A7a: Surface water recipient-Type and use of the main recipient
	A7b: Surface water recipient-Distance between waste management facilities, recipient
	A8a: Protection of underground water due to infiltration
	A8b: Protection of underground water due to the supply via surface water
	A9a: Geomorphology of the area-Hydrological characteristics
	A9b: Geomorphology of the area-Surface formulation and slope protection
	A10: Borrow pits for clay sealing methods
B.Environmental	B1a: Land cover, ecological characteristics, landscape-Occupation
	B1b: Land cover, ecological characteristics, landscape-Proximity
	B2: Optical isolation
	B3a: Nuisance by odour and air pollution-Distance recipient
	B3b: Nuisance by odour and air pollution-Winds
	B4a: Nuisance from the circulation of the transported vehicles in inhabited areas-Annoyance from traffic
	B4b: Nuisance from the circulation of the transported vehicles in inhabited areas-Annoyance settlements
C. Land-Planning	C1: Distance of settlements
	C2a: Distance from agricultural activities-Land Occupation
	C2b: Distance from agricultural activities-Proximity
	C3: Distance from stock-raising activities
	C4: Distance from industrial activities
	C5a: Proximity to incompatible uses-Protected areas
	C5b: Proximity to incompatible uses-Landscape protection area
	C5c: Proximity to incompatible uses-Touristic zones
	C5d: Proximity to incompatible uses-Archaeological sites
	C6a: Final access road-Type of network
	C6b: Final access road-Necessary works
D. Operational	D1a: Impacts on operation of waste management facilities from the climatic conditions in the area
	D1b: Impacts on operation of waste management facilities from the climatic conditions in the area
	D2: Adequacy of the available area-Expansion Capabilities
	D3: Adequacy of covering material
E. Financial	E1: Demands for infrastructure works
	E2: Land value
	E3: Availability of public utilities
	E4: Cost for waste transportation to the site

A significant step for the entire procedure was the quantification of the significance of each category of criteria (categories A-E) as well as per criterion in each category. The determination of these weights was based on the opinion of the people involved in municipal solid waste and the experience of the project team in the development of multi-criteria analysis applications. Firstly weights were defined for each group of criteria and secondly weights were defined for every criterion in the group. After the multiply of every criterion weight with the group weight that it belongs, the final weights were calculated.

The next essential step of the procedure was the grading of alternative potential sites. In order to implement this step, the collection and recording of data for each individual criterion for the four potential sites took place. The following table presents the grading results for the four potential sites obtained for the first criteria category's individual criteria. The same was done for the individual criteria of the other four categories. It is noted that a number of individual criteria had the same value for the four potential sites and in particular:

- A4, A6, A7a, A10 from the Geological- Hydrogeological group;
- B4a from the Environmental group;
- C3, C4, C5b, C5d from the Environmental group;
- D1b, D3 from the Operational group;
- E3 from the Financial group.

Table 6-5: Multi criteria matrix for Geological-Hydrogeological group

Site/Criterion	A1	A2	A3	A4	A5	A6	A7a	A7b	A8a	A8b	A9a	A9b	A10
Z1	5	5	5	10	7	10	8	4	5	4	8	7	10
G2	7	5	3	10	10	10	8	10	6	3	1	10	10
OR1	10	10	5	10	10	10	8	4	10	4	6	10	10

Table 6-6: Multi criteria matrix for Environmental group

Site/Criterion	B1a	B1b	B2	B3a	B3b	B4a	B4b
Z1	3	2	1	10	10	7	3
G2	8	8	5	3	1	7	10
OR1	5.5	5.5	1	3	1	7	3

Table 6-7: Multi criteria matrix for Land-planning group

Site/Criterion	C1	C2a	C2b	C3	C4	C5a	C5b	C5c	C5d	C6a	C6b
Z1	2	5	5	10	10	1	10	10	10	10	10
G2	4	7	7	10	10	10	10	4	10	10	8
OR1	3	7	7	10	5	10	10	10	10	8	9

Table 6-8: Multi criteria matrix for Operational group

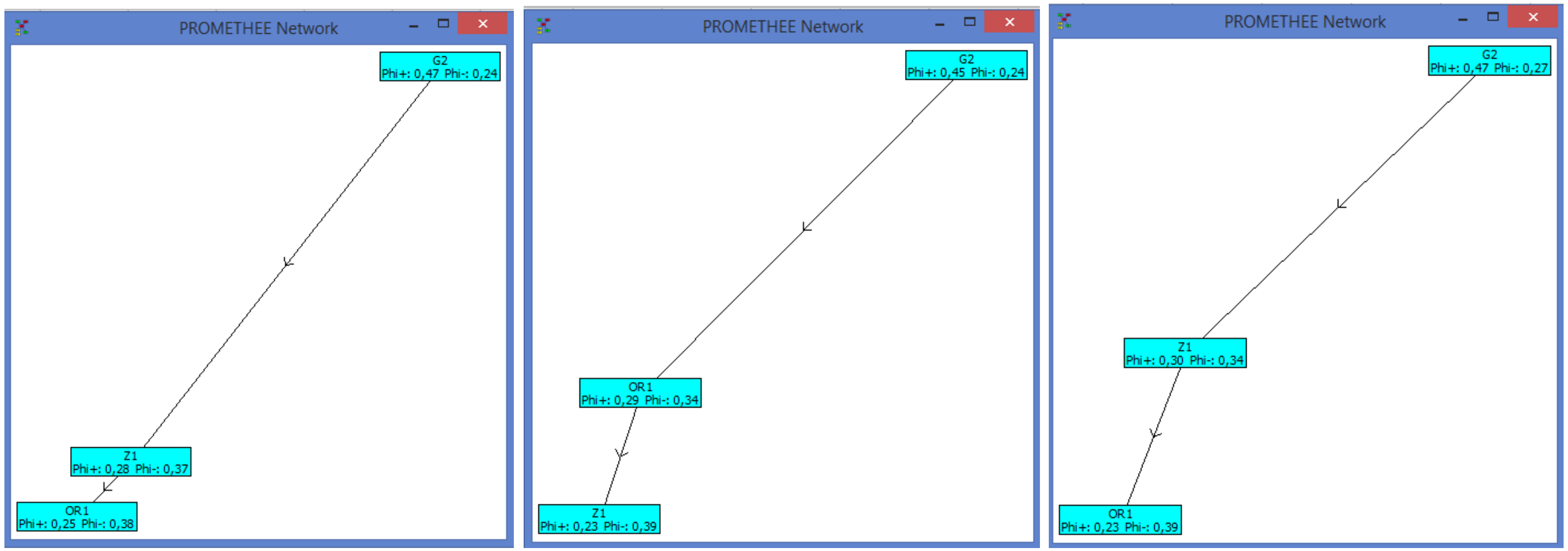
Site/Criterion	D1a	D1b	D2	D3
Z1	1	5	9	5
G2	1	5	10	5
OR1	3	5	8	5

Table 6-9: Multi criteria matrix for financial group

Site/Criterion	E1	E2	E3	E4
Z1	9	5	7	3
G2	7	7	7	2
OR1	9	5	7	1

After the development of a multi-criteria matrix as well as the determination of the p and q thresholds, the outcome was entered into a software tool for the ranking of the three alternative potential sites for central waste management facilities. After running the software tool PROMETHEE method (Preference Ranking Organization Method for Enrichment Evaluation), the alternative potential landfill sites, concerning central waste management facilities, were ranked according to their performance (complete ranking - PROMETHEE II). The following figures show the complete ranking results for each alternative Scenario (A’, B’ or C’).

Figure 6-17: Complete ranking of the potential sites



Scenario_A' **Scenario_B'** **Scenario_C'**

Site G2 located in Debartsa Municipality was ranked as the best potential site for the construction and operation of a central waste management facility in Southwest Region. In the following table are summarized the rankings for the different alternatives for each criteria group from the application of PROMETHEE method.

Table 6-10: Ranking of alternative areas for each criteria group/PROMETHEE method

		Scenario A'	Scenario B'	Scenario C'
Method	**Criteria Group**	**Ranking**		
PROMETHEE	A: Geological-Hydrogeological	OR1→G2→Z1	OR1→G2→Z1	OR1→G2→Z1
	B: Environmental	G2→Z1→OR1	G2→Z1→OR1	G2→Z1→OR1
	C: Land-planning	G2→OR1→Z1	G2→OR1→Z1	G2→OR1→Z1
	D: Operational	G2→Z1→OR1	G2→Z1→OR1	G2→Z1→OR1
	E: Financial	Z1→G2→OR1	Z1→G2→OR1	Z1→G2→OR1

6.3.2 Option analysis for location of LWMF (TSs) – Selected site description

The selection of the appropriate location for the construction of Transfer Stations is also an important issue for the successful implementation of an Integrated Solid Waste Management System. In order to identify the municipalities where TSs should be established in Southwest Region the project team applied the following steps:

- The maximum possible number of TSs was determined taking into consideration the quantity of waste to be transported through those facilities in correlation with the distance.
- Maps which illustrate (i) the location of the central waste management facility, (ii) the possible TSs, (iii) the municipalities which will be served for each TS and (iv) the Municipalities which will transport their waste directly in CWMF, were created.
- The Rulebook 'Rules on minimum technical terms and conditions with regard to the protection of the environment that shall be met by transfer stations, the conditions to be met on the sites where the Transfer Stations should be built or set up and the time limits for waste storage in the transfer station according the type of waste' was taken into consideration.
- For each TS of each region Break Even Points were calculated. To calculate the break-even point, the following determined:
  - ✓ Transfer Station Cost (cost to build, own, and operate transfer station, in €/t)
  - ✓ Direct Haul Payload (average payload of collection truck hauling directly to WMC, in tons)
  - ✓ Transfer Haul Payload (average payload of transfer truck hauling from transfer station to landfill, in tons)
  - ✓ Transportation Cost (average cost of direct or transfer hauling, €/km)
  - ✓ Assumption that the mobile equipment will be replaced in 12 years from the beginning of the operation
  - ✓ The investment cost of civil works and equipment of TSs in yearly basis in order to be included in the unit costs
- Letter of request from the project office was sent to the selected municipalities (identified after analytical calculations) in order to propose sites for the establishment of the TSs. In order to

facilitate the search of the proper location, the required size of the plot area determined from the project team.

The analytical calculations concerning the task of Transfer Stations will be presented in a next paragraph of the present chapter. The municipalities in which Transfer Stations will be constructed are the municipalities of (i) Debar, (ii) Struga, (iii) Kichevo and (iv) Ohrid.

The following table presents the municipalities which will be served for each TS.

Table 6-11: TSs and municipalities which will be serve

TS	Served Municipalities
Debar TS	Debar, Centar Zhupa
Struga TS	Struga, Vevchani
Kichevo TS	Kichevo, Plasnitsa, Makedonski Brod
Ohrid TS	Ohrid

The municipality of Debartsa will transfer its waste directly to the Central Waste Management Facilities.

The basic characteristics of the four selected site locations for Transfer Stations in Southwest Region, are presented as follows:

Debar TS

- ❖ The site which was proposed by Debar Municipality is located north - northwest of Debar settlement in a direct distance of approx. 1.5 km.
- ❖ The total surface of the proposed site is 1.4 ha
- ❖ The site limits of the area are in vicinity with existing non compliant MSW landfill.
- ❖ The closest Emerald site is "Mavrovo" (MK0000007) in a direct distance of approx 5.6 km northeast of the proposed site.
- ❖ The nearest settlement is Debar settlement.
- ❖ The access is easy and takes place through the existing local road network (P1202).
- ❖ There is no need for major road access works.

The following figures illustrate the plot area of the proposed site and the settlements in the vicinity of the TS site.

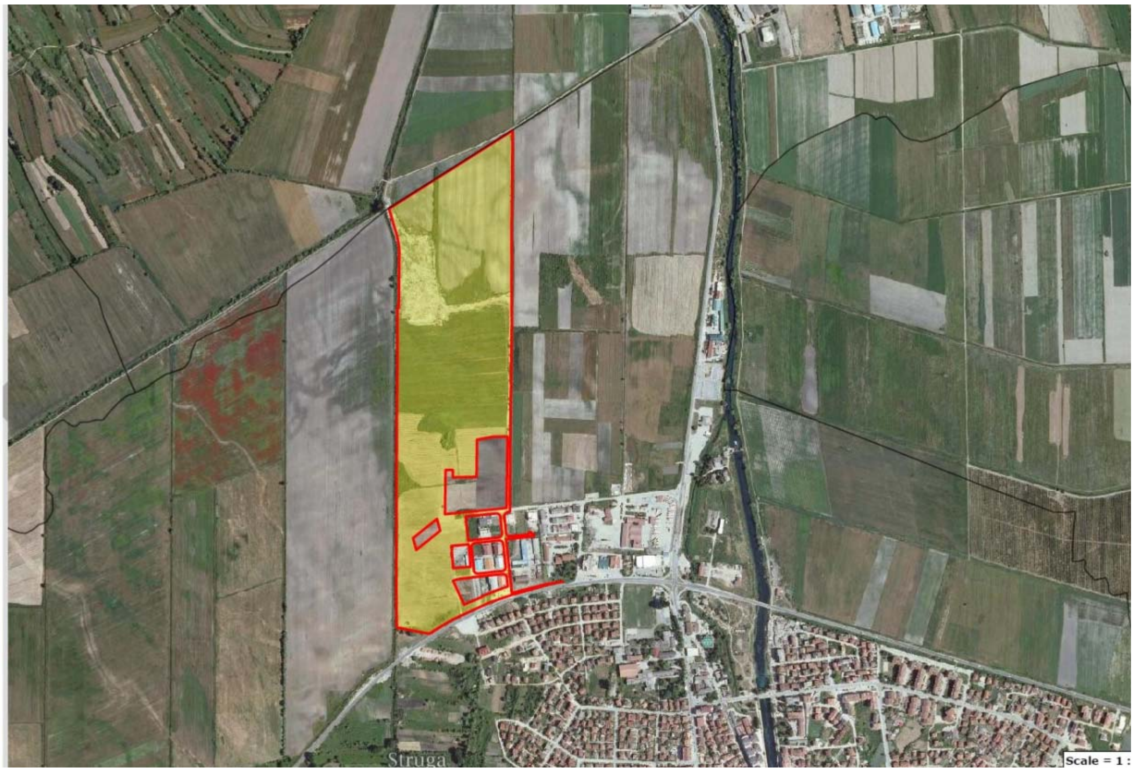
Figure 6-18: Plot area of the proposed site, boundaries of closest Emerald areas/Debar TS

Struga TS

- The site which was proposed by Struga Municipality is located North of Struga settlement in a direct distance of approx. 1.6 km.
- The total surface of the proposed site is 2.6 ha
- The proposed site is located in an existing non compliant municipal landfill (RALL 006)
- The closest Emerald site is "Ohridsko Ezero" (MK0000024) in a direct distance of approx 2 km south of the proposed site.
- The nearest settlement is Struga settlement
- The site limits of the area are in vicinity with existing non compliant MSW landfill.
- The access is easy through the existing local road network. The proposed site is placed on the west of the road R-1201 that connects Struga settlement with Debar settlement to the industrial zone of Struga settlement.
- Works required for the improvement of current access road, due to the fact that there is an existing paved road in the entrance of the transfer station

The following figures illustrate the plot area of the proposed site and the settlements in the vicinity of the TS site.

Figure 6-19: Plot area of the proposed site, boundaries of closest Emerald areas/Struga TS



Kichevo TS

- ❖ The site which was proposed by Kichevo Municipality is located north-northeast of Kichevo settlement in a direct distance of approx. 6 km.
- ❖ The total surface of the proposed site is 2.8 ha
- ❖ The proposed site is located in an existing non compliant municipal landfill (RALL 003)
- ❖ The closest Emerald site is Mavrovo site (MK0000007) in a direct distance of approx 15 km west of proposed site.
- ❖ The nearest settlement is Oslomej settlement in a direct distance of approx. 300 m
- ❖ The access to the site is through the road which connects Kichevo settlement with Oslomej settlement.
- ❖ Works required for the improvement of current access road

The following figures illustrate the plot area of the proposed site and the settlements in the vicinity of the TS site.

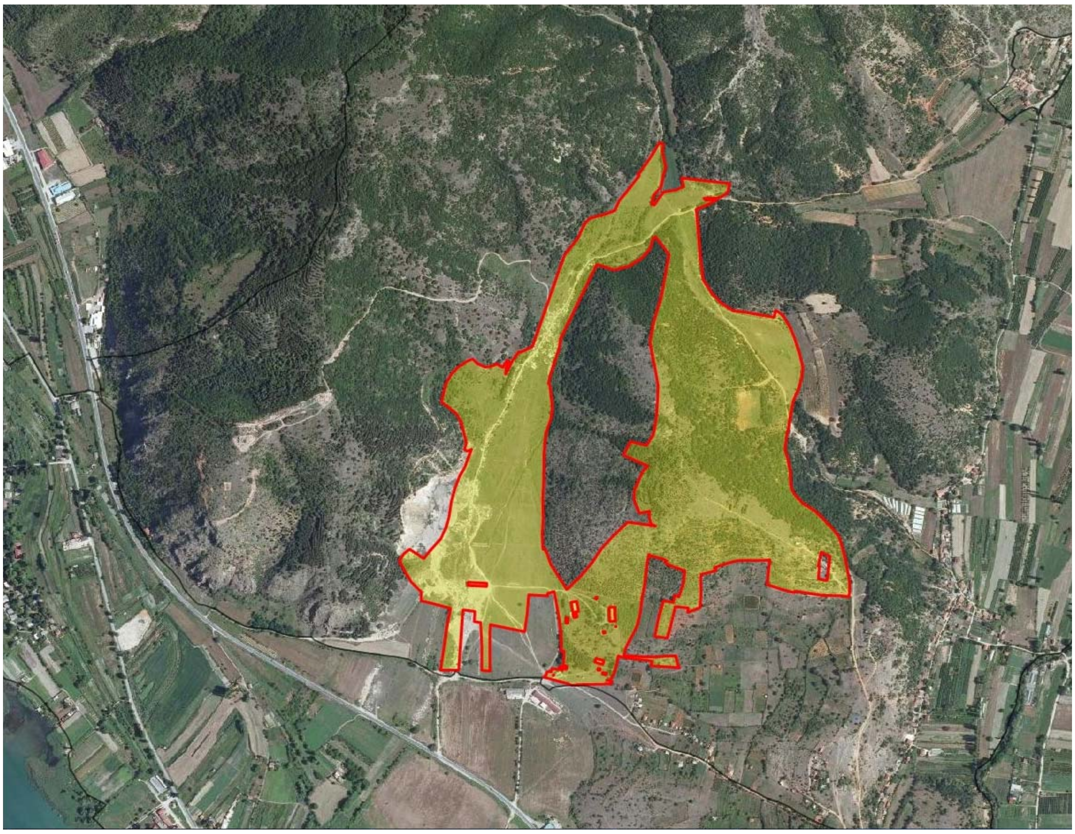
Figure 6-20: Plot area of the proposed site, boundaries of closest Emerald areas/Kichevo TS

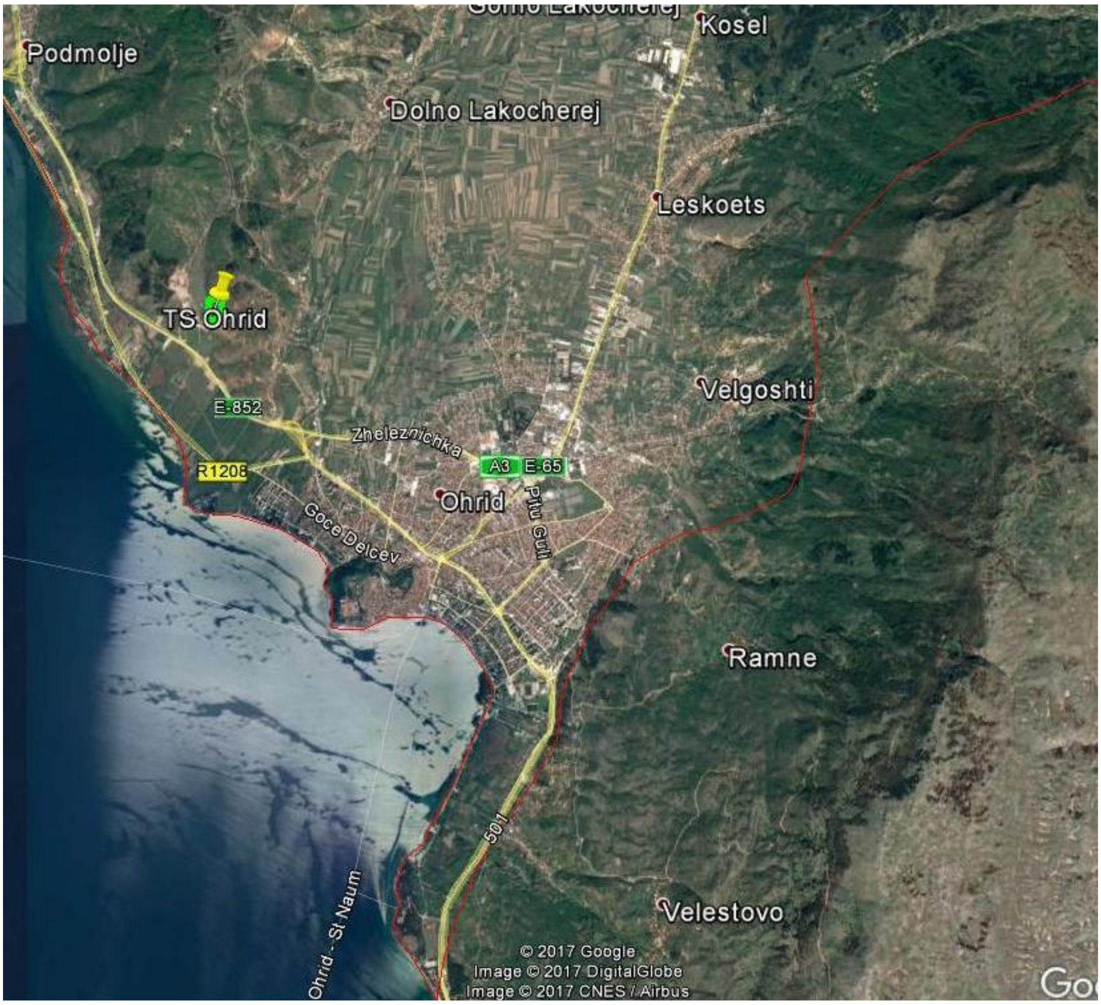
Ohrid TS

- The site which was proposed by Ohrid Municipality is located Northwest of Ohrid settlement in a direct distance of approx. 2 km.
- The total surface of the proposed site is 2.8 ha.
- The proposed site is located in immediate vicinity with a non compliant municipal landfill (RALL 005) with solid municipal and C&D waste.
- The closest Emerald sites are:
  - ✓ "Ohrid lake" (MK0000024) in a direct distance of approx. 1 km southwest of the proposed site.
  - ✓ "Calichica" (MK0000001) in a direct distance of approx. 5 km east of the proposed site.
- The nearest settlement is Orman settlement in a direct distance of approx 0.7 km.
- The access is easy through the existing local road network. The proposed site is located north of the road A3 that connects Ohrid settlement with Struga settlement.
- Earthworks are required for the improvement of the current access road.

The following figures illustrate the plot area of the proposed site and the settlements in the vicinity of the TS site.

Figure 6-21: Plot area of the proposed site, boundaries of closest Emerald areas/Ohrid TS





6.4 Option analysis on transfer stations

Solid waste Transfer Stations (TS) are solid waste reception facilities that are used as interim stations for waste transportation to distant waste treatment and disposal facilities. They can play an important role in the regions total waste management system as a link between the collection system of solid municipal waste and their final disposal. While TS facilities may vary, all serve a same basic purpose, to consolidate the waste from multiple collection vehicles into larger, high-volume transfer vehicles. Their advantages are summarised as follows:

- Economically transport waste to a distant landfill
- Increase municipal collection efficiency
- Provide convenient drop-off locations for residents
- Reduce traffic volume at a landfill

Consolidating smaller loads from collection vehicles into larger transfer vehicles reduces hauling costs by enabling collection crews to spend less time travelling to and from distant disposal sites and more time collecting waste, resulting in reduced fuel consumption and collection vehicle maintenance costs, plus produces less overall traffic, air emissions, and road wear.

A transfer station also provides an opportunity to screen waste prior to disposal, flexibility in selecting waste disposal options, as well as an opportunity to serve as a convenience center for public use.

In their simplest form, transfer stations are facilities with a designated receiving area where waste collection vehicles discharge their load, but in some cases, transfer stations are also used as multi-purpose facilities that include: storage of recyclable materials, household hazardous waste collection depots, and in some cases collection points for organic materials destined for composting sites.

Social, political, economical and geographical factors establish the need of transfer station in a region and the primary reason for using a transfer station is to reduce the cost of transporting waste to treatment/disposal facilities.

Deciding whether a transfer station is appropriate for an individual community is based on determining if the benefits outweigh the planning, sitting, designing, and operating costs against the savings the transfer station might generate from reduced hauling costs.

The type of station that will be feasible for a community depends on the following design variables:

- Required capacity and amount of waste storage desired;
- Types of wastes received;
- Processes required recovering material from wastes or preparing it (e.g. shred or bale) for shipment;
- Types of collection vehicles using the facility;
- Types of transfer vehicles that can be accommodated at the disposal facilities, and;
- Site topography and access.

6.4.1 Waste quantities

The waste quantities that will be transferred to CWMF in G2 site (Debartsa Municipality), either directly with waste collection vehicles or through transfer stations, are equal to **59,133 t/y** after removal of hazardous waste, waste collected in Green Points, waste from home composting actions, and other waste streams (i.e. WEEE, construction and demolition waste, etc.).

The quantity of waste per municipality of Southwest region that will be transferred for the appropriate treatment and disposal is presented in the following Table.

Table 6-12: Waste quantities per municipality that will be transferred to CWMF in G2 site (aver. 2021-2046)

Municipalities	Quantity (t/y)	Participation %
Vevchani	365	0.6%
Debar	7,275	12.3%
Debartsa	704	1.2%
Kichevo	12,367	20.9%
Makedonski Brod	1,724	2.9%
Ohrid	22,044	37.3%
Plasnitsa	1,312	2.2%

Municipalities	Quantity (t/y)	Participation %
Struga	12,445	21.0%
Centar Zhupa	897	1.5%
TOTAL	**59,133**	**100.0%**

6.4.2 Location and capacities of all potential transfer stations

Organized collection and transport of municipal waste will cover all settlements in nine (9) municipalities in Southwest Region, and 100% of the population. In addition to the local population, during the tourist season, collection and transport of waste is also cover waste by tourists and residents who occasionally stay in holiday homes, in the area of Southwest Region.

As it is already mentioned in the first step in the procedure of determining the possible maximum number of TSs which should be constructed, was the determination of the quantities of waste that will be transferred through those facilities and the implementation of maps.

The total quantity to be transferred to the CWMC in Debartsa, either directly with waste collection vehicles, or through transfer stations, is equal to **59,133 t/y** (2021-2046 average waste quantity). The waste quantities to be transferred via TS vary depending on the number of TS and the municipalities which will be served. The waste streams which will be transferred through TSs will be (i) mixed waste, (ii) recyclable waste and (iii) green waste.

As it is mentioned in previous paragraph, a request letter from the project office was send in the municipalities of Ohrid, Struga, Debar and Kichevo, in order to propose specific locations for the construction of a Transfer Station. In order to facilitate the search of the proper location, the required size of the plot area determined from the project team. Two out of four municipalities (Struga & Debar) send a positive reply with a proposed site. Ohrid Municipality replied that they didn't prefer the construction of a TS for the transportation of their waste and it's preferable for them to transfer their waste through collection vehicles. Kichevo Municipality requested a proposal from the project team regarding the TS location. Although Ohrid gave a negative reply, the option for the construction of a TS in this municipality was examined.

The following table presents an overview of all potential TS locations and their waste capacities and an overview of the Municipalities that will transfer their waste directly to CWMF without TS. The sustainability of potential TSs will be examined through the Break Even Point Calculations.

Table 6-13: Capacities of all potential TSs (average quantities 2041-2046)

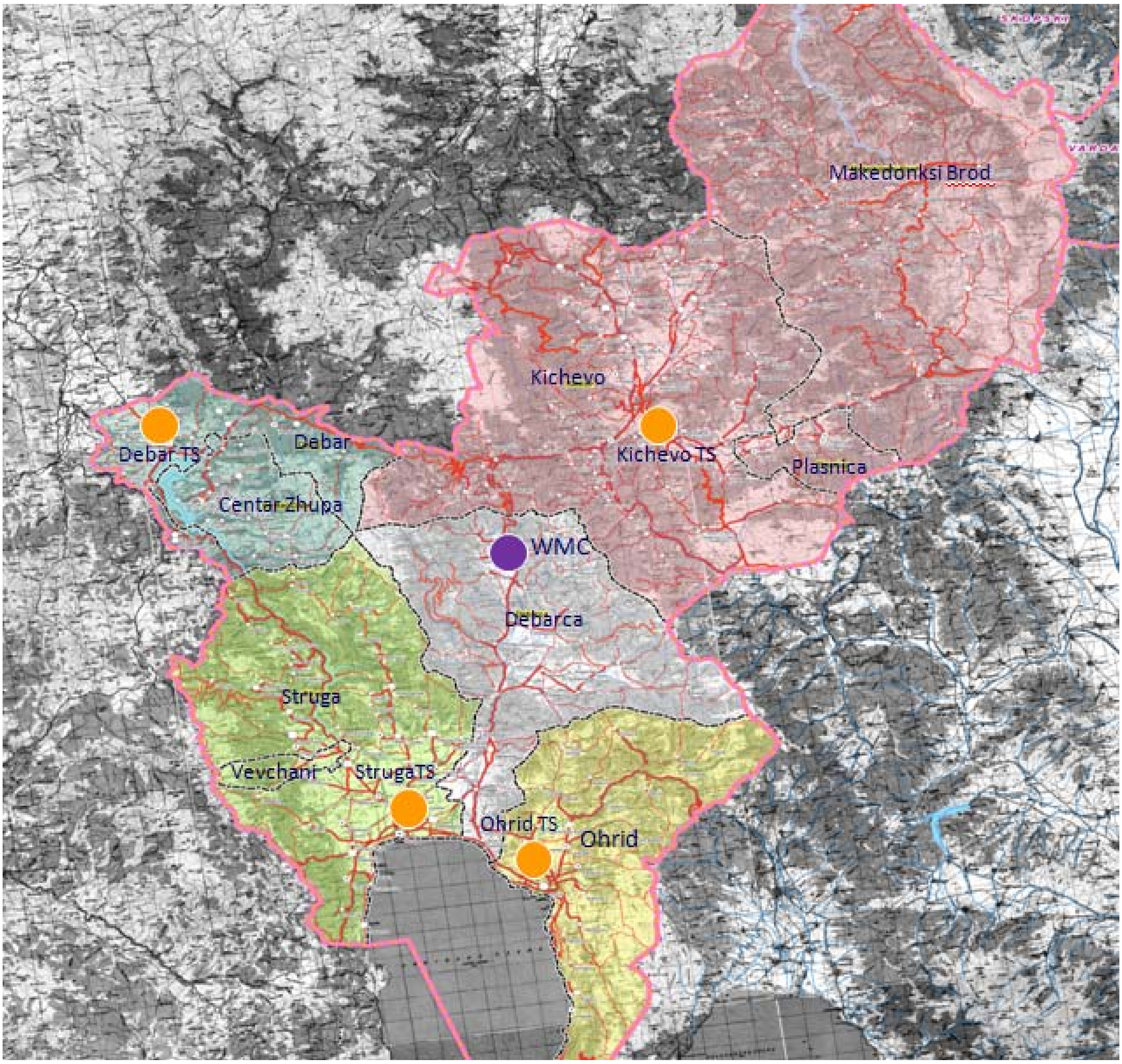
Potential TS	TS to CWMF (roundtrip, km)	Served municipalities	Residual waste stream (t/y)	Recyclable waste stream (t/y)	Green waste stream (t/y)	Total Capacity (t/y)
Struga	76	Struga	8,769	2,920	756	12,445
		Vevchani	257	86	22	365
		Sub-total	***9,026***	***3,006***	***778***	***12,810***
Debar	179	Debar	5,126	1,707	442	7,275
		Centar Zhupa	632	211	55	897
		Sub-total	***5,758***	***1,917***	***496***	***8,172***
Kichevo	78	Kichevo	8,714	2,902	751	12,367
		Plasnitsa	924	308	80	1,312
		Makedonski Brod	1,215	405	105	1,724
		Sub-total	***10,853***	***3,614***	***935***	***15,403***
Ohrid	65	Ohrid	15,534	5,172	1,339	22,044
		Sub-total	***15,534***	***5,172***	***1,339***	***22,044***
Total quantity transported through TSs						**58,429**

Table 6-14: Capacities of municipalities that will transfer their waste directly to CWMF (average quantities 2041-2046)

Direct transportation to CWMF-Municipalities	Roundtrip to CWMF (km)	Residual Waste stream (t/y)	Recyclable waste stream (t/y)	Green waste stream (t/y)	Total Capacity (t/y)
Debartsa	31	496	165	43	704
	Sub-total	***496***	***165***	***43***	***704***
Total quantity transported directly					**704**

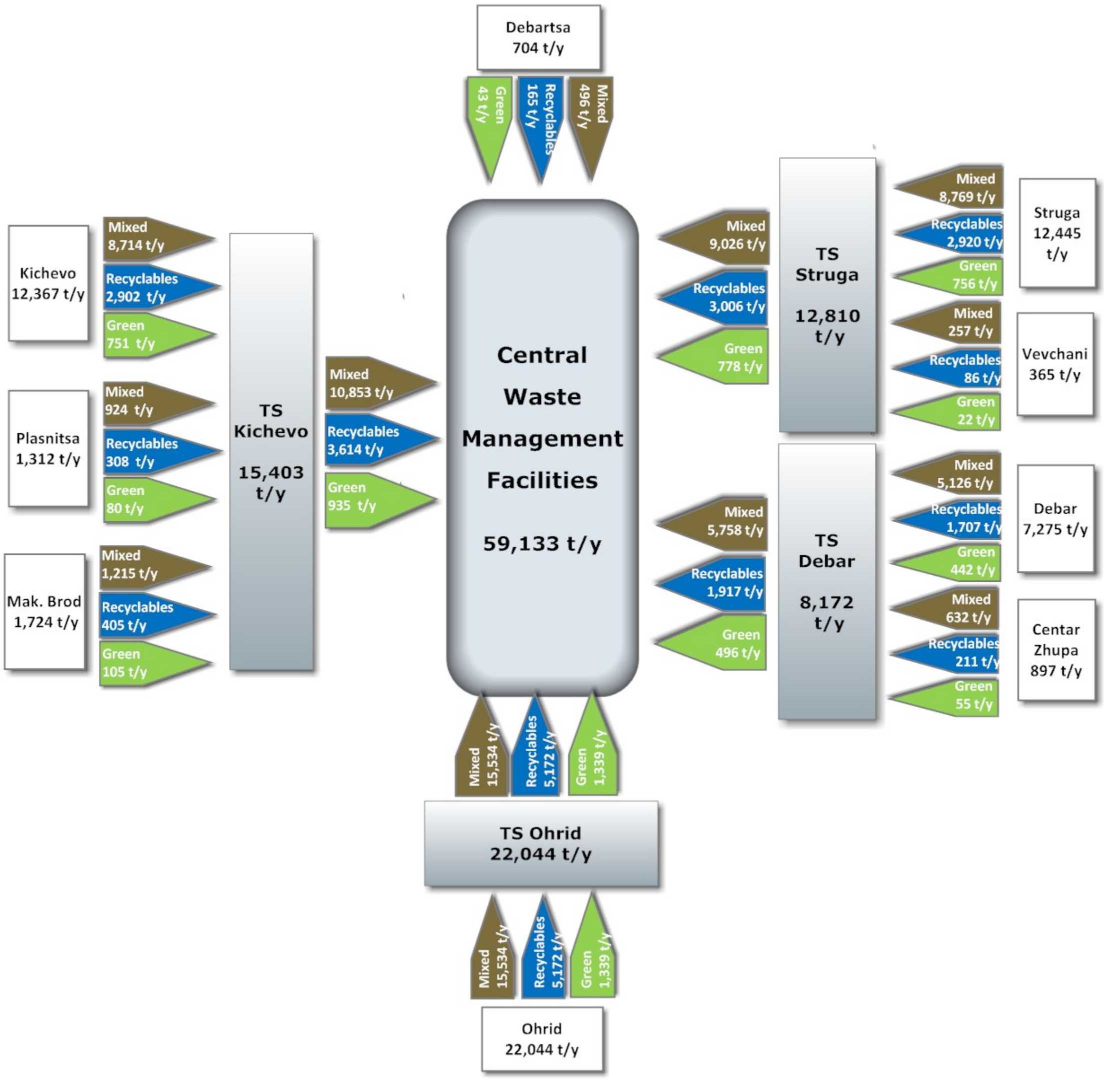
The following map illustrates the proposed locations, in a municipality level, and the municipalities which will be served for each proposed TS. Also municipalities that transport their waste directly to CWMF are presented.

Figure 6-22: Locations of potential Transfer Stations and WMC and respective serviced municipalities



The following diagram illustrates the proposed Transfer Stations, the municipalities which will be served from them, the municipality in which these will be located, the quantities which will be transferred through them and the municipalities and their quantities which will transfer their waste directly to CWMF.

Figure 6-23: Overall proposed transportation system in Southwest region



6.4.3 Break-Even Point calculation concerning Transfer Station task

The Break Even Points were calculated for each proposed TS of the region. To calculate the break-even point for a specific facility, it is necessary to determine the following values:

- Transfer Station Cost (cost to build, own, and operate transfer station, in €/t).
- Direct Haul Payload (average payload of collection truck hauling directly to CWMF, in tons).
- Transfer Haul Payload (average payload of transfer truck hauling from transfer station to landfill, in tons).
- Trucking Cost (average cost of direct or transfer hauling, €/km).

Once these values are known, the following formulas have been used in order to calculate cost at different distances:

- Cost of Direct Haul (without the use of a waste transfer station)
  Distance (km) multiplied by Trucking Cost (€ per km) divided by Direct Haul Payload (tons)

- Cost of Transfer Haul
  Transfer Station Cost (€ per ton) plus Distance (km) multiplied by Trucking Cost (€ per km) divided by Transfer Haul Payload (tons)

6.4.3.1 Cost for build own and operate TS facility

In order to proceed with the aforementioned calculation it was necessary to determine the appropriate uploading system and transportation equipment for each Transfer Station.
TS can typically be categorized into the following basic categories:

- Direct discharge without compaction systems
- Platform/pit stations without compaction systems
- Compaction systems (Stationary compactors or press containers)

Direct discharge without compaction systems:
Waste can be unloaded directly into the "open top" of the trailer. Direct discharge without compaction stations is generally designed in two main operating floors. During the operation the waste is unloaded directly from collection vehicles (located on the top floor), through a hopper, into an open-top trailer located on the lower floor. The trailer is positioned on scale so that unloading can be stopped when the maximum payload is reached. Large trailers are necessary in order to get a good payload because the waste is not compacted.

Advantages	Disadvantages
Simple technology that does not rely on sophisticated equipment Lower capital costs No additional equipment needed for pushing waste into trailer Reduces the handling of waste	Needs grade separation for top-loading trailers No temporary storage of waste Waste can lightly compacted Limited inspection capability

Platform/pit stations without compaction systems
In platform/pit stations, collection vehicles are unloading the waste onto a floor or area where waste can be temporarily stored, and, if desired, picked through for recyclables or unacceptable materials. The waste is then pushed into open-top trailers, usually by front-end loaders. Like direct discharge stations, platform stations have two levels. If a pit is used, the station has three levels. A major advantage of these stations is that they provide temporary storage, which allows peak inflow of wastes to be levelled out over a longer period. Although construction costs for this type of facility are usually higher because of the increased floor space, the ability to temporarily store waste allows the purchase of fewer trucks and trailers, and can also enable facility operators to haul at night or other slow traffic periods. These stations are usually designed to have a storage capacity of one-half to two days' inflow.

Advantages	Disadvantages
Peak waste flow can be stored. Thus reducing the number of transfer trailers needed Bulky items can be broken down. waste compacted Simple technology Easier for materials recovery and waste screening.	High capital costs Additional equipment needed to reload waste into transfer trailer Fall hazard for people and vehicles Larger floor area to maintain

Compaction systems (Stationary compactors or press containers)

Stationary compactors use a hydraulic ram to compact waste into the transfer trailer. The trailer must be designed to resist the compaction force and for this reason usually it is made of reinforced steel. Waste is fed into the compactor through a chute, either directly from collection trucks or after intermediate use of a pit. The hydraulically powered ram of the compactor pushes waste into the transfer trailer, which is usually mechanically linked to the compactor. The main disadvantage of this compaction facility is that the ability of the facility for waste process depends on the functionality of the compactor. The selection of a good quality compactor in comparison with regular preventive maintenance of the equipment and the prompt availability of relevant personnel are essential for the reliable operation.

Another alternative of compaction system, without the presence of the aforementioned disadvantage, is the system of press containers. In this solution, waste is tipped through a hopper into press containers which can be wheeled press containers or simple press containers. In the first case of wheeled press containers, these are carried through an appropriate truck connected to the wheeled press container, while in the second case of simple press containers; these are carried through a hook lift truck. When quantities of waste are small, it is economically more feasible the use of mobile compactors (press containers wheeled or simple) than stationary compactors. In this case the waste is unloaded from the collection vehicle, through a hopper, into the feeding chute of the press container which is located on a lower floor. Each mobile compactor is a single unit that consists of a compactor with a permanently connected compaction container. This has the advantage that special preparation of the site is not needed, as the only requirement of the compactor is an electrical power connection. An electro-hydraulically driven horizontal ram, compacts the material into the container.

Due to the fact that the quantities that will be transferred through Transfer Stations are small (average quantity 2021-2046) and taking into consideration the advantages and disadvantages of each different type, concerning the uploading system of the Transfer stations, the system that will be examined further based on a **system with hopper on different levels** and regarding transportation equipment two alternative systems were examined and the most economical solution was selected.

The following figure and table illustrates and present the alternative systems for transportation equipment and the alternative options which were examined in the framework of the feasibility study.

Figure 6-24: Option Wheeled press containers and relevant trucks for wheeled press containers

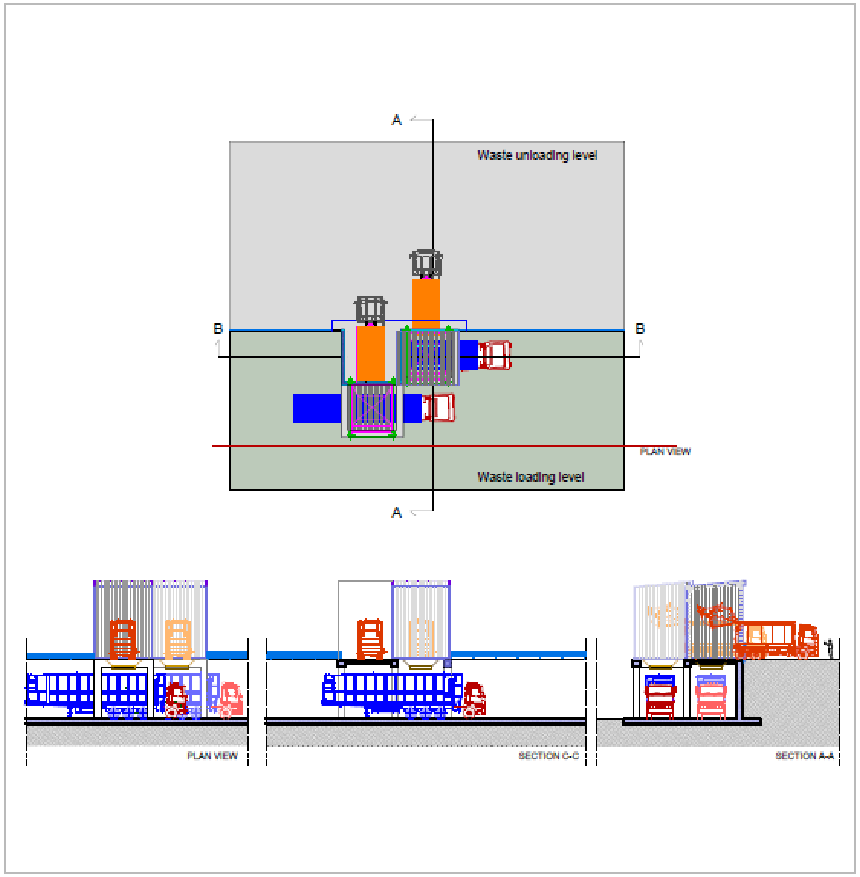
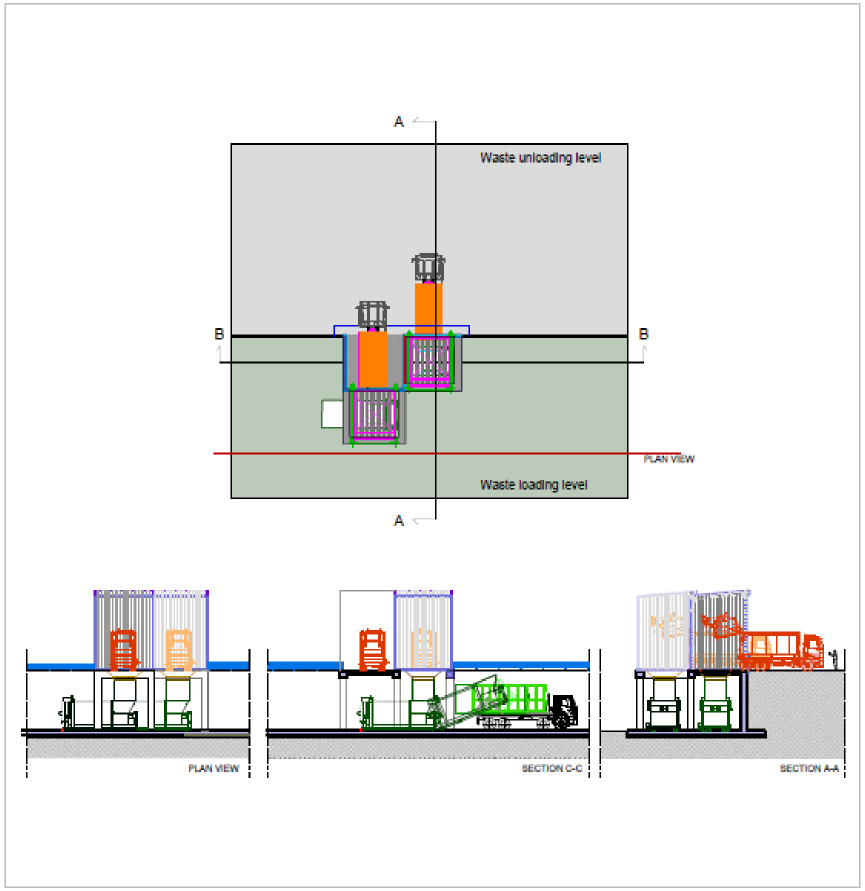
Wheeled press containers/Truck for wheeled press containers	Press containers/Truck with hook lift for press containers
	

Table 6-15: Examined alternative options concerning transportation equipment of TSs

Alternative options for transportation equipment	Option 1	Option 2
Wheeled press containers 55 m3 for mixed waste	V	
Press containers 24 m3 for mixed waste		V
Press containers 24 m3 for recyclable waste	V	V
Containers 24 m3 for green waste	V	V
Trucks for wheeled press containers	V	
Trucks for containers/press containers	V	V

The following table presents the total investment cost for each alternative option for each TS in Southwest region. Analytical calculations are presenting in the relevant Annex of the present study.

Table 6-16: Financial calculations for each alternative option and each proposed TS in Southwest region

Investment cost for transportation equipment (€) /Southwest Region	Option 1	Option 2
Struga TS	527,455	257,580
Debar TS	527,455	390,699
Kichevo TS	527,455	414,074
Ohrid TS	758,416	468,410

Option 2 (press containers for mixed and recyclable waste and open containers for green waste/truck with hook lift) selected for all the proposed TSs in Southwest region as it is the most economical solution for transportation equipment.

The next step after the selection of the appropriate technology for uploading system and transportation equipment was the calculation of investment and operational cost for all the proposed TSs taking into consideration the division on civil works, equipment of the facility and mobile equipment. The following table provides the calculations for investment and operational costs for each proposed TS and the unit costs concerning the TS facility (civil works & equipment) and the transportation equipment of each TS facility. Analytical calculations are presenting in the relevant Annex.

Table 6-17: Investment/Operational cost for each proposed TS in Southwest region

	Struga TS	Debar TS	Kichevo TS	Ohrid TS
Total Investment cost of TS €/y	1,018,078	968,692	1,109,550	1,245,542
Total Operational cost of TS €/y	99,884	113,887	126,387	147,516

Table 6-18: Unit costs for build own and operate TS facilities

	Struga TS	Debar TS	Kichevo TS	Ohrid TS
Unit cost for build and operate TS facility (incl. also transportation cost to CWMF) (€/t)	11.87	20.81	13.07	9.88

6.4.3.2 Calculation of trucking cost

The average cost of direct or transfer hauling in €/km was also calculated for the determination of break even points. The following table presents the summarized results for each TS for the cases (i) the served municipalities transfer their waste directly to CWMF or (ii) through TS facilities. Analytical calculations are presenting in the relevant Annex.

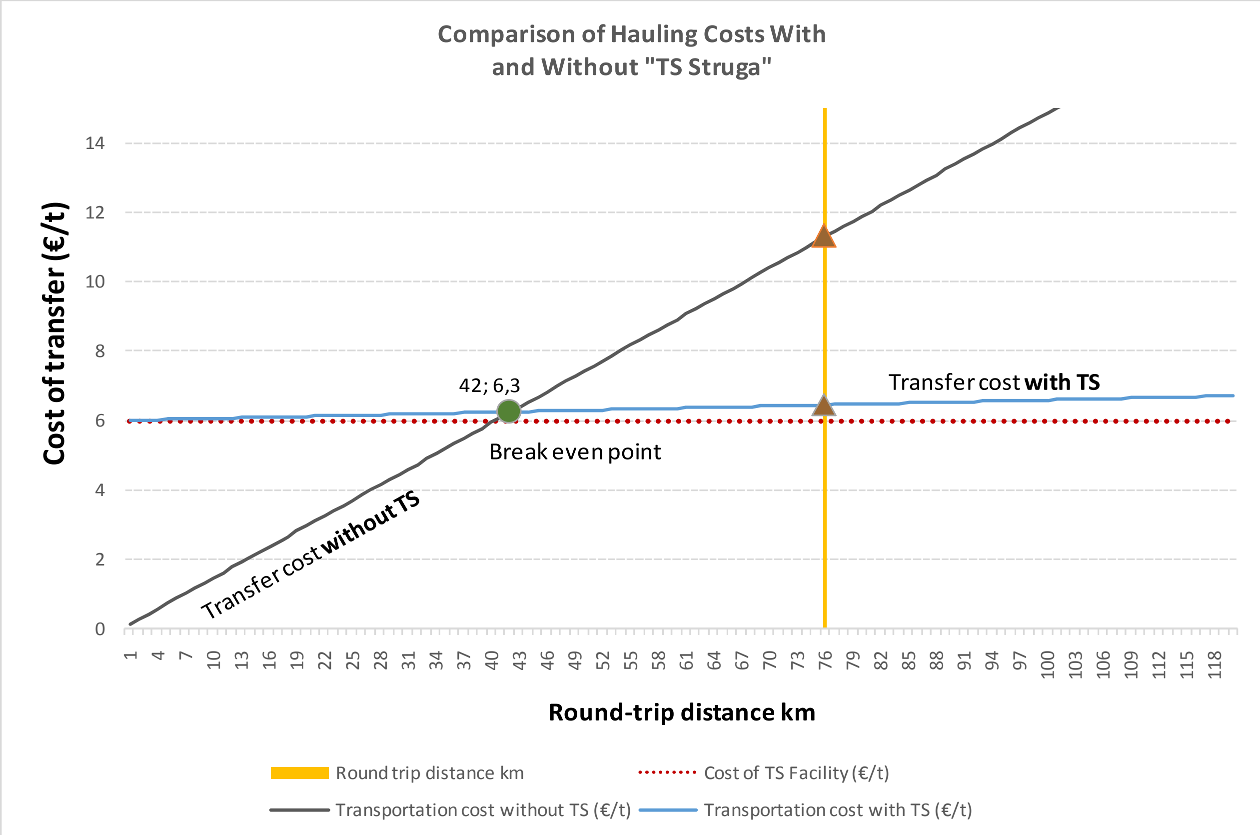
Table 6-19: Average cost of direct or transferring hauling (Investment and operational cost)

	Struga, Vevchani	Debar, Centar Zhupa	Kichevo, Plasnica, Makedonski Brod	Ohrid
Cost for transportation equipment through TSs (€/t)	5.87 (for average round-trip 76.4 km)	12.93 (for average round-trip 178.6 km)	8.06 (for average round-trip 78 km)	5.90 (for average round-trip 65 km)
Cost for transportation equipment through small trucks without TSs (€/t)	34.51 (for average round-trip 74 km)	59.64 (for average round-trip 170 km)	33.84 (for average round-trip 66 km)	25.90 (for average round-trip 73 km)

6.4.3.3 Break even points determination

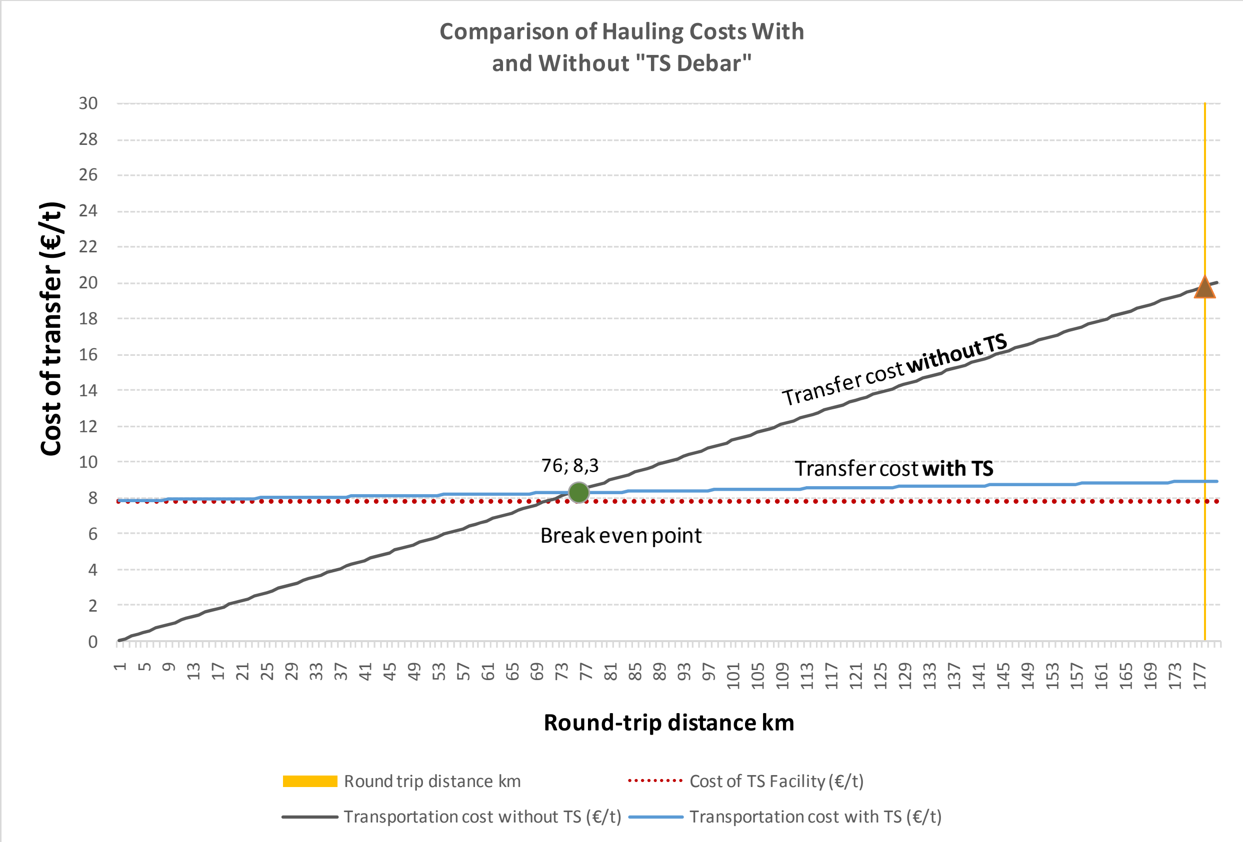
The following figures demonstrate a representative “cost versus kilometres” relationship between direct hauling waste to disposal facilities in collection vehicles versus hauling in larger vehicles for each proposed Transfer station in Southwest region.

TS in Struga municipality (served municipalities: Struga, Vevchani)



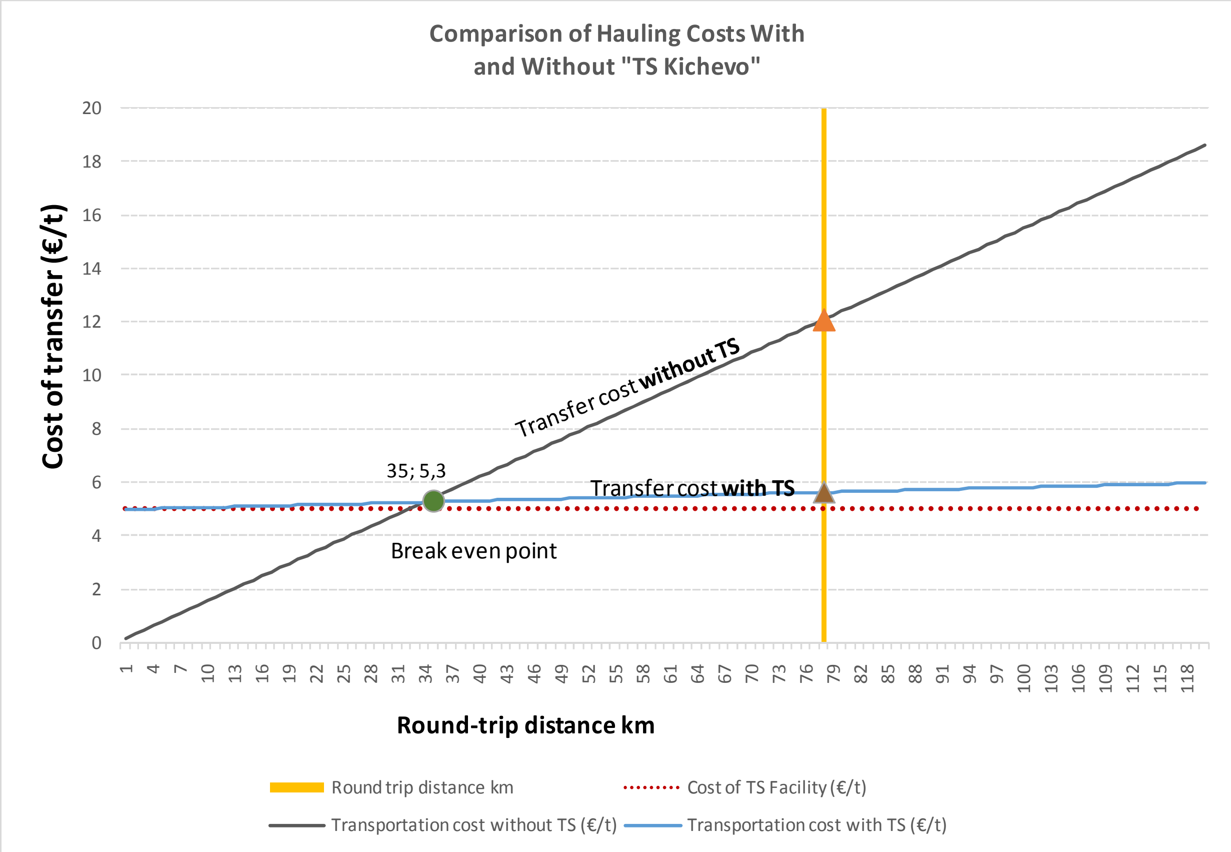
The comparison shows a break-even distance of about 42 km (round-trip), which means that is cost effective to construct this specific TS when the round-trip distance exceeds 42 km. The round-trip distance from TS location in Struga municipality to CWMF is approx. 76 km so Struga TS is cost-effective and proposed to be constructed.

TS in Debar municipality (served municipalities: Debar, Centar Zhupa)



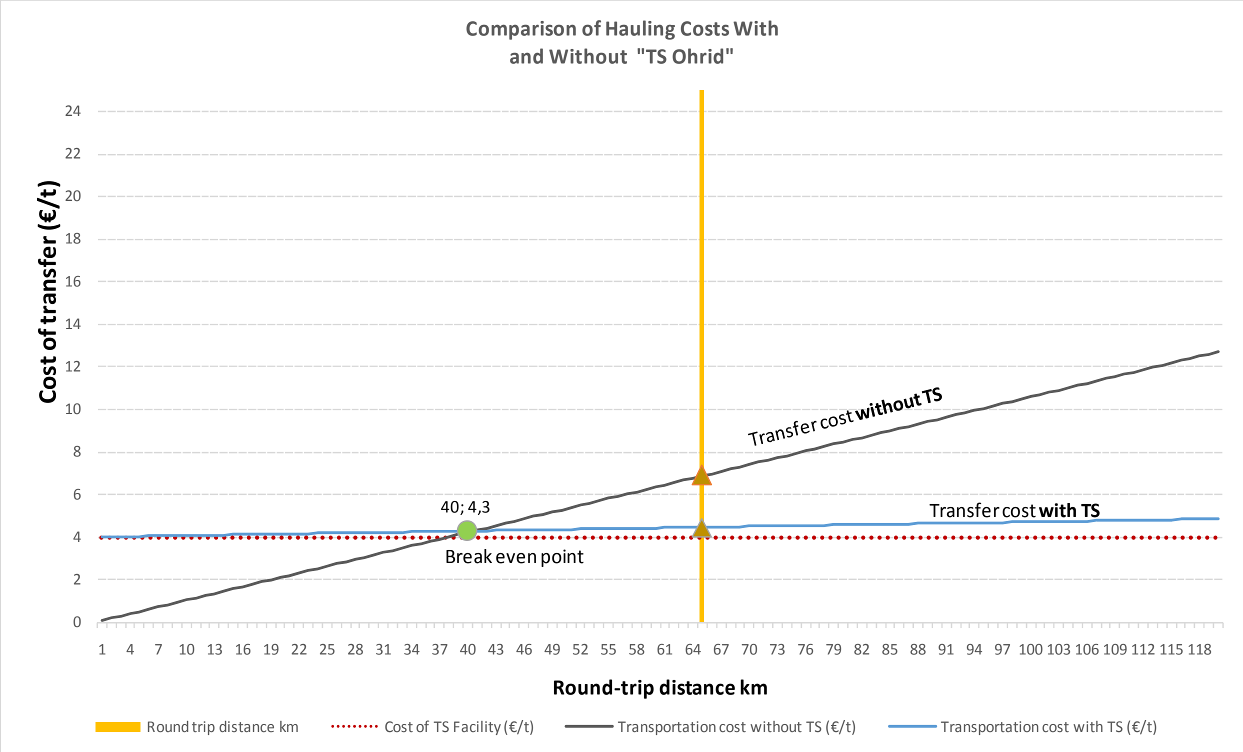
The comparison shows a break-even distance of about 76 km (round-trip), which means that is cost effective to construct this specific TS when the round-trip distance exceeds 76 km. The round-trip distance from TS location in Debar municipality to CWMF is approx. 178 km so Debar TS is cost-effective and proposed to be constructed.

TS in Kichevo municipality (served municipalities: Kichevo, Plasnitsa, Makedonski Brod)



The comparison shows a break-even distance of about 35 km (round-trip), which means that is cost effective to construct this specific TS when the round-trip distance exceeds 35 km. The round-trip distance from TS location in Kichevo municipality to CWMF is 78 km so Kichevo TS is not cost-effective and is not proposed to be constructed.

TS in Ohrid municipality (served municipality: Ohrid)



The comparison shows a break-even distance of about 40 km (round-trip), which means that, is cost effective to construct the specific TS when the round-trip distance exceeds 40 km. The round-trip distance from TS location in Ohrid municipality to CWMF is approx. 65 km, so Ohrid TS is cost effective to be constructed.

6.4.4 Analysis of alternative scenarios for waste transportation in Southwest region

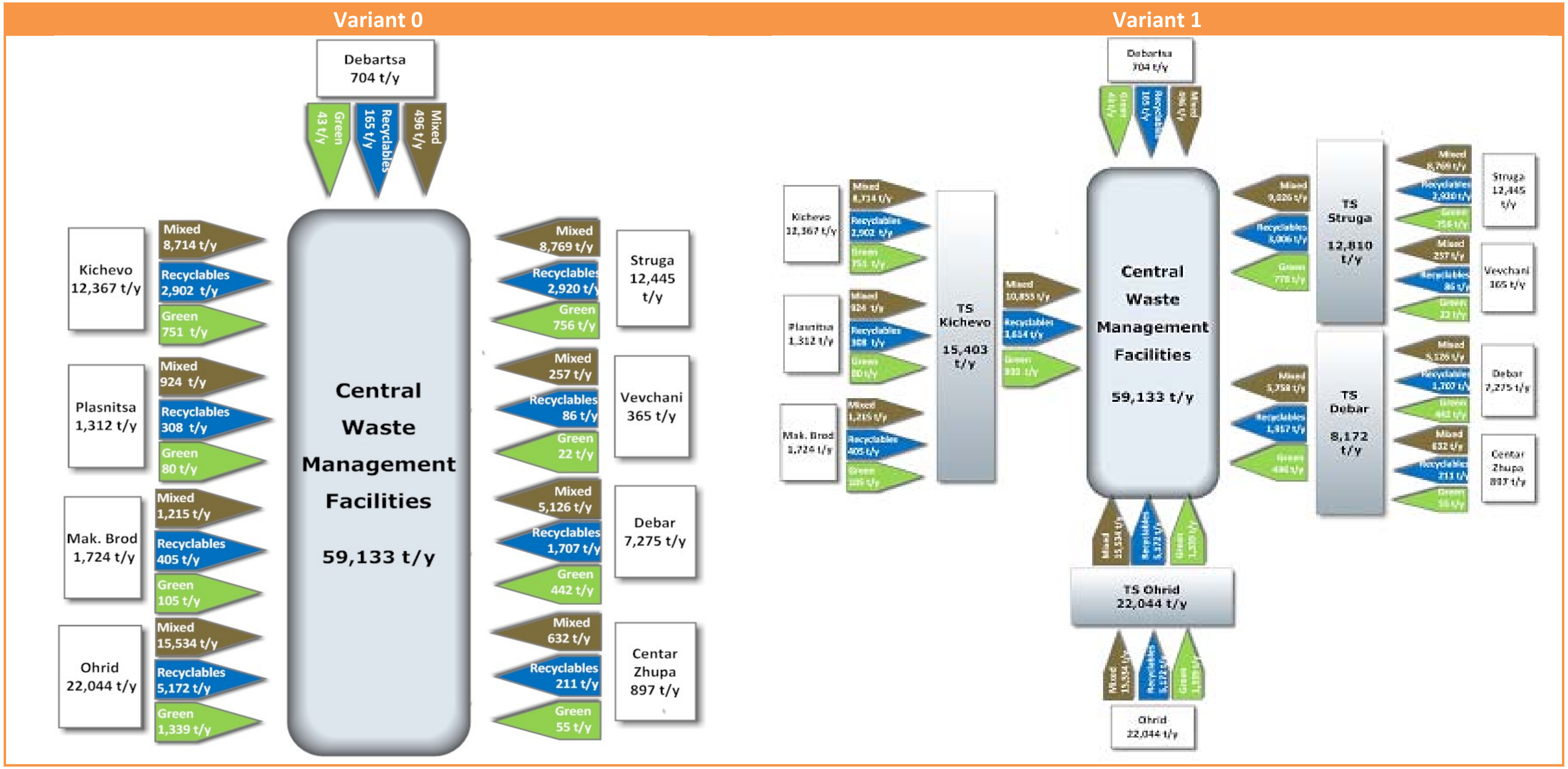
6.4.4.1 Description of options

Having determined in the previous paragraphs the transport equipment, the type / technology of TS and the number of TSs that should be constructed (justification did through Break Even Point calculations), the next step is to compare the current situation (Business as Usual) (no TSs, direct transportation to landfill with collection trucks) with the To Do Something Scenario (Variant 1). Namely, the two Variants are:

- Business as usual (Variant 0) – no TSs: Each municipality uses its own existing means i.e. waste collection vehicles, open trucks, etc. to transport the waste to the CWMC.
- Do-something (Variant 1) – four (4) TSs: at Struga, Debar, Kichevo and Ohrid, direct transportation for the municipality of Debartsa.

An overview of the waste quantities transferred according to the aforementioned variants to CWMF is presented in the following diagrammes.

Figure 6-25: Overview of alternative examined variants



For each Variant, the following Costs have been calculated:

- Investment costs (Cost for purchasing trucks (hook lift trucks and collection trucks), cost for civil works on TSs, cost for equipment of TSs, cost for transportation equipment of TSs)
- Operational costs (Cost for operating TS facilities, transportation cost of large hauling trucks, transportation cost of collection trucks for municipalities which will transfer their waste directly to CWMF)
- Levelized Unit Cost (LUC)

At this point it should be noted that in order to calculate the investment cost for the collection trucks and the operational cost derived from these trucks, the following assumptions have been taken into consideration:

- The necessary number of collection trucks for the collection and transportation of residual waste either to the TS or directly to the CWMF (it depends on the municipality) has been estimated in the base that its municipality will have its own vehicles to serve its needs and there will be no inter-municipal cooperation.
- The necessary number of collection trucks for the collection and transportation of recyclable waste either to the TS or directly to the CWMF has been estimated in the base that the municipalities can have an inter-municipal cooperation which means that the municipalities can have common trucks for the collection and transportation of recyclable waste. This cooperation will take place in the following groups: Group 1, which will include the municipalities of Struga, Vevchani, Debar and the municipality of Centar Zhupa will have the coordination and the responsibility to share the trucks in the other municipalities, Group 2, which will include the municipalities of Debartsa, Kichevo, Plasnitsa and the municipality of Makedonski Brod will have the coordination and the responsibility to share the trucks in the other municipalities and Group 3 which includes the municipality of Ohrid.
- Regarding green waste the same approach as the one that was described for recyclable waste has been applied.

6.4.4.2 Investment costs

Calculations for Variant 0

The total investment cost for collection trucks for the transportation of waste from the municipalities to CWMF estimated. The following table presents this task.

Table 6-20: Total CAPEX for necessary collection trucks per waste fraction / Variant 0 (€)

Trucks for Residual waste	Vevchani	Struga	Debar	Centar Zhupa	Kichevo	Plasnitsa	Makedonski Brod	Ohrid	Debartsa	Total
Total CAPEX (€)	79,672	464,512	464,512	0	232,256	79,672	116,128	812,896	0	2,249,648

Trucks for Recyclable waste	Ohrid	Vevchani, Debar, Struga, Centar Zhupa	Kichevo, Debartsa, Makedonski Brod, Plasnitsa	Total
Total CAPEX (€)	464,512	464,512	348,384	1,277,408

Trucks for Green waste	Ohrid	Vevchani, Debar, Struga, Centar Zhupa	Kichevo, Debartsa, Makedonski Brod, Plasnitsa	Total
Total CAPEX (€)	402,970	483,564	241,782	1,128,316

Analytical calculations are presenting in the relevant Annex.

Calculations for Variant 1

The total investment cost (Civil works, equipment and transportation equipment) for each one of the TSs is presented in the following table.

Table 6-21: Total CAPEX per TS (€)

	Ohrid TS	Struga TS	Debar TS	Kichevo TS
Total investment cost €	1,245,542	1,018,078	968,692	1,109,550

The following table presents the total investment cost concerning collection trucks for the municipalities that will transfer their waste directly to CWMF and for the municipalities that will transfer their waste to the TSs.

Table 6-22: Total CAPEX for necessary collection trucks per waste fraction / Variant 1 (€)

Trucks for Residual waste	Vevchani	Struga	Debar	Centar Zhupa	Kichevo	Plasnitsa	Makedonski Brod	Ohrid	Debartsa	Total
Total CAPEX (€)	79,672	348,384	239,016	79,672	0	79,672	159,344	464,512	0	**1,450,272**

Trucks for Recyclable waste	Ohrid	Struga, Vevchani, Debar, Centar Zhuoa	Debartsa, Kichevo, Plasnitsa, Makedonski Brod	Total
Total CAPEX (€)	232,256	232,256	232,256	**696,768**

Trucks for Green waste	Ohrid	Struga, Vevchani	Kichevo, Plasnitsa, Makedonski Brod	Total
Total CAPEX (€)	241,782	241,782	241,782	**725,346**

Summarized results

Taking into consideration all the above, the investment cost for Variant 0 and Variant 1 is presented in the following table.

Table 6-23: Total CAPEX for necessary collection trucks for Variant 0 and Variant 1 (€)

	Variant 0	Variant 1
Total CAPEX (€)	**4,655,372**	**2,872,386**

6.4.4.3 Operational costs

Calculations for Variant 0

The total operational cost for collection trucks for the transportation of waste from the municipalities to CWMF estimated. The following table presents these calculations per waste fraction.

Table 6-24: Total OPEX for necessary collection trucks per waste fraction / Variant 0 (€/y)

Trucks for Residual waste	Vevchani	Struga	Debar	Centar Zhupa	Kichevo	Plasnitsa	Makedonski Brod	Ohrid	Debartsa	Total
Total OPEX (€)	24,523	127,888	141,089	31,068	106,809	31,487	30,469	224,190	23,001	740,524

Trucks for Recyclable waste	Ohrid	Struga, Vevchani, Debar, Centar Zhuoa	Debartsa, Kichevo, Plasnitsa, Makedonski Brod	Total
Total OPEX (€)	123,929	137,129	89,808	350,866

Trucks for Green waste	Ohrid	Struga, Vevchani, Debar, Centar Zhuoa	Debartsa, Kichevo, Plasnitsa, Makedonski Brod	Total
Total OPEX (€)	131,783	164,236	80,269	**376,287**

Calculations for Variant 1

The total operational cost for each one of the TSs is presented in the following table.

Table 6-25: Total OPEX per TS (€/y)

	Ohrid TS	Struga TS	Debar TS	Kichevo TS
Total OPEX (€/y)	147,516	99,884	113,887	126,387

The following table presents the total operational cost concerning collection trucks that will transfer the waste fractions to the TSs or to the CWMF (for the municipalities that will transfer their waste directly to CWMF), is presented in the following table.

Table 6-26: Total OPEX for necessary collection trucks per waste fraction / Variant 1 (€/y)

Trucks for Residual waste	Vevchani	Struga	Debar	Centar Zhupa	Kichevo	Plasnitsa	Makedonski Brod	Ohrid	Debartsa	Total
Total OPEX (€)	19,156	63,328	58,287	20,558	68,758	24,086	46,546	86,852	23,001	**410,571**

Trucks for Recyclable waste	Ohrid	Struga, Vevchani, Debar, Centar Zhuoa	Debartsa, Kichevo, Plasnitsa, Makedonski Brod	Total
Total OPEX (€)	43,423	43,000	48,118	134,540

Trucks for Green waste	Ohrid	Struga, Vevchani, Debar, Centar Zhuoa	Debartsa, Kichevo, Plasnitsa, Makedonski Brod	Total
Total OPEX (€)	57,930	57,662	61,876	**177,468**

Summarized results

Taking into consideration all the aforementioned figures, the operational cost for Variant 0 and Variant 1 is presented in the following table.

Table 6-27: Total OPEX necessary collection trucks for Variant 0 and Variant 1 (€/y)

	Variant 0	Variant 1
Total OPEX (€/y)	**1,467,677**	**722,580**

6.4.4.4 Levelized Unit Cost (LUC)

The index of Levelized Unit Cost is an index of cost-effectiveness and it is widely used in environmental projects. It expressed in €/t and calculated by dividing the net present value of the facility's net cost flows over the reference period (including the investment and OM&A cost, net of revenues from sale of by-products such as heat, electricity and scrap metals) by the discounted quantity of waste treated in that same period, using a financial discount rate of 4%. This index is presented in the document "New Guide to cost benefit analysis of investment project' which published by European Commission, on December 2014.

Taking into account the investment costs, operating costs the waste quantities which will be transferred to CWMF for the period 2021-2046, Levelized Unit Cost (LUC) for each Variant can be determined. The following table presents an overview of LUC results for each alternative examined variant.

Table 6-28: Levelized Unit Cost per examined Variant for Southwest region

Variants	LUC (€/t)
Variant 0 (Business as Usual, no TSs will be constructed/The waste will be transported through collection trucks in CWMF)	**33.0**
Variant 1 (Do something scenario, 4 TSs will be constructed and will serve the municipalities of Vevchani, Struga, Debar, Centar Zhupa, Kichevo, Plasnitsa, Makedonski Brod and Ohrid, while the municipality of Debartsa will transport the waste directly to CWMF)	**31.4**

6.4.5 Conclusions

From the previous paragraphs, it is clear that having TS results only to advantages and benefits to the stakeholders of the project for the following reasons:

- The waste collection vehicles do not have to travel long distances up to CWMF.
- There is saving on the consumption of the fuel and the cost of the waste transport via road is minimized
- The tyre wear and other components of waste collection vehicles are minimized by avoiding long trips resulting in extended service life
- There will be less traffic at CWMF site thereby facilitating proper treatment of waste
- Less traffic in the road network since bigger volumes of waste are transferred more efficiently by dedicated mobile equipment of the TS
- More job opportunities are created for the local community
- TS locations can be used also for collection of other waste streams (i.e. WEEE, bulky, etc.).

Taking into consideration the aforementioned benefits and the needs of the present project such as travel distances and times of the waste quantities, the optimal option is to have four (4) TSs (in Struga, Debar, Kichevo and Ohrid).

6.5 Option analysis for regional waste management

6.5.1 Introduction

It is estimated that from the total quantities of municipal waste generated in Southwest Region, four waste management scenarios (including sub-scenarios) have been defined and examined.

The Regional Waste Management Plan should be cover the minimum requirements set by the national waste management legislation for packaging and packaging waste. Also should be covered a set of targets for biodegradable municipal waste (BMW) that should be diverted from landfills.

To fulfill the objectives of waste management, four main alternative waste management scenarios which include sub-scenarios have been examined and presented via a flow diagram. All proposed waste management scenarios include some common elements like (i) <u>green points</u> that will be a collection point for recyclables and wood packaging fraction, (ii) separate collection of hazardous municipal waste, (iii) separate collection of construction and demolition waste, (iv) separate collection of WEEE and (v) separate collection of other special waste streams (elastic-tires). Also all proposed scenarios include <u>separate collection of garden waste</u> and <u>sorting at source of recyclables or packaging waste</u> based on each examined scenario. Finally the proposed scenarios include a <u>collection system with the use of</u>

either 1 bin, 2 bins or 3 bins. Obviously, based on the collection system, the proposed treatment facilities (including home composting actions), are also differentiated, accordingly by the way some sub-scenarios (a, b, c) are also developed, which are involving different technologies to treat waste that are collected with the same concept (1 bin, 2 bin or 3 bin system).

The following table presents a summary of the scenarios analyzed during the elaboration of RWMP.

Table 6-29: Scenarios overview

	Scenario 1 (1 bin)			Scenario 2 (2 bins) Mixed + Biowaste	Scenario 3 (2 bins) Mixed + Recyclables			Scenario 4 (3 bins) Mixed + Recyclables + Biowaste
	1a (MBT)	**1b (MBT with AD)**	**1c (Incineration)**	**2**	**3a (MRF+ Aerobic Composting)**	**3b (MRF+ Anaerobic Digestion)**	**3c (MRF + MBS)**	**4 (MBT)**
Waste Collection	One Bin collection system			Two Bin collection system (Organic Waste Bin and Mixed Bin)	Two Bin collection system (Recyclable Waste Bin and Mixed Bin)			Three Bin collection system
Green Points	√	√	√	√	√	√	√	√
Home Composting	√	√	√	-	√	√	√	-
Mixed Bin Treatment	Mechanical Biological Treatment (MBT) with Aerobic Composting	Mechanical Biological Treatment (MBT) with Anaerobic Digestion	Incineration	MRF	MBT with aerobic composting	MBT with anaerobic digestion	MBS (Biostabilization)	Disposal to Landfill
Recyclable waste bin treatment	-	-	-	-	MRF	MRF	MRF	MRF
Organic waste bin treatment	-	-	-	Aerobic Composting	-	-	-	Aerobic Composting
Green waste treatment	Aerobic Composting	Aerobic Composting	Incineration	Aerobic Composting	Aerobic Composting	Aerobic Composting	Aerobic Composting	Aerobic Composting
Landfill	√	√	√	√	√	√	√	√

For all the aforementioned scenarios flow diagrams have been created, the targets according Law on management of packaging and packaging waste and according LoWM Article 8 for biodegradable municipal waste landfilled have been quantified and financial-economic analysis has been implemented.

Specifically, the alternative scenarios examined in relation to the minimum requirements based on national legislation according to the Law on management of packaging and packaging waste and to the Law in relation to reduction of the quantity of Biodegradable municipal waste landfilled. The table below presents the quantification of targets for all scenarios in Southwest Region.

Table 6-30: Quantification of targets for all scenarios in Southwest Region

Scenarios	Total percentage of recycling of packaging waste (2021)		Reduction of the quantity of BMW landfilled. expressed as a percentage reduction of the BMW generated in 1995	
			2021	2027
1a	56.10 %	Glass 60.16%	81.90 %	81.40%
		Plastic 47.92%		
		Paper 60.29%		
		Fe 90.49%		
		Al 90.49%		
		Wood 15.00%		
1b	56.10 %	Glass 60.16%	96.04%	95.93%
		Plastic 47.92%		
		Paper 60.29%		
		Fe 90.49%		
		Al 90.49%		
		Wood 15.00%		
1c	29.62 %	Glass 50.20%	100.00%	100.00%
		Plastic 13.20%		
		Paper 41.60%		
		Fe 36.60%		
		Al 36.60%		
		Wood 15.00%		
2	65.48%	Glass 79.83%	64.28%	74.00%
		Plastic 55.99%		
		Paper 75.47%		
		Fe 68.93%		
		Al 68.93%		
		Wood 15.00%		
3a	69.77%	Glass 68.28%	78.83%	78.25 %

Scenarios	Total percentage of recycling of packaging waste (2021)		Reduction of the quantity of BMW landfilled. expressed as a percentage reduction of the BMW generated in 1995	
			2021	2027
		Plastic 68.59%		
		Paper 70.98%		
		Fe 88.83%		
		Al 88.83%		
		Wood 15.00 %		
3b	69.77%	Glass 68.28%	91.52%	91.29%
		Plastic 68.59%		
		Paper 70.98%		
		Fe 88.83%		
		Al 88.83%		
		Wood 15.00 %		
3c	58.25%	Glass 61.54%	82.08%	81.59%
		Plastic 50.82%		
		Paper 61.54%		
		Fe 88.83%		
		Al 88.83%		
		Wood 15.00 %		
4	55.33%	Glass 61.54%	31.64%	72.10%
		Plastic 50.82%		
		Paper 61.54%		
		Fe 52.47%		
		Al 52.47%		
		Wood 15.00 %		

To conclude, Scenario 4 does not achieve the target for Biodegradable Municipal waste landfilled in 2021, and Scenario 1c does not achieve the target concerning recycling of packaging waste in 2021. All the other scenarios achieve the targets.

Financial indicators for each scenario have been calculated and are briefly presented in the table below.

Table 6-31: Financial Indicators for each waste management scenario in Southwest Region

Examined Scenarios	Total Investment Cost (million €)	Total Operational Cost (million €)	Revenues (million €)	Leveleised Unit Cost (LUC) (€/t)
Scenario 1a	21.0	2.9	0.51	71.00
Scenario 1b	25.1	1.5	1.5	65.16
Scenario 1c	55.1	7.2	2.6	129.75
Scenario 2	19.5	3.0	0.52	71.14
Scenario 3a	22.4	3.5	1.3	69.83
Scenario 3b	26.1	3.7	2.2	64.24
Scenario 3c	23.6	3.1	1.2	67.55
Scenario 4	20.5	3.1	1.1	66.21

Note: The selected scenario has been further analyzed regarding financial calculations. Conceptual design implemented, bill of quantities have been taken into consideration and the financial indicators have been recalculated.

In addition, the different waste management scenarios have been evaluated, using the PROMETHEE Multi-Criteria Analysis Method. The analysis involves three main phases, i.e. (1) the setting of criteria, (2) the weighting of criteria and (3) the ranking of alternative schemes.

The criteria were classified into four main groups (Financial, Technical, Environmental and Social-Institutional), which include individual group sub-criteria.

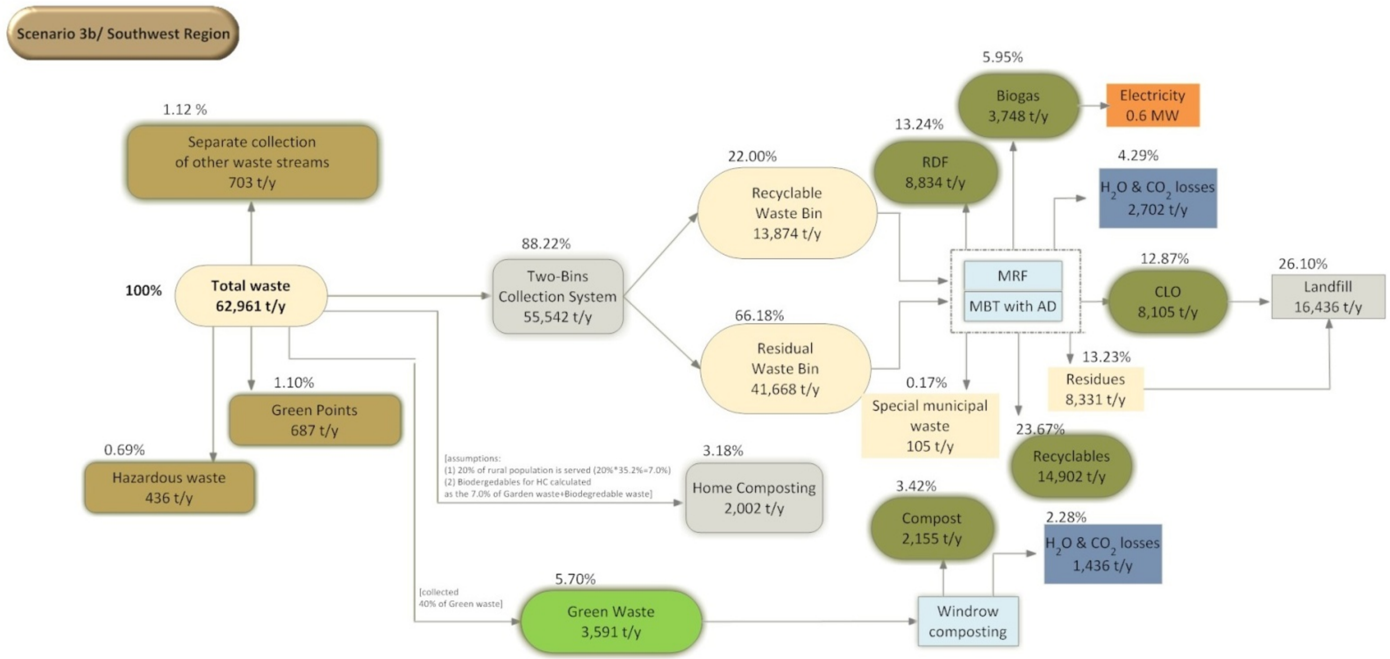
Each alternative scenario has been rated according each alternative criterion. All the criteria are benefit criteria, i.e. the higher the score, the better the performance is.

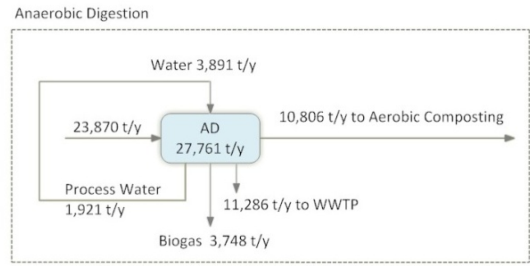
The selected scenario concerning Waste Management System in Southwest Region is Scenario 3b. The waste management system includes:

- Separate collection of recyclable materials and wood packaging fraction in green points,
- Separate collection of hazardous materials in municipal waste
- Separate collection of other waste fraction, i.e. other special waste streams (elastic-tires), WEEE and construction and demolition waste.
- Home composting actions,
- Separate collection of green waste which will be diverted to windrow composting process for the production of high quality compost.
- Recyclable waste bin which will be diverted to a Material Recovery Facility (MRF) for the recovery of recyclables (glass, paper, plastic, metals)
- Residual waste bin which will be diverted to a Mechanical Biological treatment plant (MBT) with anaerobic digestion (Biogas/Electricity production) and aerobic composting of digestate. Recyclables and RDF will be recovered from mechanical treatment of residual waste bin.
- Landfill which will accept residues from MRF/MBT and CLO.

The next figure illustrates the total waste management system which was examined and selected during the implementation of RWMP in Southwest Region:

Figure 6-26: Waste Management System in Southwest Region /Selected option in RWMP





Scenario 3b	
Collection	✓Two Bins Collection System (Recyclable Waste Bin and Residual Waste Bin) ✓Green Points ✓Separate Collection of Green waste
Treatment of Recyclable Waste Bin	✓MRF
Treatment of Residual Waste Bin	✓MBT with Anaerobic Digestion and aerobic composting of digestate
Treatment of Green Waste	✓Aerobic composting
Treatment at the Source	✓Home Composting
Products	✓Compost ✓Recyclables ✓Biogas
Landfill	✓Residues from MRF Facility and MBT

6.5.2 Project justification against scenarios Business as Usual and Do minimum

After the selection of the appropriate waste management system in Southwest Region (Scenario 3) the alternatives which will be examined in this paragraph are:

- Option 1 - Business as Usual (BaU): Collection and disposal in existing landfills and dumpsites through collection trucks. Continuation of the current situation concerning recycling.
- Option 2 - Do minimum: Collection and disposal of waste through Transfer stations and/or collection trucks in a new regional landfill, continuation of the current situation concerning recycling.
- Option 3 - Do something: Scenario 3b

Option 1-Business as Usual

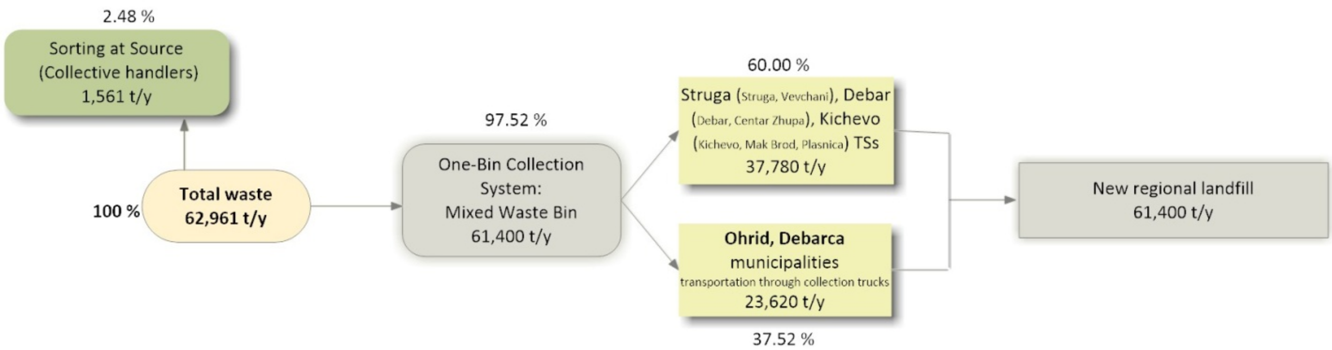
The following diagram presents the Business as Usual option for Southwest Region.

Figure 6-27: Business as Usual option

Option 2-Do minimum

The following diagram presents the Do minimum option for Southwest Region.

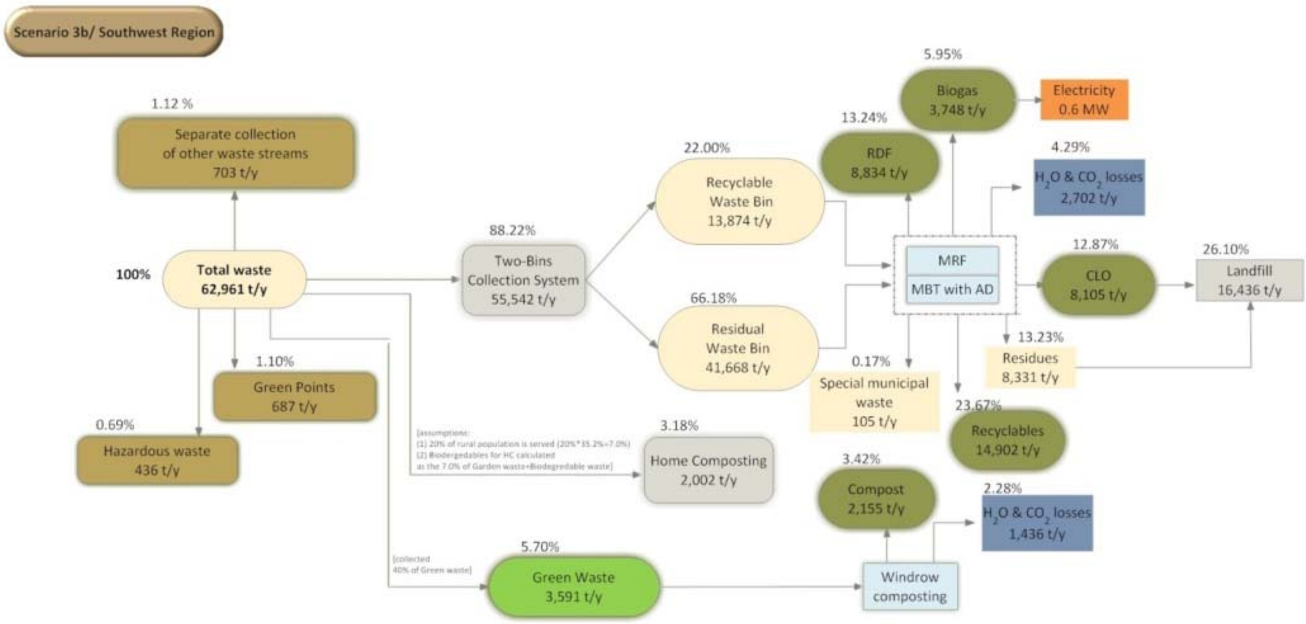
Figure 6-28: Option Do minimum



Option 3-Do something

The following diagram presents the Do something option for Southwest Region.

Figure 6-29: Do something option/Selected scenario 3b



The following table provides an overview of the total investment costs for each option.

Table 6-32: Total investment cost for each option

Investment cost (€)	Option 1: Business as Usual	Option 2: Do minimum	Option 3: Do something/Scenario 3c
Collection equipment (bins and trucks)	2,853,100	4,833,100	4,554,644
Transfer stations (Struga, Debar, Kichevo, Ohrid)	0	3,864,948	4,341,862
Composting plant	0	0	668,200
MBT/MRF	0	0	15,377,580
Landfill (A phase)	0	7,908,834	3,732,393
Total	**2,853,100**	**16,606,882**	**28,674,679**

More analytical calculations are presented in Chapter 7 and 9.

The quantification of targets concerning Business as Usual, Do minimum and Do something options according the Law on management of packaging and packaging waste and to the Law in relation to reduction of the quantity of Biodegradable municipal waste landfilled are presented in the following table.

Table 6-33: Quantification of targets for the three scenarios

Scenarios	Total percentage of recycling of packaging waste (2021)		Reduction of the quantity of BMW landfilled, expressed as a percentage reduction of the BMW generated in 1995	
			2021	2027
BaU	9.6 %	Glass 10.1%	0%	0%
		Plastic 6.3%		
		Paper 13.9%		
		Fe 10.9%		
		Al 10.9%		
		Wood 0%		
Do minimum	9.6 %	Glass 10.1%	0%	0%
		Plastic 6.3%		
		Paper 13.9%		
		Fe 10.9%		
		Al 10.9%		
		Wood 0%		
Do something (Scenario 3b)	69,8%	Glass 68.3%	91.5%	91.3%
		Plastic 68.6%		
		Paper 70.9%		
		Fe 88.8%		
		Al 88.8%		
		Wood 15.0 %		

Conclusively it is obvious that the current situation (Collection of waste, small recycling of packaging waste and disposal at landfills and dumpsites) and the do to minimum situation (construction of a new regional landfill according national and EU regulations) concerning waste management are two options which do not achieve the minimum targets that should be fulfilled. For this reason a new regional waste management system, which will include (i) construction of a new regional landfill in combination with other main facilities such as MBT/MRF and windrow composting for green waste, (ii) construction of TSs and (iii) purchasing of necessary collection trucks and bins, should be established. Although the application of the new regional waste management system required capital expenditure, this is a crucial and essential task that must be implemented as it will bring only positive effects to the community. The appropriate management of solid municipal waste will eliminate adverse impacts on the environment and human health and will support economic development and improved quality of life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

7. PROPOSED INVESTMENT PROJECT

7.1 Conceptual Design

7.1.1 Storage facilities

For the development of the two bin collection system in the project area according to the identified needs, a suitable number of bins has been determined.

The two bin collection system concerns:

- Residual waste bin which will be diverted to a Mechanical Biological treatment plant (MBT) with anaerobic digestion (Biogas/Electricity production) and aerobic composting of digestate.
- Recyclable waste bin which will be diverted to a Material Recovery Facility (MRF) for the recovery of recyclables (glass, paper, plastic, metals).

This is the collection system of the proposed scenario (Sc 3b) for Southwest Region.

After detailed calculations regarding the collection bin equipment, it was noted that the existing number of bins in some municipalities (according to data from waste questionnaires that are presented in Chapter 2, is not adequate to cover the waste collection needs of these municipalities, as well as others are too old to be functional and need to be replaced. Detailed description regarding the determination of the suitable number of collection bin equipment will be presented in Component 7 of the present Project.

The following assumptions are adopted:

- Waste generation, projections and existing collection equipment as presented in the previous chapters.
- Calculations are based on 1.1 m3 bins.
- The assumed the density of Municipal waste is 180 kg/m^3.
- The assumed frequency of collection is per day on average.
- Needs for trucks for the collection was estimated per week, taking into consideration the data provided by the municipalities (questionnaires and communication).
- A percentage of 50% of the existing bins can be utilized.
- The assumed density of recyclable materials is 120 kg/m^3.
- For municipalities that no data were available regarding the recyclable waste bins, it was assumed that there are no bins in place.

The calculations are shown in the following Tables, where bins are rounded to the upper decade.
Calculations regarding number of bins that needed to be purchased for mixed and recyclable waste that presented in the following table have been done taking into account assumptions during the implementation of the Feasibility Study. For the Cost Benefit Analysis used more detailed calculations that presented in the report 'Needs Assessement-Market Analysis-Technical Specifications' for Southwest region.

Table 7-1: Collection bins for mixed waste per municipality

Scenario 3b										
Residual waste bin (1.1 m^3 Collection Bins)										
	Vevchani	**Debar**	**Debartsa**	**Kichevo**	**Makedonski Brod**	**Ohrid**	**Plasnitsa**	**Struga**	**Centar Zhupa**	**Total**
Average Waste Generation 2021-2046, t	388	7,745	750	13,168	1,836	23,470	1,397	13,251	956	**62,961**
66.18% goes to Mixed Waste Bin										
Waste in Mixed Waste Bin (t)	257	5,126	496	8,715	1,215	15,533	925	8,769	632	**41,668**
Waste in Mixed Waste Bin (kg/d)	704	14,043	1,359	23,876	3,329	42,555	2,533	24,026	1,733	**114,158**
Daily collection (m^3/day) Density 180 kg/m^3	4	78	8	133	18	236	14	133	10	**634**
Waste Containers										
Average weekly volume (m^3)	27	546	53	929	129	1,655	99	934	67	**4,439**
Collection frequency/week	1	2	1	2	2	2	1	2	1	
Needed bin volume (m^3)	27	273	53	464	65	827	99	467	67	**2,343**
No. of 1.1 m^3 bins with 85% bin factor	29	292	57	497	69	885	105	500	72	**2,506**
No. of 1.1 m^3 bins with irregularity coefficient x1.2	35	350	68	596	83	1,062	126	600	86	**3,006**
No of weighted 1.1m^3 bins in place		157	609	317	20	385		220	14	**1,722**
No. of 1.1 m^3 bins needed to be purchased	35	272		438	73	870	126	490	79	**2,383**

Table 7-2: Collection bins for recyclables per municipality

Recyclable Waste Bin (1.1 m^3 Collection Bins)										
	Vevchani	**Debar**	**Debartsa**	**Kichevo**	**Makedonski Brod**	**Ohrid**	**Plasnitsa**	**Struga**	**Centar Zhupa**	**Total**
Average Waste Generation 2021-2046, t	388	7,745	750	13,168	1,836	23,470	1,397	13,251	956	**62,961**
22.04% goes to Recyclable Waste Bin										
Waste in Recyclable Waste Bin (t)	86	1,707	165	2,902	405	5,172	308	2,920	211	**13,874**
Waste in Recyclable Waste Bin (kg/d)	234	4,676	453	7,950	1,108	14,170	843	8,000	577	**38,011**
Daily collection (m^3/day) Density 120 kg/m^3	2	39	4	66	9	118	7	67	5	**317**
Waste Containers										
Average weekly volume (m^3)	14	273	26	464	65	827	49	467	34	**2,217**
Collection frequency/week	1	1	1	1	1	2	1	2	1	
Needed bin volume (m^3)	14	273	26	464	65	413	49	233	34	**1,571**
No. of 1.1 m^3 bins with 85% bin factor	15	292	28	496	69	442	53	250	36	**1,680**
No. of 1.1 m^3 bins with irregularity coefficient x1.2	18	350	34	595	83	530	63	299	43	**2,016**
No of weighted 1,1m^3 bins in place		29		2	8	80				**119**
No. of 1.1 m^3 bins needed to be purchased	18	336	34	594	79	490	63	299	43	**1,956**

For the estimation of quantities that will be directed to home composting process is assumed that the 20% of rural population will be served, ie 20%*35.2%=7%, and the fractions that can be used in this process are green waste and biodegradable waste. According to calculations, the total number of waste bins (capacity 0,2 m^3) that needed for all sub-scenariosfor home composting process is 3.990.

Table 7-3: Home composting bins

No of HH in Southwest Region	**56,659**
Average No of HH in rural areas	**19,948**
No of Bins for 20% of HH	**3,990**

The home composting bins will be purchased and given to the municipalities. Afterwards, the bins will be distributed to rural households under the responsibilities of municipalities upon the respective request of interested households.

The above tables, include calculations made during the implementation of the Feasibility Study of Southwest Region. During the implementation of "Need Assessments, market analyses with cost estimates and Technical Specifications (TSs) for supply of equipment for waste collection and transfer of waste for Southwest Region" Report, more detailed calculations were made. The results of these calculations are given in the following tables. These data have been take into consideration for the implementation of Cost Benefit Analysis:

Table 7-4: Results of calculations for waste bins in Southwest Region

	Number of 1.1m^3 bins (commerce & industry)	Number of 1.1m^3 bins (households)	Number of 120 lt bins (households)	1.1 m^3 bins in place	120 lt bins in place	1.1 m^3 bins to be purchased	120 lt bins to be purchased
Vevchani	0	30	0	0	0	30	0
Debar	53	258	280	51	0	260	280
Debartsa	0	0	1,234	70	250	-	984
Kichevo	64	512	1,714	118	740	458	974
Makedonski Brod	20	54	864	38	100	36	764
Ohrid	145	787	925	385	0	547	925
Plasnitsa	0	107	6	0	100	107	-
Struga	133	752	1,837	140	375	745	1,462
Centar Zhupa	0	41	633	4	28	38	606
TOTAL - SOUTHWEST	**415**	**2,541**	**7,493**	**806**	**1,593**	**2,221**	**5,995**

Municipality	Number of 1.1 m^3 bins (commerce & industry)	Number of 1.1 m^3 bins (households)	Bins in place	Bins to be purchased
Vevchani	0	30	0	30
Debar	52	273	29	296
Debartsa	0	25	0	25
Kichevo	64	567	0	631
Makedonski Brod	14	37	8	43
Ohrid	145	834	80	899
Plasnitsa	0	105	0	105
Struga	89	529	0	618
Centar Zhupa	0	57	0	57
TOTAL - SOUTHWEST	**364**	**2,457**	**117**	**2,704**

Municipality	Number of persons per household	Number of households	Home composting bins to be purchased
Vevchani	4.1	502	101
Debar	5.0	881	183
Debartsa	2.8	1,220	262

Municipality	Number of persons per household	Number of households	Home composting bins to be purchased
Kichevo	3.6	5,840	1,208
Makedonski Brod	3.0	843	196
Ohrid	3.5	2,787	573
Plasnitsa	4.0	1,018	206
Struga	4.4	4,994	1,021
Centar Zhupa	4.5	1,353	279
TOTAL - SOUTHWEST	3.9	19,438	**4,029**

7.1.2 Collection, transportation and transfer

After detailed calculations regarding the collection truck equipment, it was noted that the existing number of collection trucks in some municipalities (according to data from waste questionnaires that are presented in Chapter 2, is not adequate to cover the waste collection needs of these municipalities, as well as others are more than 8 years old, are not considered to be capable of being in service and need to be replaced. Detailed description regarding the determination of the suitable number of collection truck equipment will be presented in Component 7 of the present Project.

The number of trucks needed for the proposed waste collection system was calculated adopting the following assumptions:

- The truck capacity will be 14 m^3 for both mixed and recyclable waste.
- The truck capacity will be 6 m^3 for green waste.
- The average waste density in truck for mixed waste was considered as 0.45 t/m^3.
- The average waste density in truck for recyclable waste was considered as 0.30 t/m^3.
- The average waste density in truck for green waste was considered as 0.20 t/m^3.
- The truck utilization is considered at 85% for mixed and recyclable and green waste trucks.
- The average time for loading/unloading is considered at one hour.
- Vehicles that are in use more than eight (8) years are not considered capable of being in service.
- For the municipalities that have trucks that can be utilized, their number and capacity was taken into consideration for the calculations.

In the following tables the calculations for the extra number of trucks required per municipality are presented for the three waste streams: mixed municipal, recyclables and green waste.

Table 7-5: Required transportation equipment per municipality

Mixed Municipal Waste							
	Capacity of trucks (m^3)	Number of trucks filled per day	Total time loading/driving /unloading	Required trips per day	Number of trucks required	No. of current trucks that can be utilized	Number of extra trucks required
Centar Zhupa (Transportation to TS Debar)	6	0.9	4.0	0.9	1	0	1
Debar (Transportation to TS Debar)	6	7.2	3.2	7.2	3	0	3
Debartsa (Direct	6	0.7	3.0	0.7	1	1	0

Mixed Municipal Waste							
	Capacity of trucks (m^3)	Number of trucks filled per day	Total time loading/driving /unloading	Required trips per day	Number of trucks required	No. of current trucks that can be utilized	Number of extra trucks required
transportation to CWMF)							
Kichevo (Transportation to TS Kichevo)	14	5.2	3.7	5.2	3	3	0
Makedonski Brod (Transportation to TS Kichevo)	6	1.7	5.5	1.7	2	0	2
Ohrid (Transportation to TS Ohrid)	14	9.3	3.3	9.3	4	0	4
Plasnitsa (Transportation to TS Kichevo)	6	1.3	4.9	1.3	1	0	1
Struga (Transportation to TS Struga)	14	5.2	3.2	5.2	3	0	3
Vevchani (Transportation to TS Struga)	6	0.4	3.8	0.4	1	0	1
Total number of extra trucks required for mixed municipal waste for Southwest region							**15**

Recyclable Waste							
	Capacity of trucks (m^3)	Number of trucks filled per day	Total time loading/driving /unloading	Required trips per day	Number of trucks required	No. of current trucks that can be utilized	Number of extra trucks required
Centar Zhupa, Struga, Vevchani, Debar (Transportation to TS Debar and to TS Struga)	14	4.4	15.7	4.4	2	0	2
Debartsa, Kichevo, Plasnica, Makedonski Brod (Direct transportation to CWMF for Debartsa and transportation to TS Kichevo for the other municipalities)	14	3.4	19.6	3.4	2	0	2
Ohrid (Trasnportation to TS Ohrid)	14	4.6	3.3	4.6	2	0	2
Total number of extra trucks required for recyclable waste for Southwest region							**6**

Green Waste							
	Capacity of trucks (m^3)	Number of trucks filled per day	Total time loading/driving /unloading	Required trips per day	Number of trucks required	No. of current trucks that can be utilized	Number of extra trucks required
Centar Zhupa, Struga, Vevchani, Debar (Transportation to TS Debar and to TS Struga)	6	7.2	11.7	7.2	3	0	3
Debartsa, Kichevo, Plasnica, Makedonski Brod (Direct transportation to CWMF for Debartsa and transportation to TS Kichevo for the other municipalities)	6	5.6	15.6	5.6	3	0	3
Ohrid (Transportation to TS Ohrid)	6	7.6	2.3	7.6	3	0	3
Total number of extra trucks required for green waste for Southwest region							**9**

The above tables, include calculations made during the implementation of the Feasibility Study of Southwest Region. During the implementation of “Need Assessments, market analyses with cost estimates and Technical Specifications (TSs) for supply of equipment for waste collection and transfer of waste for Southwest Region” Report, more detailed calculations were made. The results of these calculations are given in the following tables. These data have been take into consideration for the implementation of Cost Benefit Analysis:

Table 7-6: Needs for waste transportation trucks in Southwest Region

Mixed Municipal Waste		
	Capacity of trucks (m^3)	**Number of extra trucks required**
Centar Zhupa (Transportation to TS Debar)	6	0
Debar (Transportation to TS Debar)	14	2
Debartsa (Direct transportation to CWMF)	6	0
Kichevo (Transportation to TS Kichevo)	14	1
Makedonski Brod (Transportation to TS Kichevo)	14	1
Ohrid (Transportation to TS Ohrid)	14	3
Plasnitsa (Transportation to TS Kichevo)	6	1
Struga (Transportation to TS Struga)	14	2
Vevchani (Transportation to TS Struga)	6	1
Total number of extra trucks 14 m^3 required for mixed waste for Southwest region		**9**
Total number of extra trucks 6 m^3 required for mixed waste for Southwest region		**2**

Recyclable Waste		
	Capacity of trucks (m^3)	**Number of extra trucks required**
Centar Zhupa, Struga, Vevchani, Debar (Transportation to TS Debar and to TS Struga)	14	3
Debartsa, Kichevo, Plasnica, Makedonski Brod (Direct transportation to CWMF for Debartsa and transportation to TS Kichevo for the other municipalities)	14	2
Ohrid (Trasnportation to TS Ohrid)	14	2
Total number of extra trucks required for recyclable waste for Southwest region		**7**

Green Waste		
	Capacity of trucks (m^3)	**Number of extra trucks required**
Centar Zhupa, Struga, Vevchani, Debar (Transportation to TS Debar and to TS Struga)	6	4
Debartsa, Kichevo, Plasnica, Makedonski Brod (Direct transportation to CWMF for Debartsa and transportation to TS Kichevo for the other municipalities)	6	3
Ohrid (Trasnportation to TS Ohrid)	6	3
Total number of extra trucks required for green waste for Southwest region		**10**

7.1.2.1 The TS sites and their characteristics

For the municipalities that don't transfer their municipal waste directly to the CWMF, the collection trucks will transfer the waste to the Transfer Station that servers them. The transportation of waste to the Transfer Stations will minimize the routes to CWMF resulting in positive environmental and financial impacts.

The maximum numbers of Transfer Stations that can be constructed in Southwest Region are four (4):

- Struga
- Debar
- Kichevo
- Ohrid

Transfer Technology

The method used to handle waste at the transfer station from the time it is unloaded by collection vehicles until it leaves the site is central to any transfer station's design.

In the previous chapter, Chapter 6, the sites as well as the technologies selected for the fourTS of the region are described. The waste streams that will be transferred through the transfer stations are mixed residual waste, recyclable waste and green waste.

Transfer Stations include:

- Entrance control and fencing
- Weighbridge with data recorder
- Access roads
- Administration building
- Parking area
- Surrounding planting
- Discharge hoppers

- Electrical installation
- Hydraulic installations
- Storm water protection works
- Press containers
- Green waste container
- Bulky waste

Main entrance and fencing

The perimeter of the Transfer Station area will be protected via a fence that will provide protection against access by unauthorized persons and animals. It will be made of galvanized iron ducts of 5 cm, with 2.50 m height, which will be encased in a concrete basis below the ground. The edges of the ducts will be connected with prickle wire net, which will be installed in 2 rows. A rhomboid wire net with loops will be used to restrict the trespassing of rodents. The distance between the ducts will be 3 m, and every 6 m iron struts of the same diameter as the ducts will be placed.
The entrance gate consists of two doors with 4 m length and 2.5 m height each. The entrance doors will automatically open. The doors will be coated with wire net and be secured with a lock. A sign board shall be placed at the entrance to allow easy identification.

Weighbridge

The accurate and systematic recording of incoming waste is an important monitoring element. Thus a fully electronic weighbridge will be installed in each TS. All incoming vehicles must be weighedbefore unloading the waste. The specific type and its dimensions will be defined during the elaboration of detailed design. The Weighbridge shall be in accordance with the specifications below:

- Weighbridge capacity: 60 tons with maximum intervals of 20 kg
- Size approximately 18 x 3m

Internal roads

Transfer stations typically include roadways for vehicles. Transfer trucks for long distance hauling need wide roadways with gradual slopes and curves to maneuver efficiently and safely. Also, the site will need space for parking transfer vehicles and to allow incoming and outgoing traffic to form lines without backing up onto public roads.

The transfer stations will have two levels (loading area level and unloading area level) and so there is the need to have vehicle access. Completely flat sites need ramps, constructed to allow vehicle access to upper level (or areas excavated to allow access to lower level).

The alignment of the internal roads serves the Collection Trucks to the upper level and the hook lift trucks to the lower level. The design speed is estimated Ve= 30km/h.
There will be two internal roads. One to serve the access of the hook lift trucks (long distance hauling trucks) to the lower level for loading the press containers and the other to serve the waste collection trucks to the upper lever for waste unloading. The internal roads will be paved and are designed for one lane per direction, 8.0 meters width in total.
Curves and intersections in or near the transfer station site need large turning radius to enable turns of the trucks. Due to site restrictions, the smallest horizontal curve is 15 meters which is acceptable due to low travelling speeds.

Slopes on ramps should be limited to less than 8 percent, particularly for fully loaded transfer trucks. The maximum slope used is 8.0%. The proposed cross slope at straight sections of both roads is 2.5% which is acceptable due to low travelling speeds. In curved sections the cross slopes will be maximum 5%.

Driving surfaces will be paved to minimize dust generation. The proposed pavement as follows:

- 4 cm of high density asphalt mixture
- 8 cm of low density asphalt mixture
- 10 cm of Foundation layer
- 20 cm of Sub-base layer

In order to protect the drivers and pedestrians signing and striping of roads is mandatory:

- Dashed white stripe 12 cm wide for internal marking
- Continuing white stripe 12 cm wide for external marking
- 30 cm wide white line for Stop Lines

Road signing:

Administration building

This building serves the administration staff and stores the necessary equipment for monitoring, recording the incoming waste, and weighing the incoming vehicles. Each TS will have an administration building of approx. 60 m^2, one-storey, rectangular shape located opposite to the weighting area, which will includes:

- Main Entrance
- Weighbridge Control Office
- Office
- Kitchen
- Changing rooms, shower area and WC
- Medical assistance area

Parking area

The vehicles of the employees and visitors of the TS will be parked in an open parking opposite to the administrative building. Four parking position will available with dimensions of 2.5 X 5.0 m each.

Surrounding planting

For a protective zone of greenery, trees will be planted lengthways of the fence in the TS area if possible, in all around the perimeter zone. The trees must be suitable for the local climate and will be used for minimizing the visible impact. An irrigation channel will provide the potable water necessary for the plants, which is connected with the water tank.

Metallic hoppers

The selected type of transfer station is direct discharge transfer station with mobile compaction.
Waste is discharged, through a metallic hopper, directly into the upper side hatch of the press container, which once it reaches its full capacity it will be transported to CWMF with the hook lift truck..
The hopper must have in the upper part adequate opening so that the waste collection vehicles will be able to discharge the collected waste.

In its lower part the hopper must fit to the opening of the mobile compactor so that no waste will be falling outside of the mobile compactor during the transferring procedure.
The hopper will be robust metal construction, easy to assemble and disassemble it. The main body is split into two sections and perimeter screens will be all removable and variable height depending on the circumstances and requirements.
It is made of steel and the support will be at ground level with concrete beams and columns. In order to avoid garbage dispersion, due to winds, the hoppers have a metal tube structure above.

Electrical installations (lighting, electricity, phone)
The plant shall be electrically connected to the Medium Voltage (MV) electricity network of the area. It is foreseen that MV electrical supply has been provided from public electrical network up to the entrance of transfer station. Scope of the pricing is started from that point.

Hydraulic installations
<u>Service water supply system</u>
A small water pumping set (SWPS), fed by the water tank, will be installed ensuring the supply of water to all premises. Water flow velocities in pipes shall be maintained between 1.5 to 3.0 m/s.
Potable water will be supplied to the administration building by installing autonomous 20 lt mineral potable water coolers.

<u>Water tank</u>
To supply the water booster set with water, a dedicated 15m^3 water tank will be provided. The tank will be made of HDPE.

<u>Water piping network</u>
The piping network will be constructed with 8 bar nominal pressure HDPE piping according to EN 12201-2 with SDR 21, capable of withstanding 50% pressure above maximum.

<u>Sewage system</u>
Internal sewage system will be constructed, according to local regulations, via gravitational flow pipes to the main sewage tank.

Sewage design criteria:
Concerning the hydraulic design in general, the EN 752 standards are applied and the following design criteria are used for the needs of the sewage plan:
Manholes are provided at the following locations:
- at every direction change, level or slope
- at the junction of two or more pipes
- at the end of horizontal waste pipe before connected to the main sewerage
- and at maximum distance of 80m on straight sections of pipe work

Absolute minimum flow velocity in sewage pipes:
- 0.8m/s (fluid flow up to 15 lit/sec)
- 1.0m/s (fluid flow more than 15 lit/sec)

(According to EN 752 for small diameter drains and sewers (less than DN 300) self-cleansing can generally be achieved by ensuring either that a velocity of at least 0.7 m/s occurs daily, or that a gradient of at least 1:DN is specified.)
Maximum flow velocity in sewage pipes under the peak flow should be limited to:
- 1.5m/s (for flow 2.5-15 lit/sec)
- 1.75 (for flow 15-100 lit/sec)
- 2m/s (for flow 100-500 lit/sec)

Maximum depth of flow should be between 50% - 70% of pipe diameter under the peak flow (for safety reason the limit has been chosen to be up to 50%). Wastewater network shall be constructed taking into account local guidelines and regulations from the authorities.

<u>Sewage tank & other elements:</u>
The manholes that shall be used are pre-cast HDPE manholes. The manhole design will be according to EN 752 recommended dimensions for the construction of new manholes with personnel entry. For manholes located in sag locations where ponding will occur or low areas subject to inundation, an inflow allowance of 0.4 liters/sec shall be made for each manhole.
The type of pipes that should be used to sewage network system is u-PVC pipes according to EN 1401/S41 series while the alternative HDPE pipes PN10 are also accepted. All sanitary sewers should be designed with a minimum slope of 0.4% or greater.
All sewage effluent shall be conducted to the sewage tank, fabricated from HDPE.

Storm water protection works
Overall design of flood protection works

The main aims of the construction of flood protection works are the following:
- To avoid the inflow of storm water in the sites and in this way protect its structural stability
- To protect the buildings and the roads of the sites from storm water erosion
- To protect the smooth functioning of the sites in the event of heavy rainfall.

The flood protection works of the sites consist of the following:
Storm water drainage system consisting of triangular ditches on the side of the roads, trapezoidal or rectangular ditches, wells, manholes which collect the storm water from the plateau of the buildings and lead them with safety. This system collects the storm water from the areas inside the borders of the site.

It should be noted here that crucial element of the flood protection system is the slope free surfaces of the ground inside the site: all the surfaces must be sloped towards the nearest ditch in order to prevent the retention of water in hollows of the ground. The slope of the free surfaces must be at least 0.4% with the directions shown in the general layouts of flood protection works.

Hydrology
The main aims of this section are the following:
- To avoid the inflow of storm water in the transfer stations and in this way protect its structural stability
- To avoid the inflow of storm water in the transfer stations and in this way reduce the leachate production
- To protect the buildings and the roads of the site from storm water erosion

Runoff estimation method
The hydrological calculations will be for a return period of 20 years. A safety factor was also adopted for the maximum discharge that the ditches can convey. The ditches are dimensioned in order the height y of the flow during the design storm divided by the total height of the ditch h must be below 0.80, i.e. $y/h < 0.80$.

The calculation of the runoff was made using the rational method:

$$Q= 0.000278 \times c \times i \times A \text{ (lt/sec)}$$

where:
c: runoff coefficient
i: rainfall intensity in the time of concentration (mm/hr)

A: area of catchments basin (m^2)

Runoff coefficient
For the runoff estimation of the roads, the runoff coefficient is equal to 0.90 based on the international literature on the particular subject.

Finally the runoff coefficient of the external catchment areas was calculated using the following formula (Mamassis 2008, Koutsogiannis and Xanthopoulos 1996):
C = 1 - C’1 - C’2 - C’3
The parameters presented above are for region characterized by average slope, saturated soil and sparse vegetation.

Ditch design – Hydraulic calculations
For the dimensioning of the ditches the Manning formula is used assuming that the continuity assumption is valid

$$Q = A \times V \ (m^3/s)$$
$$V = (1/n) \times R^{2/3} \times S^{1/2}$$

where:
Q = discharge (m^3/s)
A = “wet” area (m^2)
V = velocity (m/s)
(n) = manning coefficient
R = hydraulic radius (m)
S = slope
More specifically the calculations will be with the use of STONET, DRAINET software of ENCOSOFT, for pipes and open channels. The mathematical model of this program is based on the continuity equation and on Manning formula.

Fire Protection
Since there will be no storing of municipal waste at the TS (except for the containers for bulky waste), there is no need for hydrant protection. The possibility for fire spreading out is minimal and unrestricted access of fire fighting vehicles is possible.
Truck and tractors arriving and leaving the TS already have fire protection (fire extinguishers).

Equipment:
Press containers
Hydraulic steel press containers of 24 m^3 capacity will serve the purpose of compressing the residual mixed waste and the recyclable waste, reducing significantly their volume, which results to reduced transportation costs, but has also positive environmental impact.
The press containers generally consist of the filling chamber, the pressure chamber, the back hatch, the drive assembly chamber, the electric-control panel, the emergency tank for liquids, the hydraulic cylinders, observation glass.

Skid Steer Loader
There will be a skid steer loader available in each TS, for various tasks, mainly for assisting the loading of green waste.

Bulky waste container
A container will be in place at the TS in order to gather bulky items that are either found in the collection vehicles or delivered to the TS by citizens. Full containers of bulky waste are transported to the CWMF.

The following Table presents the required civil works for the TSs.

Table 7-7:Required number of civil works per TS

Cost Category	Debar	Struga	Kichevo	Ohrid
Fence	x	x	x	x
Entrance gate	x	x	x	x
Plateau and roads	x	x	x	x
Administration building	60 m^2	60 m^2	60 m^2	60 m^2
Water supply	x	x	x	x
Sewerage system	x	x	x	x
Electrical installations (lighting, electricity, phone)	x	x	x	x
Hopper	2	2	2	2
Landscaping	x	x	x	x

The following Table presents the required mobile equipment for TS.

Table 7-8: Required number of equipment per TS

Equipment	Debar	Struga	Kichevo	Ohrid
Weighbridge	1	1	1	1
Press containers 24 m^3 (for mixed waste)	3	3	4	5
Press containers 24 m^3 (for recyclable waste)	2	2	2	3
Containers 24 m^3 (for green waste)	1	1	1	2
Skid Steer Loader	1	1	1	1
Truck with hook lift	2	1	2	2
Skip for bulky waste	1	1	1	1

7.1.2.2 Description of TS operating routines

The **basic operating procedure** in each Transfer Station is as follows:
The collection trucks, coming from each municipality, enter the TS through the gate and are directed to the weighing area. Then, after the weight measurements, they continue along the paved road to the waste unloading area. The waste collection trucks after appropriate manoeuvres will unload the waste into the appropriate hopper into press containers with capacity of 24 m^3 in order to be compressed. There will be two hoppers in each TS, one for each separate waste stream, mixed residual waste and recyclable waste. When the containers reach their full capacity with the compacted waste, they are then hook lifted onto the truck (for long-distance hauling) and further transported to the CWMF. The total time for unloading and loading of waste is calculated to approximately 45 minutes.

Regarding the green waste stream, it will be transferred in to open containers with capacity of 24 m^3located in the TS area without compaction and then transferred to CWMF with hook lift trucks (for long-distance hauling).

After unloading is completed, the waste collection trucks are leaving the TS premises via the internal road network.

The Transfer Station facilities will work only in daytime, for 312 days per year.

Essential for the **proper function** of the unit is to perform a series of works related to the proper operation and maintenance of all the facilities that make up the unit. Especially the operations and maintenance of facilities include:
a) Maintenance of road.
b) Cleaning of storm water ditches and other storm water management works.
c) Clean the internal road.
d) Maintenance of green areas – irrigation.
e) Maintenance of equipment.
f) Operation - checking and tuning of the facilities at transfer station.

Environmental monitoring works
In order to achieve environmentally acceptable operation of the unit based, it is necessary to perform a series of works related to monitoring - recording and evaluation of a series of parameters related to the main environmental impacts generated by the units. In particular, the environmental works to be performed and the corresponding parameters to be monitored are the following:
a) Checking- monitoring and recording quantity of incoming waste
b) Checking and monitoring proper functioning of entire system and individual sections
c) Recording and processing of meteorological data (optional)

The **Health and Safety measures** are divided into two categories:
a) General safety and hygiene measures that apply in general for industrial facilities or construction sites and waste management projects
b) Specific measures associated with the equipment and functions of TS

The obtained measures of general health and safety work, including the following:
- Training of health and safety regulations (Personnel, users, visitors, etc)
- Provide all necessary means of protection, labour safety and hygiene (filter masks, overalls, boots, booties work gloves operators, protective helmets, reflective vests high definition, reflective waterproof and windproof jacket of high definition, goggles, earplugs, first aid box, stretcher, etc.)
- General safety provisions are required (railings, etc.)
- Personnel training

Regarding the specific security measures associated with equipment and functions of the TS, these consist mainly of the following:
- Protective bar hopper tailings
- All means of protection and automation included in self compacting containers, container rotation system and other durable equipment installation
- All means of protection and automation included in mobile equipment.

Responding to emergencies
The most common emergencies and how to deal with them are:
a) Turn out of large quantities of waste: With spare containers the possible problem is overcome. In the worst case scenario, overtime work will be required by the driver of the transhipment container vehicle.
b) Fire: all appropriate fire protection measures have been taken.
c) Jam of material in the hopper: device is offered with hydraulic release system.
d) Failure of machine: spare parts for emergency incidents are provided. In more serious incidents, the most direct possible damage restoration will be carried out. It is important to notice that under normal maintenance, no damage of the units is expected to occur.

e) Interventions by unauthorized persons: the site will be guarded all the days and hours and therefore no unauthorized persons can enter the TS.

7.1.2.2.1 Staffing

The proper function of a Transfer Station requires the following tasks to be performed on a daily basis:

- Checking– weighing of incoming waste, particularly
  - Weigh and record weight of all incoming waste.
  - Admission check or not of suspected waste loads to rejection.
  - Updated data on daily - weekly - monthly traffic of vehicles and their waste loads entering the facility.
- Transshipment of waste via the press container.
- Daily transportation from the TS facilities to disposal site (CWMF of the region)
- General works operation and maintenance of facilities

The transportation of waste in TS will take place for 312 days per year, and the schedule will be adjusted to transport arrival times of incoming waste, so the unit is operating seamlessly and smoothly.
For all aforementioned works the required personnel analyzed as follows:

Table 7-9: Personnel requirements for TS

Position title	*Indicative number of personnel*			
	Ohrid TS	**Struga TS**	**Debar TS**	**Kichevo TS**
1. Operations manager	1*			
2. Weighbridge operator	1	1	1	1
3. General tasks workers	1	1	1	1
4. Hook- lift truck drivers	4	2	2	4

* Regarding the Operations Manager position, it will be covered by one (1) person who will have under his responsibility the Operation of all four Transfer Stations in Southwest Region.

The main tasks of the aforementioned personnel are given below:

a) Operations Manager of the TS, responsible for the overall smooth operation of the TS.
b) Weighing operator: guarding of the unit and weighing of waste within the TS and data recording while performing general duties of organization /cleaning / maintenance.
c) General task workers: responsible for supervising the waste transshipment and performing general duties of organization /cleaning / maintenance.
b) Drivers: for transporting waste from the transfer station to the disposal site (CWMF of the region)

Figure 7-1: General layout of Kichevo TS

Figure 7-2: General layout of Struga TS

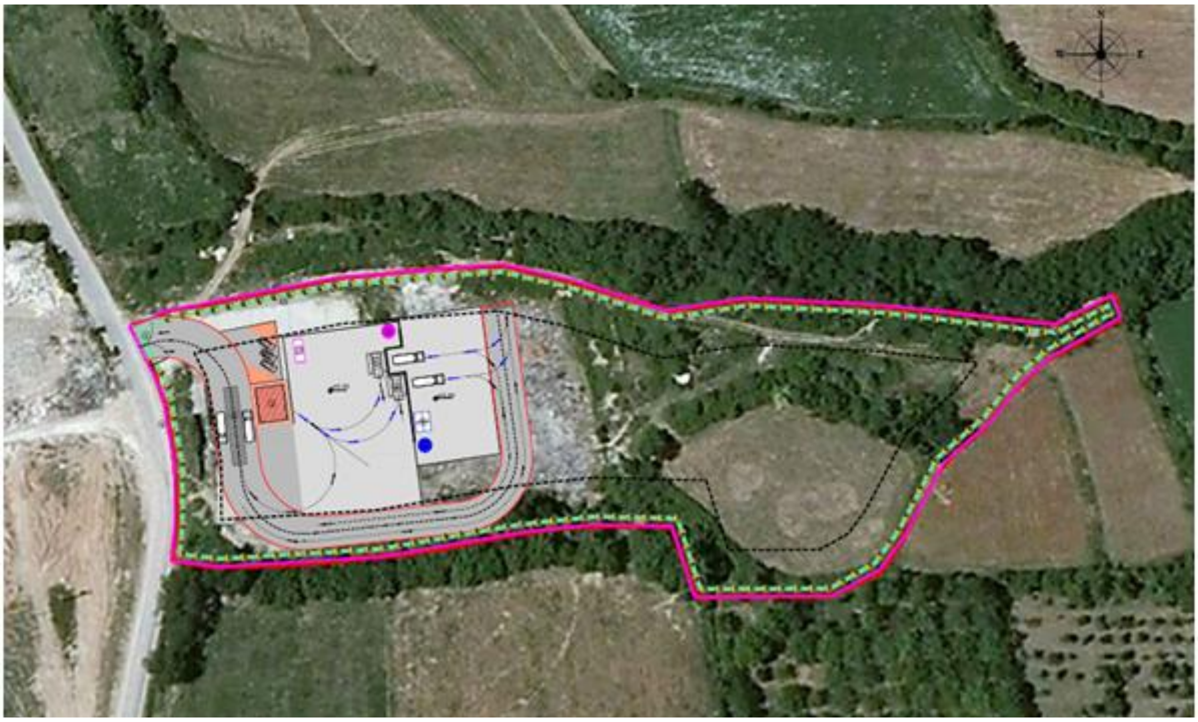


Figure 7-3: General layout of Debar TS

Figure 7-4: General layout of Ohrid TS

LEGEND	
1	ENTRANCE-GATE
2	HOPPER
3	ADMINISTRATIVE AND STAFF BUILDING
4	WEIGHBRIDGE
5	PARKING
6	BULKY WASTE
7	WATER TANK HDPE
8	WASTEWATER COLLECTION TANK HDPE
9	FENCE
10	GREEN WASTE CONTAINER
	CONCRETE - PAVING
	ASPHALT - PAVING
	PEDESTRIANS - PAVING
	NOTE: LEVEL ELEVATIONS ARE RELATIVE

Figure 7-5: Legend of the General layout of the TSs

7.1.3 Analysis of existing dumpsites and non compliant landfills

7.1.3.1 Introduction

Under the scope of the current project, took place, among other activities, a **landfills and dumpsites survey** for the four regions of the Republic of Macedonia (Vardar, Pelagonija, Skopje and Southwest) in order to perform risk screening procedure and define optimal remediation and closure approach.
Hereinafter, we will present the implemented methodology and the results of the landfills and dumpsites survey in terms of risk analysis, as well as the closure and rehabilitation approach based on national legal requirements, best international engineering practice and current local work pricing conditions.

Landfills and dumpsites survey is a combination of extensive desktop study and field investigation data analysis, following strict protocols for data collection and analysis.

- **Desktop study** includes the latest data available from official sources, including State Statistical Office, MoEPP and other governmental agencies and bodies.
- **Field investigations**are based on strict protocols, involving geological reconnaissance, geo referencing and measurement, performed according to pre-developed data collection guideline, by specialized and experienced staff with geotechnical background. Risk analysis is performed according to modified **Risk Screening System** (RSS) based on original **Rapid Hazard Assessment System** (RHAS) and **Canadian Classification System for Contaminated Sites** (CCME, 1992). The methodology used was selected as most appropriate from a list given in the EEA document "Review and analysis of existing methodologies for preliminary risk assessment".
- **Closure and rehabilitation** approach selection and costs estimation were based on national legal requirements, best international engineering practice and current local work pricing conditions.

The first step in the process is the identification of all landfills and dumpsites within the project area. This was performed through direct collaboration with local authorities. During the site visits, all additional sites noted were also visited and added to the landfills and dumpsites inventory.

Moreover, data for landfills closed in the last 20 years were collected in order to be included in future closure and remediation programs.

Additional information was gathered regarding the local conditions, including: climate, geological and hydrogeological settings, hydrology, land cover and usage, sensitive areas, demographic data.

Site visits were undertaken in all the identified Waste Disposal Facilities (WDFs), according to strict standards and included but were not limited to:

- geological reconnaissance and mapping (GPS survey, photo and geo-referencing data)
- identification of disposal methods and composition of disposed waste
- identification of sensitive receptors (settlements, agricultural land or other usage, surface and underground waters, sensitive habitats etc.)

An elaborated data collection template was developed and a comprehensive data file for each site visited was generated. All data collected were analyzed and organized according to the requirements of the risk screening methodology adopted (RSS) and a WDF inventory was prepared.
The WDF inventory was created as a result of the conducted survey, and included all technical and environmental information regarding:

- risk assessment for all waste facilities identified, according to uniform methodology;
- risk ranking and prioritization by various criteria of waste facilities identified;
- selection of closure and remediation operations

Data about WDFs (non-compliant landfills and dumpsites), technical information for them and risk assessment results, concerning the Southwest region, are given in the following paragraphs.

7.1.3.2 Waste Disposal Facilities (WDFs) in Southwest Region

As approved by the TOR, in total 9 municipalities are included in Southwest Region: Kichevo, Ohrid, Debar, Struga, Debartsa, Makedonski Brod, Plasnitsa, Centar Zhupa and Vevchani.Seven of them (Debar, Kichevo, Makedonski Brod, Ohrid, Plasnitsa, Struga and Centar Zhupa) manage at least one MSW landfill, and after screening and data collection process, following conclusion could be drafted:

- All of the municipalities have operational waste collection and handling systems, but none of them have system for separate waste collection and as mixed as is waste is disposed.
- Waste composition is closely related to settlements type (urban or rural) and population size, and although mixed MSW is dominant, biodegradable waste, construction and demolition and in some cases hazardous industrial and medical waste are disposed.
- Capping is performed only on 3landfills (Kichevo, Struga and Centar Zhupa) and in other cases translocation of contaminants with wind or water erosion is evident.
- None of the existing landfills has drainage collection systems for leachate or drainage waters.

Therefore, all of the MSW landfills identified are accounted as non-compliant MSW landfills.

Table 7-10: Non-compliant MSW landfills in Southwest Region

ID No	Municipality	City/Village	Coordinates	
			X	Y
RALL 001	Makedonski Brod	Makedonski Brod	41°30’31.30”	21°16’ 34.9”
RALL 002	Plasnitsa	Plasnitsa	41°27’44.9”	21°04’52.4”
RALL 003	Kichevo	Kichevo	41°34’22.7”	20°59’38.5”
RALL 004	Ohrid	Ohrid	41°10’21.50”	20°57’28.4”

ID No	Municipality	City/Village	Coordinates	
			X	Y
RALL 005	Ohrid	Ohrid	41°08'20.8"	20°46'15.7"
RALL 006	Struga	Struga	41°11'25.1"	20°40'06.3"
RALL 007	Debar	Debar	41°32'22.43"	20°30'58.52"
RALL 008	Centar Zhupa	Pareshi	41°29'51.10"	20°32'52.94"

Only Struga municipality has reported recently (in last 20 years) two closed non-compliant MSW landfills, which were taken into consideration in order to include them in future remediation/closure plans as the cost associated with such activities could be significant.

Table 7-11: Closed non-compliant landfills in Southwest Region

ID No	Municipalit y	City/Village	Coordinates	
			X	Y
RALLC001	Struga	Struga	41°10'34.5"	20°39'40.6"
RALLC002	Struga	Kjafasan	41°06'19.7"	20°36'57.5"

In addition, small uncontrolled landfills or so called "dumpsites" constructed without any engineering or other control measures for environmental protection were identified in all of the municipalities involved. The dumpsites are usually created in areas where no organized waste collection services are available or unknown perpetrators trying to avoid disposal costs. Although small in size (area and volume) due to different types of wastes sometimes including biological waste, chemicals or even industrial wastes they can pose great risks to surrounding environment. In total 85 dumpsites were identified in the Southwest Region.

Table 7-12: Dumpsites in Southwest Region

ID No	Municipality	City/Village	Coordinates	
			X	Y
RAIL 001	M. Brod	M. Brod	41°30'48.4"	21°13' 45.4"
RAIL 002	M. Brod	Trebino	41°31'25.1"	21°12'43.2"
RAIL 003	M. Brod	Trebino	41°31'40.5"	21°13' 03.3"
RAIL 004	M. Brod	Suvodol	41°31'09.1"	21°14' 18.4"
RAIL 005	Plasnitsa	Plasnitsa	41°28'22.8"	21°07' 17.1"
RAIL 006	Plasnitsa	Plasnitsa	41°28'07.1"	21°07' 03.9"
RAIL 007	Plasnitsa	Plasnitsa	41°28'19.3"	21°05' 57.9"
RAIL 008	Plasnitsa	Plasnitsa	41°28'28.9"	21°04' 57.2"
RAIL 009	Ohrid	Kosel	41°10'31.6"	20°50'16.6"
RAIL 010	Ohrid	Kosel	41°10'28.8"	20°51'35.3"
RAIL 011	Ohrid	Ohrid	41°07'29"	20°46'33.3"
RAIL 012	Ohrid	Ohrid	41°07'23.1"	20°46'28.2"
RAIL 013	Ohrid	Ohrid	41°09'11.6"	20°45'11.14"
RAIL 014	Ohrid	Ohrid	41°07'59.9"	20°45'55.5"
RAIL 015	Ohrid	Ohrid	41°07'47.161"	20°46'07.064"
RAIL 016	Ohrid	Ohrid	41°07'27.9"	20°46'49.3"
RAIL 017	Ohrid	Ohrid	41°06'36.4"	20°49'07"
RAIL 018	Debartsa	Botun	41°16'13.6"	20°46'45.7"
RAIL 019	Debartsa	-	41°16'37.5"	20°46'56.9"
RAIL 020	Debartsa	Belchishta	41°18'32.3"	20°50'05.9"
RAIL 021	Debartsa	Leshani	41°16'36.96"	20°52'40.6"
RAIL 022	Debartsa	Mesheishta	41°14'27.4"	20°45'50.8"
RAIL 023	Debartsa	Volino	41°12'57.1"	20°44'48.7"
RAIL 024	Debartsa	Trebenishta	41°12'29.1"	20°45'58.6"
RAIL 025	Debartsa	Orovnik	41°10'11.5"	20°44'55"

ID No	Municipality	City/Village	Coordinates	
			X	Y
RAIL 026	Struga	Struga	40°10'04.86"	20°43'32.7"
RAIL 027	Struga	Struga	40°10'25.34"	20°42'32.1"
RAIL 028	Struga	Struga	40°10'37.44"	20°41'18.5"
RAIL 029	Struga	Struga	40°10'19.039"	20°39'51.5"
RAIL 030	Struga	Kalishta	40°09'47.1"	20°39'02.8"
RAIL 031	Struga	Kalishta	40°09'30"	20°39'01.5"
RAIL 032	Struga	Kalishta	40°09'21.4"	20°39'01.3"
RAIL 033	Struga	Struga	40°08'31.5"	20°39'01.5"
RAIL 034	Struga	Struga	41°10'32.5"	20°38'40.3"
RAIL 035	Struga	Struga	41°10'51.5"	20°39'56"
RAIL 036	Kichevo	Kichevo	41°29'41.23"	20°57'45.88"
RAIL 037	Kichevo	Kichevo	41°29'50.13"	20°57'44.30"
RAIL 038	Kichevo	Kichevo	41°30'29.33"	20°57'50.82"
RAIL 039	Kichevo	Kichevo	41°30'14.45"	20°56'39.79"
RAIL 040	Kichevo	Kichevo	41°30'32.56"	20°56'49.66"
RAIL 041	Kichevo	Kichevo	41°31'06.42" 41°30'58.53" 41°30'52.95" 41°30'49.48" 41°30'40.49"	20°57'03.06" 20°57'01.04" 20°56'59.30" 20°56'58.56" 20°56'56.47"
RAIL 042	Kichevo	Kichevo	41°31'15.50"	20°56'54.56"
RAIL 043	Kichevo	Kichevo	41°31'07.17" 41°31'03.87"	20°57'17.11" 20°57'24.04"
RAIL 044	Kichevo	Kichevo	41°30'50.11"	20°58'01.77"
RAIL 045	Kichevo	s.Crvica	41°33'04.37"	20°59'41.62"
RAIL 046	Kichevo	Oslomej	41°33'42.02"	20°59'27.16"
RAIL 047	Kichevo	Oslomej	41°33'48.99"	20°59'22.31"
RAIL 048	Kichevo	Oslomej	41°34'27.17" do 41°34'23.58"	20°59'54.07" do 20°59'34.90"
RAIL 049	Kichevo	Oslomej	41°34'10.26"	20°59'19.18"
RAIL 050	Kichevo	Drugovo	41°29'44.79"	20°56'40.65"
RAIL 051	Kichevo	Drugovo	41°29'30.45"	20°56'22.34"
RAIL 052	Kichevo	Drugovo	41°28'46.62"	20°55'06.65"
RAIL 053	Debar	Debar	41°31'06.71"	20°31'10.87"
RAIL 054	Debar	Konjari	41°31'24.47"	20°30'11.88"
RAIL 055	Debar	Konjari	41°31'25.70"	20°30'22.40"
RAIL 056	Debar	Kosovrasti	41°32'04.61"	20°34'48.32"
RAIL 057	Debar	Kosovrasti	41°32'21.03"	20°35'00.30"
RAIL058	Debar	Mogorche	41°32'22.19"	20°37'12.79"
RAIL059	Debar	Debar	41°30'52.87"	20°32'01.16"
RAIL060	Debar	Debar	41°30'36.58"	20°31'11.92"
RAIL061	Debar	Dzepchishte	41°26'16.04"	20°32'26.58"
RAIL062	Debar	Otishani	41°27'07.07"	20°31'12.86"
RAIL063	Centar Zupa	Gorenci	41°30'30.35"	20°33'29.81"
RAIL064	Centar Zupa	Gorenci	41°29'52.94"	20°33'11.83"
RAIL065	Centar Zupa	Broshtica	41°29'28.75"	20°35'07.17"
RAIL066	Centar Zupa	Broshtica	41°29'37.90"	20°36'56.99"
RAIL067	Centar Zupa	Broshtica	41°29'42.71"	20°34'45.01"
RAIL068	Centar Zupa	Balanci	41°28'59.27"	20°32'47.43"
RAIL069	Centar Zupa	Golem Papradnik	41°28'48.47"	20°32'48.07"

ID No	Municipality	City/Village	Coordinates	
			X	Y
RAIL070	Centar Zupa	Golem Papradnik	41°28'28.96"	20°32'38.97"
RAIL071	Centar Zupa	Mal Papradnik	41°28'00.97"	20°32'38.45"
RAIL072	Centar Zupa	Zitineni	41°28'11.03"	20°33'46.38"
RAIL073	Centar Zupa	Zitineni	41°28'06.72"	20°34'13.78"
RAIL074	Centar Zupa	Bajramovci	41°28'47.88"	20°34'21.06"
RAIL075	Centar Zupa	Breshtanik	41°27'21.79"	20°35'09.68"
RAIL076	Centar Zupa	Breshtanik	41°27'20.08"	20°35'12.98"
RAIL077	Centar Zupa	Pralenik	41°27'37.83"	20°32'58.12"
RAIL078	Centar Zupa	Kodzadzik	41°26'29.42"	20°35'45.19"
RAIL079	Centar Zupa	Kodzadzik	41°26'25.32"	20°36'23.41"
RAIL080	Centar Zupa	Novak	41°26'17.99"	20°36'44.13"
RAIL081	Centar Zupa	Novak	41°26'12.23"	20°36'50.93"
RAIL082	Centar Zupa	Novak	41°26'22.15"	20°36'53.57"
RAIL083	Centar Zupa	Novak	41°26'04.56"	20°37'01.42"
RAIL084	Centar Zupa	Elevci	41°25'19.01"	20°37'4.98"
RAIL085	Centar Zupa	Dolgash	41°25'25.46"	20°35'19.34"

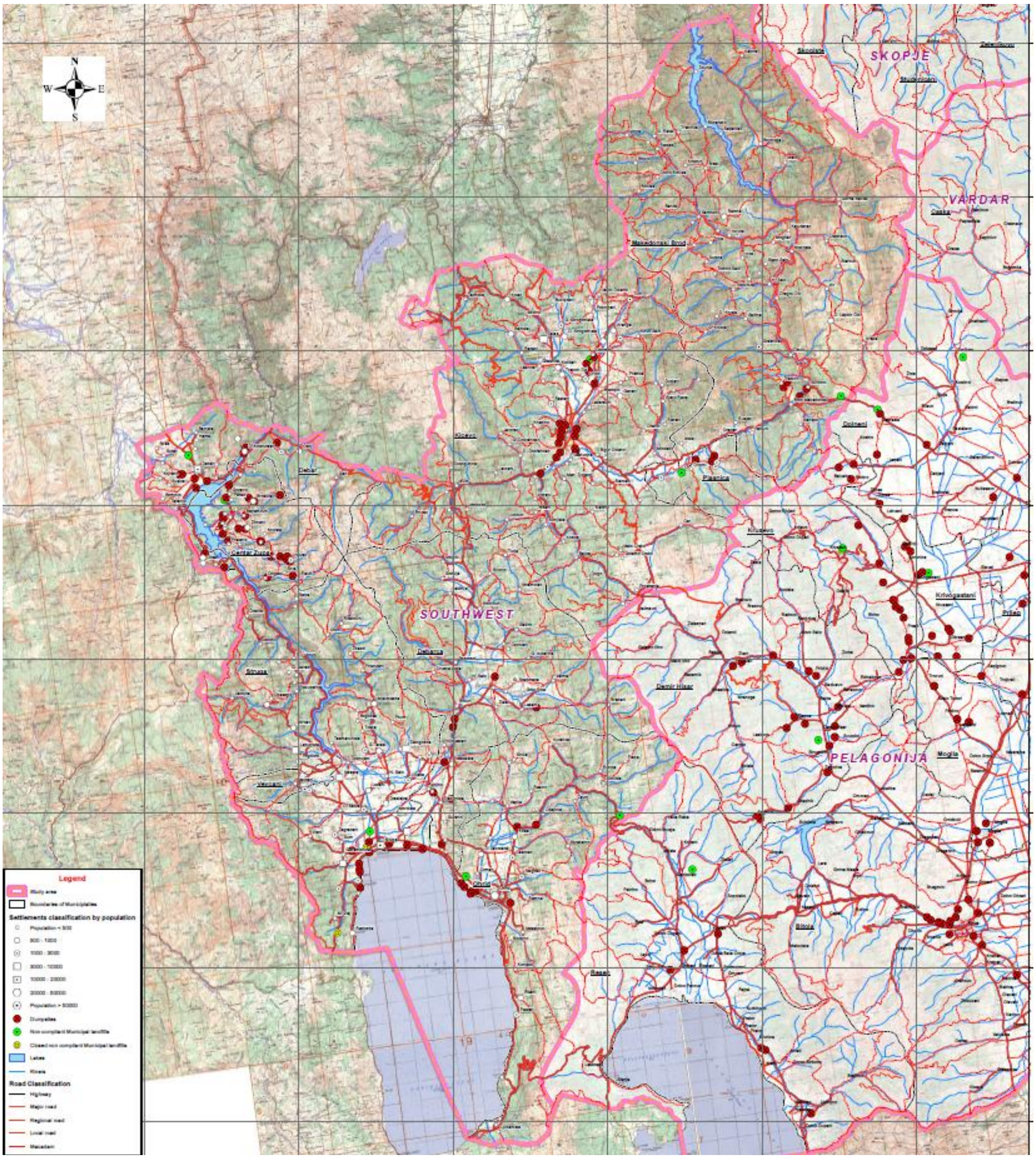


Figure 7-6: Location of WDFs

7.1.3.3 WDFs description

Summary of the data collected about each municipality's WDFs (non-compliant landfills and dumpsites), including georeferenced maps, as well as satellite images are presented below.

Municipality of Vevchani

According to data from Municipality of Vevchani, there are noWDF's (municipal landfill and/ordumpsites) within municipality territory.

Municipality of Debar

According to data from Municipality of Debar, one municipal landfill and total of 10 dumpsites were identified within municipality territory.

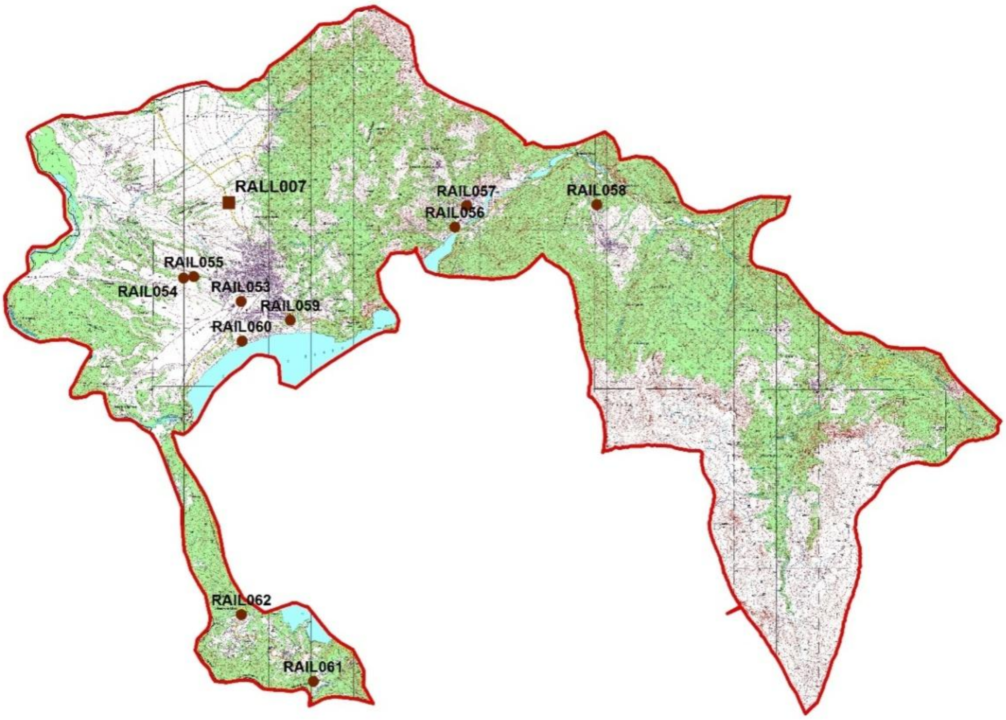


Figure 7-7: Location of WDFs in Debar municipality

Figure 7-8: Satellite image of the location of WDFs in Debar municipality

Figure 7-9: Satellite image of the location of WDFs (dumpsites) in Debar municipality

General data summary of all WDFs identified in Debar Municipality is given at the table below.

Table 7-13: WDFs' data in Debar Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume [m^3]
1	RALL007	Debar	41°32'22.43"	20°30'58.52"	20 000	5	8	100 000
2	RAIL053	Debar	41°31'06.71"	20°31'10.87"	300	0.7	1	200
3	RAIL054	Konjari	41°31'24.47"	20°30'11.88"	400	1.2	2	300
4	RAIL055	Konjari	41°31'25.70"	20°30'22.40"	30	0.2	0.5	6
5	RAIL056	Kosovrasti	41°32'04.61"	20°34'48.32"	300	1	2	300
6	RAIL057	Kosovrasti	41°32'21.03"	20°35'00.30"	100	0.5	1	50
7	RAIL058	Mogorche	41°32'22.19"	20°37'12.79"	1 000	1.5	3	1 500
8	RAIL059	Debar	41°30'52.87"	20°32'01.16"	350	3	5	1 000
9	RAIL060	Debar	41°30'36.58"	20°31'11.92"	1 000	2	3	2 000
10	RAIL061	Djepchishte	41°26'16.04"	20°32'26.58"	400	1	1.5	400
11	RAIL062	Otishani	41°27'07.07"	20°31'12.86"	50	2	3	100

Municipality of Debartsa

According to data from Municipality of Debartsa, only 9 dumpsites were identified within municipality territory (no MSW landfill).

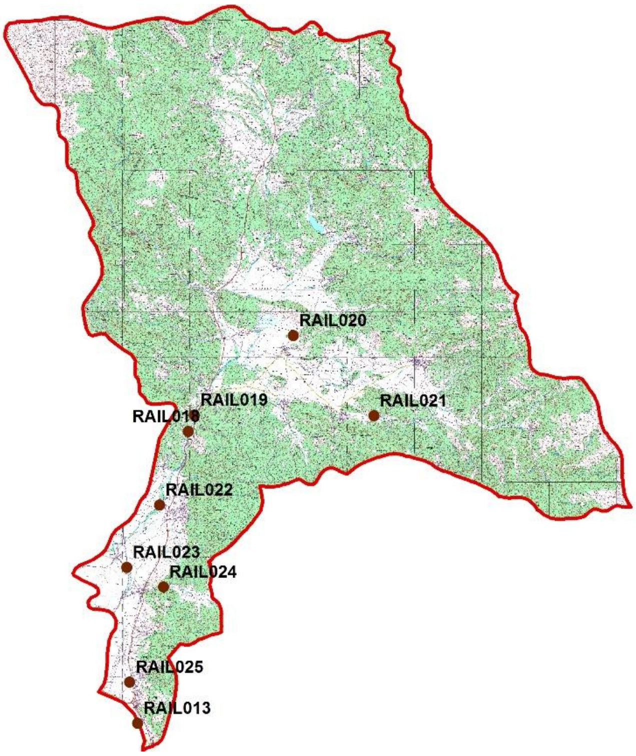


Figure 7-10: Location of WDFs in Debartsa municipality

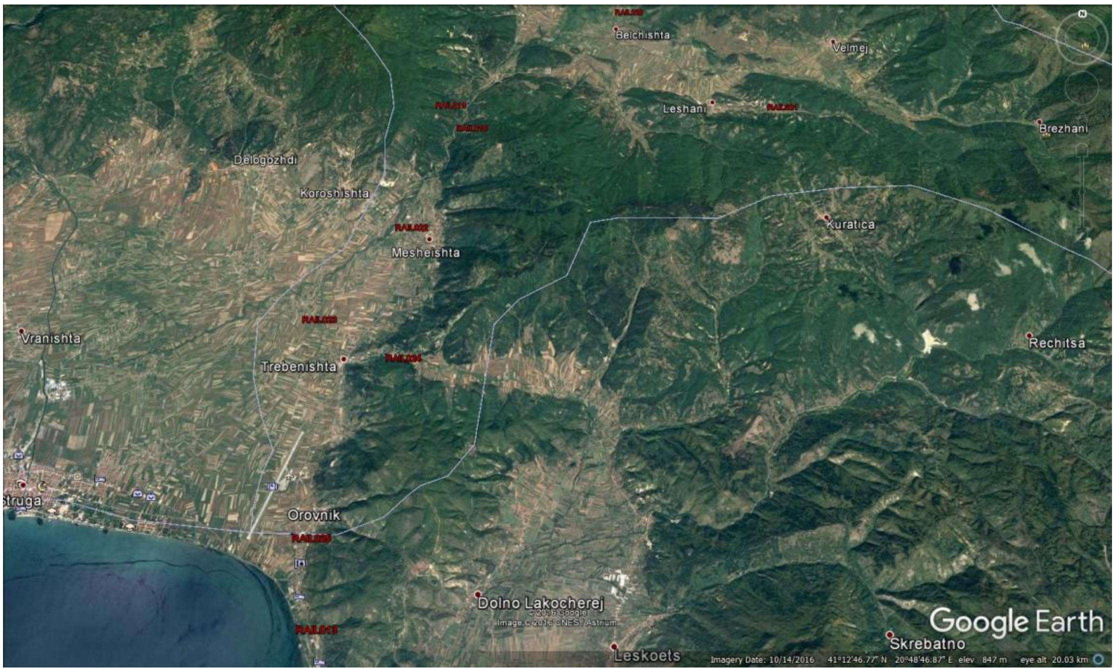


Figure 7-11: Satellite image of the location of WDFs (dumpsites) in Debartsa municipality

General data summary of all WDFs identified in Debartsa Municipality is given at the table below.

Table 7-14: WDFs' data in DebartsaMunicipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume[m^3]
1	RAIL013	Ohrid	41°09'11.6"	20°45'11.14"	50	1	1.5	50
2	RAIL018	Botun	41°16'13.6"	20°46'45.7"	300	1	1.5	300
3	RAIL019	Botun	41°16'37.5"	20°46'56.9"	40	1	1.5	40
4	RAIL020	Belchishta	41°18'32.3"	20°50'05.9"	70	1	1.5	70
5	RAIL021	Leshani	41°16'36.96"	20°52'40.6"	70	1	1.5	70
6	RAIL022	Mesheishta	41°14'27.4"	20°45'50.8"	150	1	1.5	150
7	RAIL023	Volino	41°12'57.1"	20°44'48.7"	100	1	1.5	100
8	RAIL024	Trebenishta	41°12'29.1"	20°45'58.6"	200	0.5	1	100
9	RAIL025	Orovnik	41°10'11.5"	20°44'55"	1 000	1	1.3	1 000

Municipality of Ohrid

According to data from the Municipality of Ohrid, two municipal landfill and total 8 dumpsites were identifiedwithinmunicipal territory.

Figure 7-12: Location of WDFs in Ohrid municipality

Figure 7-13: Satellite image of the location of WDFs (dumpsites) in Ohrid municipality

Figure 7-14: Satellite image of the location of WDFs in Ohrid municipality

General data summary of all WDFs identified in Ohrid Municipality is given at the table below.

Table 7-15: WDFs' data in Ohrid Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume[m^3]
1	RALL004	Ohrid	41°10'21.50"	20°57'28.4"	65 000	22	25	1 430 000
2	RALL005	Ohrid	41°08'20.8"	20°46'15.7"	26 400	1	2.5	26 400
3	RAIL009	Kosel	41°10'31.6"	20°50'16.6"	300	1	1.5	300
4	RAIL010	Kosel	41°10'28.8"	20°51'35.3"	50	0.5	1	25
5	RAIL011	Ohrid	41°07'29"	20°46'33.3"	50	0.5	1	25
6	RAIL012	Ohrid	41°07'23.1"	20°46'28.2"	100	1.5	2	150
7	RAIL014	Ohrid	41°07'59.9"	20°45'55.5"	200	1	1.2	200
8	RAIL015	Ohrid	41°07'47.161"	20°46'07.064"	50	1	1.5	50
9	RAIL016	Ohrid	41°07'27.9"	20°46'49.3"	10	0.5	0.6	5
10	RAIL017	Ohrid	41°06'36.4"	20°49'07"	500	1	1.2	500

<u>Municipality of Plasnitsa</u>

According to data from Municipality of Plasnitsa, one non-compliant MSW landfill and 3 dumpsites were identified within the municipal territory.

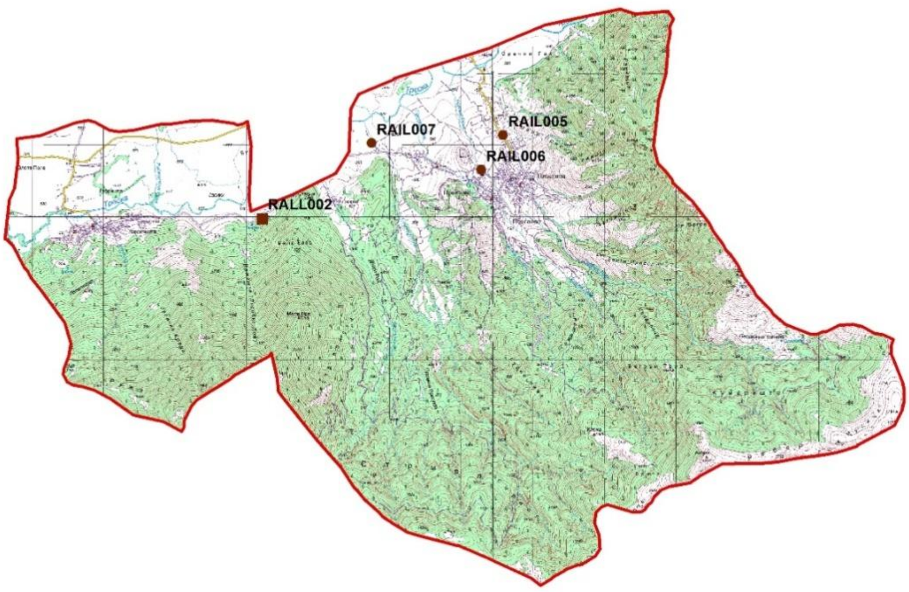


Figure 7-15: Location of WDFs in Plasnitsa municipality

Figure 7-16: Satellite image of the location of WDFs (non – compliant landfill) in Plasnitsa municipality

Figure 7-17: Satellite image of the location of WDFs (dumpsites) in Plasnitsa municipality

General data summary of all WDFs identified in Plasnitsa Municipality is given at the table below.

Table 7-16: WDFs' data in Plasnitsa Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume[m^3]
1	RALL002	Plasnitsa	41°27'44.9"	21°04'52.4"	1 500	1.5	2.5	2 200
2	RAIL005	Plasnitsa	41°28'22.8"	21°07' 17.1"	100	1.5	3	150
3	RAIL006	Plasnitsa	41°28'07.1"	21°07' 03.9"	100	4	7	400
4	RAIL007	Plasnitsa	41°28'19.3"	21°05' 57.9"	500	0.5	1	250

Municipality of Struga

According to data from the Municipality of Struga, one non-compliant MSW landfill and 10 dumpsites were identified within municipality territory.

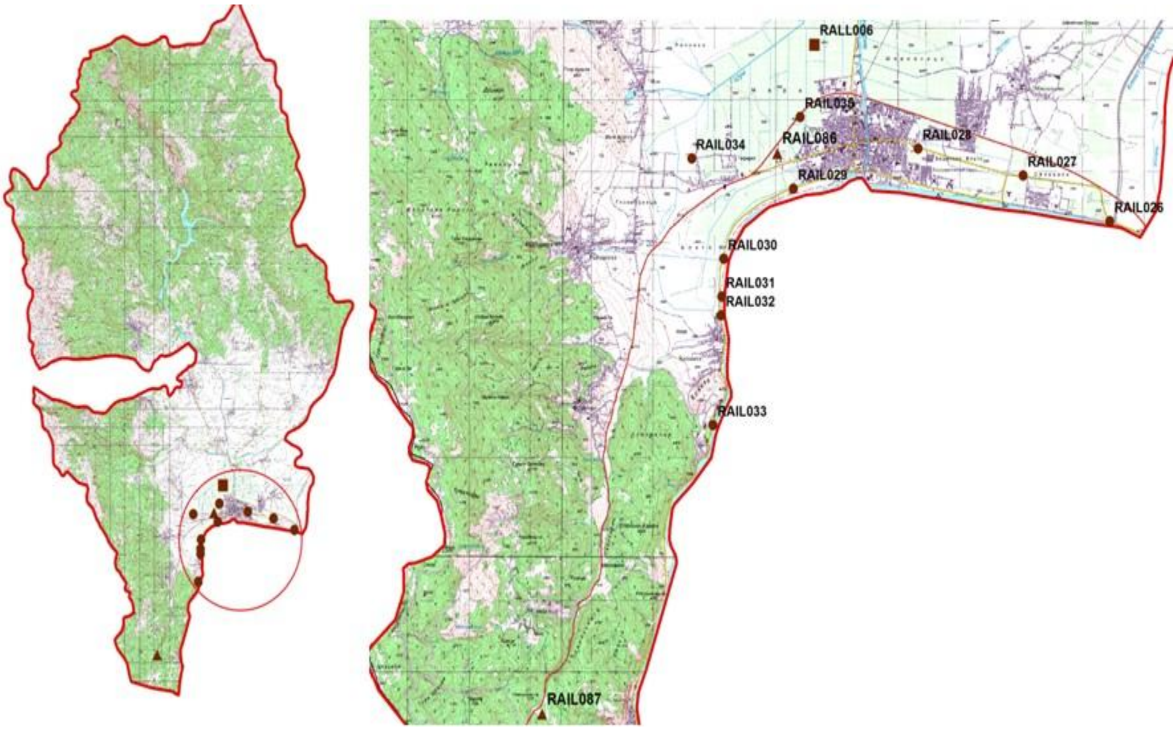


Figure 7-18: Location of WDFs in Struga municipality

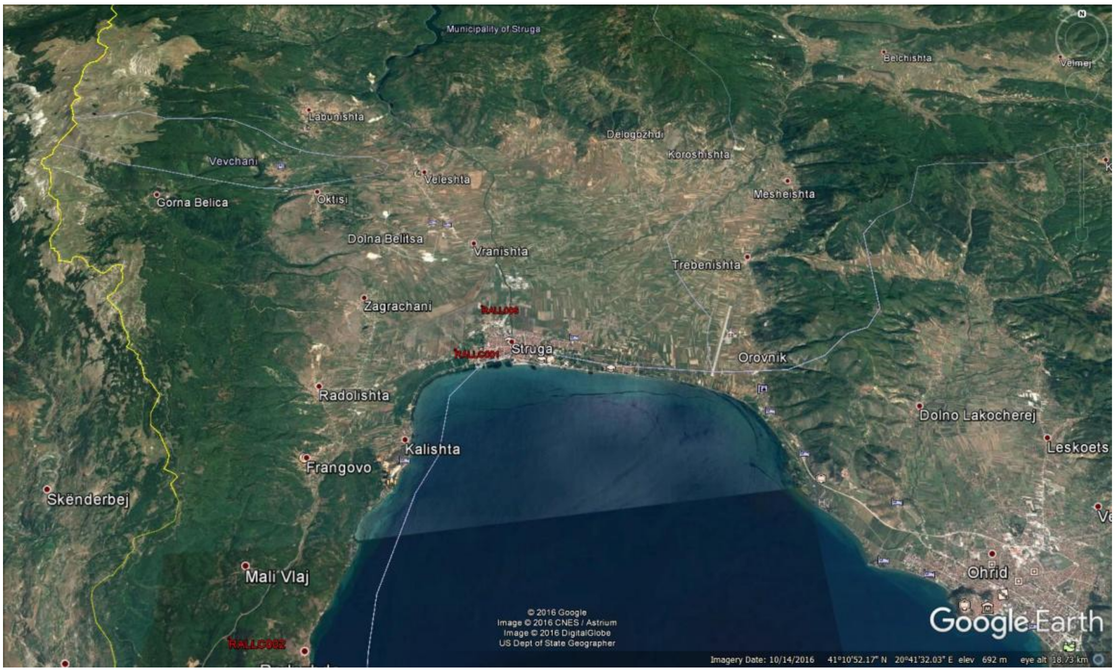


Figure 7-19: Satellite image of the location of WDFs (non – compliant landfill) in Struga municipality

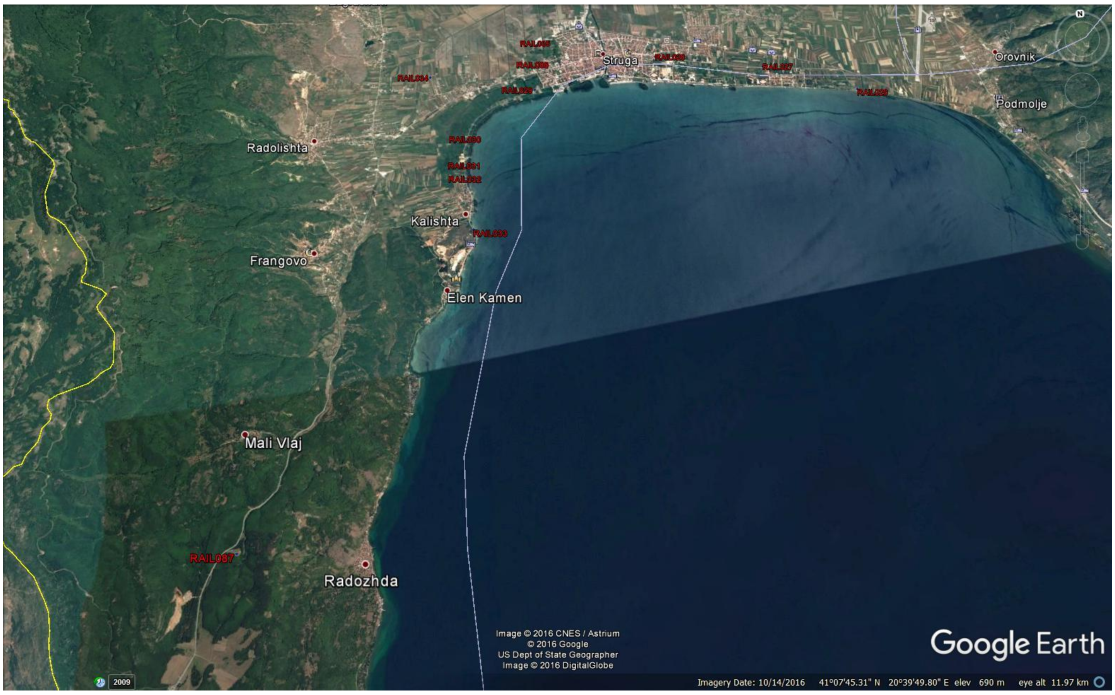


Figure 7-20: Satellite image of the location of WDFs (dumpsites) in Struga municipality

General data summary of all WDFs identified in Struga Municipality is given at the table below.

Table 7-17: WDFs' data in Struga Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume[m^3]
1	RALL006	Struga	41°11'25.1"	20°40'06.3"	35 000	8.5	10.5	297 500
2	RALLC001	Struga	41°10'34.5"	20°39'40.6"	5 000	1	1.5	5 000
3	RALLC002	Struga	41°06'19.7"	20°36'57.5"	10 980	4	5	43 900
4	RAIL026	Ezerski Lozja	41°10'04.86"	20°43'32.7"	600	1	1.5	600
5	RAIL027	Ezerski Lozja	41°10'25.34"	20°42'32.1"	100	1	1.5	100
6	RAIL028	Struga	41°10'37.44"	20°41'18.5"	200	1	1.5	200
7	RAIL029	Struga	41°10'19.039"	20°39'51.5"	400	0.5	1	200
8	RAIL030	Kalishta	41°09'47.1"	20°39'02.8"	500	1	1.5	500
9	RAIL031	Kalishta	41°09'30"	20°39'01.5"	200	1	1.5	200
10	RAIL032	Kalishta	41°09'21.4"	20°39'01.3"	250	1	1.5	250
11	RAIL033	Struga	41°08'51.5"	20°39'04.5"	100	0.5	1	50
12	RAIL034	Struga	41°10'32.5"	20°38'40.3"	400	1	1.5	400
13	RAIL035	Struga	41°10'51.5"	20°39'56"	500	1	1.5	500
14	RAIL086	Struga	41°10'34.5"	20°39'40.6"	5 000	1	1.5	5 000
15	RAIL087	Struga	41°06'19.7"	20°36'57.5"	10 980	4	5	43 900

Municipality of Centar Zhupa

According to data from the Municipality of Centar Zhupa, one no-compliant municipal landfill and23 dumpsites were identified within municipality territory.

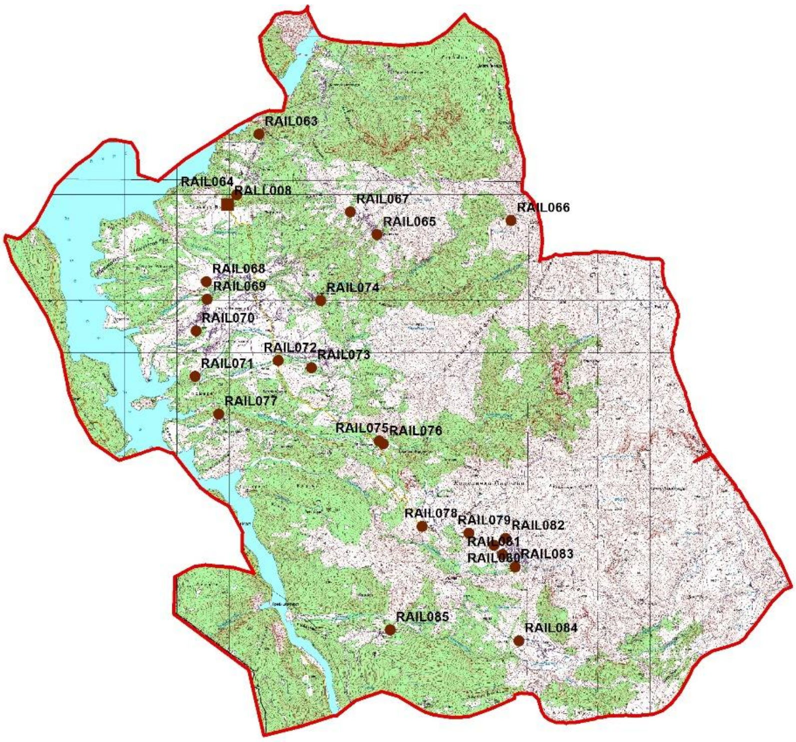


Figure 7-21: Location of WDFs in Centar Zhupa municipality

Figure 7-22: Satellite image of the location of WDFs (non – compliant landfill) in Centar Zhupa municipality

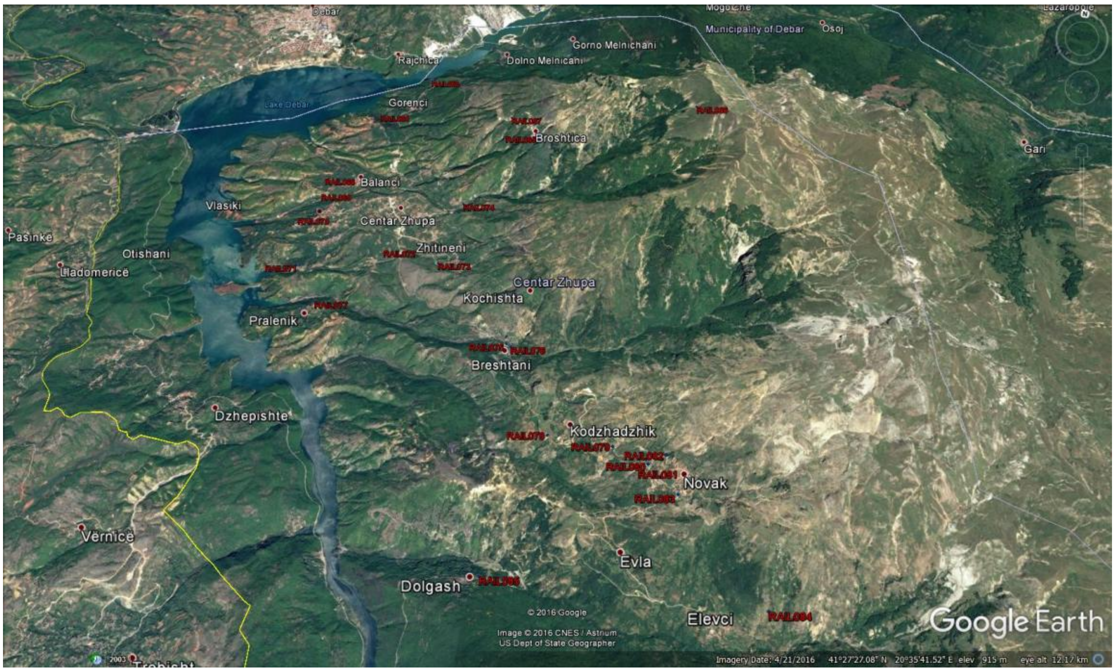


Figure 7-23: Satellite image of the location of WDFs (dumpsites) in Centar Zhupa municipality

General data summary of all WDFs identified in Centar Zhupa Municipality is given at the table below.

Table 7-18: WDFs' data in in Centar Zhupa Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume[m^3]
1	RALL008	Pareshi	41°29'51.10"	20°32'52.94"	500	6	8	3 000
2	RAIL063	Gorenci	41°30'30.35"	20°33'29.81"	15	1	2	15
3	RAIL064	Gorenci	41°29'52.94"	20°33'11.83"	30	2	4	60
4	RAIL065	Broshtica	41°29'28.75"	20°35'07.17"	200	2.5	5	500
5	RAIL066	Broshtica	41°29'37.90"	20°36'56.99"	100	2	3	200
6	RAIL067	Broshtica	41°29'42.71"	20°34'45.01"	200	1.5	3	300
7	RAIL068	Balanci	41°28'59.27"	20°32'47.43"	50	0.2	0.5	10
8	RAIL069	Golem Papradnik	41°28'48.47"	20°32'48.07"	100	1	3	100
9	RAIL070	Golem Papradnik	41°28'28.96"	20°32'38.97"	30	0.5	0.6	15
10	RAIL071	Mal Papradnik	41°28'00.97"	20°32'38.45"	20	0.5	0.6	10
11	RAIL072	Zitineni	41°28'11.03"	20°33'46.38"	500	4	5	2 000
12	RAIL073	Zitineni	41°28'06.72"	20°34'13.78"	30	0.3	0.5	10
13	RAIL074	Bajramovci	41°28'47.88"	20°34'21.06"	40	2	3	80
14	RAIL075	Breshtanik	41°27'21.79"	20°35'09.68"	30	1	2	30
15	RAIL076	Breshtanik	41°27'20.08"	20°35'12.98"	40	1	2	40
16	RAIL077	Pralenik	41°27'37.83"	20°32'58.12"	30	1	1.5	30
17	RAIL078	Kodzadzik	41°26'29.42"	20°35'45.19"	50	0.2	0.5	10
18	RAIL079	Kodzadzik	41°26'25.32"	20°36'23.41"	30	1	2	30
19	RAIL080	Novak	41°26'17.99"	20°36'44.13"	50	0.4	0.5	20

No	ID	Settlement	X	Y	Area [m²]	Avg. Thikness [m]	Max. Thikness [m]	Volume[m³]
20	RAIL081	Novak	41°26'12.23"	20°36'50.93"	15	0.3	0.5	5
21	RAIL082	Novak	41°26'22.15"	20°36'53.57"	500	3	4	1 500
22	RAIL083	Novak	41°26'04.56"	20°37'01.42"	150	1.5	2	225
23	RAIL084	Elevci	41°25'19.01"	20°37'4.98"	30	0.5	1	15
24	RAIL085	Dolgash	41°25'25.46"	20°35'19.34"	100	1	2	100

Municipality of Kichevo

According to data from the Municipality of Kichevo, one non-compliant municipal landfill and total 17 dumpsites were identified within municipal territory.

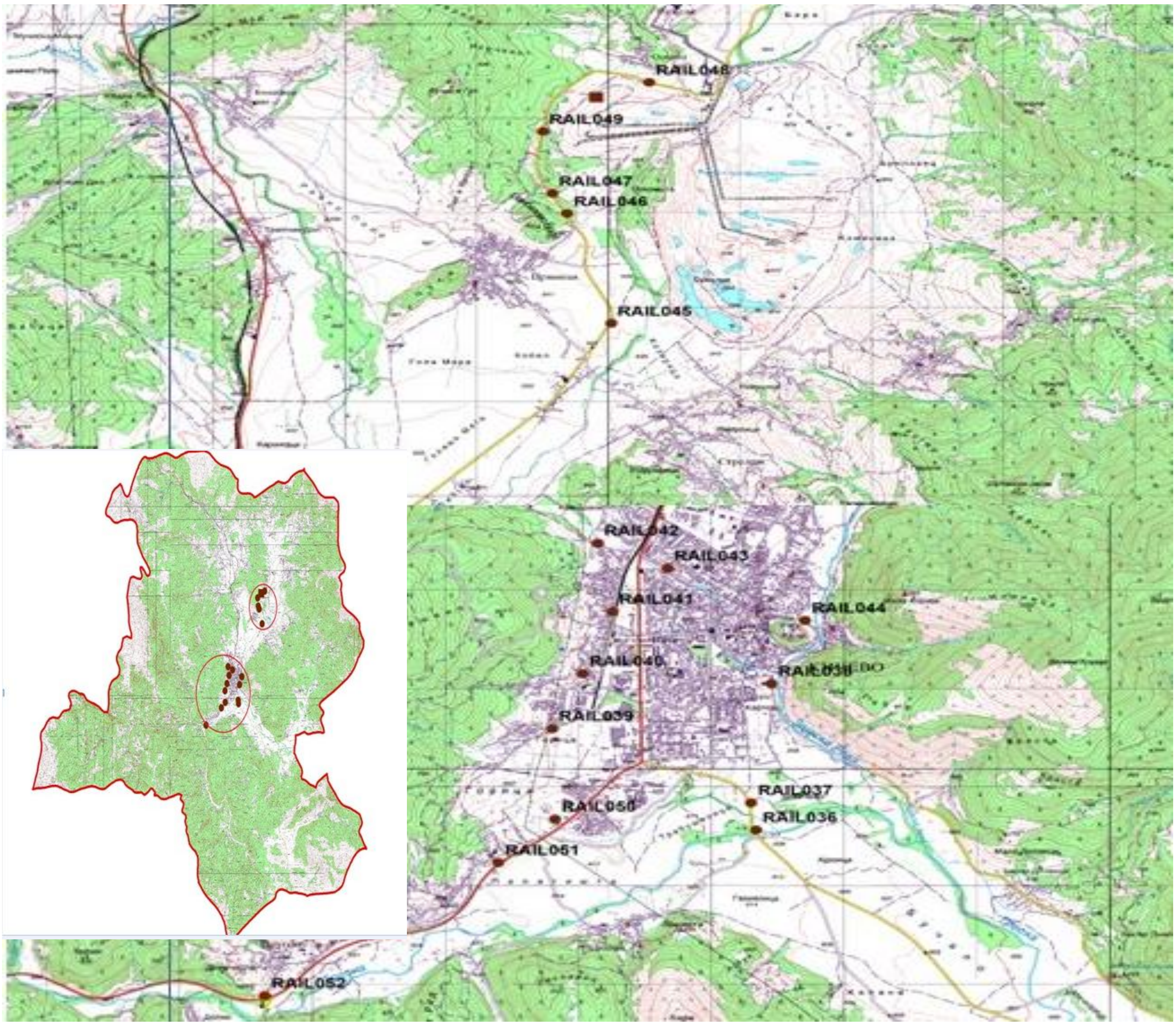


Figure 7-24: Location of WDFs in Kichevo municipality

Figure 7-25: Satellite image of the location of WDFs (non – compliant landfill) in Kichevo municipality

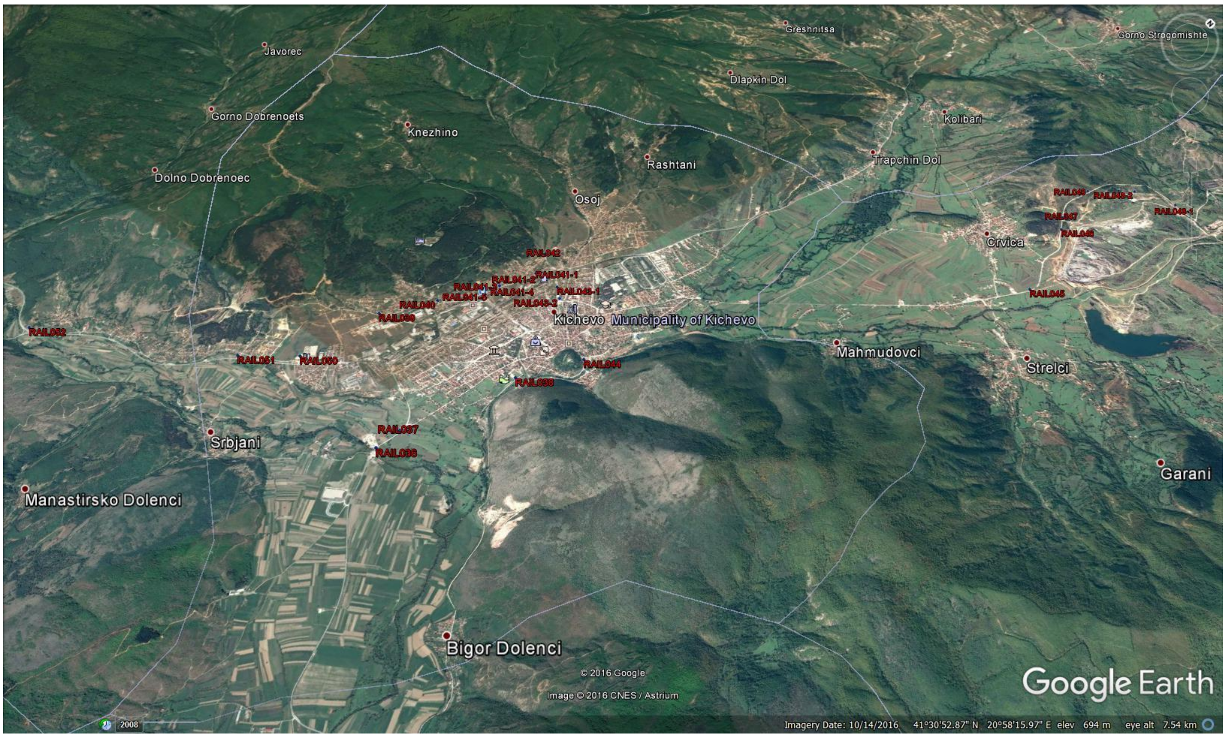


Figure 7-26: Satellite image of the location of WDFs (dumpsites) in Kichevo municipality

General data summary of all WDFs identified in Kichevo Municipality is given at the table below.

Table 7-19: WDFs' data in Kichevo Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume [m^3]
1	RALL003	Kichevo	41°34'22.7"	20°59'38.5"	500	14	20	7 000
2	RAIL036	Kichevo	41°29'41.23"	20°57'45.88"	100	0.3	0.5	30
3	RAIL037	Kichevo	41°29'50.13"	20°57'44.30"	50	0.6	1	30
4	RAIL038	Kichevo	41°30'29.33"	20°57'50.82"	100	0.5	1	50
5	RAIL039	Kichevo	41°30'14.45"	20°56'39.79"	40	0.5	0.7	20
6	RAIL040	Kichevo	41°30'32.56"	20°56'49.66"	20	0.4	0.5	8
7	RAIL041	Kichevo	41°31'06.42" 41°30'58.53" 41°30'52.95" 41°30'49.48" 41°30'40.49"	20°57'03.06" 20°57'01.04" 20°56'59.30" 20°56'58.56" 20°56'56.47"	30	0.7	1	20
8	RAIL042	Kichevo	41°31'15.50"	20°56'54.56"	100	0.5	1	50
9	RAIL043	Kichevo	41°31'07.17" 41°31'03.87"	20°57'17.11" 20°57'24.04"	30	3	4	100
10	RAIL044	Kichevo	41°30'50.11"	20°58'01.77"	30	0.5	0.7	15
11	RAIL045	s.Crvica	41°33'04.37"	20°59'41.62"	50	0.5	0.7	25
12	RAIL046	Oslomej	41°33'42.02"	20°59'27.16"	30	1.5	2	50
13	RAIL047	Oslomej	41°33'48.99"	20°59'22.31"	50	0.4	0.5	20
14	RAIL048	Oslomej	41°34'27.17" to 41°34'23.58"	20°59'54.07" to 20°59'34.90"	300	0.3	0.5	90
15	RAIL049	Oslomej	41°34'10.26"	20°59'19.18"	300	1	2	300
16	RAIL050	Drugovo	41°29'44.79"	20°56'40.65"	200	0.3	0.5	60
17	RAIL051	Drugovo	41°29'30.45"	20°56'22.34"				
18	RAIL052	Drugovo	41°28'46.62"	20°55'06.65"				

<u>Municipality of Makedonski Brod</u>

According to data from the Municipality of Makedonski Brod, one non-compliant MSW landfill and total of 5 dumpsites were identifiedwithinmunicipality territory.

Figure 7-27: Location of WDFs in Makedonski Brod **municipality**

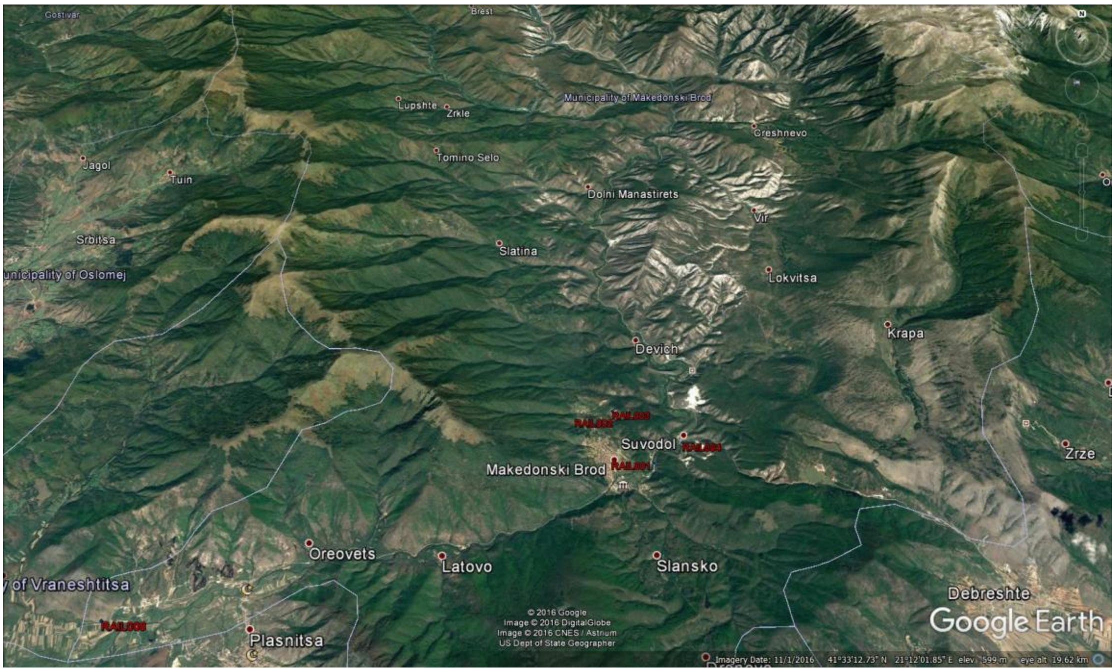


Figure 7-28: Satellite image of the location of WDFs (dumpsites) in Makedonski Brod municipality

Figure 7-29: Satellite image of the location of WDFs (non – compliant landfill) in Makedonski Brod municipality

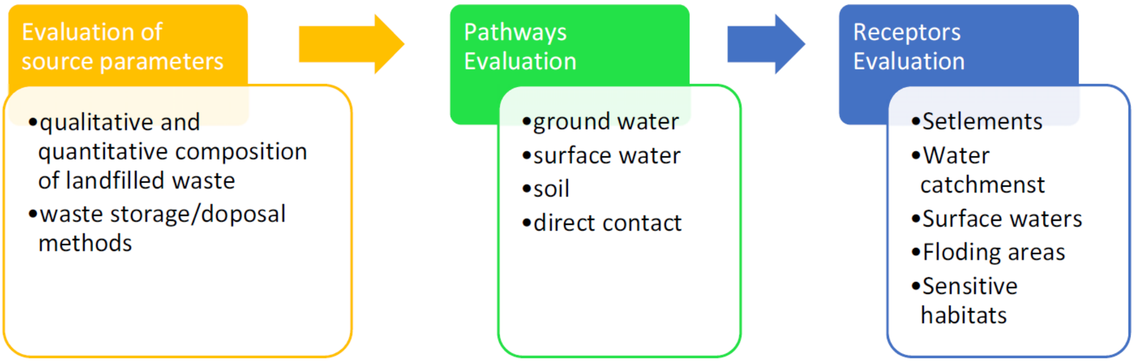
General data summary of all WDFs identified in Makedonski Brod Municipality is given at the table below.

Table 7-20: WDFs' data in Makedonski Brod Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume [m^3]
1	RALL001	M. Brod	41°30'31.30"	21°16' 34.9"	500	14	20	7 000
2	RAIL001	M. Brod	41°30'48.4"	21°13' 45.4"	100	0.3	0.5	30
3	RAIL002	Trebino	41°31'25.1"	21°12'43.2"	50	0.6	1	30
4	RAIL003	Trebino	41°31'40.5"	21°13' 03.3"	100	0.5	1	50
5	RAIL004	Suvodol	41°31'09.1"	21°14' 18.4"	40	0.5	0.7	20
6	RAIL008	Plasnitsa	41°28'28.9"	21°04' 57.2"	50	0.5	1	25

7.1.3.4 Environmental risk assessment

All data collected during the identification and site visits process were properly formatted and used as an input to the RSS (Risk Screening System). The RSS is based on the equation:



Risk = Hazard x Pathway x Receptor

where:

Hazard = Toxicity x Quantity x Mobility

Pathway = Containment x Pathway barrier 1 x Pathway barrier 2 x … (the likelihood of there being a complete pathway being defined by various barriers in the pathway) and:

Receptor = a single value between 0 and 1 defining the sensitivity or vulnerability of the receptor, whether people or an ecological environment.

The Hazard Component has three parameters that are purely a measure of the hazard potential - not a measure of whether the hazard potential is realized as a risk. The potential for realizing the risk is dealt with by the pathway and receptor parameters.

- The toxicity of the contaminant parameter is a measure of the ability of the contaminants to cause adverse human health and environmental effects.
- The extent/ quantity of the contaminant parameter is a measure of the amount of the potentially hazardous substances on the site being assessed at the time of the assessment.
- The mobility of the contaminant parameter assesses the ability of the hazardous substance to migrate or be transported along a pathway once released into the environment.

The Pathway Component defines the likelihood of contact with, or transport to, a receptor and its associated parameters are functions of the site and surroundings, not of the hazardous substance itself. There are three exposure pathways: Surface water, Groundwater, Direct pathway, which have one parameter is common considered: the containment parameter, which defines the security of the contaminant at the site.

The Receptor Component The risk to receptors is dependent on contact with contaminated material, whether soil or water (surface or underground). This may depend on the type of site use, in the case of the direct contact pathway, or the likelihood of a person or ecological receptor coming into contact with, or using, contaminated water.

Risk classification - Group of priority actions and time frame of planning activities

According to the methodology used, three exposure pathways were considered (surface water, groundwater and direct contact) and, based on the risk value calculated, all municipal landfills and dumpsites were divided in three basic categories, as given in the table below.
The landfill score prioritizes them into one of three risk categories.

The following table presents the categorization concerning risk classification, the priority of actions, and the time frame within which the activities are planned to be implementedfrom environmental point of view.

Table 7-21: Risk distribution, activities needed to be taken and time frame of planning activities

Risk category	Priority group/ Activities needed to be taken	Time frame	Risk range
I – minimal risk	Priority group I: Stays in inventory, no actions needed	Not defined	**R ≤ 0.02**
II – medium risk	Priority group II: Stays in inventory and additional investigations are needed (monitoring and investigations)	Long term	**0.02 < R< 0.1**
		Medium term	**0.1 ≤ R< 0.4**
III – high risk	Priority group III: Additional investigations for environmental impacts and rehabilitation	Medium term	**0.4 ≤ R < 0.7**
		Short term	**R ≥ 0.7**

Summarized results of the prioritization and grouping of WDFs from Southwest region in terms of a) the estimated risk for sensitive environmental media and b) the necessary additional investigation (monitoring)/ remediation measures and scheduling of their implementation are presented in Tables 7-13 and 7-14.

Table 7-22: Non-compliant MSW landfills (including closed) categorization

No	Region	Municipality	Settlement	Landfill No.	Risk category	Priority Group	Time Frame
1	Southwest	Makedonski Brod	Makedonski Brod	RALL001	**III**	**III**	Medium
2		Plasnitsa	Plasnitsa	RALL002	**III**	**III**	Medium
3		Kichevo	Kichevo	RALL003	**II**	**II**	Medium
4		Ohrid	Ohrid	RALL004	**II**	**II**	Medium
5		Ohrid	Ohrid	RALL005	**II**	**II**	Medium
6		Struga	Struga	RALL006	**III**	**III**	Medium
7		Struga	Closed site	RALLC001	**III**	**III**	Medium
8		Struga	Closed site	RALLC002	**II**	**II**	Medium
9		Debar	Debar	RALL007	**II**	**II**	Medium
10		Centar Zhupa	Pareshi	RALL008	**II**	**II**	Medium

Table 7-23: Dumpsites categorization

No	Region	Municipality	Settlement	Dumpsite ID	Risk category	Priority Group	Time Frame
1	Southwest	M. Brod	M. Brod	RAIL001	**II**	**II**	Medium
2		M. Brod	Trebino	RAIL002	**II**	**II**	Medium
3		M. Brod	Trebino	RAIL003	**II**	**II**	Long
4		M. Brod	Suvodol	RAIL004	**II**	**II**	Medium
5		Plasnitsa	Plasnitsa	RAIL005	**II**	**II**	Medium

No	Region	Municipality	Settlement	Dumpsite ID	Risk category	Priority Group	Time Frame
6		Plasnitsa	Plasnitsa	RAIL006	II	II	Medium
7		Plasnitsa	Plasnitsa	RAIL007	II	II	Medium
8		Plasnitsa	Plasnitsa	RAIL008	II	II	Medium
9		Ohrid	Kosel	RAIL009	II	II	Medium
10		Ohrid	Kosel	RAIL010	II	II	Medium
11		Ohrid	Ohrid	RAIL011	II	II	Medium
12		Ohrid	Ohrid	RAIL012	II	II	Long
13		Ohrid	Ohrid	RAIL013	II	II	Medium
14		Ohrid	Ohrid	RAIL 014	II	II	Long
15		Ohrid	Ohrid	RAIL015	II	II	Medium
16		Ohrid	Ohrid	RAIL016	II	II	Medium
17		Ohrid	Ohrid	RAIL017	II	II	Medium
18		Debartsa	Botun	RAIL018	II	II	Medium
19		Debartsa	-	RAIL019	II	II	Long
20		Debartsa	Belchishta	RAIL020	II	II	Medium
21		Debartsa	Leshani	RAIL021	II	II	Long
22		Debartsa	Mesheishta	RAIL022	II	II	Medium
23		Debartsa	Volino	RAIL023	II	II	Medium
24		Debartsa	Trebenishta	RAIL024	II	II	Long
25		Debartsa	Orovnik	RAIL025	II	II	Medium
26		Struga	Struga	RAIL026	II	II	Long
27		Struga	Struga	RAIL027	II	II	Medium
28		Struga	Struga	RAIL028	II	II	Long
29		Struga	Struga	RAIL029	II	II	Medium
30		Struga	Kalishta	RAIL030	II	II	Long
31		Struga	Kalishta	RAIL031	II	II	Long
32		Struga	Kalishta	RAIL032	II	II	Medium
33		Struga	Struga	RAIL033	II	II	Long
34		Struga	Struga	RAIL034	II	II	Medium
35		Struga	Struga	RAIL035	II	II	Medium
36		Kichevo	Kichevo	RAIL036	II	II	Medium
37		Kichevo	Kichevo	RAIL037	II	II	Medium
38		Kichevo	Kichevo	RAIL038	II	II	Medium
39		Kichevo	Kichevo	RAIL039	II	II	Medium
40		Kichevo	Kichevo	RAIL040	II	II	Medium
41		Kichevo	Kichevo	RAIL041	II	II	Medium
42		Kichevo	Kichevo	RAIL042	II	II	Long
43		Kichevo	Kichevo	RAIL043	II	II	Medium
44		Kichevo	Kichevo	RAIL044	II	II	Medium
45		Kichevo	s.Crvica	RAIL045	III	III	Medium
46		Kichevo	Oslomej	RAIL046	II	II	Medium
47		Kichevo	Oslomej	RAIL047	II	II	Medium
48		Kichevo	Oslomej	RAIL048	II	II	Medium
49		Kichevo	Oslomej	RAIL049	II	II	Medium
50		Kichevo	Drugovo	RAIL050	II	II	Long
51		Kichevo	Drugovo	RAIL051	II	II	Medium
52		Kichevo	Drugovo	RAIL052	II	II	Medium
53		Debar	Debar	RAIL053	II	II	Medium
54		Debar	Konjari	RAIL054	II	II	Medium
55		Debar	Konjari	RAIL055	II	II	Medium
56		Debar	Kosovrasti	RAIL056	II	II	Medium
57		Debar	Kosovrasti	RAIL057	II	II	Medium

No	Region	Municipality	Settlement	Dumpsite ID	Risk category	Priority Group	Time Frame
58	Southwest	Debar	Mogorche	RAIL058	II	II	Medium
59		Debar	Debar	RAIL059	II	II	Long
60		Debar	Debar	RAIL060	II	II	Medium
61		Debar	Dzepchishte	RAIL061	II	II	Medium
62		Debar	Otishani	RAIL062	II	II	Medium
63		Centar Zhupa	Gorenci	RAIL063	II	II	Medium
64		Centar Zhupa	Gorenci	RAIL064	II	II	Medium
65		Centar Zhupa	Broshtica	RAIL065	II	II	Medium
66		Centar Zhupa	Broshtica	RAIL066	II	II	Medium
67		Centar Zhupa	Broshtica	RAIL067	II	II	Medium
68		Centar Zhupa	Balanci	RAIL068	II	II	Medium
69		Centar Zhupa	Golem Papradnik	RAIL069	II	II	Medium
70		Centar Zhupa	Golem Papradnik	RAIL070	II	II	Medium
71		Centar Zhupa	Mal Papradnik	RAIL071	II	II	Medium
72		Centar Zhupa	Zitineni	RAIL072	II	II	Medium
73		Centar Zhupa	Zitineni	RAIL073	II	II	Long
74		Centar Zhupa	Bajramovci	RAIL074	II	II	Medium
75		Centar Zhupa	Breshtanik	RAIL075	II	II	Medium
76		Centar Zhupa	Breshtanik	RAIL076	II	II	Medium
77		Centar Zhupa	Pralenik	RAIL077	II	II	Medium
78		Centar Zhupa	Kodzadzik	RAIL078	II	II	Medium
79		Centar Zhupa	Kodzadzik	RAIL079	II	II	Medium
80		Centar Zhupa	Novak	RAIL080	II	II	Medium
81		Centar Zhupa	Novak	RAIL081	II	II	Medium
82		Centar Zhupa	Novak	RAIL082	II	II	Medium
83		Centar Zhupa	Novak	RAIL083	II	II	Medium
84		Centar Zhupa	Elevci	RAIL084	II	II	Medium
85		Centar Zhupa	Dolgash	RAIL085	II	II	Medium

7.1.3.5 Closure and remediation of identified sites

Regional waste management approach envisages closure and remediation of all MSW landfills and dumpsites which pose danger to environment and health and safety of general population and does not fulfill technical and legal requirements for waste disposal facilities.

Optimal closure and remediation approach should provide long term protection of environment around waste disposal facility with minimal costs and resources engaged. In general terms, the remediation measures should prevent further contamination of the surface and groundwater, prevent soils direct and indirect pollution, prevent direct contact with disposed waste materials and prevent air pollution through sequestration of landfill gas after the waste disposal facility closure.

According to the national regulations (Rulebook on technical conditions for the landfills construction, Official Gazette of the Republic of Macedonia, No 78/2009) and best engineering practices in Europe, existing landfills are usually capped in order to prevent contaminated material from leaving the area and to prevent human or animal contact with the contaminated materials.

The General requirements for landfills/ dumpsites capping include the following/are:

Gas Drainage Layer	Obligatory for landfills with capacity above 100000 m^3
Synthetic Impermeable Layer	Not obligatory
Mineral impermeable layer	Obligatory
Drainage Layer - 0.5 m	Not obligatory
Reclamation layer of soil and humus ≈ 1.0 m	Obligatory

Based on the legal requirements and specifications of each of the Waste Disposal Facilities identified, remediation will in general include the following activities:

- reshaping of the landfill, to assure long term slope stability and provide for capping construction;
- construction of surface waters capture and sequestration system;
- construction of gas drainage system (if needed);
- construction of impermeable capping (layer of clay/ bentonite mats);
- construction of ground masses for reclamation layer;

In most cases and especially for the WDFs assessed to pose high risks, additional site investigations are necessary in order to define optimal closure and remediation approach.

The main environmental risks from uncontrolled dumpsites include but are not limited to:

- pollution of the surrounding areas from water leachate and wind dispersion of light waste fractions;
- pollution of surface waters in the vicinity of the landfill by direct disposal of waste and/ or contaminated landfill leachate;
- contamination of groundwater;
- direct contact with dangerous waste materials

Due to small quantities, dumpsites are usually cleaned and waste collected is disposed according to legal requirements. In general, closure process or cleaning involves:

- removal of all waste, including contaminated soil;
- disposal of the waste and contaminated soil at MSW landfill or at the landfills under the closure process;
- remediation of the dumpsite area (reshaping, re-vegetation)

7.1.3.5.1 Closure and Remediation approaches

Having in mind technical requirements and best engineering practices, as much as the identified landfills and dumpsites specifics, two distinct types of closure and remediation approaches are proposed;

⇒ The first one is securing waste “ex situ” and assumes cleaning of the site (removal of the waste and contaminated soil) and disposal of the waste at appropriate landfill according to legal requirements.

⇒ The second is securing the waste “in situ” and assumes capping the waste with appropriate infrastructure to provide long term environmentally safe storage of the waste. This approach includes two options, capping with and without construction of gas drainage systems.

Selected closure and remediation approaches (models) for different types of landfills and dumpsites are summarized in the table below.

Table 7-24: Summary of closure and remediation approaches (models)

Closure&Rehabilitation approach ID	Type	Application	Description
CR model A – Site cleaning	Ex situ	For small landfills and dumpsites < 5 000 m^3ranked as a low, medium and high risks	Excavation and re-deposition of the waste and contaminated soils on the municipality landfill in whose territory they are.
CR model B – capping without gas collection	In situ	For landfills marked as low, medium and high risk and volume up to 100 000 m^3	Construction of capping layer, soil cover and surface water control systems (diversion channels).
CR model C – capping with gas collection	In situ	For landfills ranked as high risks and volume above >100 000 m^3 and medium and high risk and volume above >500 000 m^3.	Construction of capping layer, soil cover, gas collection systems and water systems (diversion channels)

Closure and Remediation Model "A" - Site cleaning belongs to the first type of closure and remediation approaches, whereas, Closure and Remediation Models "B" and "C", the basic features of which are illustrated at the following figures, belong to the second type.

Remediation activities for the implementation of the **model A** include:
✓ removal of disposed waste which in current pricing conditions, can be performed with a bulldozer/front end loader or excavator at a cost price
✓ waste transport and re-disposal to existing municipality landfill (distance up to 50 km)
✓ waste compaction with roller
✓ re-cultivation (grassing) on areas cleared of waste

This approach is t is proposed for remediation of non-compliant MSW landfills with disposed waste volume up to 100,000 m^3, and ranked as medium and high risk sites and in all time plans (long, medium and short term). This approach assumes construction of capping system with following components/layers;
✓ the surface layer, at least one meter thick, and the upper layer 0.4 m containing organic matter (humus) are suitable for grass;
✓ separator (usually geotextile 400g/m^2);
✓ mineral drainage - minimum 0.5 m (gravel, min. $\kappa > 10^{-4}$m/s);
✓ sealing or impermeable layer (2 x 25cm mineral insulation with min. $\kappa > 10^{-9}$m/s equivalent bentonite material);
✓ gas drainage and gas collection layer (gravel);
✓ household waste

Closure and remediation Model "B" - capping without gas collection

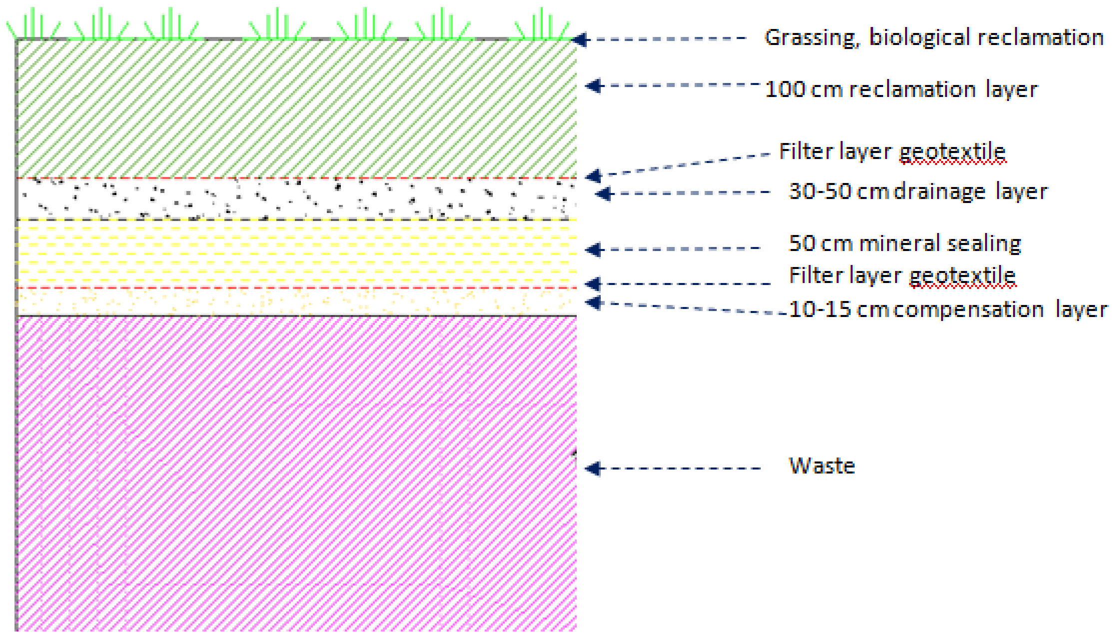


Figure 7-30: Capping cross section with cost estimation forClosure and Remediation model "B"

Closure and remediation Model "C" - capping with gas collection
Model C approach is proposed for remediation of non-compliant MSW landfills ranked as a high risk and waste volume above 100,000 m^3 in a short time plan. It is also applied for landfills with significant volume of disposed waste (above 500,000 m^3) and medium and high risks in a short term. Closure and remediation activities for Model C are presented bellow;

- ✓ profiling of deposited waste, spreading and leveling with a bulldozer
- ✓ laying leveling layer of ground masses with thickness of 0.1 – 0.15 m
- ✓ construction of gas drainage system (drainage blanket of gravel)
- ✓ construction of gas drainage and gas venting system:
- ○ for flaring of the captured gas emissions from landfill (model C1 - used for landfills with volume of deposited waste from 100,000 to 500,000 m^3)
- ○ for utilization of landfill gas emissions (model C2 - used for landfill volume of waste disposed of over 500,000 m^3)
- ✓ laying of geotextile separator (300 - 400 g/m^2)
- ✓ construction of mineral layer (compacted clays 0.5 m or 2 × 25 cm thickness, $k=1\times10^{-9}$ m/s) or hydro geomembrane
- ✓ laying drainage layer of washed up river gravel fraction *12/35*for removal of infiltrated water with $k>10^{-4}$ m/s (0.5 m)
- ✓ laying of geotextile separator (300 - 400 g/m^2)
- ✓ construction of remediation layer with thickness of 1 m
- ✓ biological remediation of landfill - grassconstruction of protective belts
- ✓ landfill monitoring (for landfills with volume of deposited waste above 15,000 m^3)

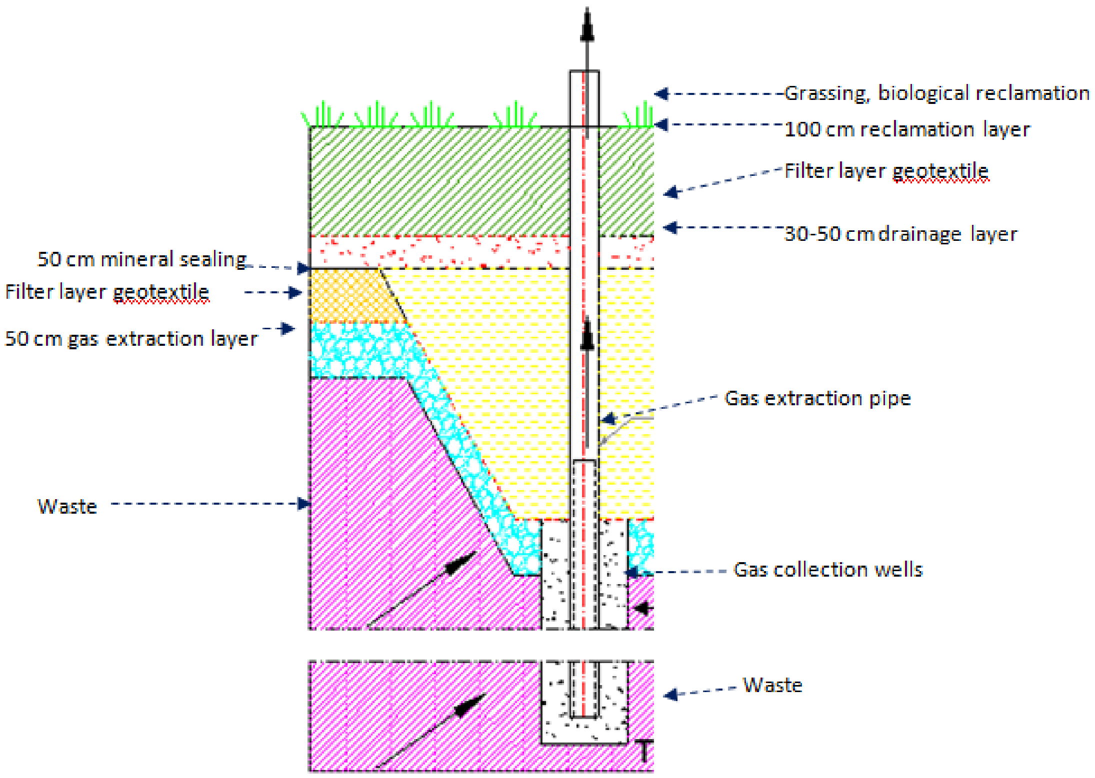


Figure 7-31: Capping cross section with cost estimation for Closure and Remediation model “C”

After care and monitoring

International best practice requires proper after care and monitoring of closed landfills. Aftercare measures and monitoring programs, as well as estimation of the average monitoring costs, will be applied to those sites, that will be remediated according to the Closure and Remediation Models “B” and “C”.

In general, monitoring programs may involve all or some of the following activities:
- runoff quality and quantity monitoring
- leachate and quantity monitoring
- surface water quality
- ground water (including of site)
- gas emissions (quality/ content and quantity)
- slopes stability (survey of slope inclination and shape)

Urgent measures for identified sites

In order to reduce environmental impacts until closure and remediation operations are started and fill the data gaps necessary for proper design of closure and remediation measures of high and medium risk landfills, a set of urgent measures is proposed. Urgent measures for non-compliant landfills and dumpsites include:

- development and launch of monitoring programs
- complete construction or restoration of fences around landfills
- permanent entrance control in the active landfills area
- placing warning signs for forbidding: waste incineration, landfilling outside designated areas
- marking the landfills approach with warning signs for permitted waste disposal
- informative campaigns for general population of unauthorized access (outside the specified time for disposal) to active landfill

7.1.3.5.2 Closure and remediation for identified sites in Southwest Region

Based on site visits and risk screening data, Models A (site cleaning), B (landfill capping without gas collection system) and C (landfill capping with gas collection system) should be applied to the WDFs in Southwest region as given at the table below.

Table 7-25: Closure and remediation approaches for identified sites in Southwest region

	Dumpsite ID	Closure and Remediation approach			Municipality	Settlement	Dumpsite Area [m^2]	Dumpsite Volume [m^3]
		Model A – Site cleaning	Model B – Capping without gas collection	Model C – Capping with gas collection				
1	RAIL001	✓			MakedonskiBrod	MakedonskiBrod	500	500
2	RAIL002	✓			MakedonskiBrod	Trebino	100	50
3	RAIL004	✓			MakedonskiBrod	Suvodol	100	100
4	RAIL005	✓			Plasnitsa	Plasnitsa	100	150
5	RAIL006	✓			Plasnitsa	Plasnitsa	100	400
6	RAIL007	✓			Plasnitsa	Plasnitsa	500	250
7	RAIL008	✓			Plasnitsa	Plasnitsa	50	25
8	RAIL009	✓			Ohrid	Kosel	300	300
9	RAIL011	✓			Ohrid	Ohrid	50	25
10	RAIL013	✓			Ohrid	Ohrid	60	60
11	RAIL015	✓			Ohrid	Ohrid	50	50
12	RAIL016	✓			Ohrid	Ohrid	10	5
13	RAIL017	✓			Ohrid	Ohrid	500	500
14	RAIL018	✓			Debartsa	Botun	300	300
15	RAIL020	✓			Debartsa	Belchishta	70	70
16	RAIL022	✓			Debartsa	Mesheishta	150	150
17	RAIL023	✓			Debartsa	Volino	100	100
18	RAIL025	✓			Debartsa	Orovnik	1000	1000
19	RAIL027	✓			Struga	Struga	100	100
20	RAIL029	✓			Struga	Struga	400	200
21	RAIL032	✓			Struga	Kalishta	250	250
22	RAIL034	✓			Struga	Struga	100	50
23	RAIL035	✓			Struga	Struga	500	500
24	RAIL036	✓			Kichevo	Kichevo	100	100
25	RAIL037	✓			Kichevo	Kichevo	50	50
26	RAIL038	✓			Kichevo	Kichevo	100	100
27	RAIL039	✓			Kichevo	Kichevo	40	20
28	RAIL040	✓			Kichevo	Kichevo	30	15
29	RAIL041	✓			Kichevo	Kichevo	30	15
30	RAIL043	✓			Kichevo	Kichevo	15	7
31	RAIL044	✓			Kichevo	Kichevo	400	200
32	RAIL046	✓			Kichevo	Oslomej	500	750
33	RAIL047	✓			Kichevo	Oslomej	1000	1500
34	RAIL048	✓			Kichevo	Oslomej	5000	5000
35	RAIL049	✓			Kichevo	Oslomej	100	150
36	RAIL051	✓			Kichevo	Drugovo	20	6
37	RAIL052	✓			Kichevo	Drugovo	1000	1500
38	RAIL053	✓			Debar	Debar	300	200
39	RAIL054	✓			Debar	Konjari	400	300
40	RAIL055	✓			Debar	Konjari	30	6
41	RAIL056	✓			Debar	Kosovrasti	300	300

	Dumpsite ID	Closure and Remediation approach			Municipality	Settlement	Dumpsite Area [m^2]	Dumpsite Volume [m^3]
		Model A – Site cleaning	Model B – Capping without gas collection	Model C – Capping with gas collection				
42	RAIL057	✓			Debar	Kosovrasti	100	50
43	RAIL058	✓			Debar	Mogorche	1000	1500
44	RAIL060	✓			Debar	Debar	1000	2000
45	RAIL061	✓			Debar	Dzepchishte	30	15
46	RAIL062	✓			Debar	Otishani	50	100
47	RAIL063	✓			CentarZhupa	Gorenci	15	15
48	RAIL064	✓			CentarZhupa	Gorenci	30	60
49	RAIL065	✓			CentarZhupa	Broshtica	200	500
50	RAIL066	✓			CentarZhupa	Broshtica	100	200
51	RAIL067	✓			CentarZhupa	Broshtica	200	300
52	RAIL068	✓			CentarZhupa	Balanci	50	10
53	RAIL069	✓			CentarZhupa	Golem Papradnik	100	100
54	RAIL070	✓			CentarZhupa	Golem Papradnik	30	15
55	RAIL071	✓			CentarZhupa	Mal Papradnik	20	10
56	RAIL072	✓			CentarZhupa	Zitineni	500	2000
57	RAIL074	✓			CentarZhupa	Bajramovci	40	80
58	RAIL075	✓			CentarZhupa	Breshtanik	30	30
59	RAIL076	✓			CentarZhupa	Breshtanik	40	40
60	RAIL078	✓			CentarZhupa	Kodzadzik	50	10
61	RAIL079	✓			CentarZhupa	Kodzadzik	30	30
62	RAIL080	✓			CentarZhupa	Novak	50	20
63	RAIL081	✓			CentarZhupa	Novak	15	5
64	RAIL082	✓			CentarZhupa	Novak	500	1500
65	RAIL083	✓			CentarZhupa	Novak	150	100
66	RAIL084	✓			CentarZhupa	Elevci	30	15
67	RAIL085	✓			CentarZhupa	Dolgash	100	100
68	RAIL003	✓			MakedonskiBrod	Trebino	150	75
69	RAIL012	✓			Ohrid	Ohrid	100	150
70	RAIL014	✓			Ohrid	Ohrid	200	200
71	RAIL019	✓			Debartsa	-	40	40
72	RAIL021	✓			Debartsa	Leshani	70	70
73	RAIL024	✓			Debartsa	Trebenishta	200	100
74	RAIL026	✓			Struga	Struga	600	600
75	RAIL028	✓			Struga	Struga	200	200
76	RAIL030	✓			Struga	Kalishta	500	500
77	RAIL031	✓			Struga	Kalishta	200	200
78	RAIL033	✓			Struga	Struga	200	200
79	RAIL042	✓			Kichevo	Kichevo	250	400
80	RAIL050	✓			Kichevo	Drugovo	40	40
81	RAIL059	✓			Debar	Debar	350	1000
82	RAIL073	✓			CentarZhupa	Zitineni	30	10
83	RAIL010	✓			Ohrid	Kosel	50	25
85	RAIL045		✓		Kichevo	s.Crvica	5000	10000
86	RAIL077	✓			CentarZhupa	Pralenik	30	30
87	RALL001		✓		MakedonskiBrod	MakedonskiBrod	22500	22500
88	RALL002	✓			Plasnitsa	Plasnitsa	1 500	2 200
89	RALL003		✓		Kichevo	Kichevo	3 000	15 000

	Dumpsite ID	Closure and Remediation approach			Municipality	Settlement	Dumpsite Area [m²]	Dumpsite Volume [m³]
		Model A – Site cleaning	Model B – Capping without gas collection	Model C – Capping with gas collection				
90	RALL004			✓	Ohrid	Ohrid	65 000	1 430 000
91	RALL005		✓		Ohrid	Ohrid	26 400	26 400
92	RALL006			✓	Struga	Struga	35 000	297 500
93	RALL007		✓		Debar	Debar	20 000	100 000
94	RALL008	✓			CentarZhupa	Pareshi	500	3000
95	RALLC001	✓			Struga	Struga	5000	5000
96	RALLC002		✓		Struga	PreminKafasan	10 980	43 900
	Total	**87**	**6**	**2**				

7.1.4 Technical description of new regional landfill

7.1.4.1 Plan of site location and surrounding area

The construction of the new regional landfill in South West Region was proposed to be located at G2 (Debartsa) location. The centre will be developed as an integrated waste management facility. The anticipated setout and appearance of the centre will be important to surrounding and neighboring settlements, so it is important to provide good access for vehicles, protective embankments/ vegetation and good architecture where buildings and infrastructure are visible.

The new regional landfill in Southwest Region is going to be located in a site that administratively belongs to Debartsa Municipality and it is located in the northeast of the settlement of Laktinje in a distance of approx. 1.0km, in the southeast of the settlement of Godivje in a distance of approx. 1.3km, northwest of the settlement of Arbinovo in a distance of approx. 1.5km and northeast of the settlement of Vrbjani in a distance of approx. 2.4km. The above mentioned distances refer to approximate straight line/direct distance, and from the establishment borders of the settlements.

Figure 7-32: Satellite image ofthe location of the site

The access to the site is easy, through the road E65 which connects Ohrid settlement with Kichevo settlement, and then following the local paved road to Godivje settlement.

Figure 7-33:Satellite image of the location of theacess to G2 site

The closest settlement to the site is the settlement of Laktinje, in a distance of approximately 1.0km. The optical isolation is in a good level from the road E65 (connects Ohrid with Kichevo settlement) and is in a moderate level from the nearby settlements. In the wider area of the site there is no site of archaeological interest under distance of 3km. In addition, there are some facilities of tourist interest under construction, located south – southwest of the site at 1.8 km (direct line distance).

There are no protected areas neaby the site in a distance under 3km. The closest protected areas to the site are the Emerald protected area "Belchishko Blato" with code MK0000014, at approx. 7.3km south of the site and the protected area "Pesoschanska Reka" at approx. 4.3km west of the site.

According to Corine land cover 2012, the land occupation of the site and the wider area is characterized as land principally occupied by agriculture, with significant areas of natural vegetation and complex cultivation patterns.According to the site visit, the proposed site can be characterized as occupied by land with ordinary ecological features. Climate in Debartsa is sharper variant of moderate continental climate due tothe considerable altitude (mountain air). The highest temperature appears in the months of July and August (32.5 to 34.4^{o}C), when the precipitation is the smallest. The coldest months are January (2.2^{o}C) and February (3.4^{o}C). Average annual precipitation amounts from 682 to 793 mm. The prevailing winds are south-southeast.

Regarding the geological and hydrogeological characteristics of the area considered, it includes Pliocene sediments that appear west of the alluvial sediments of the stream Vrbjanska. Pliocene includes clay, clay-sands and gravels accounted as semi permeable. After a short geological prospection, it can be assumed that the surface parts of the terrain are built of clay materials with sub capillary porosity. As per Hydrogeological map of the Republic of Macedonia (1:200,000) those areas fall into waterless terrains. There are no significant tectonic structures within or near the site area. Rock masses are estimated as non- coherent or slightly coherent. Pliocene sediments have very low thickness without the appearance of dominant structures of crimping.The site area is flat with the presence of a gentle valley in its central parts.

The site is located far from any active seismic structures. As per the Seismic Risk map of R. Macedonia this area belongs to the zone 8˚ with a seismic coefficient Ks = 0,050. Vrbjanska stream passes 500 m east of the site and Sateska River flows in vicinity. Sateska River is the largest river in the region and therefore the main drainage artery.There are no wells for groundwater pumping within or near the site.The main recipients are relatively large rural settlements (Pesocani, Botun and Trebenishte), but all at a distance more than 10 km from the site. Highly permeable alluvial environment, which is an integral part of Sateska River alluvium, is located 500 meters east from the site. As mentioned above site is flat and without significant slopes, but due to the central position in the valley it has a large catchment area (over 400ha or 4Km^2).

Regarding the technical and operational characteristics of the site, the altitude of the site ranges from 886 to 908 meters (mean average 897 m). The total expqansion of the area that could be used according to the morphological characteristics is approx. 20.5 ha, so there is enough space to implement theCentral Waste Management Facilities. Regarding the property ownership of the site, it could be characterized mainly as private. According to the geological characteristics, there is availability of soil material for the daily cover.

In the area of G2 (Debartsa) there are currently no infrastructure works available. The access to the site is easy, through the road E65 which connects Ohrid settlement with Kichevo settlement, and then following the local paved road to Godivje settlement. For the final access to the site, about 100m improvement road works are required. The site could be connected to the public utility networks through the nearby settlement.

More detailed information concerning the environmental assessment of the location is presented in chapter 8 of the present Study.

7.1.4.2 Topographic plans of site (existing and after closure)

This paragraph presents the outcomes of the topographic plan that was conducted at the location of the future CWMF of Southwest Region in Debartsa municipality. The survey was conducted between the period of 18.03.2017 and 19.03.2017.

After completing the terrain works, a 3D model of the terrain was created with scale of 1:1000 with a display of all elements that are part of this location.

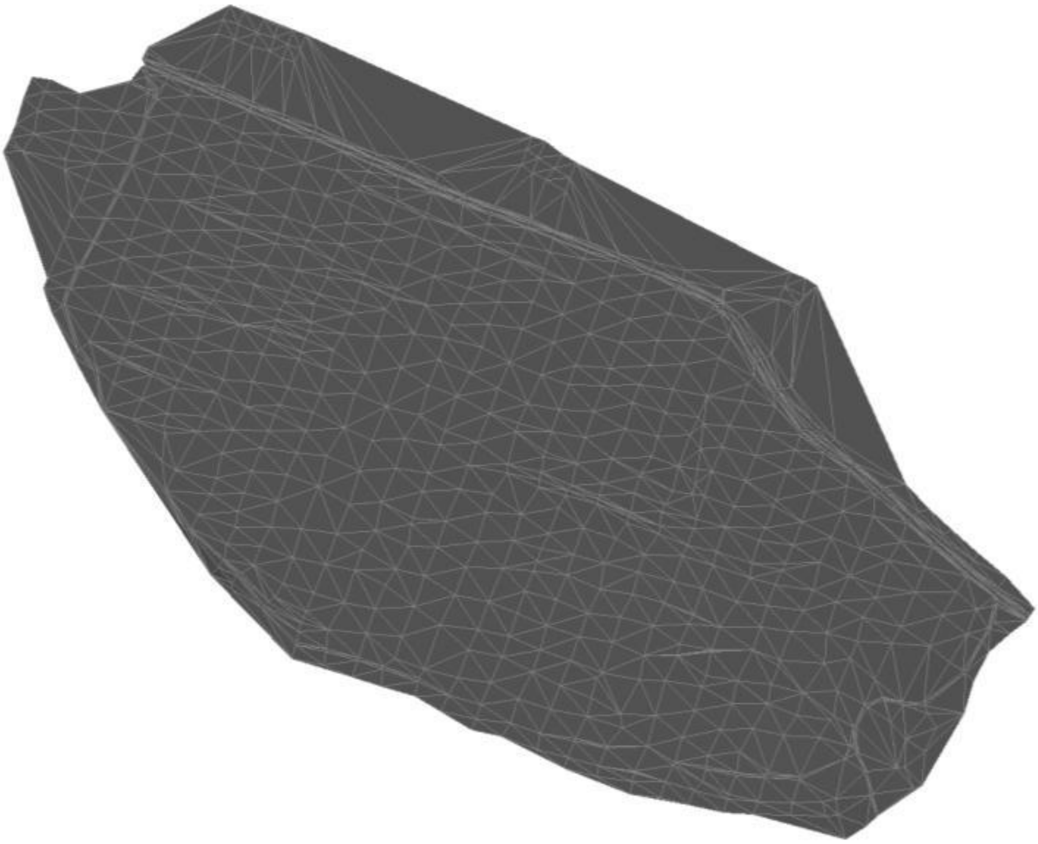


Figure 7-34: 3D model of the terrain

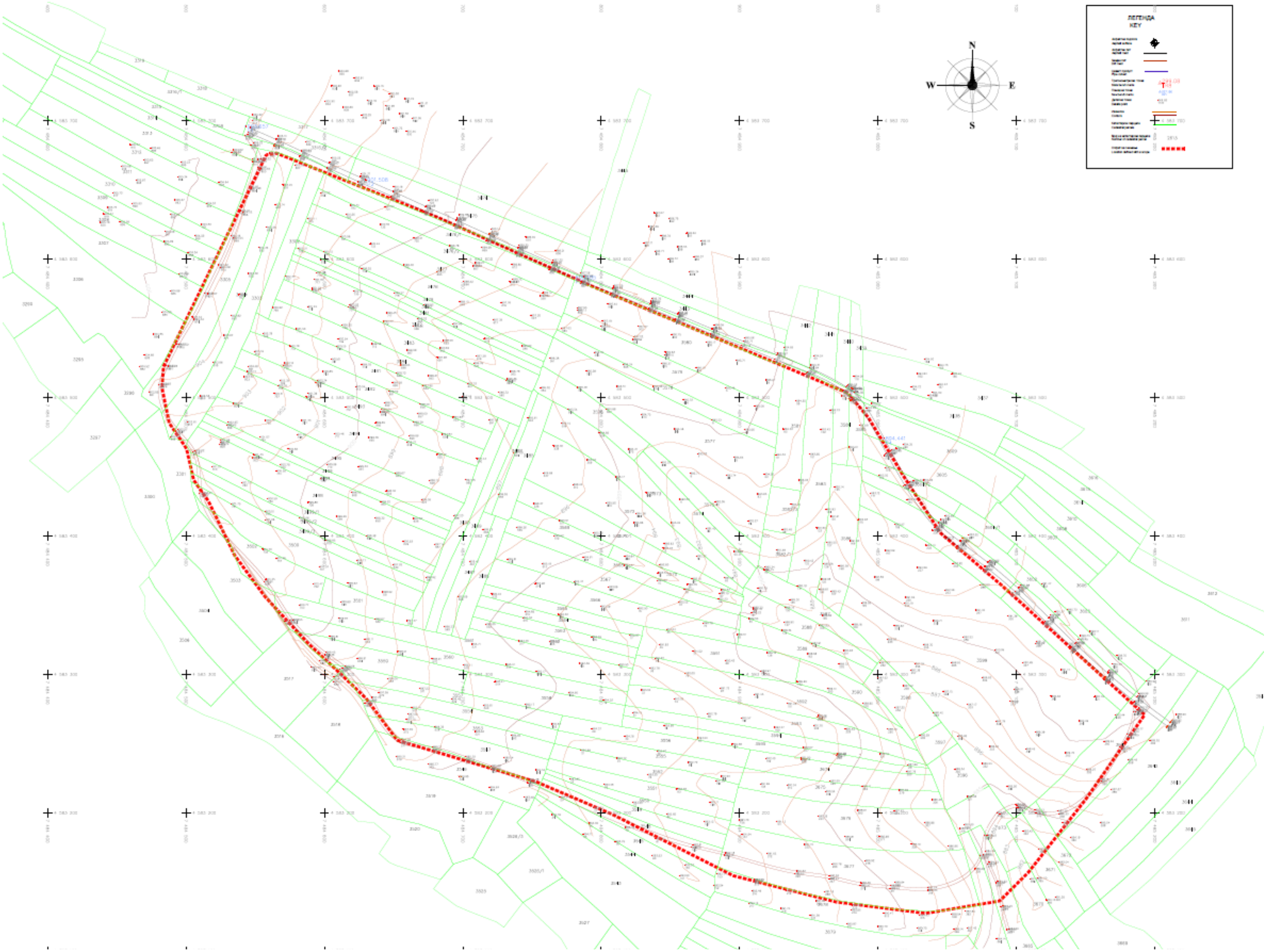


Figure 7-35: Topographic plan of existing site

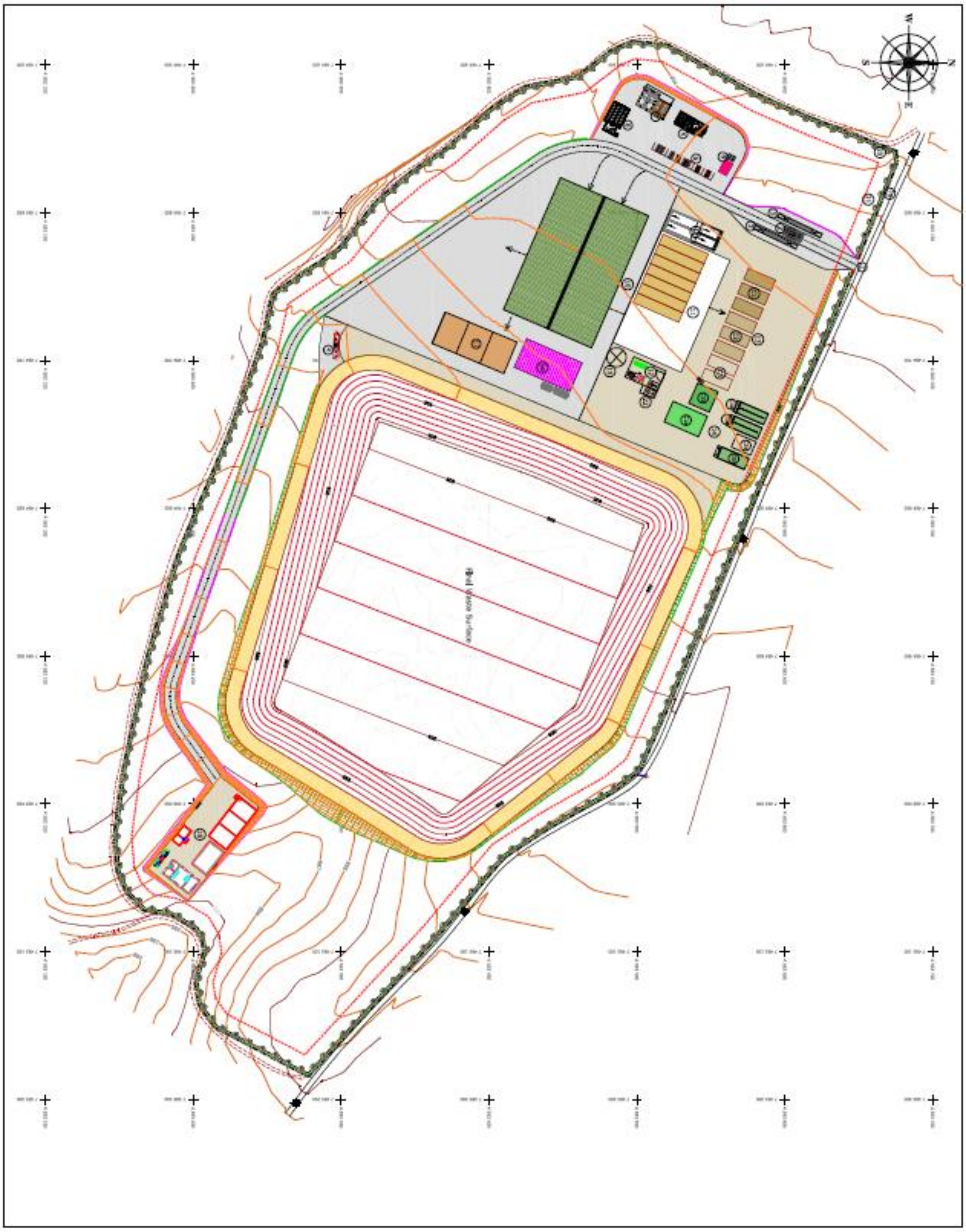


Figure 7-36: After closure topographic plan

7.1.4.3 Hydro – geological and geotechnical survey

GEOLOGY OF WIDER AREA

Geotectonicaly, "Godivje-G2" site is located within Western Macedonian zone, and the general geological composition of the site and position within the Vardar zone are shown in the beneficiary country's geological map with separated tectonic zones as shown in the following figure.

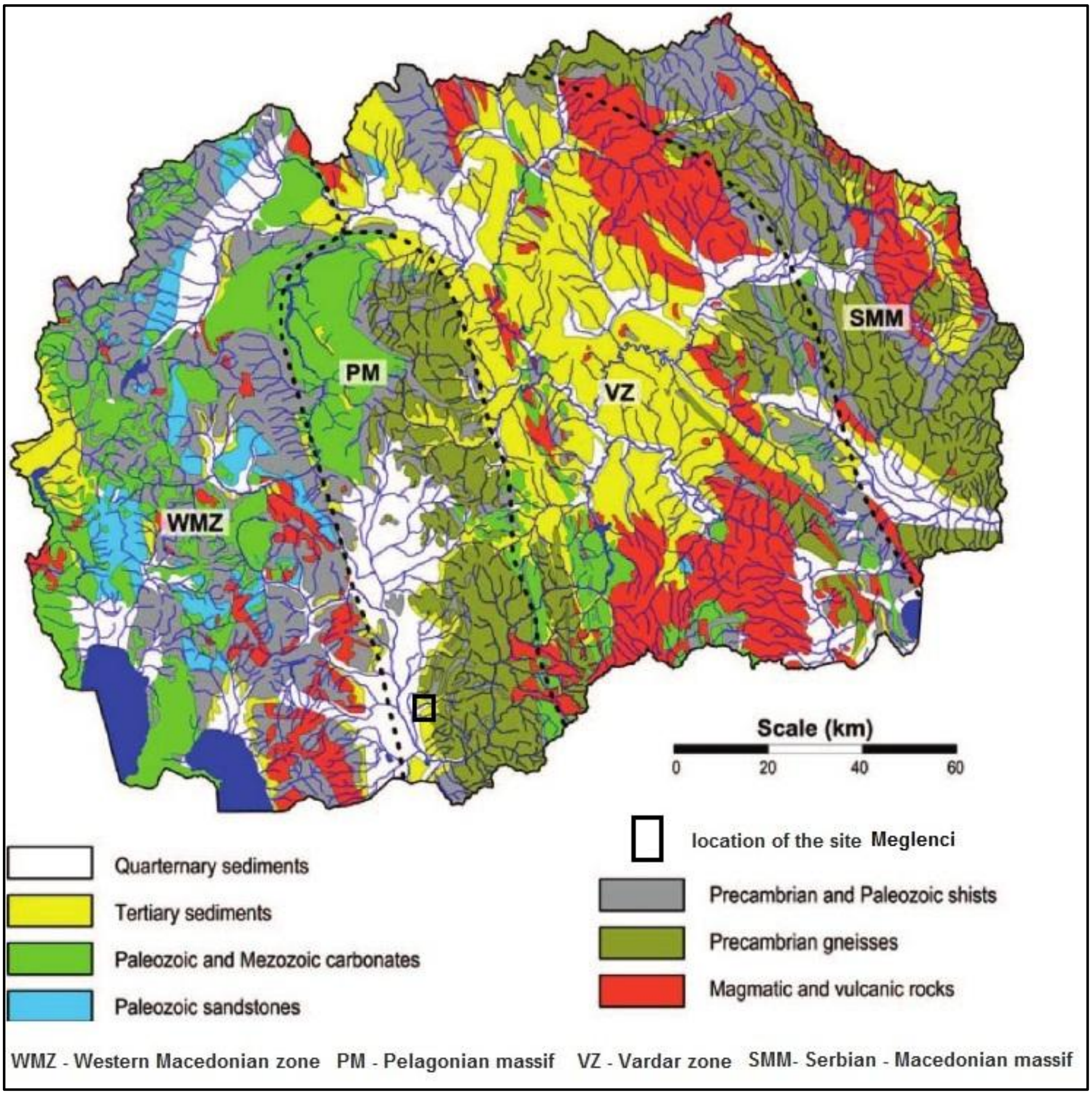


Figure 7-37: Beneficiary country's geological map with separated tectonic zones

Administratively, Godivje-G2 site is located within the territory of Debartsa Municipality, located in central part of Western Macedonia and encompasses the Debartsa valley.

The geological composition of the area of the Municipality of Debartsa is real mosaic of different rocks from different age, from Palaeozoic to Quaternary.

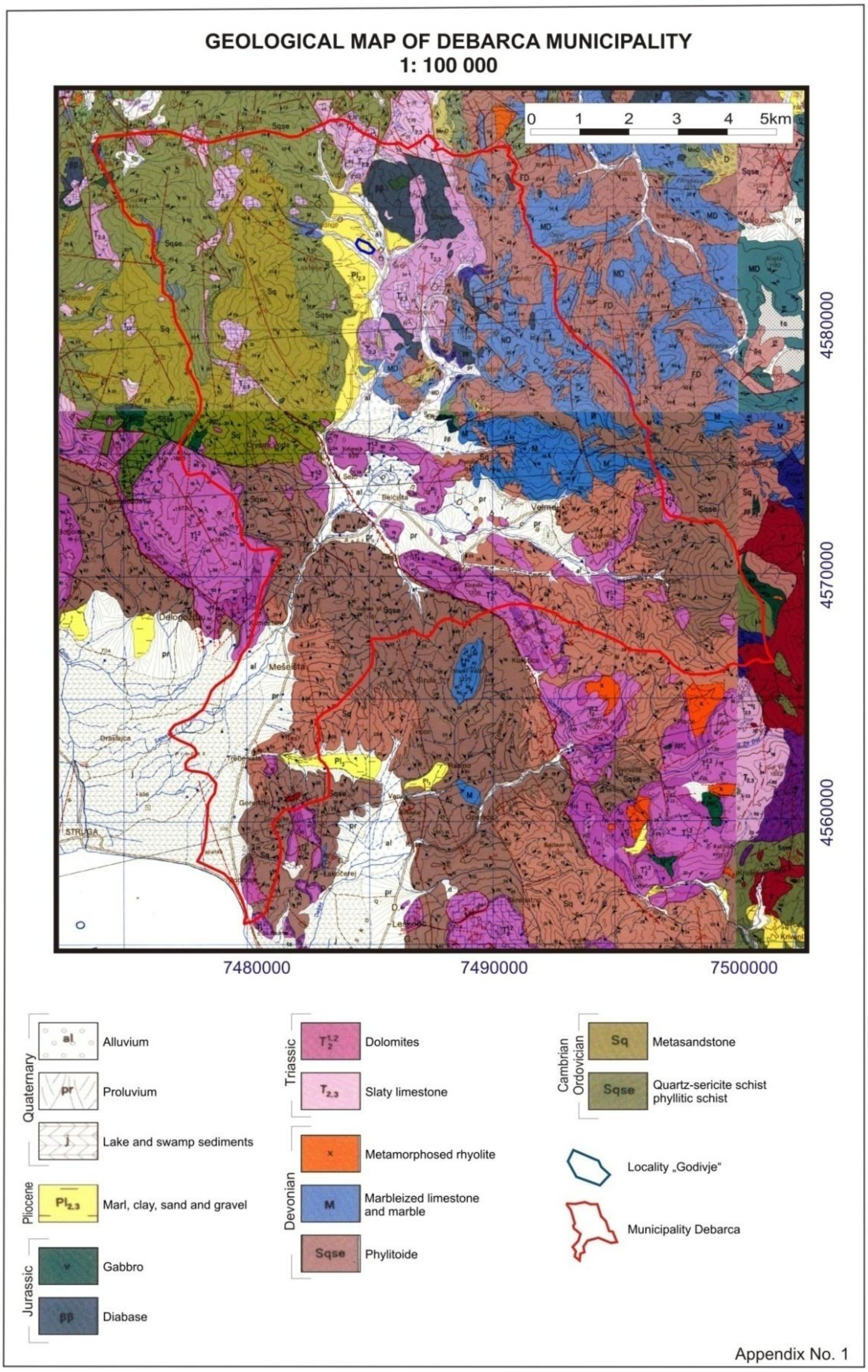


Figure 7-38: Geological map of Debartsa Municipality

Description of different rock formations found within the Debartsa territory grouped according the respective geological areas are given below.

PALEOZOIC

Quartz - sericite schists (phyllite schists) (Sqse)–are mostly composed of phyllites, but alsoinclude metasandstones, quartz - sericite schists, graphitic schists, etc. These lithological members change each other, vertically and horizontally. Phyllites are thin plated rocks with a light brown color and silky glow that comes from leaves of sericite, muscovite and chlorite.

Metasandstones (Sq) appear in different horizons of the stratigraphic column and alternately replace the phylite schists. Phylitoide included mainly phylite, and less commonly slates, sandstones, sericite - quartz schists etc. These rocks alternately replace each other, horizontally and vertically.

Phyllitoides (FD).Devonian rocks mostly composed of phyllites, but also include slates, sandstones, sericite - chlorite schists etc. These lithological members change each other, vertically and horizontally.

Marble series (MD) is represented with several types of marbles: plated, massive, crinoidal and dolomite marbles.

Metamorphic rhyolites (χ)protrude in Paleozoic schists or occur as interlayer lens like bodies.Almost completelytheir primary massiveness and gain schistose texture is lost. They have light gray, light greenish to gray color and high rigidity andare composed of phenocrystals of feldspar and quartz.

MESOZOIC

Triassic sediments (T) include two facies:

Facies of clastic sediments (conglomerates, sandstones, slates and cherts),

Facies of carbonate sediments (plated, massive and dolomite limestone).

Diabase’s (ββ)are connected with Jurassic magmatism and occur as intrusions in Paleozoic and Mesozoic rocks. Diabase’s havedark green color and are very strong and compact. The structure is ophiolitic or doleritic. They are composed of plagioclases, augite and chlorite.

Gabbros (v)occur with the diabases and are characteristic with their dark greenish color, great strength and compactness. Their structure is gabbroide granular, and the texture is massive. They are composed of basic plagioclase (altered), augite and olivine.

CENOZOIC

Pliocene (Pl2,3) sediments are developed on large area within the Debartsa basin and are partially covered with Quaternary sediments. Middle Pliocene sediments are developed in well stratified sediments represented with gravel, sand, different clays and marls. Upper Pliocene is developed in poorly stratified material represent by clays, gravels and sands. Upper Pliocene sediments have larger spreading related to middle Pliocene sediments.

Proluvia (pr) sediments are much developed on the border parts of Debartsa. They are composed of coarse clastic unsorted material, partially processed or unprocessed, composed of the surrounding bedrocks.

Alluvial (a) sediments are spread along the larger rives riverbeds and are mostly developed along the Crni Drim, Sateska, Koselska, Openichka, Cherava and Bolnska rivers. These sediments are composed of coarse clastic material composed of gravels, sands and sandy clays.

GEOLOGY OF THE STUDY AREA

According to data from BGM (Basic Geological Map) 1 - Kicevo Sheet (scale 1:100 000), study area ("Godivje-G2") and its immediate vicinity is composed of Pliocene sediments with small thickness and presented with marls, different clay-gravel and sands. Those sediments transgressively cover metamorphic rock from Paleozoic age as well as carbonate rocks of Mesozoic age.

Area planed for landfill (and associated facilities)construction covers 234 807m^2.Entire area was prospected and litologhical units composing the area were determined. Units found are presented at detailed area map.

As shown on the map,area of interests is a flat surface with the presence of a shallow depression in its south– eastern parts.The entire area is composed of Pliocene sediments (usually represented by claysh marls and gravel), but it should be noted that in the south east and south west parts of the area those Pliocene sediments are covered with diluvia materials with undetermined thickness.

Figure 7-39: Photo of the study area

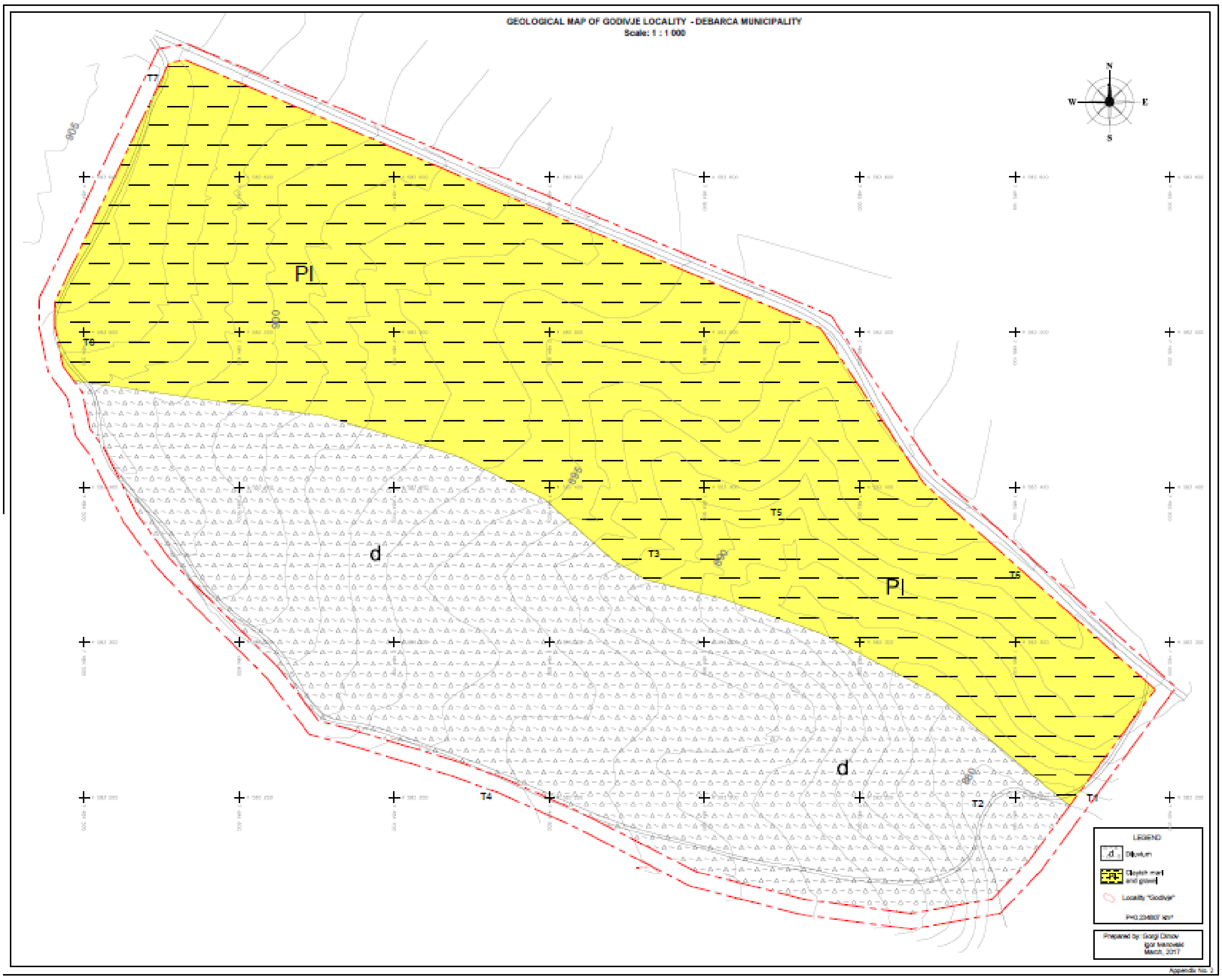


Figure 7-40: Geological map of the study area

Diluvia sediments(d)– As stated above, those layers are mostly present in the south-western and south-eastern parts of the study area and they are created with the disintegration of the material from the bedrocks. Completed shallow digs and field (macroscopic) examination shows that the diluvia sediments are composed of dark - brown dusty clay mixed with humus material. Sediments are fine-grained and have variable thickness which decrease going towards the upper parts of the depression. The following figure shows a small trench located in the dusty clays clearly presenting their colour, structure and grain-size composition.

Figure 7-41: Investigative trench located in dusty clays

In situ plasticity test (material is wetted and twisted as thin as possible strip), shows that material is very clayishas it can be twisted in very small strips(with diameter below 5 mm).

Pliocene sediments (Pl)within the study area appear on the surface only in the north-western and north-eastern parts, and are usually covered with thin (10 cm) layer of humus. Stratigraphically, Pliocene sediments come above diluvia sediments in the southern part of the area.

The initial explorations showed that Pliocene sediments within the area are composed of clayish marls and gravels. Clayish marls dominate the area except the north-western parts, where just under the humus cover gravels mixed with clay occur. There is a shallow trench constructed in the eastern side of the area of interest. It can be seen that Pliocene sediments appear on the surface and are composed of well diagenesed clayish marls, with light brown to yellowish colour.

Figure 7-42: Well diagenesed clayey marls with yellowish color

In the northwestern parts, gravel sediments mixed with the humus cover the marls. They are composed of poorly processed pieces of the surrounding schists and limestones with size up to 5 cm.

Figure 7-43: Gravel sediments

Initial geological investigations indicate that there is a clear distinction between diluvia and Pliocene sediments found within "Godvije-G2" site, but with this level of investigations their relations cannot be accurately defined.

TECTONIC - SEISMIC CHARACTERISTICS OF THE STUDY AREA

The study area is located within the western part of the Republic of Macedonia and belongs to Western Macedonian geotectonic unit.

It should be noted that Debartsa ridge was formed in middle Pliocene, when the terrain was covered with intensive radial movements. Faults within the ridge have North - South and East - Westorientation and are filled with Pliocene and Quaternary sediments. Large number of anticline and syncline structures can be noted around the ridge, and most remarkable are;

- Slatinska anticline on southeast,
- Preseka syncline and Vrbjanska anticline on the north, and
- Slavejska anticline on southeast.

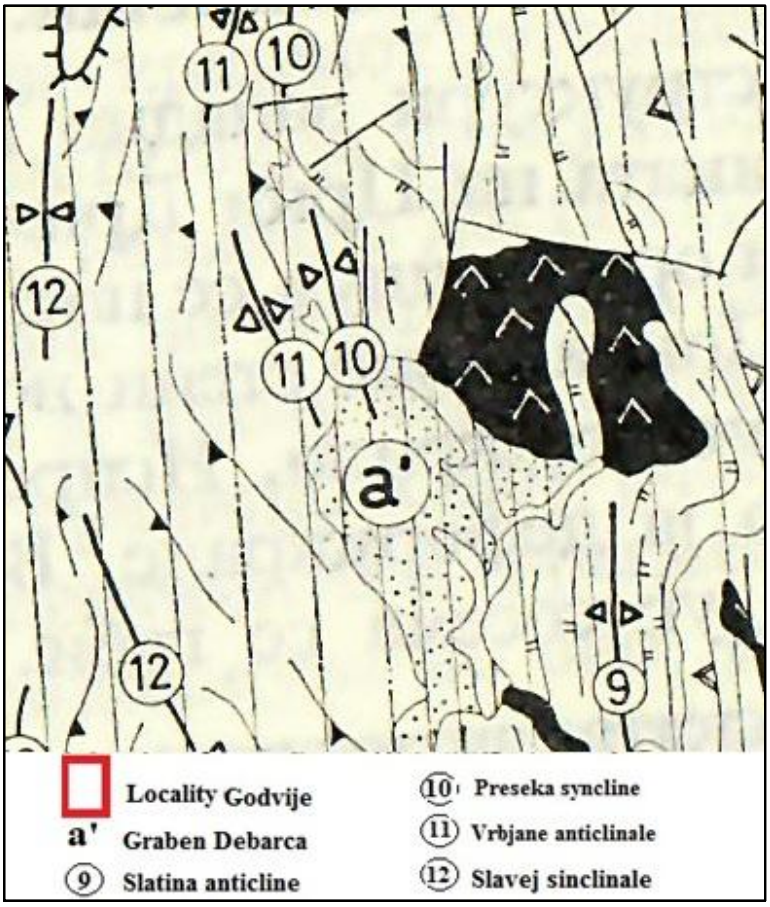


Figure 7-44: Tectonic map of the broader area of the study area

SEISMIC FEATURES OF THE TERRAIN

Epicentral areas on the territory of the Republic of Macedonia are covered with three seismic zones: Western - Macedonian, Vardar and Eastern - Macedonian zone.

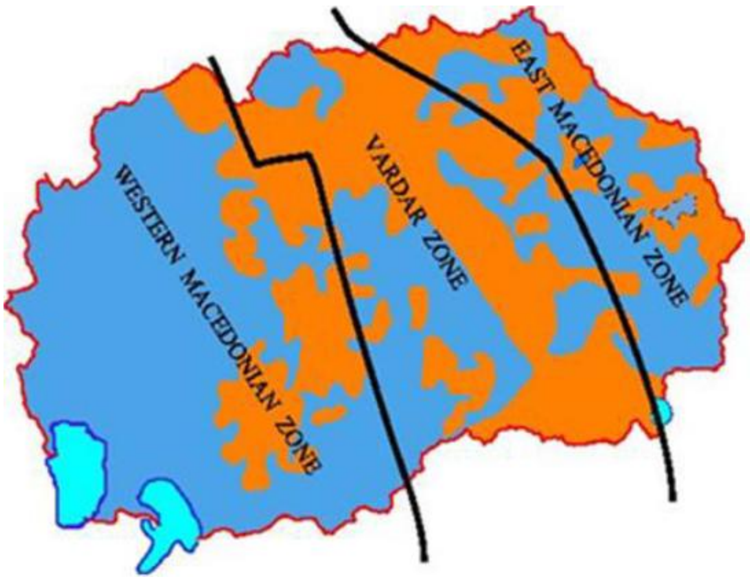


Figure 7-45: Seismic zones in the Republic of Macedonia

Western - Macedonian seismic zone corresponds to two tectonic units: Western - Macedonian zone with its intermediate parts to Mirdita in Albania and Pelagonia horst - anticlinorium. There are few epicenter areas: Tetovo - Gostivar, Debar, Kicevo, Pestani - Ohrid - Struga, Bitola and Bitola - Florina.

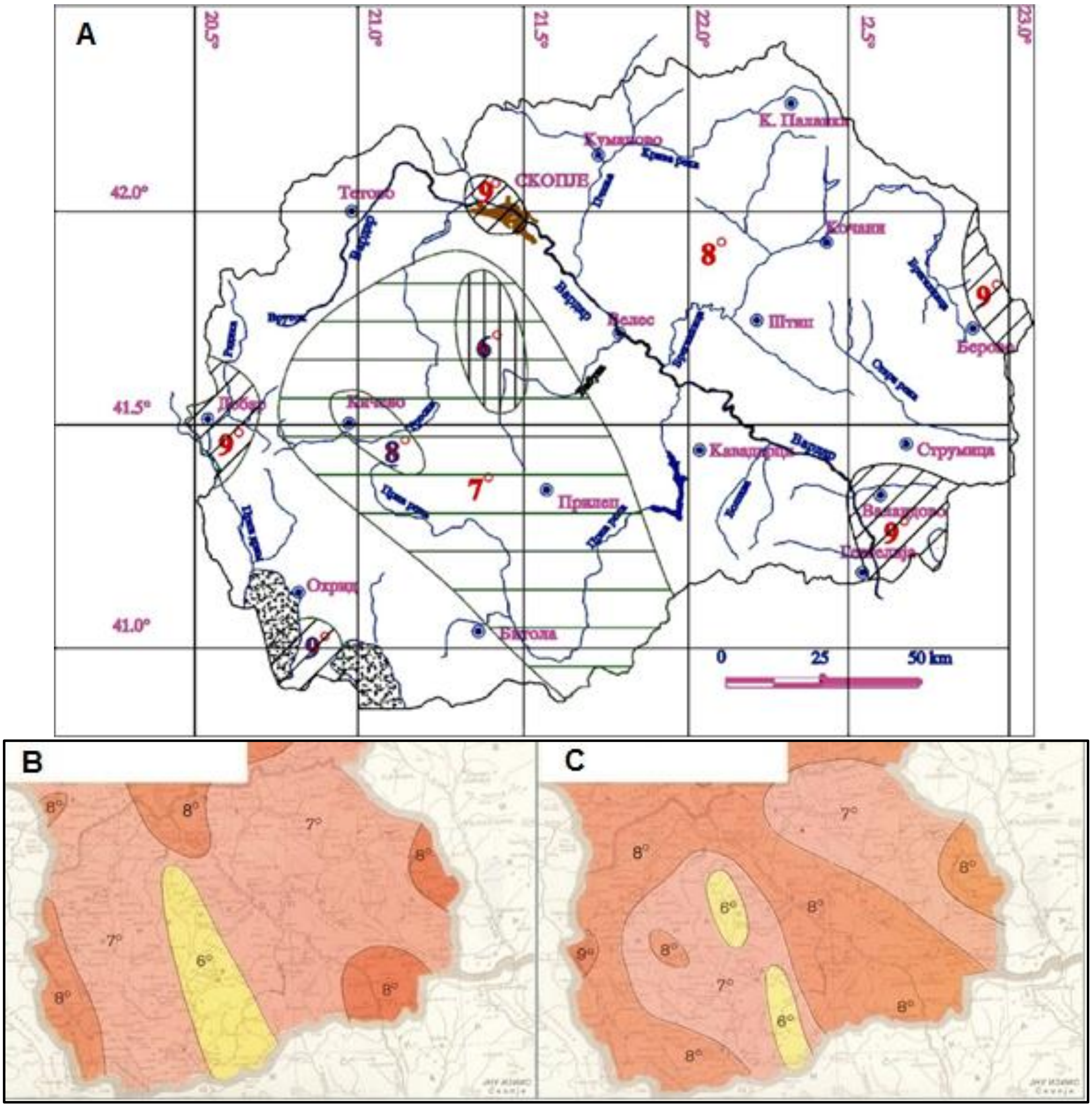


Figure 7-46: Map of intensities for return period of A - 500 years, B- 200 years and C – 100 years

Earthquakes with intensity up to 9oaccording the MCS-scale at 500 years return period are expected only within few limited zones, while the largest part of the territory (including the study area) is in the zone of expected intensities of up to 8oaccording the MCS. The study area is within zone with expected intensities of 8o according MCS.

The Map of seismic sources on the territory of the Republic of Macedonia for maximal expected magnitude ML ≥ 6.0 present zones with the most intensive seismic activity. In some cases, those places are sources of autochthonous earthquakes and in other they are zones of anomalous absorption of seismic energy from distant earthquakes.

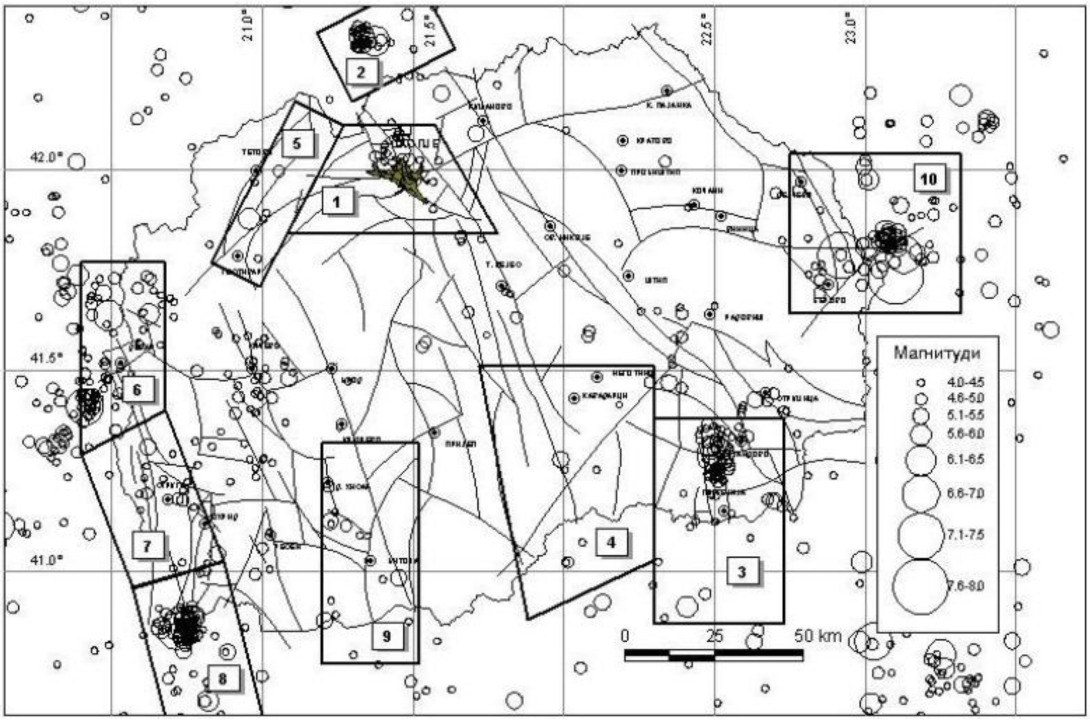


Figure 7-47: Map of seismic sources on the territory of the Republic of Macedonia for maximal expected magnitude ML ≥ 6.0

As shown on the map, the "Godivje-G2" site is out of the areas with the most intensive seismic activity and stronger earthquakes should not be expected.

HYDROGEOLOGICAL FEATURES

Hydrogeological conditions within the study area were analyzed in order to determine possibilities for high groundwater levels occurrence within the future regional landfill site, as well as to determine the need for surface and ground waters protection measures. Analysis includes;

- hydrogeological function of rocks,
- types of hydrological - hydrogeological occurrences.

Rock types found within study area, can be classified according to their hydrogeological function as:

- hydrogeological complexes whichinclude Pliocene sediments
- hydrogeological insulators which include diluvia sediments composed of dusty clays

Within the hydrogeological complex, gravelsin Pliocene sediments are typical collectors with inter-granular porosity and they allow infiltration of surface waters to the zone with constant underground water level or layers of clayish marl or clayas typical hydrogeological insulators. Within this complex, boundary springs are formed. Site prospection indicates that gravels are mixed with clay and clayish marl, which make their filtration coefficient significantly lower.

The largest part of the study area is composed of clayish marls or their surface disintegrations. Those formations are hydrogeological insulators with filtration coefficient k = 0.01 – 0.1 m'/day. Also diluvia sediments composed of dusty clays and humus matter can be classified as insulators that prevent rapid infiltration of surface waters. This is supported with notation of small wet area in the lowest parts of the site (south-eastern). This area actually presentthe lowest part of the erosion basin and all atmospheric waters are drained to this zone, but due to low water permeability of the surface, small temporary wetlands are formed.

GEOTHECNIAL CHRACTERISTCS

Geological prospection also includes general determination of site geotechnical characteristics, as follows:

- Determination of contemporary geological processes and phenomena(landslides, rockslides, gully's and ravines),
- Geotechnical categorization of rock masses,
- Terrain stability conditions,
- Surface waters presence,
- Foundation,
- Cover and sealing materials.

SLOPE STABILITY– CONTEMPORARY PROCESS AND PHENOMENA

Site prospection did not determine presence of contemporary geological processes and phenomena (landslides, rockslides, gully's and ravines), and terrain can be classified as a stable in natural conditions. Natural slopes within the study areahave angles below20° andoccurrences of active land-sliding were not determined.

Since the study area is a complex environment, composed of poorly bounded rock masses that occur in layers (vertically the layers show some mechanical anisotropy and discontinuity that could condition sliding), all cautions during design and construction works are strongly recommended.

CATEGORIZATION OF ROCK MASSES

From engineering geology point of view, clayish marls and gravels from Pliocene complex could be classified as unbounded or poorly bounded rock masses. They are mainly medium compressed and well diagenesed and because of this, direct excavation (mechanical) can be used without the need of ripping and/or blasting. The same applies to diluvia dusty clays which perhaps have even less cohesion than Pliocene sediments.

FLOOD AND RUNNOF

Prospection visits didn't reveal permanent or periodic flows within the study area and its immediate vicinity, so possibility of flooding could be literally eliminated. Having in mind size of the catchment area and slope angles, construction of drainage facilities for acceptance of rainwater is recommended.

WASTE (DAILY) COVER MATERIALS

First impression isthat gravels within Pliocene sediments are semipermeable and can meet the requirements for daily waste cover so the quantitiesthat will be obtained during the earthworks for foundation of buildings and disposal cells excavation, can later be used for this purpose.

In case additional quantities are needed, or excavated materials does not meet the purpose, we suggest utilization of Pliocene gravels within the site immediate vicinity, as there are several appropriate locations for borrow pits organisation.

SEALING MATERIALS

Diluvia and clayish marls from Pliocene sediments can be used for geological barriers construction (sealing). In case additional quantities are needed or excavated materials does not meet the purpose, we suggest utilization of diluvia and proluvia sediments along the road to Laktinje village (1.5 km from the site), where old clay borrow pits can be found.

Figure 7-48: Inactive borrow pit of clay

FOUNDATION

Foundation of heavy and complex facilities in thick Pliocene environments should be very carefully planned and performed, as the rule "excavation to fresh rock" here does not apply because such rocks cannot be found near the surface and detailed geotechnical analysis of the site is of crucial importance. First impressions indicate that some measures in order to improve properties of the ground base will be necessary. If possible, foundation in diluvia sediments and the clays should be avoided because of the appearance of swelling, or those materials should be fully removed from the site of the foundation.

7.1.4.3.1 Conclusions

Main conclusions emerged from geological prospection of G2 site, could be summarized as follow:

- Administratively, site G2 is located within the territory of Debartsa Municipality. This is rural municipality, located in central part of Western Macedonian and encompasses the Debartsa valley.
- The geological composition of the area of the Municipality of Debartsa is real mosaic of different rocks from different age, from Paleozoic to Quaternary.
- Geomorphologically, study area is a flat surface, with the presence of a shallow depression in its south - east parts.
- Largest part of the area is composed of Pliocene sediments (clayish marls and gravel) that appear on the surface and onlyin south east and south west parts those Pliocene sediments are covered with diluvia material with undetermined thickness.
- "Godivje-G2" site is located outside of most intensive seismic activity areas and stronger earthquakes should not be expected.

- Rocks present within the study area, in terms of their hydrogeological function, can be classified as hydrogeological insulators (diluvia sediments composed of dusty clays) and hydrogeological complexes (Pliocene sediments).
- Landslides, rockslides, gully's and ravines where not determined and terrain can be classified as a stable in natural conditions. Occurrences of active landslides were also not determined.
- There are no permanent or periodic flows within study area and flooding potential is very low.
- Gravels withinthe Pliocene sediments are semipermeable and can meet the requirements for daily waste cover.
- Preliminary investigations and in situ tests indicate that diluvia and clayish marls from Pliocene sediments can be used for geological barriers construction (sealing).

7.1.4.4 Proposed site layout with infrastructure and staged filling plan (min. scale ~ 1:1.000).

The concept of the general layout design follows the topography and geology of the site.

The entrance is foreseen from the northwest end of the site. From the point of entry an internal road will begin with 8m width which ends at the downstream area of the landfill where the Leachate Treatment Plant is designed in order to receive the leachate by gravity (elevation at +885.00 m).

Immediately after entering the site,the vehicles will pass from the guardhouse and weighbridge. In case of vehicles that do not need to be weighted, there will be the possibility to bypass the weighbridge by side lanes. Following the road downhill next facilities to be met, are biological treatment facilities and the green waste facilities. More specifically, in this level, which covers an area of 19,710 m^2 and has a mean elevation at +900.27 m,the anaerobic digestion building with the process water tank and the biofilter, the composting area for organic material, the composting area for green waste, the biogas station and the flare unit for landfill gas are located.

Following again the road downhill, it leads to the waste treatment facilities. More specifically, in this level, which covers an area of 22,700 m^2 and has a mean elevation at +899.44 m, the reception area of the mechanical sorting building, the biofilter and the recyclable storage are located.At the other side of the road, there is the auxiliary facilities' level.This area is 4,340 m^2, and it has a mean elevation at +900.94 m. The administrative building, the maintenance building, the energy building, the water tank and the parking area are foreseen at this area.

Regarding the landfill design, all the configurations have been decided based on the following principles (having in mind the slopes of the terrain):

- Proper leachate collection, avoiding mixture with the rain water.
- Easy accessibility of the garbage trucks to the bottom of the basin.
- Construction of a perimeter trench for runoff of the rain water.
- The height of the final waste body should not exceed by far the existing topography.

The SL design was based on the Landfill Directive 99/31/EC and the respective national legislation: No. 07-4408 Rulebook (May 20, 2009).

The overall SL of Southwest region, will be developed in two phases, Phase "A" and Phase "B". Phase "A" will be divided in two subcellsand Phase "B" in three subcells.

Phase "A" will be divided in two subcells A1 and A2. This will be achieved with the construction of a separation dike, dividing the bottom in two areas. For the construction of phase "A" of the landfill, 39,400 m^3 excavations and 47,500 m^3 embankments will be required. From the total volume of the embankments, the backfilling of the separation dike will be 1,700 m^3. Additionally, 24,000 m^3 excavations and 64,310m^3 embankments for the configuration of the area for the whole central waste management facility (administration area, MRF and composting area, LTP area, internal road connections) will be required. The surface of phase "A" will be about 23,700 m^2 (excavation level) and it will have a total capacity of 168,600 m^3. The lowest altitude of the phase "A" (in absolute units above Sea level) will be +886.21 m, while the highest altitude will be +898.24 m. The estimated life of the landfill is expected to be almost 8 years.

The bottom has longitudinal inclination 3.00%, with direction from west to east and transverse inclination 1.00%, so that the leachate will be collected by gravity (Drawing 4 - General Layout of works - Start of operation phase A).

The sides of the basin are designed with grade 1:3 (height:base). The sealing system is described in chapter 7in detal.

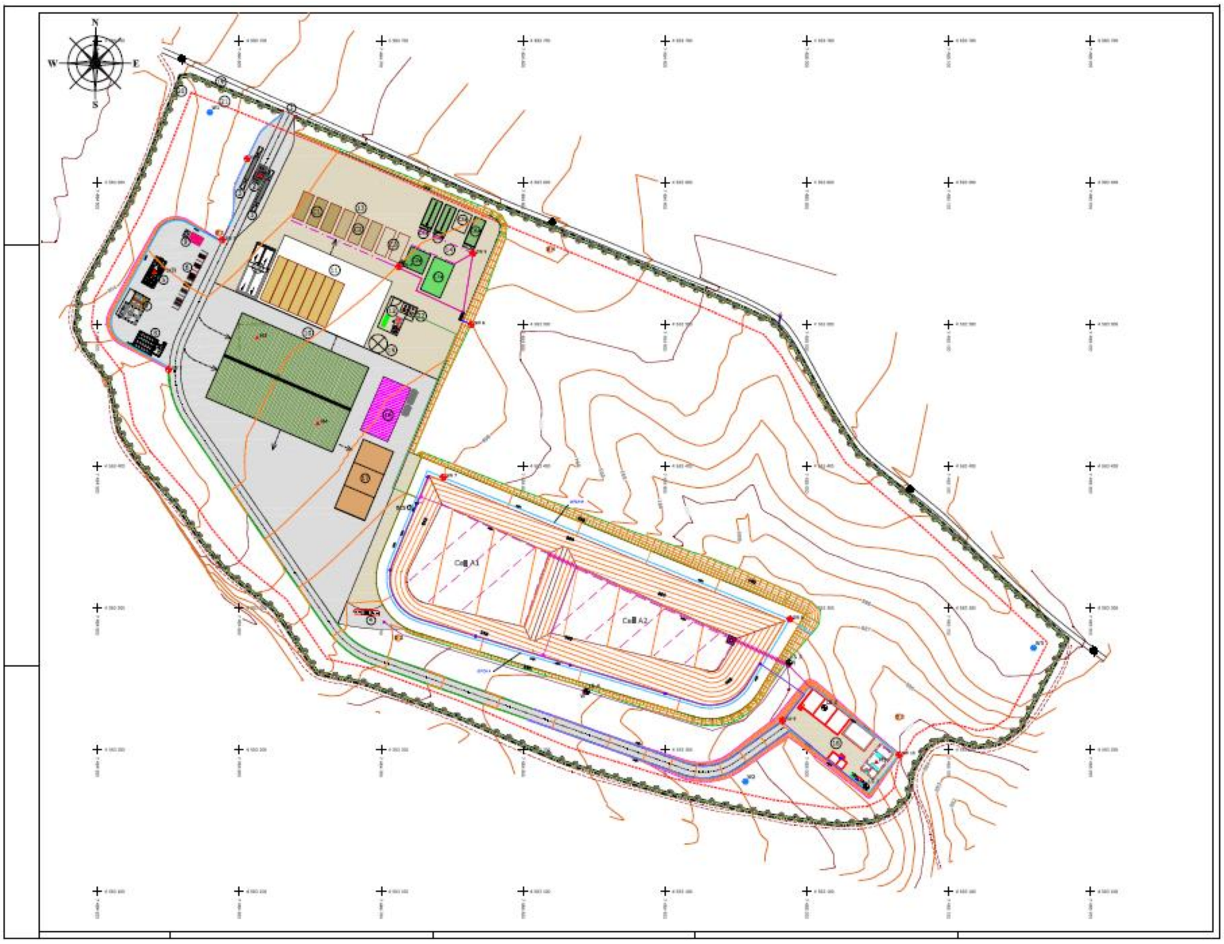


Figure 7-49: General Layout of works - Start of Operation of Phase A

Phase "A" and "B" will be separated with the construction of a dike. The dike will have 10 meters width and maximum 5.6 meters height from the natural ground. Both of its sides will have slopes of 1:3 (height:base).

The following table presents the basic characteristics of Landfill - Phase "A".

Table 7-26: Main technical characteristics for the phase A

Element	Amount	Unit
Excavation	39,400	m^3
Backfill	45,800	m^3
Phase A - Bottom excavation level	47,500	m^2
Phase A - Slopes excavation level	11,850	m^2
Total area	11,850	m^2
Capacity	23,700	m^3

At the north of phase "A", phase "B" will be developed (Drawing 6 - General Layout of works - Start of operation phase B).

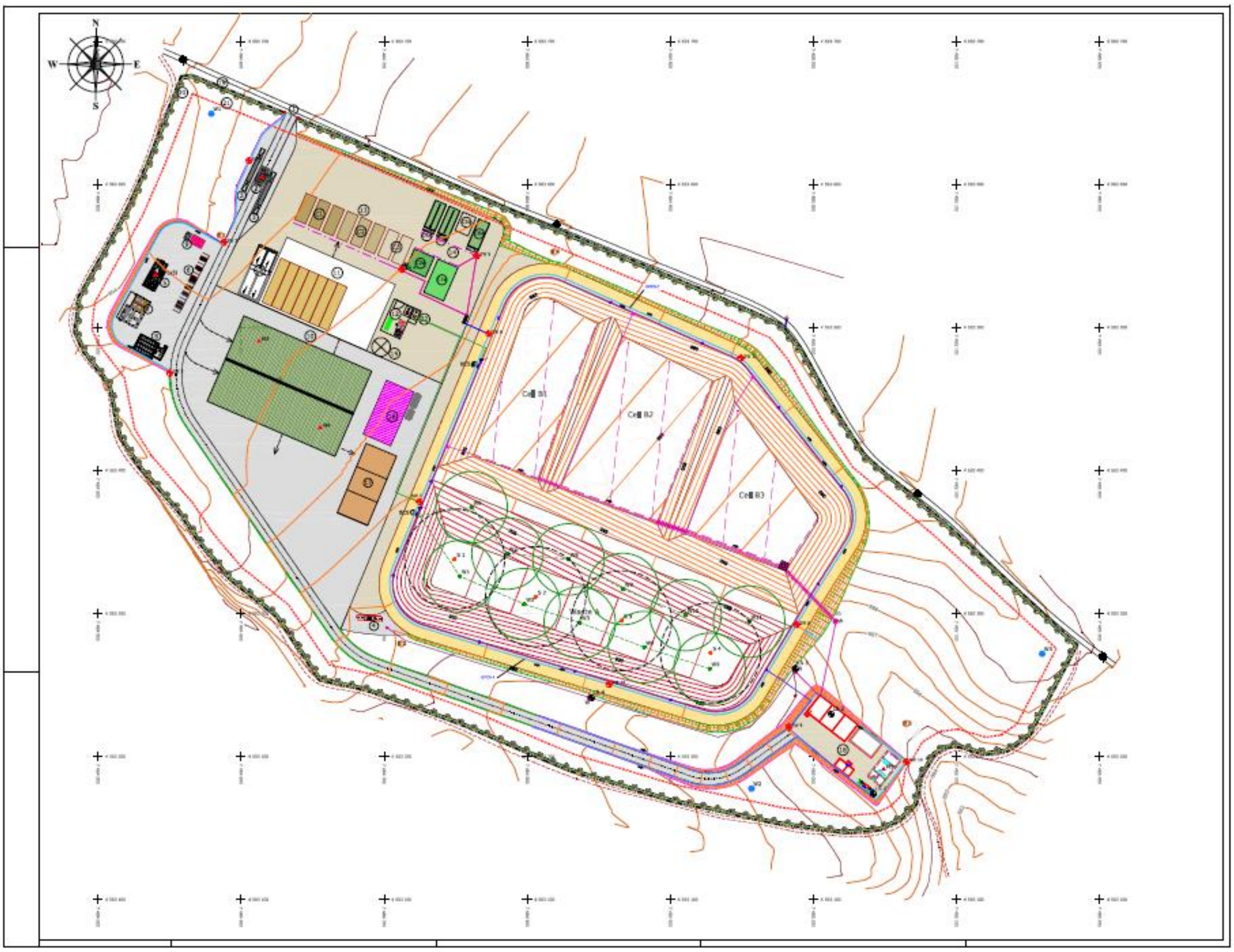


Figure 7-50: General Layout of works - End of Operation of Phase A - Start of operation of Phase B

Phase "B" will be divided in three subcells B1, B2 and B3. This will be achieved with the construction of two separation dikes, dividing the bottom in three areas. For the construction of phase "B" of the landfill, 72,300 m³ excavations and 20,900 m³ embankments will be required. From the total volume of the embankments, the backfilling of the separation dikes will be 5,820 m³. The surface of phase "B" will be about 42,800 m² (excavation level) and it will have an additional capacity of 381,550 m^3.

The total estimated lifetime of the landfill is expected to be at least 26 years with a capacity of 550,150 m^3.

The following table presents the basic characteristics of the landfill in total.

Table 7-27: Main technical characteristics for total landfill

Element	Amount	Unit
Excavation	111,700	m^3
Backfill	60,880	
Backfill (with separation dikes)	68,400	m^3
Total landfill - Bottom excavation level	36,740	m^2
Total landfill - Slopes excavation level	29,760	m^2
Total area	66,500	m^2
Capacity	550,150	m^3

Note: The daily cover, which is considered as the 10% of the waste volume, is included in the above mentioned waste volumes.

7.1.4.5 Proposed designs for bottom lining and top cover systems

In the design phase of a landfill, three stages should be considered:

- The construction stage, when barriers and networks for the safe management of pollutants are installed (membranes, lining systems, leachate and biogas collection systems).
- The operation stage, when daily cover of disposed waste takes place, while monitoring the environmental impacts related to waste deposition.
- The Closure and aftercare stage, when the application of the top cover takes place for the minimization of the environmental impacts related to the deposited waste. Also, the monitoring of the environmental impacts related to the landfill continues for several years, while activities for the utilization of the site take place.

Landfill bottom sealing system

According to the Rulebook on technical conditions for the landfills construction, Official Gazette of the Republic of Macedonia No 78/2009 the bottom sealing system of a landfill is a technical system of structures and measures that are being built at the bottom and swept sides of the bottom of the landfill, in order to prevent pollution of soil, groundwater and surface water. The bottom sealing system includes at least the following:

- Flexible synthetic waterproof membrane / geomembrane
- Drainage layer
- Drainage pipe for leachate collection

Protection of soil, groundwater and surface water is to be achieved by:

- **During the operational phase / active phase** of the landfill with a combination of the geological barrier with the bottom liner of the landfill, and
- **During the passive stage / after closure** with a combination of the geological barrier with the bottom liner and with a combination of the geological barrier and the top liner.

The geological barrier is determined by geological and hydrogeological conditions below and in the vicinity of the landfill site according to Paragraph (2) of the Rulebook on technical conditions for the landfills construction, Official Gazette of the Republic of Macedonia No 78/2009, providing sufficient retention capacity to prevent the potential risk to soil and groundwater.

The landfill base and sides shall consist of a mineral layer which satisfies the thickness and permeability requirements for water (determined by the coefficient of water permeability K) provides protection to soil, groundwater and surface waters, at least equivalent to the one resulting from the following parameters:

- Landfill for hazardous waste: $K \le 1.0 \times 10^{-9}$ m/s; thickness ≥ 5 m;
- Landfill for non-hazardous waste: $K \le 1.0 \times 10^{-9}$ m/s; thickness ≥ 1 m;
- Landfill for inert waste: $K \le 1.0 \times 10^{-7}$ m/s; thickness ≥ 1 m.

Where the geological barrier does not naturally meet the above conditions it can be completed artificially by applying a layer of sealant mineral land and use of other appropriate technical measures to provide equivalent protection of soil, groundwater and surface water. An artificially established geological barrier should be no less than 0.5 meters thick.

With regard to the minimum requirements of the legislation (Rulebook on technical conditions for the landfills construction, Official Gazette of the Republic of Macedonia No 78/2009), the bottom sealing system of the landfill will be carried out as follows:

- mineral layer with a minimum thickness of 1m and a coefficient of water permeability $K \le 1{,}0 \times 10^{-9}$m/s or artificial mineral coated layer with a minimum thickness of 0.5m from improved soil or similar (clay), that provides equivalent protection as a mineral layer with a minimum thickness of 1m and a coefficient of water permeability $K \le 1{,}0 \times 10^{-9}$m/s
- Geo – membrane with thickness ≥ 2mm and
- Drainage layer for leachate collection with a thickness exceeding 0,5 m with a coefficient of water permeability $K \ge 1{,}0 \times 10^{-3}$m/s.

More specifically, the selected bottom lining system for the landfill consists of the following layers:

- Sub base of compacted soil, with thickness of 0,3m;
- Artificial mineral coated layer with thickness of 0,5m from improved soil or similar, that provides equivalent protection as a mineral layer with thickness of 1m and a coefficient of water permeability $K \le 1{,}0 \times 10^{-9}$m/s. Alternatively a geo-synthetic clay layer (GCL) could be used, which would ensure equivalent results to the aforementioned barrier layer of clay material, which is to be mounted on soil materials of thickness 0.5 m;
- Geo – membrane with thickness 2mm ;
- Protection geotextile for the geo-membrane with a surface mass of 800 gr/m^2;
- Drainage layer from gravel with thickness 50 cm and permeability $K \ge 1{,}0 \times 10^{-3}$m/s. Alternatively, only on the slopes of the landfill, a drainage layer of geo-synthetic materials with equivalent permeability and flow rate as that of the gravel layer of thickness 0.5 m with $K > 1 \times 10^{-3}$m/s could be constructed. In this case the layer should lie above embedded separation geotextile.;
- Separation geotextile between drainage layer and waste with a surface mass of 400 gr/m^2

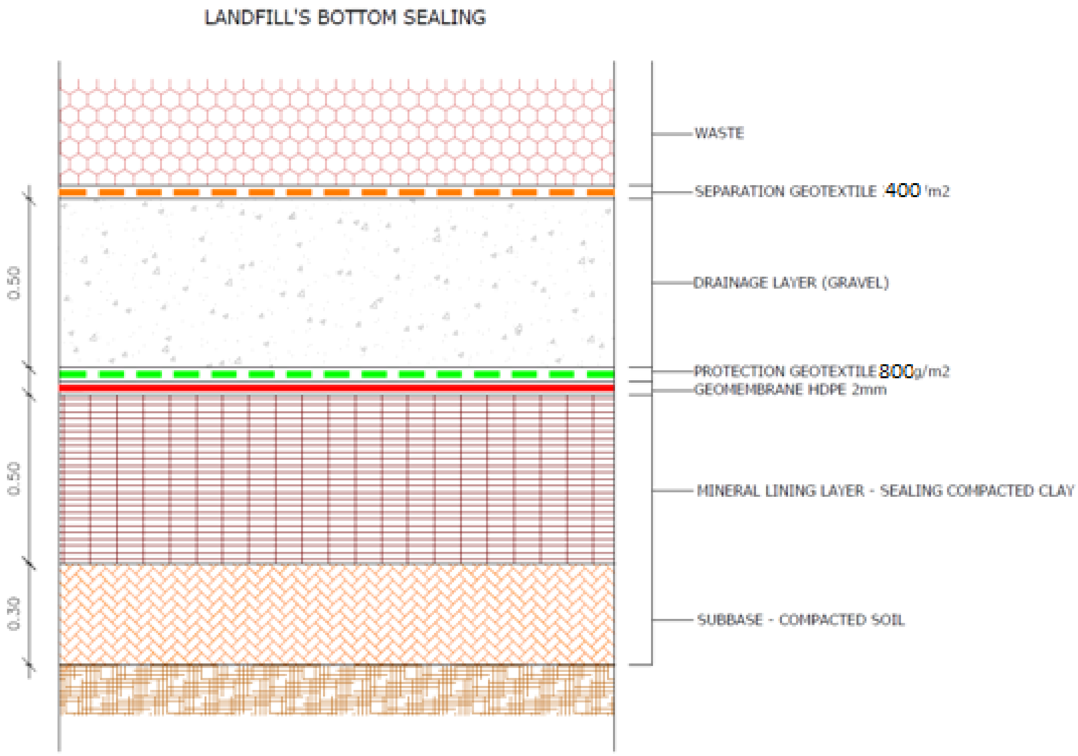


Figure 7-51: Bottom Lining System

Landfill surface sealing system (top cover)

This section describes the closure, capping and aftercare of the landfill, so as to minimize penetration of surface water into the landfill cells and to provide protection of atmospheric air and surface water against contamination from the waste cells.

The objectives of the surface sealing system are to:

- Minimize infiltration of water into the waste;
- Allow surface drainage and maximize outflow;
- Control the landfill gas emission, and
- Enable a physical separation between waste and plant - animal life.

The landfill surface sealing system will consist of the following layers (according to the Rulebook on technical conditions for the landfills construction, Official Gazette of the Republic of Macedonia No 78/2009):

- Surface layer of soil with thickness of at least 1,0 m, from which the upper 0,3m will consist of enriched topsoil for vegetation purposes;
- Separation geotextile between surface layer and drainage layer with a surface mass of 300gr/m^2
- Drainage layer with thickness 0,5 m with a coefficient of water permeability K ≥1,0 x10^{-4}m/s. Alternatively, a drainage layer of geo-synthetic materials with equivalent permeability and flow rate as that of the gravel layer of thickness 0.5 m with K> 1x10^{-4}m/s could be constructed. In this case the layer should lie above embedded separation geotextile;

- Compacted mineral layer with thickness greater 0,6m with a coefficient of water permeability K≤ 1,0 x 10^{-9}m/s. Alternatively a geo-synthetic clay layer (GCL) could be used, which would ensure equivalent results to the aforementioned barrier layer of clay material.
- Separation geotextile between mineral layer and gas drainage layer with a surface mass of 300gr/m^2
- Separation geotextile between mineral layer and gas drainage layer with a surface mass of 300gr/m^2
- Gas drainage layer with thickness 0,3 m. Alternatively, a drainage layer of geo-synthetic materials with equivalent permeability and flow rate as that of the gravel layer of thickness 0.3 m with K> 1x10^{-4}m/s could be constructed. In this case the layer should lie above embedded geotextile separation.;
- Temporary cover layer of soil with a minimum thickness of 0,2m

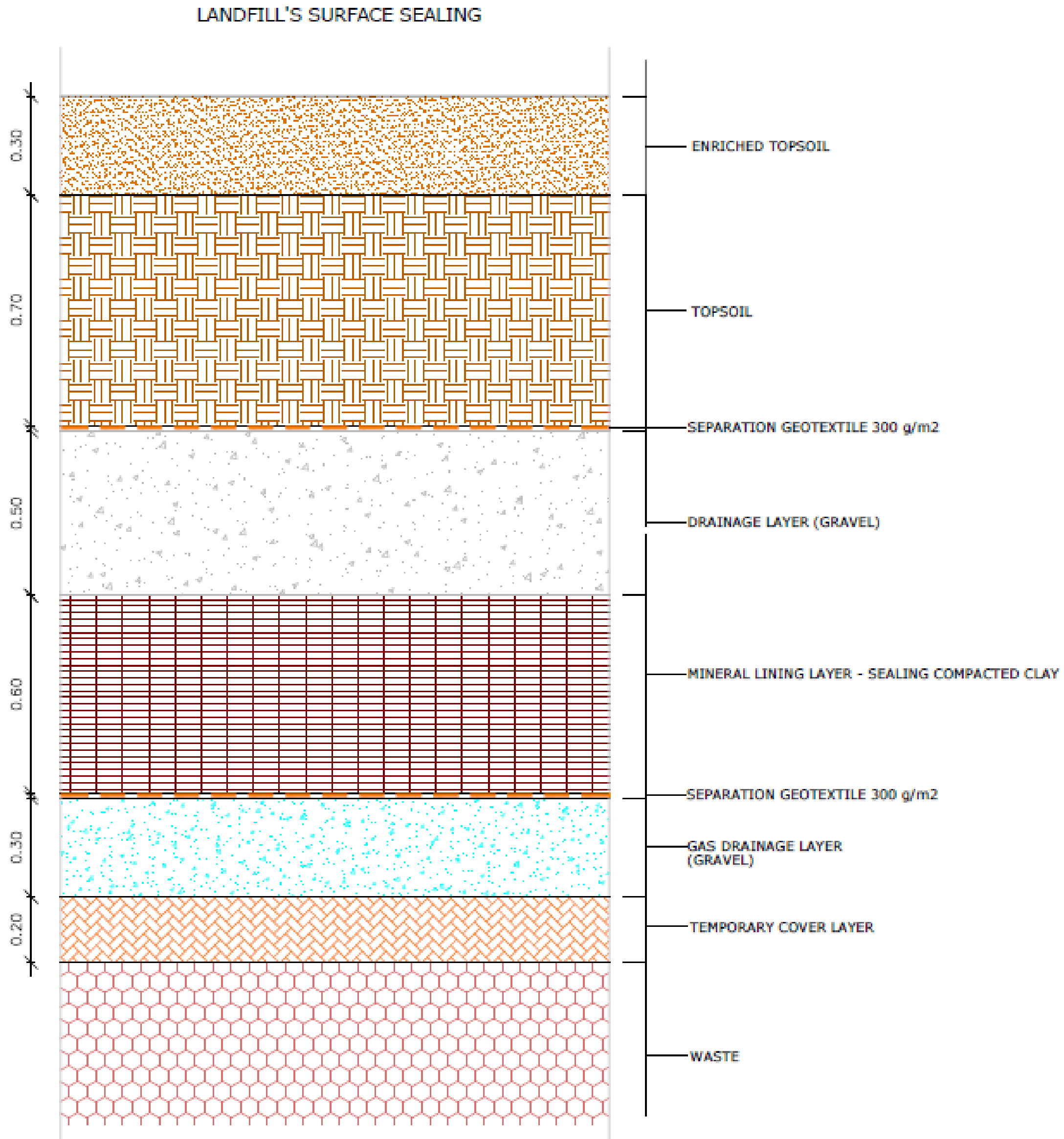


Figure 7-52: Top surface sealing system

7.1.4.6 Description of landfill operating routines and interim cover systems.

Landfill operating routines, not only include the daily activities associated with the placement of waste residues in the landfill, but also the execution of a variety of specialized tasks related to leachate management and gas extraction.

Routine duties of landfill operators include:
- weighing and inspecting waste loads;
- monitoring of treatment facilitates;
- moving waste residue to appropriate disposal areas;
- waste disposal operation (residue tipping, compaction, cover soil placement);
- operation and maintenance of the leachate control system;
- operation and maintenance of gas control systems;
- standard site maintenance;
- record keeping and reporting.

The waste transportation trucks that enter the landfill are coming either from the transfer stations (long vehicles) or directly from the settlements (collection trucks). The trucks enter the weighbridge area to record the necessary information for billing. Then, they are directed to the designated unloading areas according to the truck load (residual bin waste, recyclable waste). After the treatment process, the stabilized residue is directed with loader trucks (landfill transportation equipment) to the dedicated disposal area – active face of the landfill.As loader trucks unload their contents, landfill personnel, using appropriate equipment, pushes the material and compacts itutilizing compactors designed to maximize density. The surface upon which the daily cover is applied should be well compacted and free from major ruts and depressions. The proper soil compaction contributes to the minimization of the required soil cover material.

Figure 7-53: Compaction at the landfill and Loading of soil cover material

The regular application of daily cover soil is perhaps the most fundamental control on direct effects arising from landfilling. There will be availability of soil material for the daily cover of which was accumulated and during the construction phase of the landfill. For the placement of required cover material (at the necessary frequency and amount), cover soil is hauled to the working face. The cover material for the daily and interim cover is laid out as follows: the soil material is propelledonto the inclined surface and evens it as much as possible. All the waste residues should be covered, not only at the slopes but also at the top of each cell. The thickness of the cover layer varies and depends on the characteristics of the cell.

Cover soil should be applied to the working face whenever operations are suspended, such as at the end of the working day, or over weekends. In addition, cover should be applied more frequently across the top and to any exposed sides of the daily cells throughout the day if at all possible. All waste residues should be completely covered with a layer of cover soil (or appropriate alternative cover) at the end of each working day.

Intermediate cover refers to the placement of suitable, adequate and stable soil (i.e. indicative 200-300 mm) over deposited waste residue for a period of time prior to temporary capping or prior to further disposal of waste in that area. Intermediate cover has the same objectives as daily cover, i.e. to control nuisances such as litter, odour and vermin, but in addition, intermediate cover should reduce the infiltration of rainfall, help prevent the escape of leachate and landfill gas, and be functional over a prolonged period of time.

When landfill Phase A' ends operation, a temporary cover of 50 cm soil will be applied on the northern waste surface slope as a temporary cover layer. This cover layer will remain there until the waste of Phase B' reaches the elevations of the waste of Phase A' temporary slope and therefore, it will lay upon the existing waste. During the operation of Phase B', on the waste slope of Phase A' the temporary cover shall be removed. The remaining surrounding slopes of waste residue Phase A (east, west, south) may be covered with final top cover layers.

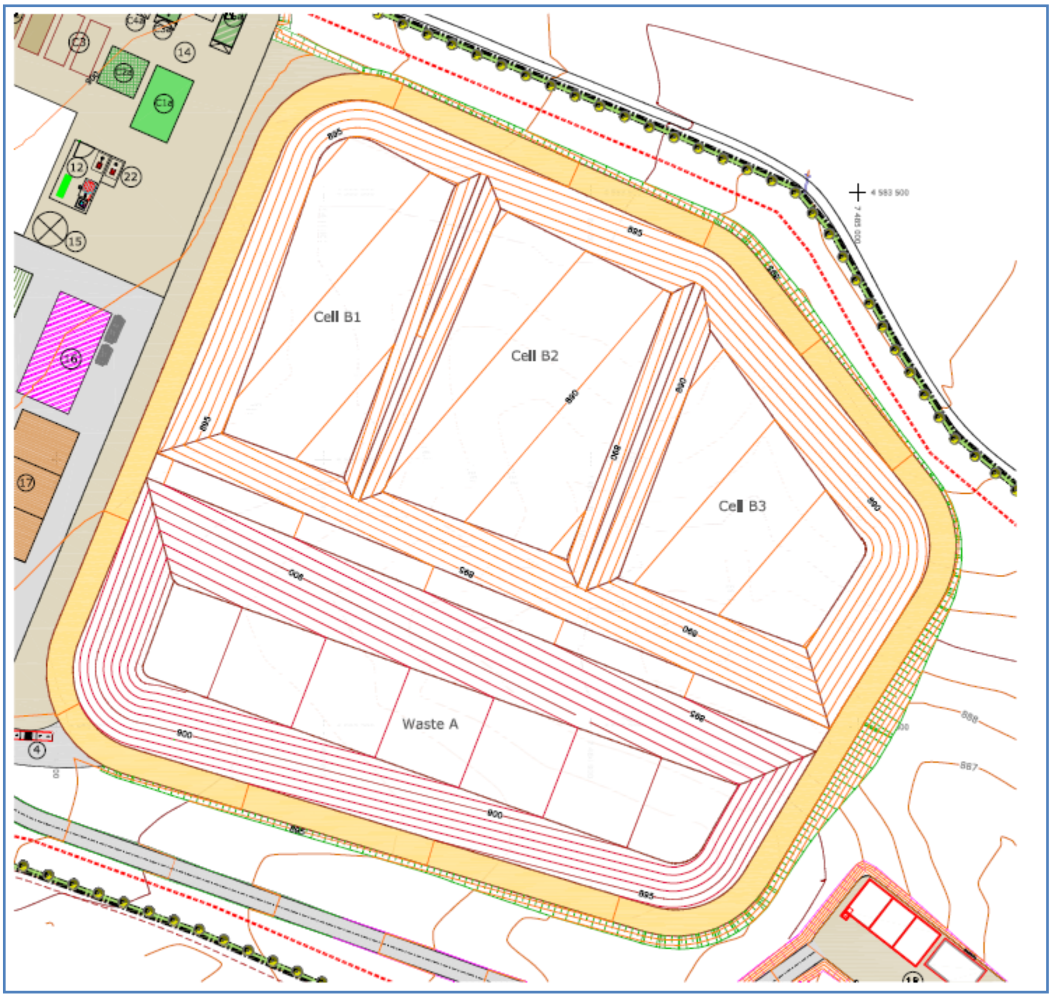


Figure 7-54: Start of landfill operation - Phase B'

Waste residue placement and compaction follows a predetermined filling sequence designed to fill the containment area in an organized manner than meets desired site objectives (e.g., slopes for stormwater control, placement of internal hauling roads).Strategic waste filling results in a final landfill configuration that meets designed targets for elevation, side slopes, stormwater control structures, and grading of the landfill top deck.

In addition to waste tipping, compaction, and soil placement, the landfill operatoris responsible for other operational features of the site such as operation andmaintenance of the leachate removal and gas control systems.

The liquids addition operator (or operators) carries out the tasks in the operations plan and uses judgment based on knowledge of the system’s specifications, system response, and other relevant training to ensure effective operations. It should be noted that liquid addition system is a common practice on southern Europe for enhancing biodegradation of waste due to evapotranspiration that takes place especially during summer period. The enhancement of biodegradation of waste has the adnavages of faster biogas production and quicker stabilization of landfill mass.

Adding liquid to a landfill is an option and a technically correct solution fot the beneficiary. During operation phase, the beneficiary will monitor the appropriate parameters and can decide whether or not this technique will be applied.

A key component of assessing the performance of landfills operated to enhance waste stabilization is evaluation of landfill gas quantity and quality. Thorough and careful operations are critical to successful implementation of gas collection and control, as well as air addition, for sustainable landfill operation. The operator must evaluate gas well liquid level measurements (for vertical well systems) to assess potential operational changes to the liquids addition system that may be warranted.
In a similar manner as the leachate control system, mechanical landfill gas extraction blowers must be maintained and the well field must be appropriately balanced to ensure efficient collection and to minimize possible risk of landfill fires.

Figure 7-55: Monitoring the gas system

Table 7-28: Typical monitoring parameters for landfill operation

Monitoring parameter	Typical units	Description
Liquid addition flow rate	Volume per time (gpm, lpm)	A permissible range of flow rates into an addition device or a series of devices will be specified in the operations plan. The operator will adjust the flow rate as required by adjusting control valves, the pumping system, or altering the devices used for addition
Cumulative liquids added	Volume (gal., L)	For some devices or landfill areas, a maximum allowable volume of added liquids may be specific for a given time period (e.g., daily maximum allowable).The operator will need to track the volume and stop addition once reached
Liquid pressure	Pressure (psi, in. w.c.)	The pressure of added liquids may be limited to avoid concerns with seeps and slope stability. Operator will need to monitor pressure and adjust or cease operation if thresholds are exceeded
Liquid depth	Depth (in., m)	The depth of liquid may be limited, such as depth of leachate on liner system or in a vertical well. The operator will need to monitor depth and adjust or cease operation if thresholds are exceeded
Leachate composition	Concentrati on (mg/L)	Leachate samples will be periodically analyzed. In the short-term, some changes may indicate that operations require adjustment (e.g., rapid decrease in specific conductance may indicate too much stormwater is entering leachate collection system; sudden decrease in pH and increase in BOD may indicate portions of system are stuck in acid-forming phase). In long-term, leachate composition can be used to help assess the progression of landfill stability

Monitoring parameter	Typical units	Description
Air and gas flow rate	Volume per time (cfm, lpm)	Air flow rates added to or extracted from the landfill will be periodically measured for individual devices. For air addition, flow rate limits will be specific in the operation plan. For gas extraction, for wells with large flow rates(especially at small vacuums) may suggest that additional extraction points are warranted. Flow rate can be directly measured or calculated (e.g., based on differential pressure across an orifice plate)
Gas pressure	Pressure (psi, in. H_2O)	Gas pressures at well heads, points in the GCCS network, or points within landfill are measured
Gas composition	Concentration (percent, part per million)	Portable or fixed meters may be used to determine composition of major gascomponents to assess performance of gas extraction and air addition systems.Portable sampling containers may be used to analyze major or trace gases
Temperature	Degrees (°C, °F)	Measurement of internal landfill temperature provides an assessment of wastebiological activity. Temperature of landfill gas may be measured using a portable meter(often the same meter used to measure composition)
Moisture content	% Wet weight	Internal moisture sensors may be used to assess the efficiency of moisture distribution systems

Standard site maintenance activities include mowing grass, maintaining roads, and repairing erosion damage. Those tasks are also an important part of day to day activities is the cleaning and general maintenance of landfill roads in order to provide safe and unhindered access from the access point to the facilities and from and to the tipping face at all times. Another daily operation needed at a landfill is wheel cleaning in order to prevent mud or other debris carry over onto public road network.

7.1.4.7 Overall earth materials balance for site

The total mass balance of the site refers to the overall earthworks, excavations and backfillings, for the construction of the landfill, the facilities's area and all networks and infrastructures. Additionally, it includes all soil material needed for daily covering (10% of landfill's capacity) from the beginning of waste disposal till the closure of the site

		Cut Volume (m^3)	Fill Volume (m^3)	
1a. Landfill	(phase A)	**+39,400**	**-47,500**	
	(phase B)	**+72,300**	**-20,900**	
1b. Separation dikes	(phase A)	**-**	**-1,700**	
	(phase B)	**-**	**-5,820**	
2. Bottom sealing (sub base - compacted soil 30cm)	(phase A)	**-**	**-7,110**	
	(phase B)	**-**	**-12,840**	
3. Facilities area (including road network)		**+24,000**	**-86,700**	
4. Buildings and infrastructures		**+50,000**		
5. Rainwater collection	(phase A)	**+520**	**-**	

		Cut Volume (m^3)	Fill Volume (m^3)	
	(phase B)	**+330**	**-**	
6. Waste cover material	(phase A)		**-16,860**	
	(phase B)		**-38,160**	
		+186,550	***-237,590***	
TOTAL				*-51,040 m^3*

Finally, for the construction and operation of phase A a quantity of 113,920 m^3 soil excavations and 159,870 m^3 of fillings will be needed.

Respectively, for works Phase B additional 72,630 m^3 of soil excavations and additional 77,720 m^3 of fillings will be needed.

7.1.4.8 Net filling volume, density and efficient operational life (overall and for each cell / phase)

The capacity of the landfill in Southwest Region is calculated on the basis of the mass balance with additional 10.0% volume due to daily soil coverage. The compacted waste density is assumed to equal 0.90 t/m^3. The life-time, area and the capacity in m^3 are shown in the table below.

Table 7-29: Capacity of landfill cells

Landfill Phases	Period (y)	Area (m^2)	Actual Capacity, m^3
A PHASE*	8	23,700	168,600
B PHASE**	18	42,800	381,550
TOTAL	**26**	**66,500**	**550,150**

* Phase A will be financed by EU funds, ** Phase B will be constructed in the future

Year	Quantities	Compaction of residues (t/m^3)	Cover material factor (%)	Anual capacity (m3)	Total Capacity cumulative year(m^3)
2021	16.049			19.615,82	19.615,82
2022	16.120			19.702,10	39.317,92
2023	16.193			19.791,75	59.109,67
2024	16.269			19.884,92	78.994,58
2025	16.349			19.981,78	98.976,36
2026	16.418			20.066,98	119.043,34
2027	16.492	**0.90**	**0.10**	20.156,76	139.200,10
2028	16.569			20.251,34	159.451,44
2029	16.651			20.350,92	179.802,36
2030	16.737			20.455,74	200.258,11
2031	16.712			20.425,67	220.683,78
2032	16.688			20.396,93	241.080,71
2033	16.666			20.369,50	261.450,20

Year	Quantities	Compaction of residues (t/m^3)	Cover material factor (%)	Anual capacity (m3)	Total Capacity cumulative year(m^3)
2034	16.645			20.343,36	281.793,57
2035	16.624			20.318,50	302.112,07
2036	16.585			20.270,67	322.382,74
2037	16.547			20.224,16	342.606,90
2038	16.510			20.178,95	362.785,85
2039	16.474			20.135,03	382.920,87
2040	16.439			20.092,36	403.013,23
2041	16.388			20.030,29	423.043,52
2042	16.339			19.969,55	443.013,07
2043	16.290			19.910,13	462.923,20
2044	16.243			19.852,00	482.775,20
2045	16.196			19.795,14	502.570,33
2046	16.137			19.722,89	522.293,23

The total lifetime of landfill will be 26 years. The landfill's basin is divided in phases (according the conceptual design). The construction of the basin will be progressive, that means that it is going to be constructed in phases.

The operation of phase A, will begin by disposing waste, starting from its lowest part. When the phase A has reached its filling capacity, the disposing of waste will continue in the next phase.

The bottom of the basin is configured with 3% longitudinal and 1% transversal slopes to the middle of the cell. The typical inclination of the slopes is 1:3.

With this design both phases have the potentiality:

- To work discernible, in terms of the waste deposition
- To reduce the amount of the produced leachate i.e. every cell will be temporarily closed during operation and after the end of its operation it will be partly closed, so the rain fall cannot enter on full surface into the waste body.

The philosophy of the landfill design is presented in the following figure (source: conceptual design).

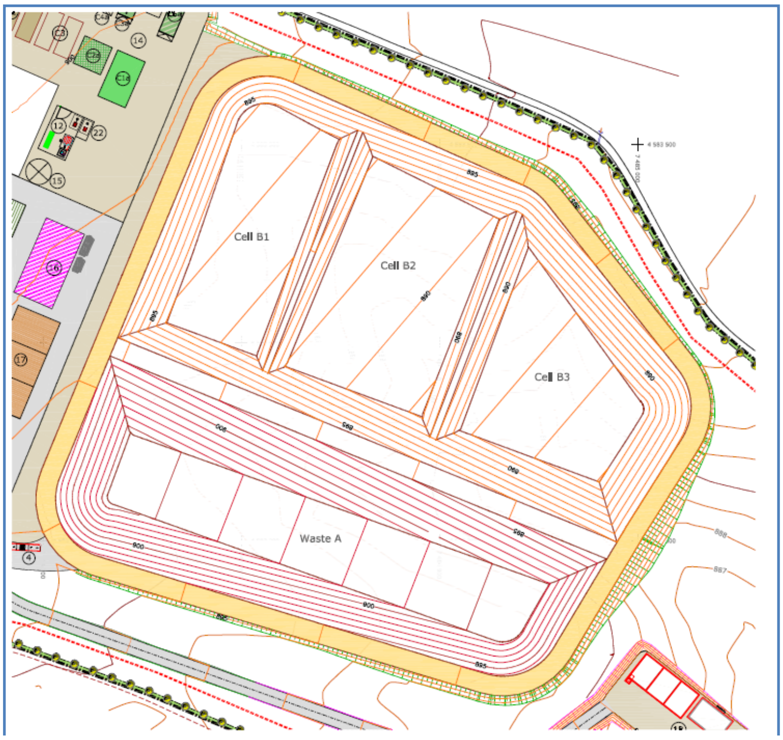


Figure 7-56: Landfill (End of Phase A operation & Start of Phase B)

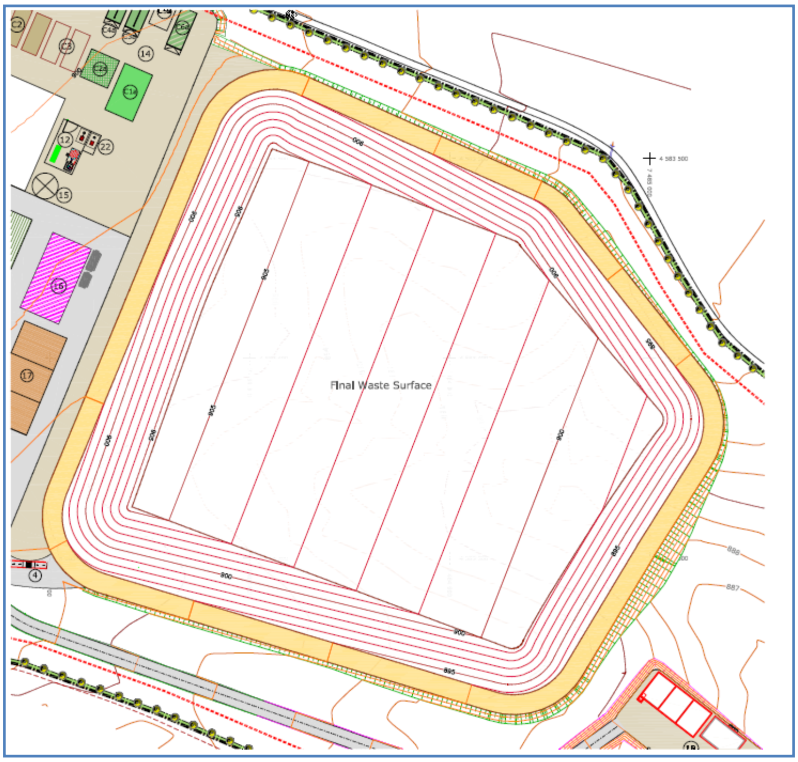


Figure 7-57: Landfill (End of Phase B operation)

7.1.4.9 Leachate collection, treatment and disposal system, including leachate composition and volume forecast – for the lifetime of the site.

7.1.4.9.1 Leachate collection, treatment and disposal system

Generation of leachate is an inevitable consequence of the waste disposal practice. It arises from precipitation entering into the waste mass, as well as from the humidity content of waste and in the result of biodegradation of organic compounds into the waste.

Leachate contains suspended solids, soluble waste components, soluble decomposition products and microbes. The most of leachate components have the potential to be toxic and could cause the death of river life, directly (through toxins and BOD_5) or indirectly (via eutrophication). They can also contaminate drinking water. Therefore, under no circumstances should the leachate be discharged to surface and underground water. Besides, the legislation is very strict concerning this matter. The composition of the leachate produced in a landfill, depends on the type, composition and age of waste, the degree of compression in landfills, etc.

Experience has shown that the isolation of the base itself, without collection and removal of leachate, can ultimately cause more harm than good. Therefore, a collection and drainage system is essential, and is one of the most important stages in the construction of a landfill, as the lifetime of the isolation is largely dependent on this.

The principles of leachate collection system that rule the proposed design are:

- The input amount of rainwater should be reduced as much as possible. Leachate collection system is designed in accordance with the surface water management, as the correlation between them is strong. Trenches parallel with the footprint of the landfill will be developed in order to prohibit the runoff into the landfill’s body.
- The collection and drainage system should ensure long-term collection of the total quantity of leachate and exclude any admixture with rainwater.

The system for leachate management was chosen upon the following requirements:

- not to cause damage, deformities or shifts in the isolation system during its placement
- the pipes should be hydraulically efficient and should withstand chemical, industrial and physical burdens, not only during the phase of operation, but at the phase of the landfill aftercare as well (50 years. 40oC. waste density: 1.5 Mg/m3)
- free flow of leachate towards its collection tank should be enabled and leachate should be treated in a rather easy way
- the hydraulic height of leachate should not exceed 50 cm above the geomembrane.

In the proposed design, leachate flows due to gravity from the various points of the landfill basin and slopes to the collection pipes. The basin of the landfill is shaped to have slopes at about 3 % longitudinal on the main drainage pipe. The collection of leachate shall be facilitated by pipes, which will be positioned having an adequate inclination to achieve effective flow of leachate to the lower level of the basin, installed within the drainage layer in a special surface formation of the deposition basin. The collection pipes shall be made of HDPE perforate by 2/3 of their diameter and shall have a nominal diameter D = 500 mm (central collection pipe in the bottom’s “deep point”) and D = 250 mm, according to Drawing 17- General Layout of leachate collection works. The diameter has been selected taking into consideration precipitation data of the area, as well as the slopes of the landfill basin. The pipes will be installed into the gravel layer. For the installation of the leachate collection pipes a special topical formation of the basin is constructed.

According to the proposed design, at the bottom of phase A two (2) mainroutes of pipes will be established. For each route different pipeswill be placed in order to conform to the distinct operation phases. One internalseparation embankment will be constructed on the bottom of phase Ain order to divide the operation area into two smaller parts. In this way,rainwater falling into Cell A2 in the southern part of phase A is extractedbefore it becomes leachate.

The collection pipes are gathered by gravity into the collection manhole inside the bottom of the landfill.One transport pipe enter to the central manhole W outside the landfill and from there liquid is directed to the leachate collection tank via HDPE DN500 PN10 pipe. The manholes will be made of HDPE.

For the collection of the leachate of phase B, three (3) main routes of pipes will be established. For each route different pipes will be placed in order to conform to the distinct operation phases.

Two internal separation embankments will be constructed on the bottom of phase Bin order to divide the operation area into three smaller parts. In this way,rainwater falling into Cell B2, B3 in the southern part of phase B are extractedbefore it becomes leachate.

The collection pipes are gathered by gravity into the collection manhole inside the bottom of the landfill. One transport pipe enter to the central manhole W outside the landfill and from there liquid is directed to the leachate collection tank via HDPE DN500 PN10 pipe.

A network of collection pipes will be established in the area of wheel washing facility transfer contaminated water via wells to the leachate collection tank by gravity.

From the reverse osmosis, there will be the opportunity to recirculate the leachate via a pumping station to the recirculation network. In the recirculation line, wells will be included every 80m.Finally, a network of collection pipes will be established in the area of composting to transfer contaminated water via well to an oil separator and then to anadjacent ditch.

Dimensioning of leachate drainage pipes

Discharge estimation method

The calculation of the maximum leachate production is made for the corresponding dimensioning of the leachate collection system.

The calculation of the maximum leachate production is made by using the rational method:

$Q=0.000278x \ c \ x \ i \ x \ A$

where:

c: runoff coefficient

i: rainfall intensity in the time of concentration (mm/s)

A: area of catchment's basin (m²)

Concetraition time
The rainfall duration used for the calculation of critical intensity corresponds to the concentration time of the catchment basin.
For the calculation of the concentration time the Kirpich equation is used:

$$t_c = 0{,}1947 \; x \; L^{0{,}77} \; x \; S^{(-0{,}385)}$$

where:
Tc: time of concentration (min)
L: longest watercourse length (m)
S: slope between the highest point in the catchment and the catchment outlet

Collection system design – hydraulic calculations
For the dimensioning of the pipes the Manning formula will used assuming that the continuity assumption is valid.
Q = A x V

$$V = \frac{1}{n} \times \sqrt[3]{R^2} \times \sqrt{S}$$

where:
Q = discharge (m3/s)
A = "wet" area (m²)
V = velocity (m/s)
n = Manning coefficient
R = hydraulic radius (m)
S = slope

7.1.4.9.2 Leachate composition

Once collected, the leachate has to be treated and discharged according to regulations in force and in particular the Official Gazette no. 81 of 15.6.2011 on Rules, terms, conditions and emission limit values for discharge of purified wastewater. In the context of the Feasibility Study, the possibilities for leachate treatment are:

- Pre-treatment and partial recirculation to landfill; disposal of remaining liquid to the municipal sewer system.
- Full treatment of the surplus leachate; reuse for internal industrial uses or discharge to the nearest surface water recipient

The first option requires the wastewater to be transported to a connection point where it can be inserted into the sewer system. This transport may be done by a pipeline. However, no WWTP exists in the broader area and this option is not applicable for the present case.

The second option allows discharge of wastewater into a local water body.
The hydraulic load, m^3/day, of the leachate treatment system is calculated from meteorological data and the surface of landfill cell. To this, the other sources of wastewater (washes, etc) are added. In particular, sanitary wastewater (personnel sewage), MBT wastewater and various washes will be pumped via a standard prefabricated PE pumping pit also to WWTP, as the WWTP is compatible with any kind of biodegradable wastewater.

The WWTP capacity must be such to accept leachate generated for the most rainy month during the first phase, i.e. 76 m^3/d. During the second phase, leachate flow will be approx. doubled, 171.1 m^3/d, and the WWTP extension will be constructed at that time.

In particular, the various sources of wastewater generation are as follows:

1. Landfill leachate: 76 m^3/d (Phase A)
2. Anaerobic digestion, 31,0 m^3/d
3. Composting process, 2,8 m^3/d
4. Washes of floors, mechanical equipment and trucks, 2 m^3/d
5. Reception area, 0,5 m^3/d
6. Personnel sewage (domestic wastewater), 5 m^3/d
7. Biofilter, 4,5 m^3/d
8. Recirculation, condensates, safety factor, etc (depends on the selected technology) 38,2 m^3/d
   Total: 160 m^3/d

Parameters considered for selection of technology for leachate treatment are:

- Proven efficiency
- Availability in modular plants
- Ease of installation and operation
- Simplicity and requirement for less skilled personnel to operate
- Land requirement for installation.

Leachate contains a high concentration of organic and inorganic contaminants including humic acids, ammonia nitrogen, heavy metals and inorganic salts, having a relatively high toxicity and adverse effect to the environment. Consequently, landfill leachate needs to be pre-treated on site to meet the standards prior to discharge into the sewer or directly to surface water. The processes used often require combined techniques which are designed as modular or multistage units, suitable for pollution abatement.

The composition and quantity of leachates varies with time according to the degree of biological decomposition of waste. Initially, for freshly deposited mixed waste, concentration of dissolved& colloidal organic carbon and ammonium nitrogen is very high, whereas pH is low. However, Mechanical – Biological technologies for treatment of waste have the result of stabilising the organic fraction, and therefore leachates are generated at a reduced pollution and hydraulic load. Therefore, in a landfill for residues, leachate quality depends on parameters, such as:

- The degree of co-disposal of residues with common municipal waste
- Public participation in "Sorting at the Source" schemes, especially of food and green waste
- Waste composition
- The type of MBT and the duration of the stabilisation process (simple or intensive)

Leachate is regarded as a medium polluting stream, as biological treatment (combination of anaerobic and composting process) improves its characteristics. MBT, reception area and composting wastewater are regarded as streams with a strong load.

On the other hand, washes, sewage, etc can be taken as low polluted stream. The typical parameters for a range of pollutants, based on literature and similar projects, is presented in the following Table:

Table 7-30: Composition of produced leachates

PARAMETER	Landfill leachate and recirculation	Biofilter	MBT-composting	Personnel sewage	Washes	Average values, mg/l	Average values,kg/d
Flow m^3/day	114,2	4,5	34,3	5	2	160	160
BOD_5, mg/l	1.800	100	10.000	300	500	3.450	552
COD, mg/l	4.800	150	18.000	500	1.000	7.320	1.171,2
NH_4-N mg/l	800	50	3.500	30	150	1.330	212,8
NO3-N mg/l	10	0	30	20	20	20	3,2
Suspended solids SS mg/l	500	500	500	400	500	500	80
Phosphor P, mg/l	0,1	0	5	15	0	10	1,6

In regard to the effluent standards for discharge into surface waters, these are set by Gazette no. 81 / 15.6.2011, Table 1, and are aligned with Directive 91/271 / EEC of the Council on the treatment of urban waste water. A full list of parameters, including a range of metals, are set in the Gazette; the most important for the design are presented in next Table:

Table 7-31: Effluent limits for common parameters

PARAMETER	Value (mg/l)
pH	6.5-9
Colour	colourless
BOD	25
COD	125
Aromatic hydrocarbons	0.1
Phenols	0.1
Total Suspended Solid (TSS)	35
Total Phosphorus (P)	1
Total Nitrogen	10
Total Ammonium	10
Total Nitrates	2

7.1.4.9.3 Alternative options for leachate treatment and technical description of them

Three alternative technologies - options are considered in the Feasibility study:

A. Basic option: this option comprises of two aeration lagoons. The lagoons are constructed from soil and are sealed with a suitable system in order to prevent leachate to infiltrate into the sub soil, similar to the landfill system. It includes an impermeable HDPE membrane covered with two layers of geotextile and concrete blocks and a clay layer under the HDPE.
B. Intermediate option: this option consists of i. Reception – Equalisation tanks with a drum screen and a Pumping station, ii. Secondary treatment bioreactor and iii. Temporary storage tanks.

C. Advanced option: this option regards an advanced plant comprising of three stages, i. Reception – Equalisation tank with a drum screen – Pumping station, ii) Secondary treatment bioreactor and iii) Reverse Osmosis (RO) plant.

Leachate from the first cell is collected via the bottom collection system and is transferred to the plant. The design flow rate is selected to 160 m^3/d, where at the same time sufficient equilisation volume must be provided in order to account for heavy rainfalls.

Option A
This system comprises of an Aeration lagoon with preliminary dimensions 35 x 25 x 2,5m and effective volume of 2.000 m^3. The liquid flows afterwards to a second, Maturation - Sedimentation lagoon with dimensions 35 x 25 x 2,5m and effective volume of 2.000 m^3. Aeration will be facilitated by injection-type aerators, that provide the necessary oxygen quantities to the biomass. The lagoons have a pyramid shape.
The lagoons can be constructed from locally available soil. The bottom liner of the lagoons will be constructed of impermeable HDPE membrane covered with geotextile, preventing leachate to infiltrate into the sub soil.
A storage basin will be made of concrete. Part of treated leachate will be recirculated to landfill during non-raining days via a high-pressure pumping station and recirculation pipe ∅100. The sediment/sludge will be deposited in the landfill.

Option B
Similarly, landfill leachates and industrial wastewater from the various sources flow by gravity or by a pumping station to an equalization – homogenisation tank with a volume of 2.400 m^3. The role of the tank is liquid equalization in periods of intense raining, where homogenisation-preaeration takes place with a venturi type jet aerator. Feed to the downstream unit is provided with two submerged pumps regulated by a level meter (piezoresistive). The volume of the reception tank is selected empirically, so as to provide capacity of incoming flow (first phase) for a number of days, i.e.:

$$76\ m^3/d \times 30d = 2.280 \approx 2.400\ m^3$$

Activated sludge (extended aeration) bioreactors can be either continuous or batch type. For leachate treatment the type of Sequential Batch Reactor is more common. These aerobic biological treatment plants are designed to be able to perform the following processes:
- Oxidation of organic carbon compounds
- Nitrification of ammoniacal-N
- Full or partial denitrification of nitrate-N.

Each of the treatment processes is effected by communities of bacteria, which metabolise the contaminants. A well-designed treatment process must ensure that the bacteria are provided with optimal growth conditions, and are mixed intimately with the leachate to be treated, with oxygen, nutrients as necessary, and at appropriate temperatures and pH-values.

The Sequencing Batch Reactor (SBR) treatment process has been developed as a readily-automated, extended aeration system, that is particularly well suited to the higher organic strength and concentrations of ammoniacal-N in landfill leachates. The larger volume of the main SBR tank makes for efficient aeration, high rates of dilution of incoming leachates, and high resistance to shock loading. An SBR is a cyclically operated, suspended growth, activated sludge process. The only conceptual difference between the SBR and a conventional activated sludge system is that each SBR tank carries out functions such as aerobic biological treatment, equalisation, settlement of solids, effluent clarification and decanting, over a time sequence rather than in spatially separate tanks. The ability to vary the time sequence (compared to the inflexibility of specific volumes of separate tanks), enables a very robust and flexible treatment system to be provided. SBR systems that have been designed for particular loading rates, of ammoniacal-N or of organic contaminants, will have considerable flexibility to receive this as either small volumes of strong leachate, or as larger volumes of weaker leachate. This can be important as leachate character changes over time to ensure that optimum treatment performance is maintained.

The system is completed with a sludge tank and an exit tank.Oxygen demand will be met via surface or submerged aerators (for example ejectors). The SBR volume will be around 1,900 m^3. The operating cycle of a typical SBR system comprises four main phases, nominally: FILL, REACT, SETTLE, DECANT, IDLE. A typical SBR operating cycle for a "step feed" type (minimising toxic effects of ammonia) is as follows:

Table 7-32: Typical Operation cycle of SBR

No	Operation phase	Equipment status	Duration (min)	Time from start (min)
1a.	Feed – no aeration	Feed Pump ON Aeration OFF	12	12
1b.	Biological oxidation	Feed Pump OFF Aeration ON	228	240
PHASE 1a – 1b REPEAT 5 TIMES				**1290**
3.	Sludge removal	Sludge Pump ON	60	1260
4.	Sedimen-tation	Aeration OFF Mixer OFF	120	1380
5.	Supernatant removal	Decant ON	60	1440
6.	Idle	Mixer ON	Δt	1440+Δt
	END OF CYCLE			

Installed equipment will be:

- ✓ Aeration system (surface or submerged)
- ✓ one submerged mixer
- ✓ one floating decanting system
- ✓ one sludge (mixed liquor) removal pump, activated at the end of the biological oxidation phase
- ✓ ten dosing pumps (five stand-by) for chemicals, soda (for alkalinity control), antifoam, methanol, nutrients and hypochlorite)
- ✓ one DO-meter
- ✓ one pH/Redox meter
- ✓ one level sensor
- ✓ one portable pump
- ✓ one scum well

The above described SBR is able to provide effluent with a BOD_5 value of less than 25 mg/l and a NH_4 value of less than 2 mg/l. However, it is not likely that it can match the standard for COD - metals, due to the strong nature of leachates

Option C
This option is similar to "B" and consists of an equalization-homogenizationconcrete tank with 2.400 m³ volume and an SBR type bioreactor. Since the effluent will not have the required characteristics for disposal to a surface water receiver, it is necessary to employ a "polishing" process such as Reverse Osmosis.

The purpose of the membrane-type separation process, is to remove "hard COD" and dissolved salts. RO concentrate amounts to typically 30% of the inlet volume. The cut off size (membrane pore size) and operating pressure for the various membrane systems is shown in the following picture.

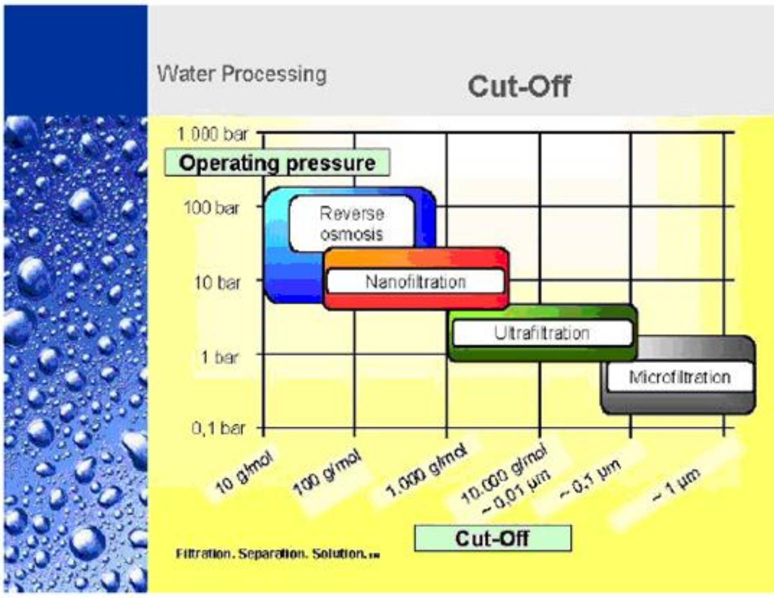


Figure 7-58: Cot off size for membrane applications

The RO process offers permeate qualities qualified for water re-use/ river discharge even on difficult waste waters. The RO unit will be installed together with the sand filter vessels in a similar, 40" container. The pressurized feed is pumped initially into the sand filter vessels and after flows through the channels of the membrane elements. The feed gets concentrated more and more and leaves the vessel as concentrate. The permeate flows to a permeate collection pipe outside the membrane vessel. Occasionally the modules need to be flushed/ washed with clean water (CIP, cleaning-in-place). The pressurised permeate feeds directly the effluent well and from there it is directed to a surface water receiver. Alternatively, irrigation of green areas or other internal industrial usage can be considered.

The saline concentrate from RO will be stored in a temporary storage tank and from there it is recirculated to the landfill via a mono pump.

In the present feasibility study, Option C combines a biological and a membrane stage (type RO) which both result in a purified effluent with very good characteristics. The reverse osmosis application retains the majority of the organic and inorganic pollutants. It comprises a technically advanced option for leachate treatment and therefore it is proposed for implementation. The saline concentrate must be recirculated to landfill (approx. 30% of the initial volume).

Leachate and concentrate management is in accordance with the Law on Water and the rest of the national regulations.

The flow diagram of the proposed WWTP process is as follows:

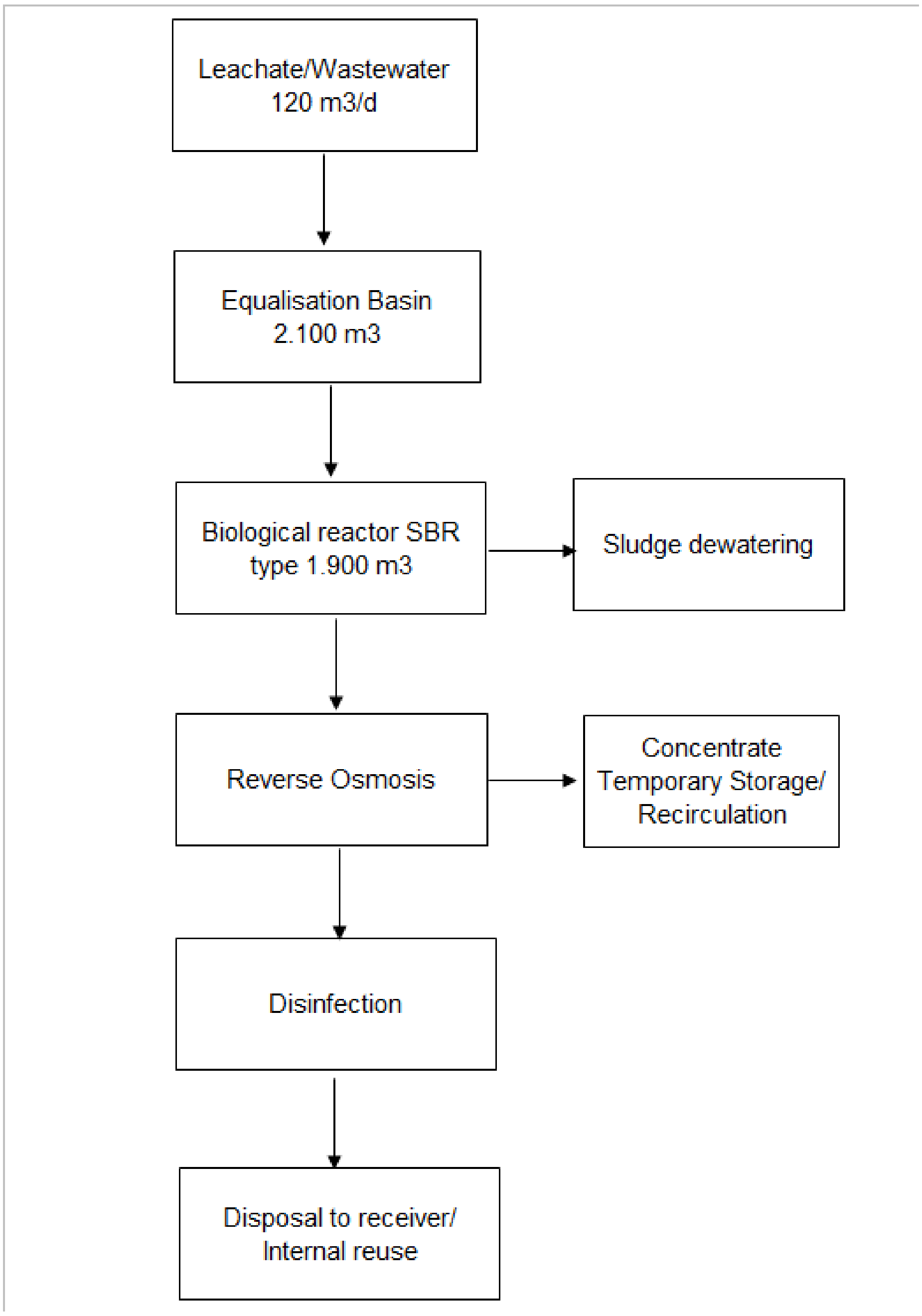


Figure 7-59: LTP flow diagram

The leachate treatment plant will include indicatively the following units:

- Main incoming collector pipe
- Reception - Homogenisation tank
- Pumping station
- Feed flow measurement unit
- Drum screen
- Bioreactor for Nitrification and Denitrification
- Chemical dosing systems (Nutrient, Anti-foam, soda, methanol, hypochlorite)
- Intermediate storage tanks
- Sludge dewatering unit
- Automation (PLC, SCADA, metering devices)
- Service building
- Energy Building
- Reverse Osmosis plant
- Concentrate tank

All materials goods, workmanship, equipment, components and tests, shall conform to the appropriate European standard specification (EN) requirements or National Standards. If such standards do not exist then the ISO standards shall apply. This does not however preclude the use of other standards provided that they are equal to or exceed the standards quoted in the Specification. National seismic codes will apply to the design of all structures.

The biological reactor tank will be closed, in order not to have excessive temperature losses, taking into account the climate conditions in the region.

Reinforced concrete C30/37 sulphate resistant will beused. The whole interior of the tanks will be coated for resistance against leachate with waterproofing sealing.

7.1.4.9.4 Leachate volume forecast for the lifetime of the site

Leachate Production

The selection of the most appropriate scheme was based on the expected quantities of the produced leachate, which must be collected, removed and finally treated according to the suggested technique.
For the determination of the volume, the rate of production and the qualitative composition of leachate, the following information were required:

- the climatic conditions of the region (height and distribution of precipitation, temperature)
- the qualitative composition of waste
- the way of the sanitary landfill operation
- the age of layers

In this study, the quantity of leachate has been estimated for the operation phases of the landfill which consist of the following:

- The landfill is divided into two phases.

- The elimination of the leachate production is achieved by temporary sealing of the surface of waste that is exposed to rainwater for a long.
- According to the operational phase each time, the surface that is taken into account for the calculation of the produced leachate is shown below along with the assumptions for the runoff coefficient each time.

The operational phases are the following:

1. Scenario 1. Cell A1 in operation: 9,935 m^2, c=0.0
2. Scenario 2. Cell A1 filled and Cell A2 in operation. This phase includes a temporary sealed area of Cell A1 and towards the perimeter, a temporary sealed area towards the internal berm of the landfill and a sloped area of waste towards Cell A2. For the temporary sealed area which is sloped towards the perimeter of the landfill, the runoff coefficient is taken 0.7, whereas for the sloped area of waste towards the internal berm, this coefficient is taken 0.5. For the rest of the area in operation the runoff coefficient is taken 0.0.

   So, the assumptions include: 3,304 m^2 with c=0.7, 2,148 m^2 with c=0.5 and 17,138 m^2 with c=0.0.
3. Scenario 3. Cells A1, A2 filled and Cell B1 in operation. This phase includes a temporary sealed area of phase A towards the perimeter, a temporary sealed area towards the internal berm of the landfill and a sloped area of waste towards Cell B1. For the temporary sealed area which is sloped towards the perimeter of the landfill, the runoff coefficient is taken 0.7, whereas for the sloped area of waste towards the internal berm, this coefficient is taken 0.5 For the rest of the area in operation the runoff coefficient is taken 0.0. So, the assumptions include: 15,736 m^2 with c=0.7, 4,890 m^2 with c=0.5, 13,627 m^2 with c=0.0
4. Scenario 4. Cell A1,A2, B1 filled and Cell B2 in operation. This phase includes a temporary sealed area towards the perimeter, a temporary sealed area towards the internal berm of the landfill and a sloped area of waste towards Cell B2. For the temporary sealed area which is sloped towards the perimeter of the landfill, the runoff coefficient is taken 0.7, whereas for the sloped area of waste towards the internal berm, this coefficient is taken 0.5For the rest of the area in operation the runoff coefficient is taken 0.0. So, the assumptions include: 21,590 m^2 with c=0.7, 2,263 m^2 with c=0.5, 28,844 m^2 with c=0.0
5. Scenario 5. Cells A1, A2, B1,B2 filled and Cell B3 in operation. This phase includes a temporary sealed area towards the perimeter, and a sloped area of waste towards Cell B3. For the temporary sealed area which is sloped towards the perimeter of the landfill, the runoff coefficient is taken 0.7. For the rest of the area in operation the runoff coefficient is taken 0.0. So, the assumptions include: 28,020 m^2 with c=0.7, 35,350 m^2 with c=0.0.
6. Scenario 3. All phases A and B filled: 63,370 m^2 with c=0.7.
7. Scenario 4. All phases A and B filled and sealed: 63,370 m^2 with c=0.90.

From the leachate production calculations, the worst scenario for the 1st phase of the landfill(greatest leachate quantity generated) is No 2, i.e. cells A1 is filled and cell A2 is in operation. Regarding the entire lifetime of thelandfill, the worst scenario is No 5, i.e. Cell 3B is in operation.

To estimate leachate production, initially the evapotranspiration had to be determined. Evapotranspiration (ET) regards the sum of the real water losses through the evaporation of soil and mold and the transpiration of the flora. On the other hand, Dynamic (potential) evapotranspiration (ETP) regards a corrected (slightly decreased) evapotranspiration value, where an excess of moisture exists on the same surfaces. For the calculation of the hydrological balance, the dynamic evapotranspiration is used.
In this study, the determination of the potential evapotranspiration has been conducted using the Thornthwaite equation:

$$ETP = PE = (PE)_x \, x \, \frac{DT}{360}$$

where:
ETP = PE = corrected potential evapotranspiration (mm /month)
(PE)x = average potential evapotranspiration (mm/month)

$$(PE)_x = 16x(\frac{10xTi}{J})^a$$

and:
Ti = mean monthly air temperature
J = annual heat index
a = surface flow coefficient

$$J = \sum J_i$$

and:
Ji = monthly heat index

$$Ji = 0{,}09x\sqrt{Ti^3}$$

$$a = 0{,}016 \cdot J + 0.5$$

$$\frac{DT}{360} = 0.1217 \times P$$

and:
P = the average percentage of hours of daylight for each month of the year for latitudes between 33^o and 47^o north of Equator.

The average hours of daytime for each month of the year were calculated using linear interpolation, based on the relevant hydrological table. The mean monthly precipitation and the mean monthly temperature were calculated, given data presentedChapter 2 of the present study above.

The temperature data were provided from the station located in the municipality of Bitola and refer to the last 20 years (1997– 2016).The precipitation data were provided from the station located in the settlement of Izvor and refers to the last 20 years (1997 – 2016).

Having calculated the evapotranspiration, produced leachate is easy to estimate upon the hydrological balance.

$$L = P - R - E - (axW)$$

where:
L = leachate generated

P = precipitation
R = surface flow
E = evapotranspiration (ETP)
a = absorption of waste (defined as the quantity of water withhold by waste, reduced by the quantity of water produced during biodegradation reactions)
W = weight of waste entering the landfill

For the hydrological balance implementation, the following assumptions have been made.

- There is no leaking towards the groundwater table, due to the sealing of the bottom of the active basin.
- There is no other rainwater inflow from the wider basin, due to the construction of rainwater ditches, which direct the surface flow away from the waste body.

The results of the leachate estimation are shown in following table:

Table 7-33: Leachate production (mm/month)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation (mm/month)	105	104.7	89	78.4	79.4	51.6	45.4	29	75.5	117.9	118.4	128.8
Temperature (^oC)	1.6	2.6	7.1	11.8	15.9	19.6	22.1	22	17.1	12.1	7	2.5
Monthly heat index (J_i)	0.18	0.38	1.70	3.65	5.71	7.81	9.35	9.29	6.36	3.79	1.67	0.36
Annually heat index (J)	50.24											
Surface flow coefficient (a)	0.69											
Average potential evapotransporation (PE)x (mm/month)	3.04	5.59	25.31	52.37	86.01	113.28	134.98	126.63	80.33	48.11	20.75	5.32
Corrected potential evapotransporation (ETP)(mm /month)	2.99	5.44	22.03	38.20	52.53	45.86	43.08	28.63	49.45	39.50	19.04	5.22

Table 7-34: Monthly average leachate production (m^3/month)

Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cell A1 in operation	1013.43	986.13	665.38	399.40	267.00	57.07	23.07	3.66	258.84	778.87	987.18	1227.81
Cell A1 filled and Cell A2 in operation	1948.70	1887.64	1211.50	717.02	503.87	126.58	64.54	22.12	487.67	1424.29	1843.62	2355.54
Cells A1, A2 filled and Cell B1 in operation	2080.69	1990.59	1096.08	676.09	529.99	184.71	125.28	64.83	510.76	1348.93	1809.81	2499.45
Cells A1, A2 and B1 filled and Cell B2 in operation	3669.74	3529.79	2083.53	1331.10	964.57	288.77	175.26	79.79	931.58	2559.82	3312.81	4420.22
Cells A1, A2 and B1, B2 filled and Cell B3 in operation	4404.65	4236.38	2498.46	1640.79	1172.50	347.65	209.28	94.27	1132.55	3101.67	3974.37	5305.24
All Cells filled	1806.42	1645.58	296.15	496.82	503.16	326.99	287.70	183.77	478.44	747.13	1044.56	2118.09
All Cells sealed	475.65	318.61	563.99	496.82	503.16	326.99	287.70	183.77	478.44	747.13	750.30	485.67

Table 7-35: Daily average leachate production (m^3/day)

Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cell A1 in operation	32.69	35.22	21.46	13.31	8.61	1.90	0.74	0.12	8.63	25.12	32.91	39.61
Cell A1 filled and Cell A2 in operation	62.86	67.42	39.08	23.90	16.25	4.22	2.08	0.71	16.26	45.94	61.45	75.99
Cells A1, A2 filled and Cell B1 in operation	67.12	71.09	35.36	22.54	17.10	6.16	4.04	2.09	17.03	43.51	60.33	80.63
Cells A1, A2 and B1 filled and Cell B2 in operation	118.38	126.06	67.21	44.37	31.12	9.63	5.65	2.57	31.05	82.57	110.43	142.59
Cells A1, A2 and B1, B2 filled and Cell B3 in operation	142.085	151.30	80.60	54.69	37.82	11.59	6.75	3.04	37.75	100.05	132.48	171.14
All Cells filled	58.27	58.77	9.55	16.56	16.23	10.90	9.28	5.93	15.95	24.10	34.82	68.33
All Cells sealed	15.34	11.38	18.19	16.56	16.23	10.90	9.28	5.93	15.95	24.10	25.01	15.67

Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cell A1 in operation	1.36	1.47	0.89	0.55	0.36	0.08	0.03	0.00	0.36	1.05	1.37	1.65
Cell A1 filled and Cell A2 in operation	2.62	2.81	1.63	1.00	0.68	0.18	0.09	0.03	0.68	1.91	2.56	3.17
Cells A1, A2 filled and Cell B1 in operation	2.80	2.96	1.47	0.94	0.71	0.26	0.17	0.09	0.71	1.81	2.51	3.36
Cells A1, A2 and B1 filled and Cell B2 in operation	4.93	5.25	2.80	1.85	1.30	0.40	0.24	0.11	1.29	3.44	4.60	5.94
Cells A1, A2 and B1, B2 filled and Cell B3 in operation	5.92	6.30	3.36	2.28	1.58	0.48	0.28	0.13	1.57	4.17	5.52	7.13
All Cells filled	2.43	2.45	0.40	0.69	0.68	0.45	0.39	0.25	0.66	1.00	1.45	2.85
All Cells sealed	0.64	0.47	0.76	0.69	0.68	0.45	0.39	0.25	0.66	1.00	1.04	0.65

From the above, the following can be concluded:

- The maximum leachate production during the operation of Cell A1 filled and Cell A2 in operation, amounts to 75.99 m^3/day
- The maximum leachate production, which is 171.14 m^3/day occurs Cell A1,A2, B1,B2 filled and Cell B3 in operation.

7.1.4.10 Gas ventilation or collection/ utilization system

7.1.4.10.1 Introduction

Landfill control systems are employed to prevent unwanted release of landfill gas into the atmosphere or soil. Recovered landfill gas can be used to produce energy or to be flared under controlled conditions to eliminate the discharge of greenhouse gases to the atmosphere.

Municipal solid-waste stabilization in a landfill can be separated into two major biological stages:

- An aerobic degradation phase, which happens almost immediately after waste placement
- An anaerobic degradation phase, which develops once the oxygen originally present in the landfill is consumed.

The large amount of organic matter in solid wastes allows biodegradation to proceed. Organic wastes (food and garden waste), which are generally the first components of MSW (municipal solid waste) to undergo biodegradation, typically have the higher percentage of waste composition.

Landfill gas is composed of a number of gases, but mainly methane (CH_4) and carbon dioxide (CO_2) at approximate percentages of 55% and 45% respectively. It also has other minor components such as hydrocarbons, hydrogen sulphide (H_2S), ammonia (NH_3), oxygenated and halogenated organic compounds. The principal gases are produced from the decomposition of the organic fraction of MSW. Landfill gases occur in five or less sequential phases:

1) **Aerobic phase**: in the 1st phase organic biodegradable components undergo microbial decomposition as they are placed in the landfill and soon after under aerobic conditions until entrapped O_2 is consumed. This may last for a few weeks up to several months. The predominant gases synthesized during this stage are carbon dioxide (CO_2) and water vapour (H_2O).
2) **Transition phase**: The 2nd phase begins as conditions shift from aerobic to anaerobic as a result of oxygen depletion. The principal gases produced are CO_2 and – to a lesser extent –hydrogen (H_2)
3) **Acid phase**: The microbial activity initiated during phase II accelerates with the production of significant amounts of organic acids and lesser amounts of hydrogen gas. This phase includes three steps as following:
   - The hydrolysis of higher-molecular mass compounds into compounds suitable for use by microorganisms as source of energy and cell carbon.
   - The microbial conversion of the compounds resulting from step 1, into lower molecular mass intermediate compounds (CH_3COOH).
   - The last step involves the conversion of the intermediate compounds produced in phase II into carbon dioxide and lesser amounts of hydrogen gas.
4) **Methane fermentation phase**: another group of microorganisms convert the acetic acid and hydrogen gas into CH_4 and CO_2. Microorganisms responsible for this conversion are strictly anaerobic and are called methanogenic.
5) **Maturation phase**: the maturation phase occurs after the readily available biodegradable organic material has been converted to CH_4 and CO_2 in phase 4. The rate of landfill gas generation diminishes significantly since most of the available nutrients have been removed with leachate.

Biogas is a gas which contributes to the greenhouse effect, with a global warming potential (GWP) 21 times higher than CO_2; this is why recovering this potential not only contributes a highly valuable energy yield (calorific capacity between 5,000 and 9,350 Kcal/m^3) but also avoids local and global environmental impact.

The amount and composition of the gas generated depend on a variety of factors such as the type of waste, water penetration, the type of surface cover, the disposal method applied, etc. European legislation (1999/31/EC on waste disposal) envisages the collection and treatment of the biogas produced. As soon as the site reaches its end of life, biogas continues to be generated and has to be recovered up to a typical point of 40% methane content (usually for fifteen years after closure).

The lower heat output is approximately 5,000 kcal/m^3, while the highest caloric capacity is approx. 9,350 kcal/m^3. In this case, the produced gas components are usually found in acceptable levels. The composition of the landfill biogas is normally in the content range appearing in the following table.

Table 7-36: Typical landfill gas composition

Component	Chemical formula	Concentration
Methane	CH_4	0 - 85 Vol %
Carbondioxide	CO_2	0 - 88 Vol %
Carbonmonoxide	CO	2.8 Vol %
Ammonia	NH_3	0 – 0.35 ppm
Hydrogen	H_2	0 – 3.6 Vol %
Oxygen	O_2	0 – 31.6 Vol %
Nitrogen	N_2	0 – 82.5 Vol %
Hydrogen sulfide	H_2S	0 - 70 ppm
Acetaldehyde	CH_3CHO	150 ppm
Ethylmercaptans	C_2H_2SH	0- 120 ppm
Acetone	C_2H_6CO	100 ppm
Benzene	C_6H_6	0.08 Vol %
Argon	Ar	0.01Vol %
Heptanes	C_7H_{16}	0.45 Vol %
Toluene	$C_6H_5CH_3$	0.09 Vol %

7.1.4.10.2 Potential Hazards from biogas production

Sometimes, landfill gas is entrapped within the soil cracks and gaps and is unable to escape into the atmosphere through the landfill's coverage surface. Once the gas is depleted by the oxygen content bound to the soil, it causes irreversible damage to the existent vegetation. Gas dispersion through the soil, pipes and fittings, may also lead to gas accumulations under the buildings located near the disposal site. One significant inherent risk arising from uncontrolled methane generation is mixing with air, which may cause explosions and fires. The flammability of the gas is determined by the content of methane; particularly, mixtures 5 – 15% methane in air have explosive properties, whereas mixtures higher than 15% have flammable properties.

According to the above, biogas may cause the following risks:

- Smell
- Damage to vegetation
- Fires
- Explosions.

7.1.4.10.3 Estimation of landfill gas production

Gas production rates at landfills vary significantly, depending on the waste types and moisture content of the wastes. As is the case with leachate, the quality and quantity of landfill gas vary with time. There are a number of gas emission models available to evaluate the quality and quantity of landfill gas. Among these is the USEPA, Landfill Gas Emissions Model (LandGEM) V3.02 predicts gas generation flows based upon site specific information including waste tonnage placement and inflow, waste types, volumetric capacity and life expectancy.

In order to calculate the biogas generation from the waste that will be landfilled, LandGEM model has been applied. LandGEM is the most widely used mathematical model for the calculation of landfill gas production. It is the 1st order equation, which is adopted by US EPA and many researchers, especially when field data are limited (i.e. recording of methane production of an existing landfill in order to determine the equation parameters) as following:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k \cdot L_o \cdot \left(\frac{M_i}{10} \right) \cdot e^{-k \cdot t_{ij}}$$

Where:

Q_{CH4} = annual methane generation in the year of the calculation (m^3/year)
i = 1-year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1-year time increment
k = methane generation rate ($year^{-1}$)
k $= -ln^{(0,5)/t1/2}$
$t_{1/2}$ =the time necessary to reduce the initial concentration of the organic matter into half
L_o = potential methane generation capacity (m^3/Mg)
M_i = mass of waste accepted in the i^{th} year (Mg)

t_{ij} = age of the j[th] section of waste mass Mi accepted in the i[th] year (decimal years, e.g., 3.2 years)

In order to calculate the Lo value, it is assumed that the chemical equation is (Andreottola&Cossu, 1988):

$$C_aH_bO_cN_d + nH_2O \rightarrow xCH_4 + yCO_2 + wNH_3 + zC_5H_7O_2N \quad (1)$$

Where $C_5H_7O_2N$ is the molecule of the bacteria that becomes negligible over time. So, equation (1) becomes:

$$C_aH_bO_cN_d + \frac{4a-b-2c+3d}{4}H_2O \rightarrow \frac{4a+b-2c-3d}{8}CH_4 + \frac{4a-b+2c+3d}{8}CO_2 + dNN_3 \quad (2)$$

Based on equation (2) it is apparent that:

1 mol C=1 mol biogas (CH_4+CO_2) ⇔ 1 Kg =1.867 m³ biogas at Normal Conditions (3)

Therefore, the amount of biogas produced depends on the amount of biodegradable organic carbon, present in waste.

In order to determine this amount, the following equation applies (Andreottola&Cossu, 1988):

(Ce)i = (C)i x (fb)i x (1-u)i x pi (4)

where:
(Ce)i: amount of biodegradable organic carbon of component i (kg /kg of waste),
(C)i: amount of organic carbon of component i (kg /kg DS of component i),
(fb)i: fraction (biodegradable) of (C)i (kg of biodegradable organic carbon /kg of organic carbon),
ui: moisture content of component i (kg of water /kg of wet weight of component i),
pi: wet weight of component i

From equation (3) and (4) it results:

$$C_o = 1.867 * \sum_i (C_e)_i = 1.867 * \sum_i [(C)_i * (fb)_i * (1-u)_i * p_i] \quad (5)$$

Where:
C_o = potential biogas generation capacity ⇔ $L_o = C_o/2$, in m^3/kg of waste, assuming that biogas contains CH_4 at 50% v/v.

The waste streams that will be diverted to landfill are the following:
- Residues from mechanical separation after their treatment in Biostabilization process
- Digestate (comes from anaerobic Digestion) after its treatment in Biostabilization process
- Residues from recyclables which collected at source

For the estimation of the biogas production through the years of the landfill operation and aftercare, the parameters *C, fb* and *u* were determined according to literature and estimations based on similar projects (landfills, MBTs, etc.). Hence, mixed waste (Andreottola&Cossu, 1988) and estimations for moisture based on the fact that wet mixed waste is collected in the "wet" bin:

Table 7-37: Parameters for the calculation of Lo of mixed waste

Components	ui	Ci	(fb)i
Biodegradables	0.65	0.6	0.85
Paper – Cardboard	0.25	0.4	0.5
Others	0.3	0.55	0.2

Each waste stream has also a different behaviour with regards to the k coefficient (y^{-1}), because biodegradable components for example are readily biodegradable wastes, while wood may take several years to biodegrade. To sum up, the calculated values for Lo and the values taken for k are presented below:

Table 7-38:Lo and k values for the various components in waste landfilled

Components	Rate of biodegradation	Half time, t	k, t-1	Lo, m^3 CH_4/ton of component
Biodegradables	Short term	3.75	0.185	167
Paper	Medium term	6.93	0.100	140
Others	Long Term	23.10	0.030	72

Based on this last table, it obvious that biodegradables, paper and the "others" fraction, are the categories of waste that produce biogas. The "others" fraction is assumed to contain biodegradable organic carbon just to assure safety of calculations.

According to the Regional Plan for Southwest Region, the quantities of biodegradablesthat will be disposed in the landfill site, are presented in the following table.

Table 7-39:Biodegradables to be disposed (t/y)

Year	Quantities of biodegradables landfilled (t)
2021	2,835
2022	2,847
2023	2,859
2024	2,872
2025	2,886
2026	2,898
2027	2,910
2028	2,923
2029	2,937
2030	2,951
2031	2,946
2032	2,942
2033	2,937
2034	2,933
2035	2,928
2036	2,921
2037	2,913
2038	2,906
2039	2,899
2040	2,893

Year	Quantities of biodegradables landfilled (t)
2041	2,883
2042	2,874
2043	2,865
2044	2,856
2045	2,847
2046	2,836

From literature, usually the biogas management systems in landfill sites can achieved 40% – 90% collection efficiency. In our case, the biogas extraction efficiency has been assumed to be 60% during the operation phase and 75% after the rehabilitation of the landfill site.

Based on the abovementioned, the calculated quantities of biogas production and recovery are presented in the following table, considering that the above quantities are short – term biodegradables for safety reasons.

Table 7-40: Biogas production and recovery from landfill site

Year	BiogasProduction (m^3/y)	BiogasProduction (m^3/h)	BiogasRecovery (m^3/h)
2021	0	0.0	0.0
2022	161,026	18.4	11.0
2023	295,541	33.7	20.2
2024	408,050	46.6	27.9
2025	502,298	57.3	34.4
2026	581,400	66.4	39.8
2027	647,808	74.0	44.4
2028	703,703	80.3	48.2
2029	750,900	85.7	51.4
2030	790,909	90.3	54.2
2031	824,986	94.2	56.5
2032	853,025	97.4	58.4
2033	876,056	100.0	60.0
2034	894,937	102.2	61.3
2035	910,378	103.9	62.4
2036	922,972	105.4	63.2
2037	933,012	106.5	63.9
2038	940,941	107.4	64.4
2039	947,126	108.1	64.9
2040	951,873	108.7	65.2
2041	955,434	109.1	65.4
2042	957,853	109.3	65.6
2043	959,334	109.5	65.7
2044	960,046	109.6	65.8
2045	960,129	109.6	65.8
2046	959,702	109.6	65.7
2047	958,725	109.4	82.1
2048	796,800	91.0	68.2
2049	662,224	75.6	56.7
2050	550,377	62.8	47.1
2051	457,421	52.2	39.2
2052	380,164	43.4	32.5
2053	315,956	36.1	27.1

Year	BiogasProduction (m^3/y)	BiogasProduction (m^3/h)	BiogasRecovery (m^3/h)
2054	262,593	30.0	22.5
2055	218,242	24.9	18.7
2056	181,382	20.7	15.5
2057	150,747	17.2	12.9
2058	125,287	14.3	10.7
2059	104,126	11.9	8.9
2060	86,540	9.9	7.4
2061	71,924	8.2	6.2
2062	59,776	6.8	5.1
2063	49,680	5.7	4.3
2064	41,289	4.7	3.5
2065	34,316	3.9	2.9
2066	28,520	3.3	2.4
2067	23,703	2.7	2.0
2068	19,700	2.2	1.7
2069	16,373	1.9	1.4
2070	13,607	1.6	1.2

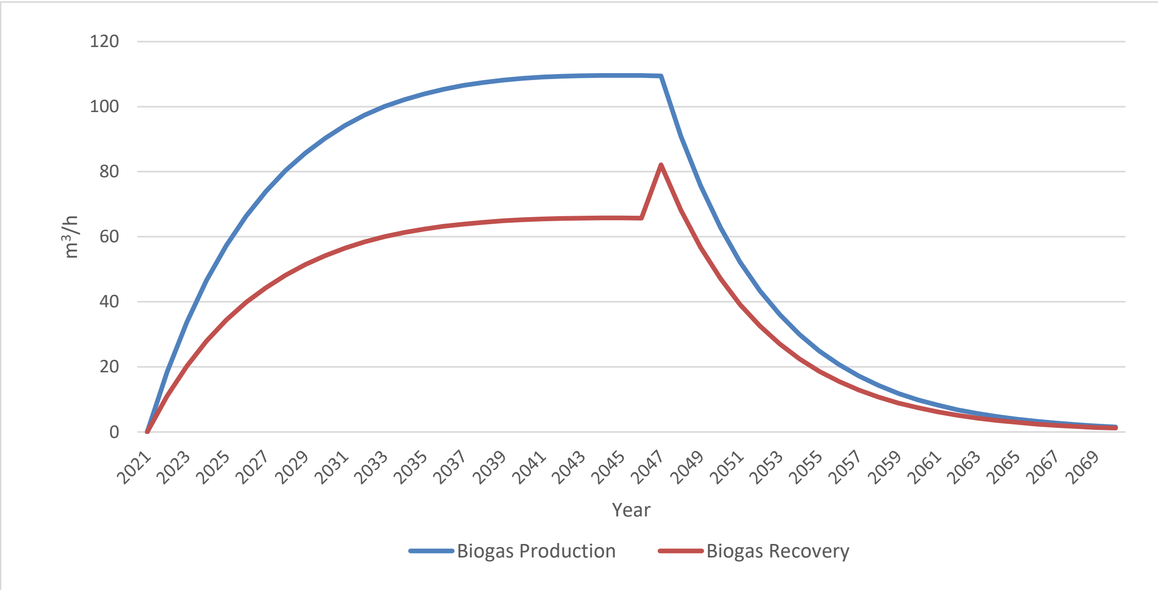


Figure 7-60: Biogas production and recovery over time

As it can be seen from the above, the maximum biogas quantity is observed in year 2047 (which is the year after the landfill will accept waste). This maximum quantity reaches 109.4 m^3/h. What is more, it is estimated that the biogas quantity that it can be recovered is 82.1 m^3/h. Therefore, it is proposed to use a flare unit with capacity of 100Nm^3/h, which can sufficiently cover the biogas management needs of the examined landfill site, during its operation and after its rehabilitation.

7.1.4.10.4 Biogas management system - Technical specifications

The landfill gas management system will consist of the following:

- Gas extraction wells
- Gas collection and transfer system, including pipe works, condensate collection units and biogas collection sub-stations
- Flare unit

In many traditional landfills, gas collection system is not initiated until after the final landfill cover is constructed. However, landfills generate LFG (principally methane and carbon dioxide) earlier in the process, during the operation of the landfill. Benefits offered by this aspect are the availability of gas for productive uses and the potential for LFG impacts (to the atmosphere, groundwater, or to potential receptors) are reduced. Therefore, gas collection and recovery system in landfills shall be installed either during the waste filling in the cell or immediately after cell completion.

Different techniques may be used to collect LFG. The most common method of landfill gas collection involves installation of vertical gas wells in the waste and connecting those wellheads to lateral piping that transports the gas to a collection header using a blower or vacuum induction system. A blower system is used to induce a vacuum in the gas manifold and the wells and to extract gas from the landfill waste body. The vacuum has to be maintained in such a way so as not to draw air into the landfill, as the air drawn into the landfill may slow down the methanogenic microbial activity and may cause explosions and fires.

7.1.4.10.5 Gas extraction wells

The most common method of landfill gas collection involves installation of vertical gas wells in the waste and connecting those wellheads to lateral piping that transports the gas to a collection header using a blower or vacuum induction system.

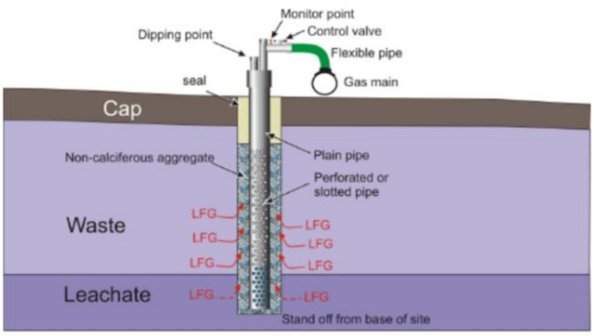
As mentioned above, due to accelerated biodegradation gas wells should be installed into the landfill to collect landfill gas at the early phase.Landfill gas can be extracted soon after gas generation begins, which is rapidly initiated in landfills. Considering the fact that landfill gas generation starts soon after waste disposal and that models show considerable portion of the landfill gas generated from the first years after waste disposal, collecting gas early in the lifetime of landfill is a major advantage.

The installation of gas extraction wells are foreseen for the landfill in order to collect generated biogas. The gas wells will be uplifted with the increase of the waste body height, up to the maximum filling level. The wells will have a diameter approximately 0.8m and will be filled with a material as gravel or crashed stone. Inside the well, a HDPE perforated pipe with a diameter of at least 110mm will be immersed. This ensures a uniform extraction of the gas generated inside the deposit's body with under pressure. These wells will have a depth that will reach at least 3m above the bottom drainage layer.

At their final height, all pipes from the vertical wells shall end up to a well head, having a side branch for the connection with the horizontal piping network. The well head shall be made of HDPE and shall be equipped with press relief valve, flow, temperature and sampling access points. In order to control and analyze the effectiveness of the gas collection system and to measure fugitive gas emissions, the quantity and quality of collected LFG should be measured, including flow rate, temperature, pressure and composition (CH_4 and O_2). Collected LFG flow rate, temperature, and pressure can be measured by installing gauges on well heads.

At the branch of the well head a butterfly valve shall be positioned assisting the landfill gas control from the specific well. A special fitting made of flexible HDPE shall be used for the connection to the horizontal transfer pipeline. In order to protect the well head a prefabricated concrete pipe (approximately 1m high and 1m diameter) shall be positioned on top of each well with a metal cap for protection and easy access.

At the top edge of the gas well it is applied a sealing capping system. Up to the maximum filling level, non-perforated pipes will be installed in the last 2 m of the vertical wells and they will be surrounded by seal of impermeable material (e.g. clay, bentonite). Hence, the penetration of the air and storm water inside the waste body around the gas collection wells must be avoided, as well as gas emissions into the atmosphere. The next figure shows a vertical gas collection well.

a)


b)


Figure 7-61:a) Typical gas extraction well scheme and b) representative photo of a wellhead protected by prefabricated concrete pipe.

A sufficient number of wells shall be constructed for the landfill gas collection. The distance between two vertical wells shall be 40-60 m considering an effective radius of approx. 25-30 m around each well. The relative positioning of the wells is represented in the following figure.

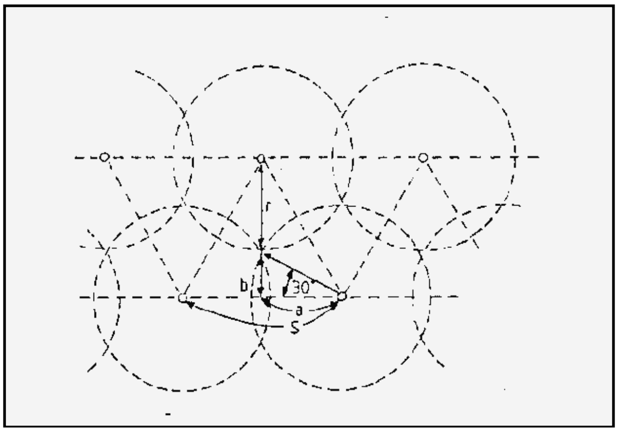


Figure 7-62: Landfill gas vertical wells positioning

7.1.4.10.6 Biogas transfer piping network

Connecting the wells to main collection pipes is the most common way to get the LFG to the recovery system. In particular, each well will be connected to the gas collection stations through collection pipes.Gas collection pipes shall be installed with a slope to the gas collection stations, in order to evacuate the water condensed inside the pipe. The pipes shall be provided with flexible devices that allow the connection to the gas stations in a way that damage is minimized. The pipes and the flexible connections shall be of HDPE with a pressure resistance ≥ PN 6.

The collection pipes diameter will be ≥ 90 mm, such as to ensure a gas velocity not higher than 10 m/s.The gas collection pipes will bear butterfly valves at their connection to the collection stations, assisting the landfill gas control from the specific pipe and allowing stopping gas flow. Before the butterfly valves the pipes have sampling points. Within the stations, individual pipes are connected via a manifold to the main discharge pipe. One more butterfly valve is placed between the collection cylinder and the main discharge pipe.

The number of the gas stations is determined upon the landfill shape, the number of wells and their distribution.They shall be completely sealed and well ventilated, whereas non-authorized personnel access will be strictly forbidden. Warning (no smoking and no fire) signs on the potential risks related to biogas presence shall be located within the gas collection stations area. The stations shall be placed outside the cells and should be accessible from the perimeter of the site.

Gas collected through the extraction wells is transmitted to the gas stations through collection pipes and finally to the flare unit through the main pipes. The main transfer pipes shall be made of HDPEwith a pressure resistance ≥ PN 6 and a diameter ≥ 90mm such as to ensure a gas velocity not higher than 10 m/s.They will be installed underground and they shall be protected against freezing at the surface with a layer of soil. This main pipes should allow for easy access for any damages.

Since biogas is saturated with water vapours it leads to condensate formation in the pipe network. The biogas main pipe will be connected in the lowest level point of the container of the biogas collection stations with a condensate trap for collecting all generated condensates. From the condensate traps the condensates will lead back to the landfill site using a portable pump.

7.1.4.10.7 Flare unit

The landfill gas will be combusted in compliance to EU environmental protection standards. The flare unit shall be a closed-type, allowing high efficiency with combustion at least at 1,000 °C and 0.3 s residence time to ensure compliance with the emission regulations. The capacity of the flare unit is proposed to be 100 m^3/h, with turn down ratio 1:5.

The flare unit shall be equipped with automatic ignition and wind shield valves. The flare unit shall include all safety equipment including, but not limited to a solenoid operated pressure break valve, flame arrester and blow off valve. In particular, it shall be equipped with:

- Blower unit with EEx-proof motor
- Ignition burner
- Combustion chamber
- Flame arrestors

- Flowmeter
- Quick closing valve
- Burner control system with UV detection
- Pressure, temperature control and monitoring
- Electrical control weather proof cabinet
- Gas Analysis System (CH_4, O_2, CO_2)
- Condensate trap

The material of combustion chamber shall be heat resistant stainless steel, and gas touched parts from stainless steel.

The compact plant shall also be equipped with all necessary safety features for the safe handling and combustion of the landfill gas (guideline EN60079-ff for explosion protection).

7.1.4.11 Surface and ground water protection works

The main aims of this section are the following:

- To avoid the inflow of storm water in the landfill and in this way protect its structural stability.
- To avoid the inflow of storm water in the landfill and in this way reduce the leachate production
- To protect the buildings and the roads of the landfill site from storm water erosion

The overall design is presented in the general layout of the flood protection works which accompanies this text.
The flood protection works of the site consist of the following:

- Circumferential ditches (ditches A and B) stretch around the landfill and prevent storm water from entering in it, as well as collect the storm water from the surface of the final cap after the landfill closure. The dimensions of these ditches differ according to the runoff calculations and the slopes.
- Ditches collect the runoff from the parts inside the landfill (buildings and treatment areas and the embankments surfaces). The ditches may have rectangular or trapezoidal or triangular shape of suitable section.
- Manholes where there is a connection between ditches. All the wells are covered with grate for the prevention of accident occurrence and debris.
- Culvert pipes are going to be constructed. Also, manholes will be constructed, in order to give access to the pipe for maintenance reasons.

It should be noted that crucial element of the flood protection system is the slope free surfaces of the ground inside the site: all the surfaces must be sloped towards the nearest ditch in order to prevent the retention of water in hollows of the ground. The slope of the free surfaces has a range among 1% - 3% with the directions shown in the general layouts of flood protection works.

Runoff estimation method
The hydrological calculations were made for a return period of 20 years. A safety factor was also The hydrological calculations were made for a return period of 20 years. A safety factor was also adopted for the maximum discharge that the ditches can convey. The ditches were dimensioned in order the height "y" of the flow during the design storm divided by the total height of the ditch "h" must be below 0.80, i.e. $y/h < 0.80$.

The calculation of the runoff was made using the rational method:
Q= 0.000278 x c x i x A (lt/sec)
where:
c: runoff coefficient
i: rainfall intensity in the time of concentration (mm/hr)
A: area of catchment basin (m^2)

Runoff coefficient
For the runoff estimation of the roads, the runoff coefficient is equal to 0.90 based on the international literature on the particular subject.
For the runoff estimation of the final cover of the landfill a runoff coefficient of 0.80 was used, which is the highest of the typical runoff coefficients presented in Integrated Solid Waste Management, Tsobanoglouset. al. page. 457.
Finally the runoff coefficient of the external catchment areas was calculated using the following formula (Mamassis 2008, Koutsogiannis and Xanthopoulos 1996):
C = 1 - C’1 - C’2 - C’3
The parameters presented above are for region characterized by average slope, saturated soil and sparse vegetation.

Ditch and culvert design – Hydraulic calculations
For the dimensioning of the ditches and the culverts the Manning formula was used assuming that the continuity assumption is valid
Q = A x V (m3/s)
V = (1/n) x R2/3 x S1/2
where :
Q = discharge (m3/s)
A = “wet” area (m^2)
V = velocity (m/s)
(n) = manning coefficient
R = hydraulic radius (m)
S = slope
More specifically the calculations will be with the use of STONET, DRAINET software of ENCOSOFT, for pipes and open channels. The mathematical model of this program is based on the continuity equation and on Manning formula.

7.1.4.12 Site infrastructure such as access roads, fencing, weighing bridge, service and staff building, washing installation etc.

The necessary infrastructure for the proper function of Central Waste Management Facilities is:
- Main entrance and fencing
- Administration building
- Weighbridge
- Tire washing system
- Maintenance building
- Washing facility
- Water supply network
- Sewage network

- Fire protection system
- Water tank
- Energy building
- Parking
- Control system for monitoring and automation of Central Waste Management Facilities

The entrance of the Facility is located in the north side, where the security house and weighbridges are placed. The maintenance and service buildings are situated close to the entrance. In the center of the site the landfill cells will be constructed. Incoming trucks are directed to the MBT reception area.
The general layout of the WMC is presented below:

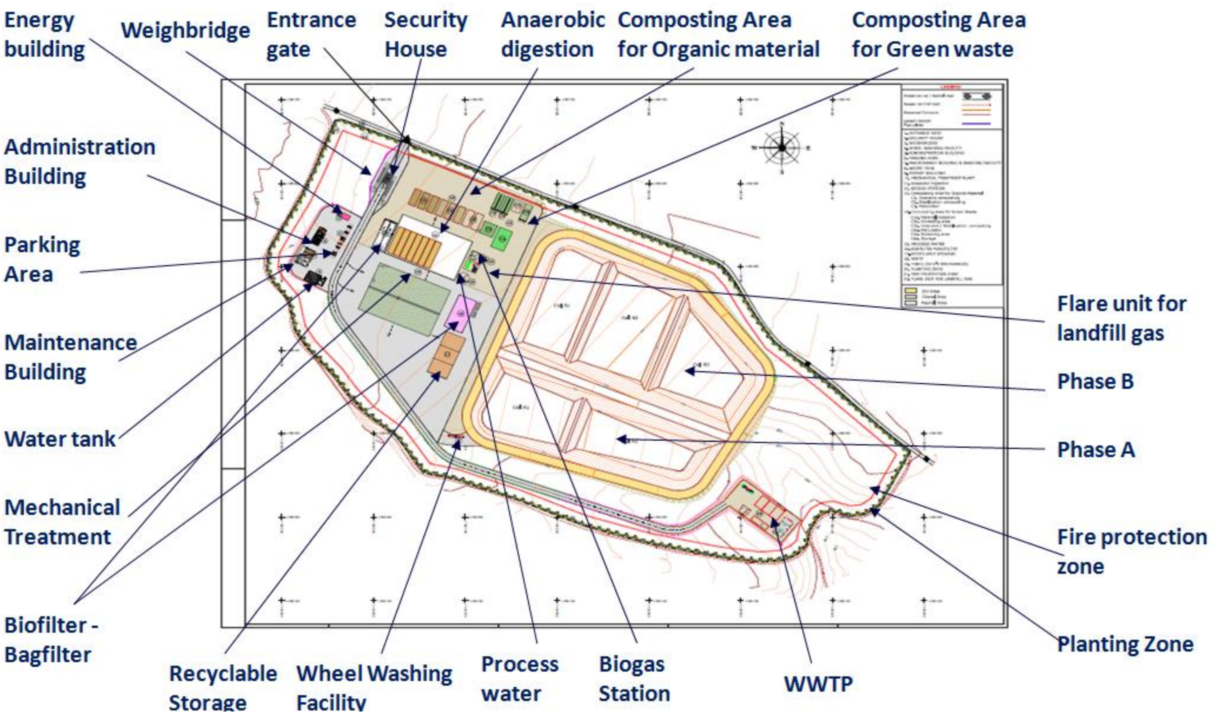


Figure 7-63: General layout of Central Waste Management Facilities

Access Road

An asphalt road serves the purpose of access to the CWMF. It will be constructed in order to serve heavy vehicles according to local regulations. The road will have 3.5 m wide with shoulders of 0.5 m width in each lane and will have maximum slope 8%.

Further improvement of existing road network is not considered necessary at this point.

Entry area

1) Fencing – Entrance Gate

The perimeter of the areas of the CWMF will be protected via a fence made of galvanized iron ducts of 5 cm diameter, 2.50 m height, which will be encased in a concrete basis below the ground. The ducts will be vertical and will reach height 2.00 m above the ground. In the last 50 cm the ducts will have a gradient of 30o to the external side of the fence. The edges of the ducts will be connected with prickle wire net.

The prickle wire net will be 2 mm thick and will be installed in 2 rows. In both the vertical and the sliding parts of each duct holes will be made in order for the reinforcement wire and the prickle wire net to be developed. The reinforcement wire will be 4 mm thick and will be installed in 3 rows. A rhomboid wire net with loops (5 X 5 cm) will be used to restrict the trespassing of rodents.

The distance between the ducts will be 3.00 m., and every 6.00 m iron struts will be placed of the same diameter as the ducts. The struts will be encased in a concrete basis, of dimension 0.50 X 0.50 X 0.60 m. The entrance gate consists of two doors with 4.00 m length each and 2.50 m height. The entrance doors will automatically open. The doors will be coated with wire net and be secured with a lock.

2) Information Sign

Right after the entrance gate there will be posted an information sign in accordance with the requirements of EU. The information boards will measure 2.0 m x 2.5 m, with sheet metal which will include at least the following:

- The emblem of European Union
- Title of Project
- Project budget
- The Fund participating from EU funding
- Contract number
- Details of Employer
- Details of Project Engineer
- Details of Construction Contractor
- References to EU assistance, as defined in the relevant regulations

3) Security house

The weighbridge house is envisaged with the purpose of serving weighbridge for this reason it is located next to the weighbridges.

It shall be a building with solid Ferro-concrete structure, sloping roof, and brick facade and partitioning walls, covering a total surface of 24.40 m^2, with one main work room with sanitary unit and an entry hall with a kitchenette.

External landings with staircases provide two-way access to the work room and entry hall. The landings are made safe by 1.05m high railings.

The building shall be equipped with a desk and the necessary electronic equipment for weighing and data recording of the incoming/outcomming vehicles.

4) Weighbridge

One of the most important elements to monitor and control the operation of the Central Waste Management Facilities is an accurate and systematic recording of incoming waste. This requires the existence of a Weighing area where all incoming vehicles before discharging waste must be weighed. A fully electronic weighbridge will be installed.

The delivery shall be in accordance with the specifications below:

- Weighbridge capacity: 60 tons with maximum intervals of 20 kg
- Size approximately 18 x 3m

5) Administration building

This building serves the project administration, the personnel and the visitors. Next to it, parking area for personnel and visitors is envisaged. The administrative building has approximately 153.50 m²surface and the following rooms:

- Entrance (4.18 m2)
- Control room (9.11 m2)
- Office (18.87 m2)
- Meeting room (2.50 m2)
- Laboratory (7.15 m2)
- Respiratory (4.91 m2)
- WC (3.58 m2)
- Washroom/Showers/WC/Lockers women (18.09 m2)
- Washroom/Showers/WC/Lockers men (17.60 m2)
- Kitchen (8.24 m2)
- Corridor (19.20 m2)

Two entrances have been provided for the administrative and operating staff, which is due to the difference in the nature of their work and the specifications for the work rooms. The operating staff can use both the entrance to the administrative part, and the separate entrance.

The specified utility space has been provided, as utility rooms with separate storage for working and personal clothing, showers, wash basins and sanitary units, and a storeroom for work clothes, respectively. The staff can use the rest room with the kitchenette.

It shall be a building with solid Ferro-concrete structure, sloping roof, and brick facade and partitioning walls.

6)Other Infrastructures

Maintenance building

The building is planned to cover the maintenance and lubricating purposes of the trucks and other mechanical equipment. The maintenance building has approximately 148.60 m2 surface and indicatively the following areas:

- Assembly pit (106.60 m^2)
- Entrance (6.32 m²)
- Storage room (7.42 m²)
- Office (9.62 m²)
- WC (2.92 m^2)

The workshop has space for repair of trucks and other transport machines servicing the landfill, the composting site and the installation for separating of waste materials, a storeroom for tools and inventory, an entry hall and sanitary unit for the service staff.

The building is a two-axis metal hall. Part of the hall is occupied by the workshop, and the other by the truck wash shed. The facade walls and roof are from façade and rooftop sandwich-panels.

The service premises are accommodated within the hall; they are of monolithic Ferro-concrete structure. There are brick partitioning walls.

Next to maintenance building, will be established an shedded washing area for vehicles (collection vehicles and mobile equipment).

Parking space
The vehicles of the visitors and works of the landfill area (including the administrative building and the maintenance building) will be parked in an open parking opposite to the administrative building. At least 18 vehicles will be parked and the dimension of each parking position will be 2.50 X 5.00 m.

Energy building/power supply infrastructure
These will host Transformer, Emergency Power Generator and Electric Panel rooms. All buildings will be compatible with National and EU regulations.

Internal roads
The internal asphalt road serves the purpose of access to the various facilities. It will be constructed for heavy vehicles according to local regulations. The internal road is 3.5 m wide with shoulders 0.5 m width in each lane and will have maximum slope 8%.

Water tanks-Fire fighting system
The fire fighting network shall cover the whole area of the facility. One water tank for fire fighting is envisaged. The water tank is envisaged near the maintenance building.
The functional designation of the water tank is to supply the site with water in the event of fire. Access is provided by an external Ferro-concrete staircase. The facility contains a pump station and two tanks with capacity of 150 cubic m. of water each.
The building is entirely dug-in, with monolithic Ferro-concrete walls, floor and rooftop slabs.
The pump station has one window for natural ventilation towards the external landing, and a double metal door with heat-insulation filling.

In the construction of buildings and other facilities all relevant fire extinguishing systems will be provided according to local regulations, such as fire extinguishing actions with flexible pipes and nozzles, portable foam extinguishers, sprinklers, etc.

Green areas
It is proposed to provide for green areas surrounding the internal road, having a protective (noise, smell) and aesthetic role. Moreover green areas around the buildings and in the entrance will also be planted. Grass and local type bushes / trees are foreseen with minimal maintenance requirements (according the conceptual design).
Regarding density mounting of the tree planting perimeter 1 tree every 10m will be placed.

Power supply
Regarding power supply all the requirements of the beneficiary country and European standards, rules and regulations must be taken into consideration. Power supply consists of other electrical installations such as external wiring, lighting installations, etc.

Control system for monitoring and automation of Central Waste Management Facilities
The central monitoring and control system is designed to incorporate the 'feeds' from the main control systems regulating the processing activities within the Central Waste Management Facilities. The design of the automation system is based on required objectives. In this context it has been foreseen the installation of a series of automatic control, measurement and management systems that will cover:

- The supervision and management of the land filling environmental operations
- The supervision and management of the MBT
- The supervision and management of the wastewater treatment plant
- The supervision and management of the support buildings where necessary, indicatively:
- Weighbridge
- Wheel wash
- Fire alarm extinguishing system
- Sewage pumping station (if needed)
- Alarm detectors
- Outdoor lighting
- etc

The central control centre of the installation is located in the administration building and consists of a network of PCs with the necessary peripherals and appropriate software for the automatic supervision and operation of all the individual facilities utilising the process commonly known as supervisory control and data acquisition (SCADA). The PCs will collate all the crucial information concerning the operational state of individual facilities of the Central Waste Management Facilities and will carry out all the necessary procedures for the smooth operation. All the localised automated control panels and the control stations within each facility, via the use of Ethernet hub switches, will be connected via a network of optical fibbers that run throughout the facility. With this set up the control programming of individual production processes is possible from within the central control station or from the localised control rooms.

The central control panels located in the administration building and the localised control rooms are equipped with all the necessary hardware and software for the control of operations. At the central control panel, placed in the provided room within the administration building and also at the localised control panels there is a flow diagram and indicators for the operational control and management of all the installed machinery and devises. Where required, optical and audio alarm signals are placed.

The operators from the Central Control System and also from the Station Control rooms have the possibility of supervision with two ways: via the above mentioned SCADA system or via manual operation from the localised control panels if necessary

Fire alarm and CCTV monitor
The Central Waste Management Facilities should foresee installation of an automatic fire alarm system in all buildings rooms. The main station of the system will be located in the office building, in the weighbridge room. CCTV monitoring system will provide continuous monitoring in real time, as well as recordings of the events. There will be continuous digital recording and an opportunity to review in case of events, including remotely via the Internet through providing internet connection.

Sewerage
Wastewater - sewerage of all buildings in the Central Waste Management Facilities will be directed to the Leachate Treatment Plant. In particular, wastewater from bunkers, biological treatment leachate, washes of vehicles, condensates, sewage from toilets of buildings will be directed via suitable drainage pipes and pumping stations (if needed) to the leachate plant and will be treated with landfill leachate. For this reason, the design of the plant will accommodate the additional loads.

Wheel washing system

Before leaving the landfill site and entering the public roads, the vehicles will undergo tyre cleaning. The purpose of the wheel washing system is to wash the tyres of transportation vehicles from mud and waste residues form landfill site

The waste water from washing basin is collected and transmitted to the sewage - leachate collection system from the landfill. Finally, the waste water reaches the leachate collection tank of the Waste Water Treatment Plant.

The washing basin is a construction from reinforced concrete plate and has:

- Length: 18m
- Net Width: 3m
- Depth: 0.45m

Fire protection zone in the perimeter of the landfill

Inside and parallel to the fence, a fire protection zone of 10.00 m width is foreseen for the perimeter of the site.

7.1.4.13 Equipment (waste compactors, earth moving material, trucks etc.)

For the sound everyday operations inside the specific landfill, the following, diesel engine, mobile equipment is chosen (detailed data concerning quantities and budget of the chosen mobile equipment is presented in the next paragraphs of the present Chapter:

a) Waste compactor: it isusedtocompactwastemass under its own weight. It is also used to spread the daily cover material. Duetoitssolidconstructionithasnoproblemswithsharp items. An indicative wastecompactorhas 32 t weight and 260 kW engine power.

Figure 7-64:Waste compactor

b) Tipping truck, self-unloading, three axles with superstructure and crane.It is used to carry the everyday soil cover material, as well as to carry any other material. An indicative tipping truck has 26 t weight and carrying capacity of 13.8 t. An indicative truck engine is EURO 6 pollution technology and 320HP engine power.

Figure 7-65: Three axles tipping trucks

c) Backhoe (wheeled)loader - excavator, with indicative weight of 8 t, indicative engine power 100 HP, with 3.5 m^3 bucket and back driving warning system. Additionally, it has a back excavation system, in order to break rocks and to form ditches.

Figure 7-66:Backhoe Loader-Excavator

7.1.4.14 Staffing

This section presents the indicative personnel requirements for the management and the normal operation of the new regional landfill.

To perform all tasks for disposal of residues in the new regional landfill, the number of personnel necessary for the proper operation is analyzed as follows:

Table 7-41: Personnel requirements for landfill

Requirements for landfill operation	
Position title	*Indicative number of personnel*
5. Landfill site supervisor	Common position with MBT operator
6. Waste compactor operator	1
7. Backhoe loader operator	1
8. Tipping truck operator	1
9. General tasks workers	Common position with MBT operator
WWTP – Landfill gas collection	
Position title	*Indicative number of personnel*
1. Manager	Common position with MBT operator
2. Environmental compliance officer	Common position with MBT operator

Finally, for the satisfactory operation of buildings and other infrastructure, apart from personnel required for the operation of mechanical and biological treatment facilities (as described in previous paragraph) and of the landfill, it is proposed that the presence of additional workers is required, as shown in following table:

Table 7-42: Personnel requirements for other infrastructure

WWTP – Landfill gas collection	
Position title	*Indicative number of personnel*
3. Manager	Common position with MBT operator
4. Environmental compliance officer	Common position with MBT operator
Requirements for technical section of vehicles	
Position title	*Indicative number of personnel*
1. Mechanical engineer	Common position with MBT operator
2. Vehicle mechanic	Common position with MBT operator
3. General tasks worker	1

7.1.4.15 Environmental Monitoring

The implementation of sustainable landfill practices will in most cases result in additional operation and monitoring requirements beyond standard engineered landfills. With the role that liquids play in such systems, the measurement and tracking of the site's water balance will be critical. Not only will this include standard measurements such as leachate generation and rainfall, but also liquids added (often measured on a per device or areal basis), liquid levels and pressures in the landfill, and liquid measurements associated with the LCRS.

Additional gas measurement requirements may be needed as Gas collection and control system GCCS operations may be implemented earlier, additional devices may be used, and the level of control needed may necessitate more frequent monitoring. Routine inspection of all landfill elements becomes more critical when practices such as liquids or air addition are employed. As described previously, leachate seeps to the landfill side slope should be anticipated and as part of the site's operation plan, routine inspection for seeps must occur and a contingency plan to manage seeps must be in place. Seeps and other surface changes act as indicators of system performance and can signal potentially more serious issues such as side slope and cover failures.

Since subsurface fire formation is a major concern with air addition, monitoring gas composition and internal landfill temperature is critical and demands additional operator effort. The landfill operator can use multiple measurement parameters and techniques to assess the performance of the sustainable landfill system. The following table lists some of the potential monitoring alternatives that might be implemented. A major part of the planning of sustainable landfill practices will be determining the level of staffing that will be required to achieve monitoring objectives and the degree of instrumentation and monitoring necessary. These determinations will consider existing regulatory and permit requirements, performance objectives, costs, and the acceptable operational risk level. Planning considerations will include determining how much of the operation and monitoring can be accomplished with permanent landfill staff and how much to turn over to outside contractors.

Table 7-43: Potential monitoring alternatives

Monitored parameter	Considerations
Leachategeneration	Leachate volumes will be monitored at most landfill sites, but tracking the water balance in systems where liquids are added is more critical. More frequent and spatially distinct monitoring may be necessary
Leachatequality	Tracking leachate quality is a helpful tool to assess stabilization activity within the landfill. It may also be useful in determining how best to operate the liquids addition system. These data may also be helpful in determining when to end the post-closure care period
Gas production	As gas is a major focus in landfills that are accelerating waste stabilization, measuring gas quantity and quality earlier, more frequently and in more places may be advantageous or required
Gas quality	Gas quality is an important indicator of system operation and is of extra importance at sites where gas is beneficially utilized and when assessing the potential presence of potential landfill fires
Waste settlement	Surface topographic measurements are often conducted on an annual basis at modern landfills. Since settlement can help evaluate the progress of landfill stabilization, more frequent and spatially distinct measurements maybe advantageous
Waste quality	Most landfills will not have a need for collection and analysis of solid waste samples. Landfills practicing rapid stabilization techniques may benefit from assessing the degree of waste stabilization with time—a waste sampling program may be developed so that the sampling locations and analytical techniques allow for a statistically meaningful tracking of wastedegradation. Additionally, degraded waste quality following completion of sustainable landfilling at a site may be measured if the beneficial reuse of the material is contemplated
Moisture	While moisture content may be determined with water balance information, devices and instruments exist for measuring internal moisture content of waste at distinct locations. Installation and monitoring of such devices have been used by some operators to track the progress of moisture distribution as a result of liquids addition (i.e., tracking the presence of moisture). Limitations exist with respect to using moisture measurement devices that provide an accurate quantitative reading

In order to implement the measures for reduction of the negative impact and to implement the positive impacts from the activities and operation of the landfills inside the CWMF, it is necessary to monitor some environmental parameters. The methods proposed for monitoring the emissions from these sectors are set out below. License requirements may vary from those stated below due to site location considerations, sensitivity of receiving waters, and scale of the operation.

A variety of methods, devices, and techniques provide the operator an ability to monitor landfill performance, both for assessing site-specific goals (e.g., airspace consumption) and to meet regulatory requirements for environmental protection(e.g., monitoring of groundwater). Operators using sustainable landfilling technologies will likely employ a larger suite of monitoring tools to assess performance and promote environmental safety. The aim of this chapter is to provide an overview of the many monitoring opportunities that may be utilized at landfills, especially those where sustainable practices are implemented.

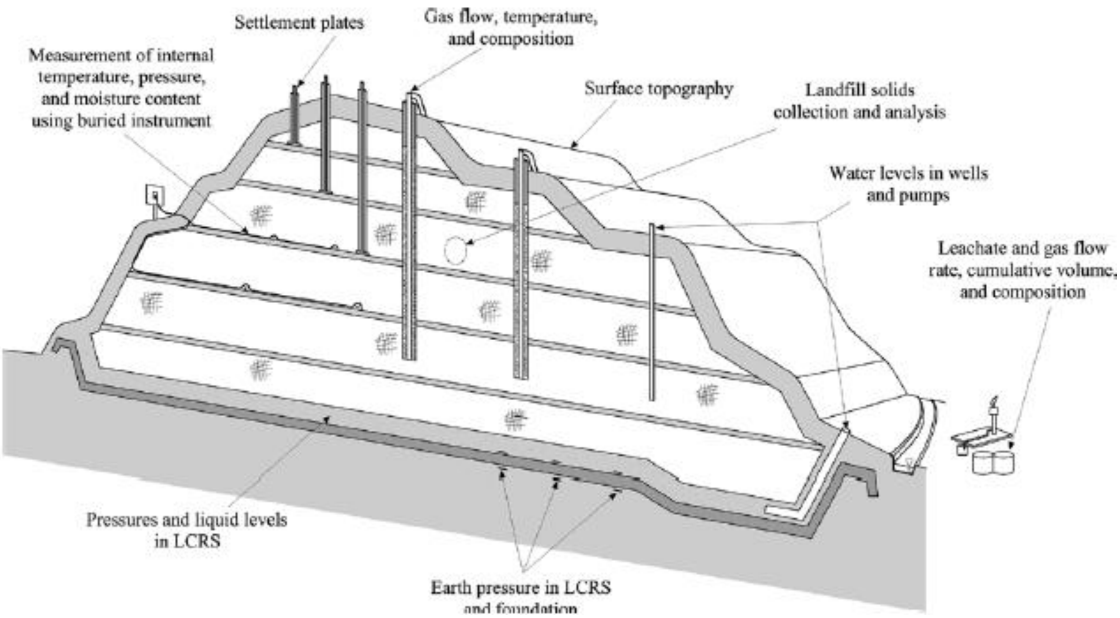


Figure 7-67: Conceptual illustration of landfill monitoring locations

- Leachate chemical composition monitoring

Landfill operators commonly monitor leachate on a routine basis as part of regulatory permit conditions, or to meet pretreatment or treatment requirements. The majority of the parameters useful for describing the chemical conditions of landfill leachate require laboratory analytical methods. Simple techniques may be performed at the landfill site if the facility is equipped with the appropriate field measurement equipment. Some of the laboratory analyses target specific components or elements (e.g., chloride, toluene), while other methods provide a measure of an overall characteristic (e.g., BOD).

Typical leachate monitoring parameters are described in the following table, and are organized into measurements made in the field and classes of constituents measured in laboratory (organic strength measurements, inorganic strength measurement, nutrients, and trace chemicals. Leachate quality can vary tremendously from site to site (and within a single site) as a function of waste type, age, climate and operating conditions.

Table 7-44: Classes of leachate monitoring constituents

Leachate constituent class	Description
Field parameters	Measurements made immediately after collecting samples using portable probes and meters
Organic strengthmeasurement	Organic chemicals are created from biological decay of the waste and leaching from waste components themselves. Some organic matter (OM) parameters represent biodegradable OM, while others characterize totalOM. The concentration and type of organic matter determines treatment requirements and provides an indication of the waste stabilization environment inside the landfill (BOD, COD etc.)
Inorganicstrengthmeasurements	Depending on waste composition, leachate contains substantial amounts of dissolved inorganic ions. There may be measured in bulk (TDS) or individually (anions, cations). Primary anions include chloride,bicarbonate, and sulfate. Primary cations include sodium, potassium, ammonium, calcium and magnesium. Most of

Leachate constituent class	Description
	the ions result from the disposed waste as the direct source (e.g. chloride and sodium from food waste). Bicarbonate (HCO_3−)primarily results from CO_2 produced during the biological waste decomposition process and its subsequent dissolution into leachate.
Nutrients	Several nitrogen and phosphorous chemicals are present in leachate, though nitrogen is more prominent. Ammonia-nitrogen content often strongly controls treatment options, although dissolved organic nitrogen can be limiting when a treatment facility discharges to nutrient-limited water bodies The form of ammonia nitrogen, either NH_4^+ (ammonium) or NH_3 (dissolved or ammonia gas) depends onpH; under neutral and acidic conditions, the majority will exist as NH_4^+. Ammonia is conserved in the anaerobic environment of a landfill and thus it builds up in leachate over time similar to ions such as chloride and sodium
Trace constituents	A variety of trace constituents, both organic and inorganic, leach from waste components in the landfill. The bulk organic and inorganic strength of leachate (along with ammonia-N, which will principally be present as one of the major ions) dominate treatment considerations. The trace pollutants, however, which occur in much lower concentration, often dictate regulatory concerns because of their potentially adverse health effects. These parameters are necessary measurements when determining how a leachate may be managed outside of the landfill. Examples of trace heavy metals include arsenic, cadmium, mercury, lead, and zinc, while examples of trace organic compounds include benzene, vinyl chloride, acetone, and anthracene. While the concentrations of these chemicals are relatively low compared to the other leachate parameters discussed, their presence may be important when assessing treatment options and long-term leachate management options, and when evaluating potential groundwater impacts.

Also Leachate samples can be collected from multiple locations, including wells or similar boreholes within the landfill, leachate sumps or pumping stations, pressurized pipes, and external storage areas (tanks, ponds). Since leachate originates from multiple locations within a landfill unit or from different landfill cells are often combined as part of the collection and conveyance system, the sample collection location should be appropriately noted and considered when interpreting results. In some cases, leachate samples can be obtained directly from a sampling port or accessible leachate surface, but certain locations will require sampling pumps or manual bailers.

Sample agitation may impact analytical results. Exposure to air can alter some water quality parameters (e.g., dissolved oxygen, oxidation reduction potential, volatile organic compound concentrations) and excessive stirring of sediments from sampling locations may result in elevated suspended solids content (which can in turn increase the concentration of other parameters if included in the measurement).

- Groundwater and Surface water Monitoring

In order to guarantee an efficient and environmentally safe treatment for monitoring of the site, there needs to be a thorough check on possible groundwater and / or subsoil contamination from a spontaneous leachate leaking. Moreover particular emphasis must be given in monitoring the quality of groundwater aquifers.

To achieve full environmental monitoring, it is proposed to monitor the water level and carry out regular sampling of the wells each semester including full range of water analysis for all the parameters that are sensitive to pollution / contamination from escaped leachate.

The frequency of measurements can be increased if the water level presents a variation or if there is pollution due to leachate escaping. The sampling will be carried out by both the upstream and the downstream wells.

The results will be evaluated with monitoring charts, with established rules and levels for each position downstream of the hydraulic gradient. The control levels will be determined by local variations in groundwater quality.

For the implementation of the environmental monitoring program, sampling from both the upstream and downstream wells should take place. With these samples will be conducted a full range of analyzes, including all the parameters that are sensitive to pollution / contamination from escaping leachate.

The parameters to be considered derived from the expected composition of the leachate and the groundwater quality. The measurement of groundwater level in the wells precedes all sampling.

As for surface water monitoring, frequent visible inspections will be made. Evidence of degradation may include obvious signs, such as dead or unhealthy flora and fauna, visible leachate pools or streams, unnatural water clarity or colour and unusual odours.Besides the visual inspections, surface water should be checked quarterly in the operating phase and every six months in the aftercare phase measuring the above parameters.

The sampling of water and wastewater must be done according to the ISO 5667-11 while the chemical analysis should be according to the "Standard methods for the examination of water and wastewater" by AWWA, APHA, WEF, as shown in the following table:

Table 7-45: Standard methods for the examination of water and wastewater

No	Parameter	Standard Method
1	pH	DIN 38 404-C 5
2	Conductivity	EN 27 888 (C 8)
3	Odours	DIN EN ISO 7887
4	B.O.D.	DIN EN 1899-1 (H 51)
5	C.O.D.	DIN 38 409-H 41
6	T.O.C	DIN EN 1484 (H 3)
7	$SO\text{-}_4$	DIN ISO 10304
8	Ammonium (NH_4-N)	DIN 38 405-D 9-2
9	Nitrogen total (org. and inorg.) Total Kjeldahl nitrogen	DIN EN 25663 (H 11)
10	Nitrate (photometric)	DIN 38 405-D 9-2
11	Nitrite (photometric)	EN 26777(D 10)
12	Cl	DIN 38 405-D 1-1
13	Zn	DIN EN ISO 11885 (E 22)
14	As	DIN EN ISO 11885 (E 22)
15	Cd	DIN EN ISO 11885 (E 22)
16	Cu	DIN EN ISO 11885 (E 22)
17	Ni	DIN EN ISO 11885 (E 22)
18	Phenols	DIN 38 409-H 16-3
19	Total Hydrocarbons (Oil-grease (mg/l))	DIN EN ISO 9377-2 (H 53)

No	Parameter	Standard Method
20	Phosphate	DIN EN 1189 (D11-4)
21	Total Solids (TS)	DIN 38 409-H 2
22	Extractable lipophilic substances	DIN 38 409-H 17
23	Dissolved Solids (DS)	DIN 38 414-S 3

- Monitoring of gas volume, pressure and flux

Appropriate management of landfill is one of the most important objectives of sustainable landfill practice in monitoring. The monitoring of gas, both as part of Gas collection and control system (GCCS) operation and to assess and control emissions to the environment, is very important. The next table summarizes the various monitoring parameters utilized to characterize landfill gas and their associated measurement techniques.

Table 7-46: Monitoring parameters for landfill gas

Parameter	Techniques
Composition	Handheld meters are typically used at the landfill site for bulk gas concentration measurement
Bulk gases: CH_4, CO_2, O_2 Trace gases: H_2S, CO, NMOC	Field techniques such as colorimetric detector tubes can be used to measure some trace gases. Trace component analysis is often performed by collecting a sample and analyzing individual components in the laboratory
Flow rate	Flow rate can be measured using a field meter and well-heads on a manual basis. Extraction pipes can be equipped with dedicated flow meters. Flow can be measured directly or can be calculated after measuring a differential pressure
Pressure	Pressure can be measured using field meters and monitoring points at the well-head or in the pipe manually. Dedicated pressure gauges can be installed at desired points. Instruments can be placed within the landfill to measure in-situ gas pressure
Surfaceemission	A variety of techniques can be used to measure the concentration or flux of gas from the landfill surface, including dedicated flux chambers, optical scanning (open-path FTIR), and portable equipment such as photo ionization detectors (PIDs) or flame ionization detectors (FIDs)

Gas flow at a landfill will be measured at multiple locations, including individual collection wells, as well as centralized regulation stations and extraction. Gas flow rate is normally measured at individual landfill gas extraction points that are equipped with a well head. A valve is used to control applied vacuum to the well, with ports on either side of the valve allowing measurement of system pressure and well pressure. The well-head includes a device for flow measurement, typically either a pitot tube or an orifice plate. Pressure measurement devices, most often in the form of a differential pressure transducer included as part of a mobile gas-monitoring meter, are used to measure pressure drop across the device, which can in turn be used to calculate flow rate. A port for temperature monitoring or an in-line temperature gauge is provided, as temperature is one of the parameters used in the flow rate calculation.

Several methods are available for monitoring gases at the landfill surface. Some regulatory programs require surface CH_4 emissions monitoring on a routine basis (typically four times per year) in areas where gas is being actively extracted. The instrument used for this monitoring normally consists of a flame ionization detector (FID) or a photo ionization detector PID and the concentrations of interest are much lower than that produced within the landfill (e.g., 500 ppm is the US-specified surface concentration limit). This monitoring approach can provide insight regarding areas where high gas production rates are occurring and/or poor GCCS performance.

Chemical Composition of Gas

Monitoring the measurements of $CH_4$and CO_2 produced from biological decomposition, coupled with N_2 and $O_2$to assess the occurrence of atmospheric air in an active GCCS, provides necessary data on conditions within the landfill and performance of the GCCS.

Thus, measurement of the concentration of landfill gas constituents is performed routinely. Since most landfill gas sources are assumed to be saturated with moisture, the water vapor content is not routinely measured. Trace chemicals of importance are also measured on occasion to address regulatory needs or site-specific issues.

Measurement of gas composition involves analysis of the major components (CH_4,CO_2, O_2) in the field, measurement of trace components in the field, or collection of a sample that is subsequently sent to a laboratory for analysis. Field devices are equipped with an infrared sensor with frequency calibrated to detect CH_4 and CO_2.

These field devices typically are also equipped with sensors to measure pressure, flow, and/or temperature at GCCS well heads. N_2 concentration is not directly measured in the field, but is often assumed as comprising the "balance" after subtracting the concentration of CH_4, CO_2 and O_2, which are normally measured directly.

Also trace gases may be of concern for a variety of reasons. Hydrogen sulfide (H_2S) is a problematic gas because of strong odor and public health issues when emitted to the atmosphere, and when collected high levels of H_2S can create problems with energy production equipment and other mechanical gas moving devices because the gas can transform to sulfuric acid and prematurely wear these components. Siloxanes are a group of chemicals that are of concern at landfills with energy production equipment, as these chemicals can build up on gas moving equipment and their oxidation product, silicate, can cause premature wear, similar to H_2S.

Another group of chemicals that may be measured is non-methane organic compounds (NMOCs). This is a group of compounds that have the potential to cause a variety of human health and environmental impacts. These compounds cause the formation of acid rain, contribute to global warming, and lead to other adverse effects.

Monitoring of Landfill Volume, Density, and Topography

The monitoring of the landfill surface is crucial for the suitable operation. Professional surveyors use a variety of techniques to measure the surface elevation of landfills and surrounding property and infrastructure. These include manual measurements using a transit and staff along with measuring tapes. More common today is GPS-enabled survey equipment that uses satellite data to measure elevation and location. In all cases, an appropriate benchmark of known elevation must be established and referenced. This benchmark should be a stable area not prone to change.

As far as the monitoring with measurement and recording of the density estimation, relates the mass of a media to the volume it occupies; specific weight relates the weight of a medium to volume. Specific weight is an important parameter to track at landfills as it reflects the efficiency of airspace utilization for a landfill unit. Most commonly, the specific weight is estimated by measuring the weight of incoming waste loads deposited in the landfill and estimating the volume of utilized airspace capacity in that same time frame based upon surface topography data. This type of measurement, however, is not the true value for the landfilled waste materials as it does not include the weight of the cover soil (which is not normally measured in routine landfilling operations).

Another complicating factor is that waste volume changes (settles) through both physical and biological mechanisms. It is common to track the apparent density (or specific weight) at a landfill site—this represents the mass (or weight) of disposed waste per volume of landfill space (waste plus soil) and is commonly used in landfill capacity projections. Specific weight or density can also be calculated by excavating or augering material from a landfill, weighing the removed material, and applying a measured or estimated volume of the excavation.

In addition slopes are routinely measured as part of surface topography surveying. Other slope measurements might also be used to assess the slopes of pipes that are constructed to provide gravity drainage and to monitor side slopes for potential movement. Both the base grade of a landfill liner and the collection pipes/trenches are sloped to provide gravity drainage of leachate to low points in the landfill (for removal). The slopes of theses pipes can be assessed using instruments such as inclinometers or settlement cells. While no instrumentation replaces routine topographic surveying and physical inspections for deformation and cracks, inclinometers can be installed on slopes to provide a continuous measurement of slope angles and to track slope changes with time. For more rapid measurements at discrete points, a hand-held slope indicator device may be used or an application may be downloaded and used on a smart phone equipped with an accelerometer.

- Monitoring in situ moisture

Given the considerable importance of moisture in advanced landfill operations, a considerable effort has been devoted to developing techniques that allow the in-situ measurement of moisture inside the landfill in order to estimate the landfill gas quantities that will produce. While not common practice, several landfill sites have installed devices to provide the operator an indication of moisture content spatially within the landfill and over time. Soil scientists and agronomists have developed and applied several different types of in-situ moisture instruments for measurement of soil water and movement. Many of these have been extended to measure moisture in landfilled waste. Several approaches have been examined, including those that record measurements from the surface of the landfill, measurements determined by tracking the movement of gases throughlandfilled waste, devices placed into boreholes within the landfill, and instruments buried within in the landfill.

Neutron probes have been commonly used to measure the moisture content of soils. In this technique, access tubes are installed in the media of interest and a neutron probe is lowered into the tube. Neutrons emitted from a radioactive source present in the instrument are emitted into the surrounding soil. The neutrons are slowed as a result of collisions with surrounding molecules; water causes a slow-down greater than most media. The cloud of neutrons around the probe can be measured with a radioactive counter (built into the probe), and thus an estimate of surrounding moisture content can be made with an appropriate calibration curve.

The sampling and analysis complies with the guidelines set out in the Landfill Directive 1999/31/EC and the National Legislation. The sampling points are indicated in the respective general layout. The monitoring process includes also the accompanying reporting. The proposed monitoring works and the frequency of analysis are given in the following table.

Table 7-47: Proposed Monitoring works and frequency for Southwest landfill site

Parameters to be monitored		Frequency	
		Operational Phase	Aftercare period
Groundwater monitoring	Level of groundwater	Every six months	Every six months
	Groundwater composition	Every six months	Every six months
Leachate monitoring	Leachate volume	Monthly	Every six months
	Leachate composition	Every three months	Every six months
	Treated leachate composition	Monthly	Monthly
Surface water monitoring	Volume and composition of surface water	Every three months	Every six months
Landfill gas monitoring	Produced biogas volume	Monthly	Every six months
	Pressure, methane content, carbon dioxide content and oxygen content	Monthly	Every six months
	Escape of landfill gas	Every six months	Every six months
Settlements monitoring	Structure and composition of landfill body	Yearly	-
	Settling behavior of the level of the landfill body	Yearly	Yearly
Meteorological monitoring	Volume of precipitation	Daily	Daily, added to monthly values
	Temperature(Highest, lowest, 14.00 h CET)	Daily	Monthly average
	Direction and intensity of predominant wind	Daily	Not required
	Evaporation (lysimetric or other appropriate methods)	Daily	Daily, added to monthly values
	Atmospheric moisture (14.00 h CET)	Daily	Monthly average
Other aftercare measures (green areas, other maintenance)		As necessary	As necessary

7.1.4.16 Closure and aftercare procedures

A targeted benefit of sustainable landfill operations is to minimize the environmental, economic, and social impacts as much as possible. Planning for the future of the facility early in the process allows the engineer and operator to maximize future use of the site and to minimize future cost and impact.

When the disposal capacity of a landfill site, or a specific operational area of a landfill, is reached, several decisions regarding how to manage these areas must be evaluated. The term closure designates the process of finalizing waste surface configuration and installing infrastructure designed as the final containment and control system for this area of waste. Post-closure care (PCC) refers to activities performed to operate and maintain closed areas so that desired performance and environmental protection are accomplished.

<u>Closure system design</u>
While many existing landfilled elements will be integrated into the design of a landfill closure system (e.g., gas collection, leachate management, stormwater control), a substantial new feature is the final landfill cover, often referred to as a cap. The primary objective of a landfill cap is to minimize rainwater entry into the landfill as a means to reduce future leachate production. Another major function is to aid in the control of landfill gas. Materials used for barrier layer construction are similar to those used for

landfill liners, including geomembranes, compacted soil, geosynthetic clay liners, or a combination of these materials.
The technical conditions set by the regulations as well a schematic of the top surface sealing system are provided in the next paragraphs of the present Chapter.

The top cover soil layer (infiltration layer) consists of soils that promote plant growth and allow for water retention and eventual evapotranspiration. Appropriate vegetation includes shallow-rooted plants consisting primarily of grasses that can help control erosion. A well-vegetated landfill surface is important to promote overland flow of water to stormwater collection points and to minimize soil loss.

Planning Consideration for Closure and Post-closure
A landfill closure plan should be developed with objectives to minimize further maintenance at the landfill site and leave the landfill in a condition so minimal environmental impacts occur. The following Table summarizes elements of the closure and post-closure planning process, and includes description of potential additional considerations for sustainable landfill activities.

A closure plan consists of many elements, but in general must include an overall description of the methods, procedures, and the processes to be utilized for closing the landfill, and should define the maximum volume of waste residue disposed of during the life of the site.

Table 7-48: Elements of landfill closure and post-closure

Closure element	Description	Potential issues with sustainable landfill practices
Final grading	Landfill surface is graded to achieve target final design elevations and slopes	More rapid and differential settlement may occur as a result of efforts to enhance waste stabilization
Capping system	An engineered series of soil (and probably geosynthetic) layers are constructed to provide a means to minimize water entry into the landfill	To achieve efficient gas collection under accelerated decomposition conditions, alternative cap types and placement timing may be required. Rapid settlement, as well as liquids entrance/exit issues, may also impact cap design
Gas control	Additional gas collection devices and collection infrastructure are installed prior to closure	Greater gas generation may necessitate additional or larger collection devices. Liquids removal from gas collection devices may be required
Leachate control	Infrastructure for removing, treating, and disposing leachate must continue to operate	Leachate Collection and Removal System (LCRS) and storage systems must accommodate the potential additional leachate production resulting from recirculation or to accommodate anticipated recirculation rates
Monitoring system installation	Equipment and instruments may be installed during closure to allow data collect in post-closure period	Sustainable landfill technologies often involve a greater degree of monitoring relative to normal landfill operation
Routine maintenance	Cover system and infrastructure must be monitored and maintained	Additional settlement may require more frequent maintenance
Leachate management	Leachate removal equipment must be monitored and LCRS operated	Added leachate volume may require more frequent maintenance and monitoring, including monitoring of seeps
Gas	GCCS must be maintained, operated, and	Additional gas volumes requires more

Closure element	Description	Potential issues with sustainable landfill practices
management	monitored for a designated period following closure	frequent maintenance and monitoring, the presence of liquids may create additional challenges in efficiently collecting gas from devices
Monitoring	Needed data must be collected, recorded and submitted to regulatory agencies	Additional monitoring instruments and Measurements may be required

Long-term care, maintenance, and monitoring of a solid waste facility followingits closure may be required for as long as 30 years or more, depending upon regulatory requirements and site-specific conditions. Objectives of long-term care include maintaining final cover, collecting and treating leachate, monitoring groundwater, and controlling gases. Routine maintenance of the landfill cover system will include repairing erosion damage, adding needed vegetation and soil amendments, routine vegetative maintenance to control overgrowth, and ensuring successful operation of surface water management components.

Drainage systems must be maintained, as drainage control problems can result in accelerated erosion. Differential settling of drainage control structures can limit their usefulness and may result in failure to direct stormwater properly off the site. In instances where erosion problems are noted or drainage control structures need to be repaired, proper maintenance procedures should be implemented immediately to prevent further damage. Failure to maintain the physical integrity of the landfill cover will promote additional infiltration into the landfill and eventually cause generation of larger leachate quantities. This will also exacerbate problems associated with leachate collection and disposal.

Record keeping requirements include site inspections and summary reports at some specified frequency during the years following closure. For instance, quantities of leachate removed and transported must be recorded, and monitoring of gas, groundwater, surface water, and leachate are commonly required.

The Leachate Collection and Removal System (LCRS) and GCCS will continue to be operated after closure and therefore will require attention during PCC. Both systems must be maintained to ensure effective operation. LCRS maintenance includes periodic leachate collection pipe cleaning, collection tank cleaning, and pump preventative maintenance and repairs.

Collected leachate must be treated or disposed of in an appropriate manner, and the quantity of leachate treated or removed should be recorded. GCCS maintenance will consist of regular maintenance of pipes, hoses, wellheads, blowers, pumps, andother infrastructure. Withdrawal pipes and collection lines may require condensate removal and repairs if damage from differential settlement occurs.

<u>Waste Filling</u>

The point of transition from an active, operating landfill to a closed facility depends on site-specific conditions, operating objectives, and regulatory requirements. Operators have pursued several different approaches with respect to implementing the initiation of closure. Theapproach foresheen is to delay closure construction while waste filling continues, expanding laterally in new disposal areas as necessary, with a final cover system constructed overoften the entire landfill unit.

The total estimated lifetime of the landfill is expected to be at least 26 yearsand is foresheen to be filled to a specified waste height that is defined according to the permitted final topography. Waste filling progresses laterally until the specified waste height is reached, and then the entire landfill is filled to the permitted waste height. A closure system is then installed for the entire landfill. The following schematic presents an example of such waste filling method.

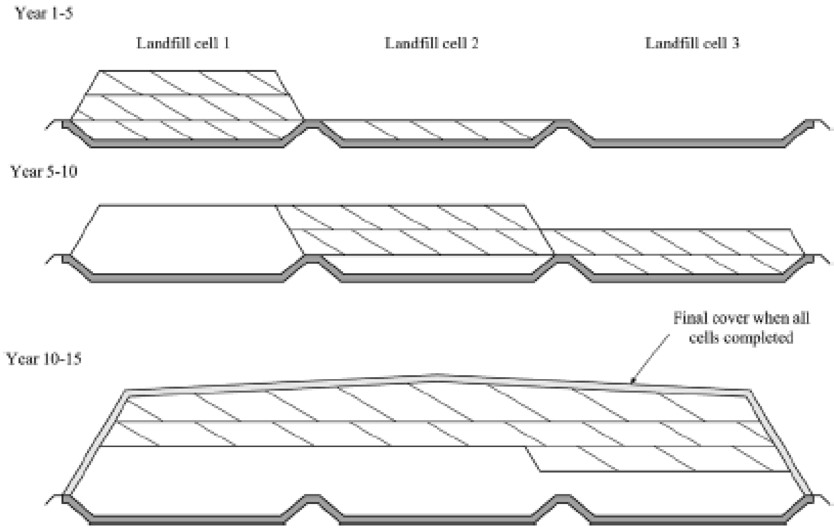


Figure 7-68: Illustration of landfill final cover system installation after entire landfill reaches final permitted elevation

Alternative covering systems

Geomembranes are common components in landfill final cover systems, resting above a suitably-prepared foundation and gas collection layer, and below an erosion layer designed to promote stormwater runoff and evapotranspiration. An alternative configuration, one that lends itself to several sustainable landfill practice objectives,utilizes the geomembrane as the uppermost layer of the cover system (i.e., the geomembrane is exposed at the surface of the landfill without a soil cover). Constructed using a traditional geomembrane, this configuration has been termed an exposed geomembrane cap (EGC). The following figure shows an EGC. One service an EGC might provide with respect to sustainable landfilling is improved gas collection. It is well recognized that placement of a geomembrane aspart of a traditional cap greatly enhances the efficiency of the gas collection system.
Since much of the gas generated from waste stabilization forms during the earlier years of landfill operation, especially when liquids addition is practiced, the use of a geomembrane during early operational periods is beneficial. When well-constructed, an EGC provides an excellent barrier to gas escape; gas collection devices such as horizontal extraction wells can be constructed directly beneath the EGC so a vacuum can be applied to facilitate gasremoval from the entire surface.

The benefits provided by EGC installation with respect to controlling leachate and stormwater are also greatest when EGC installation occurs earlier in the operatinglife of a landfill rather than towards the end when traditional cover systems are implemented. If waste is filled in the landfill unit in a manner that distinct areas of waste placement reach final grade early, an EGC can be installed fairly easily.

EGCs are constructed by first preparing the surface of the landfill using appropriate soil and then installing gas collection infrastructure (horizontal gas collectors, synthetic nets, manifold piping). One of the more important design concerns is the prevention of wind uplift. High wind velocities result in a pressure differential between the top and bottom of the geomembrane, so ballasting is required, either through anchor trenches within the waste/cover system or with placement of weights (e.g., sand bags, pipes) on top of the cover. The stormwater control system must be designed and constructed to accommodate the rapid runoff time and the increase in runoff quantity. EGCs can be integrated into the landfill's seepage control system, which is beneficial at landfills where liquids addition is practiced.

Figure 7-69: Exposed geomembranes cap used as final cover

Potential operational and maintenance issues of EGCs include deterioration of geomembranes because of exposure to ultraviolet rays, the potential damage of theexposure surface from operating personnel or equipment, and the need for ballasting because of wind-induced uplift. Some new products address this concern by designing the geomembranes to be covered with a thin layer of soil, which is retained on the surface by a synthetic turf. The following figureshows an example of such aproduct being installed on the surface of a landfill.

Figure 7-70: Closure Turf used as final cover

After- closure leachate and gas management

Leachate will continue to be collected by the LCRS after closure and during the closure period. While leachate volumes are expected to decline with time after placement of the final cover system, they are likely to be greater infacilities where leachate recirculation or outside liquids addition was practiced.

Similarly, GCCS operation will still be required until gas production becomes sufficiently low. Landfills practicing liquids addition or other enhanced stabilization techniques should reach a point of reduced gas production sooner than traditionally-operated facilities.
With the placement of the final cover system, the volume of leachate produced should decrease. Continuation of leachate recirculation or liquids addition will certainly affect post closure leachate production, but once all major moisture inputs are stopped, if the final cover system is well designed, constructed, and maintained, leachate production should decrease to a relatively small constant rate. Leachate collection volumes from well-maintained cover systems should not be subject tomajor fluctuations in response to wet weather, and should decline or remain relativelyconstant. If such variations are encountered, the integrity of the cap should be investigated to determine continuing sources of moisture intrusion and these problems addressed.

The closure plan will outline steps necessary for operating, maintaining and monitoring the performance of the LCRS. The ultimate goal will be to reduce or eliminate LCRS operation. Such decisions would be made based on information on both the amount of leachate produced and the chemical quality of the leachate.

FinalSiteUse and Configuration

Once a landfill site has been successfully closed, the owner then decides whether toisolate the site from the general public or open the site for some useful purpose, usually one focused on community activities (common for municipally-owned facilities). Closed landfill sites have been successfully used for parks and recreation, botanical gardens, ski slopes, toboggan runs, coasting hills, ball fields, amphitheaters, playgrounds, and parking areas. The use of a closed sanitary landfill as a green area (a community park) or open space is very common and presents relatively fewer challenges compared to a use that incorporate buildings and similar structures. The most commonly used vegetation is grass, though shrubs and small trees may be added where funds are available and if this type of vegetation is compatible with the end use and final cover design. Another use of closed landfills includes redevelopment into a golf course. Landfills are growing in popularity as sites for placement of solar panels and wind turbines for energy production.

Closed landfills are typically not well-suited for construction of buildings, because of mechanical and geotechnical concerns, as well as potential issues associated with landfill gas accumulation and formation of explosive conditions. Small, light buildings such as concession stands, sanitary facilities, and equipment storage sheds are often required at recreational use areas. A geotechnical engineer should be consulted if plans call for structures to be built on or near a completed sanitary landfill.

The GCCS and LCRS will normally still be operational, and associated infrastructure should be appropriately isolated,protected,and labeled with precautionary signage. All construction activities should incorporate appropriate protection and repair of the final cover system, particularlyany geomembranes or compacted soil barrier layers. Other issues that should be addressed at closed landfill sites include ponding, cracking, and erosion of cover material. Periodic maintenance includes regrading, reseeding, and replenishing thecover material; maintenance work is required to keep the fill surface from beingeroded by wind and water.

7.1.4.17 Price schedules

The tables below present the estimations regarding the investment cost of Landfill and Infrastructures works. The detailed investement cost have been calculated taking into consideration the results of the detailed design study for the landfill of Southwest region as it has been developed up to now. The detailed investment cost that is presented in the following table does not include contingencies and VAT.

Table 7-49: Investment Cost of Landfill

No	Item	Unit	Quantities	Unit Cost (€)	Total Cost (€)
1	**LANDFILL**				
1.1 Earthworks					
1.1.1	General excavation of unsuitable soil removal	m3	35,000.00	1.50	52,500
1.1.2	General excavation in soil and rock, including testing, selecting, resizing (if needed) and stockpiling the suitable material on site for engineering fill, all as shown on drawings and/or as directed by the Engineer.	m3	74,000.00	2.30	170,200
1.1.3	Engineering fill by using the suitable material stockpiled on site, including testing, all as shown on drawings and/or as directed by the Engineer.	m3	141,000.00	2.00	282,000
1.1.4	Supply of soil	m3	97,000.00	1.00	97,000
1.1.5	Clearing and grabbing of fire safety zone, including grading (if needed), all as shown on drawings and/or as directed by the Engineer.	m2	24,700.00	1.00	24,700
	Subtotal 1.1 Earthworks				**626,400**
1.2. Bottom Lining					
1.2.1	Excavation of anchoring trenches	m3	720.00	2.30	1,656
1.2.2	Subbase layer (0.30 m)	m3	7,650.00	2.00	15,300
1.2.3	Compacted clay layer (0.50 m)	m3	12,750.00	10.00	127,500
1.2.4	Drainage gravel	m3	12,250.00	20.00	245,000
1.2.5	Smooth Geomembrane HDPE liner, t = 2 mm	m2	27,200.00	6.00	163,200
1.2.6	Separation geotextile G=400g/m2	m2	27,200.00	2.70	73,440
1.2.7	Protection G=800g/m2	m2	27,200.00	3.50	95,200
	Subtotal 1.2. Bottom Lining				**721,296**
1.3. Leachate management system					
1.3.1	**Leachate Collection Works**				
1.3.1.1	HDPE PN10 DN500 Leachate pipe perforated	m	225	155.00	34,875
1.3.1.2	HDPE PN10 DN500 Leachate pipe non-perforated	m	235	140.00	32,900
1.3.1.3	HDPE PN10 DN560 Leachate pipe non-perforated	m	145	175.00	25,375

No	Item	Unit	Quantities	Unit Cost (€)	Total Cost (€)
1.3.1.4	HDPE PN10 DN250 Leachate pipe perforated	m	535	38.50	20,598
1.3.1.5	HDPE PN10 DN250 Leachate pipe non perforated	m	91	35.00	3,185
1.3.1.6	HDPE PN10 DN75 leachate pressure pipe	m	480	5.40	2,592
1.3.1.7	Wells for cleaning pipes	item	2	220.00	440
1.3.1.8	Collection manhole including all elements	item	1	3,500.00	3,500
1.3.1.9	Recirculation control wells	item	6	400.00	2,400
1.3.1.10	Filling the pipe trenches, including sand bedding and surrounding,	m^3	685	2.30	1,576
1.3.1.11	Reduced tees and joints DN500/250 including all interim parts	item	11	500.00	5,500
1.3.1.12	Inspection manholes (W1-W2), D=2000mm	item	2	3,500.00	7,000
	Subtotal 1.3.1 Leachate Collection Works				**139,940**
1.3.2	**Waste Water Treatment Plant (WWTP)**				
1.3.2.1	**Civil Works**				
1.3.2.1.1	**Reception - Equalisation Basin**				
1.3.2.1.1.1	Concrete C30/37 sulphate resistant	m3	475	250.00	118,750
1.3.2.1.1.2	Excavations	m3	4090	2.30	9,407
1.3.2.1.1.3	Backfilling with excavated material	m3	950	2.00	1,900
1.3.2.1.1.4	Waterproofing internal sealing	kg	2540	5.50	13,970
1.3.2.1.1.5	Concrete additive (1,5 kg/m3 concrete)	kg	712.5	1.80	1,283
1.3.2.1.1.6	Concrete non-reinforced C10/12	m3	53	75.00	3,975
1.3.2.1.1.7	Metallic protective hand railing	m	99	60.00	5,940
1.3.2.1.2	**SBR - storage tanks - pumping station**				
1.3.2.1.2.1	Concrete C30/37 sulphate resistant	m3	680	250.00	170,000
1.3.2.1.2.2	Excavations	m3	1115	2.30	2,565
1.3.2.1.2.3	Backfilling with excavated material	m3	298	2.00	596
1.3.2.1.2.4	Waterproofing internal sealing	kg	4000	5.50	22,000
1.3.2.1.2.5	Concrete additive (1,5 kg/m3 concrete)	kg	1020	1.80	1,836
1.3.2.1.2.6	Concrete non-reinforced C10/12	m3	55	75.00	4,125
1.3.2.1.3	**WWTP Technical Building**				
1.3.2.1.3.1	Surface	m2	188	400.00	75,200
	Subtotal 1.3.2.1 Civil Works				**431,546**
1.3.2.2	**Mechanical Works**				
1.3.2.2.1	Venturi aerator 9kW	item	1	6,000.00	6,000
1.3.2.2.2	Level and flow measurement units	item	2	2,200.00	4,400
1.3.2.2.3	Submerged SBR feed pumps and valves	item	2	2,500.00	5,000
1.3.2.2.4	Rotary screen	item	1	5,000.00	5,000
1.3.2.2.5	Submersible aerator with inverter	item	2	70,000.00	140,000
1.3.2.2.6	SBR denitrification mixer 2kW	item	1	2,500.00	2,500
1.3.2.2.7	Floating decant system	item	1	3,000.00	3,000
1.3.2.2.8	SBR sludge pump	item	1	1,800.00	1,800

No	Item	Unit	Quantities	Unit Cost (€)	Total Cost (€)
1.3.2.2.9	Chemical Tanks, 500 lt	item	5	400.00	2,000
1.3.2.2.10	Chemical dosing pumps	item	10	750.00	7,500
1.3.2.2.11	Agitators for chemical tanks	item	3	1,800.00	5,400
1.3.2.2.12	SBR pH, level and DO measuring units	item	3	2,000.00	6,000
1.3.2.2.13	RO feed pumps, valves and RO bypass valves	item	2	2,800.00	5,600
1.3.2.2.14	Sludge feed pumps and valves	item	2	2,800.00	5,600
1.3.2.2.15	Reverse Osmosis Plant, 160 m3/d 2 stages, complete, in container, including shipment, installation, start-up and training	item	1	480,000.00	480,000
1.3.2.2.16	Concentrate recirculation pumps 1,1 kW, mohno type chlorine resistant with valves	item	2	6,000.00	12,000
1.3.2.2.17	Sludge decanter 10,5 kW - 20% DS AISI 316	item	1	60,000.00	60,000
1.3.2.2.18	Polyelectrolyte preparation unit with dosing pumps and static mixer	item	1	8,000.00	8,000
1.3.2.2.19	Sludge screw conveyor 2 m3/h - 5m and storage container	item	1	10,000.00	10,000
1.3.2.2.20	Water system for washing	item	1	4,000.00	4,000
1.3.2.2.21	Other (portable pump, level switches, metal covers, railings, crane, lifting device etc)	item	1	12,000.00	12,000
1.3.2.2.22	irrigation/ water reuse system	item	1	14,000.00	14,000
1.3.2.2.23	HDPE pipelines, total including excavations and 10 cm sand layer	item	1	10,000.00	10,000
1.3.2.2.24	Spare parts, tools, furniture	item	1	8,000.00	8,000
1.3.2.2.25	Cabling, LV electric panels, Switchboards, Building electrical equipment	item	1	40,000.00	40,000
1.3.2.2.26	Automation PLC/SCADA	item	1	45,000.00	45,000
1.3.2.2.27	Earthing, Lightning protection	item	1	30,000.00	30,000
1.3.2.2.28	Deailed design, O&M manuals and as built drawings	item	1	45,000.00	45,000
1.3.2.2.29	Start-up, Trial (performance) Operation, 2 months	item	1	60,000.00	60,000
	Subtotal 1.3.2.2 Mechanical Works				**1,037,800**
	Subtotal 1.3.2 Leachate Treatment Plant (LTP)				**1,469,346**
	Subtotal 1.3. Leachate management system				**1,609,286**
1.4. Biogas management Works					
1.4.1	Horizontal transfer pipes HDPE PN10 DN110 mm	m	145	6.33	917
1.4.2	Prefabricated Biogas collection stations	pcs	1	5,900.00	5,900
1.4.3	Condensate separators	pcs	1	1,100.00	1,100
1.4.4	Foundation base for biogas collection	m3	2.5	30.00	75

No	Item	Unit	Quantities	Unit Cost (€)	Total Cost (€)
	stations				
1.4.5	Portable pump for condensate removal with pipes (supply only)	pcs	1	1,155.00	1,155
1.4.6	Landfill gas flare Q=100 m3/h	pcs	1	85,000.00	85,000
1.4.7	Foundation base for flare unit from reinforced concrete	m3	11	200.00	2,200
1.4.8	Excavations	m3	100	2.30	230
1.4.9	Filling the pipe trenches, including sand bedding and surrounding	m3	100	2.30	230
	Subtotal 1.4. Leachate Management Works				**96,807**
1.5. Rainwater Works					
1.5.1	Precast concrete pipes (int.diameter 2000mm)	m	11	500.00	5,500
1.5.2	Precast concrete pipes (int.diameter 1000mm)	m	182	133.00	24,206
1.5.3	C12/15 Concrete reinforced	m^3	1	80.00	80
1.5.4	C20/25 Concrete reinforced	m^3	265	85.00	22,525
1.5.5	Reinforcement steel B500c	tn	21.1	1,510.00	31,861
1.5.6	Formworks	m^2	2770	10.00	27,700
1.5.7	General Excavations of soft and hard Soil with machine	m^3	680	2.30	1,564
1.5.8	Gridiron	kg	1620	5.50	8,910
1.5.9	cast iron manholes cap (circular)	pcs	5	110.00	550
1.5.10	Completion / finishing with rip-rap pavement in concrete	m^3	70	150.00	10,500
1.5.11	Stepped gutter	m	20	25.00	500
1.5.12	gard screen made of galvanized steel, round bar Ø15mm, bar spacing 50mm	pcs	1	700.00	700
1.5.13	Inlet	pcs	1	200.00	200
	Subtotal 1.5. Rainwater Works				**134,796**
1.6. Monitoring					
1.6.1	Groundwater monitoring drillings	item	3	7,080.00	21,240
1.6.2	Groundwater level indicator	item	1	1,100.00	1,100
1.6.3	Biogas monitoring wells	item	4	1,167.00	4,668
1.6.4	Portable gas analyzer	item	1	5,500.00	5,500
1.6.5	Methane detectors-transmitters	item	7	900.00	6,300
	Subtotal 1.6. Monitoring				**38,808**
1.7. Mobile Equipment					
1.7.1	Compactor	item	1	375,000	375,000
1.7.2	Backhoe Loader	item	1	70,000	70,000
1.7.3	Tipping truck	item	1	60,000	60,000
	Subtotal 1.7. Mobile Equipment				**505,000**
	Subtotal 1: Landfill				**3,732,393**

Table 7-50: Investment Cost of Infrastructures

No	Item	Unit	Quantities	Unit Cost (€)	Cost (€)
2	**Infrastructure Works**				
2.1. Road Works					
2.1.1	General Excavations of soft and hard Soil with machine	m^3	6,250	2.30	14,375
2.1.2	Embankments / compacted soil	m3	4,450	2.00	8,900
2.1.3	Ballast foundation	m3	1,350	25.00	33,750
2.1.4	crush stone foundation	m3	2,800	35.00	98,000
2.1.5	asphalt concrete BA16	m2	11,400	10.00	114,000
2.1.6	Wearing course asphalt pavement	m2	11,400	8.00	91,200
2.1.7	ditch	m	830	1.30	1,079
2.1.8	shoulder	m3	55	3.00	165
	Subtotal 2.1. Road Works				**361,469**
2.2. Traffic design					
2.2.1	Traffic signs standard	item	12	125.00	1,500
2.2.2	Boards	item	4	60.00	240
2.2.3	White paint for marikng the pavement	kg	290	5.50	1,595
2.2.4	Yellow paint for marking the pavement	kg	2	5.50	9
	Subtotal 2.2. Traffic design				**3,344**
2.3 Planting					
	Woody Plants				
2.3.1	Robinia pseudoacacia pyramidalis	item	309	42.00	12,978
2.3.2	Lonicera tatarica	item	9	23.00	207
	Planting works				
2.3.3	Grass filled areas (grass mixure)	m2	903	0.40	361
2.3.4	Planting midsize deciduous trees in holes 60/60/60 cm, incl. digging holes	item	309	5.00	1,545
2.3.5	Planting shrubs in holes 50/50/40 cm, incl. digging holes	item	9	4.50	41
	Subtotal 2.3. Planting				**15,132**
2.4. Buildings and Utilities					
2.4.1	Administrative building	item	1	110,659	110,659
2.4.2	Maintenance building	item	1	170,704	170,704
2.4.3	Guardhouse	item	1	32,509	32,509
2.4.4	Weighbridge	item	1	56,000	56,000
2.4.5	Water Tank	item	1	115,592	115,592
2.4.6	Wheel washing facility	item	1	20,793	20,793
2.4.7	Fence & Entrance	item	1	84,500	84,500
2.4.8	Landscaping	item	1	11,145	11,145

No	Item	Unit	Quantities	Unit Cost (€)	Cost (€)
2.4.9	CCTV for infrastructure	item	1	25,000	25,000
2.4.10	SCADA	item	1	50,000	50,000
2.4.11	Software for documentation	item	1	15,000	15,000
2.4.12	Energy Building	item	1	134,536	134,536
2.4.13	Fire fighting network	item	1	7,130	7,130
2.4.14	External electrical power supply networks	item	1	67,224	67,224
2.4.15	Water and sewage network	item	1	119,128	119,128
2.4.16	Thermo technical part	item	1	34,370	34,370
	Subtotal 2.4. Buildings and Utilities				**1,054,290**
	Subtotal 2: Infrustracture Works				**1,434,234**

Note:<u>*Software for documentation*</u>*: It is used for the registration of the data from the monitoring system of the project:*

- *Waste registration/control*
- *Recovery of recyclables*
- *Daily operational hours*
- *Annual power consumption, fuel consumption, etc*
- *Environmental monitoring of:*
  - *leachate from the landfill body*
  - *groundwater*
  - *surface waters*
  - *collection of landfill gas*
- *Registration of accidents, unscheduled interruption of operations, and incidents connected with occupational health and safety*
- *Registration of complaints and incidents leading to complaints*
- *Etc*

7.1.5 Technical description of other proposed facilities (MBT, MRF, green waste composting plant)

7.1.5.1 Plan of site location and surrounding area

The construction of the proposed facilities is planned be at the same areas as the new regional landfill. The new regional landfill in Southwest Region as well as the proposed facilities are going to be located in a site that administratively belongs to Municipality of Debartsa and it is located close to the settlement of Laktivje. The site is analytically described previously in this chapter.

7.1.5.2 Site preparation, lay out and environmental protection measures

The concept of the general layout design follows the topography of the site and the surrounding area (mild slopes, valley landscaping, etc.). The main concern was to design a landfill with low height in relation with the surrounding area, so that to adjust the elevations in the best possible way with the existing landscaping.

More specifically, the landfill is located in the center of the site, whereas the entrance is foreseen from the north - western part of the site. Immediately after entering the site and passing from the weighbridge house, the vehicles directing to the administrative area, will have the possibility for immediate parking. However, the waste trucks directing to the MBT, shall enter the building on the left, opposite the administrative area. In case of vehicles that do not need to be weighted, there will be the possibility to bypass the weighbridge by side lanes. The WWTP is located at the north-eastern part of the site where the lowest elevations exist, so that the leachate will be transferred there by gravity.

The facilities for waste mechanical treatment, are designed at the western part of the site, following the main road from the entrance. This area is 42,520 m^2, and it has a mean elevation at +900.00 m. The biological treatment facilities for the organic fraction of municipal waste and the green waste are located northern from the mechanical sorting building on the same mean elevation.

The area for the maneuvers of the vehicles for the reception area of the Mechanical Treatment Building, as well as the area of the auxiliary buildings will be asphalted, whereas the area for composting facilities will be made of gravel.
The buildings and heavy constructions will be located mainly on excavated levels, or at least the foundations will be constructed on excavated levels.

The total earthworks for the construction of this platform together with the road works result to 23,000 m^3 excavations and 64,300 m^3 fillings.

The following paragraphs provide a summary for the proposed waste treatment facilities in SouthWest Region. The proposed CWMF include the following elements:

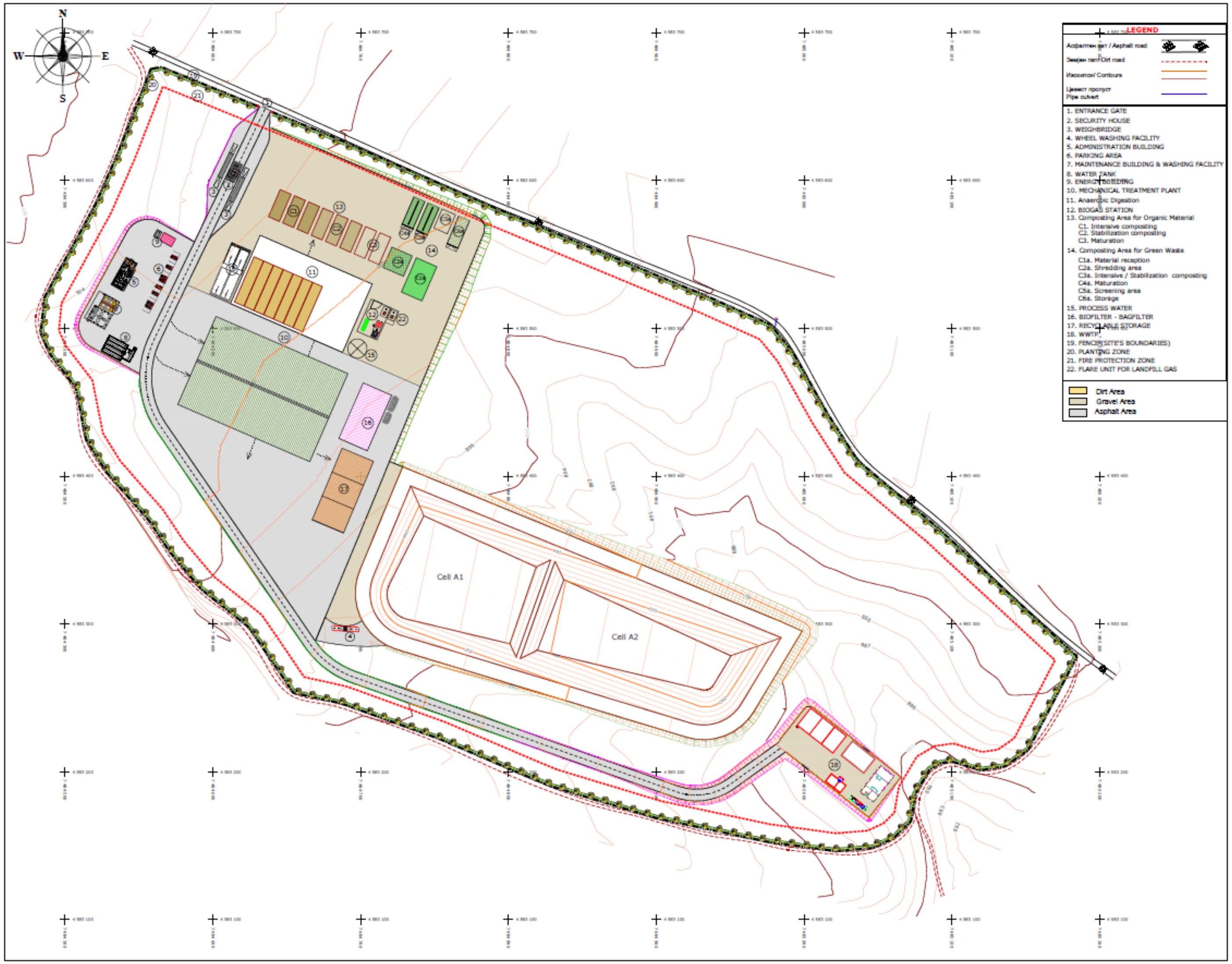


Figure 7-71: General layout of the Waste Management Center (Phase A)

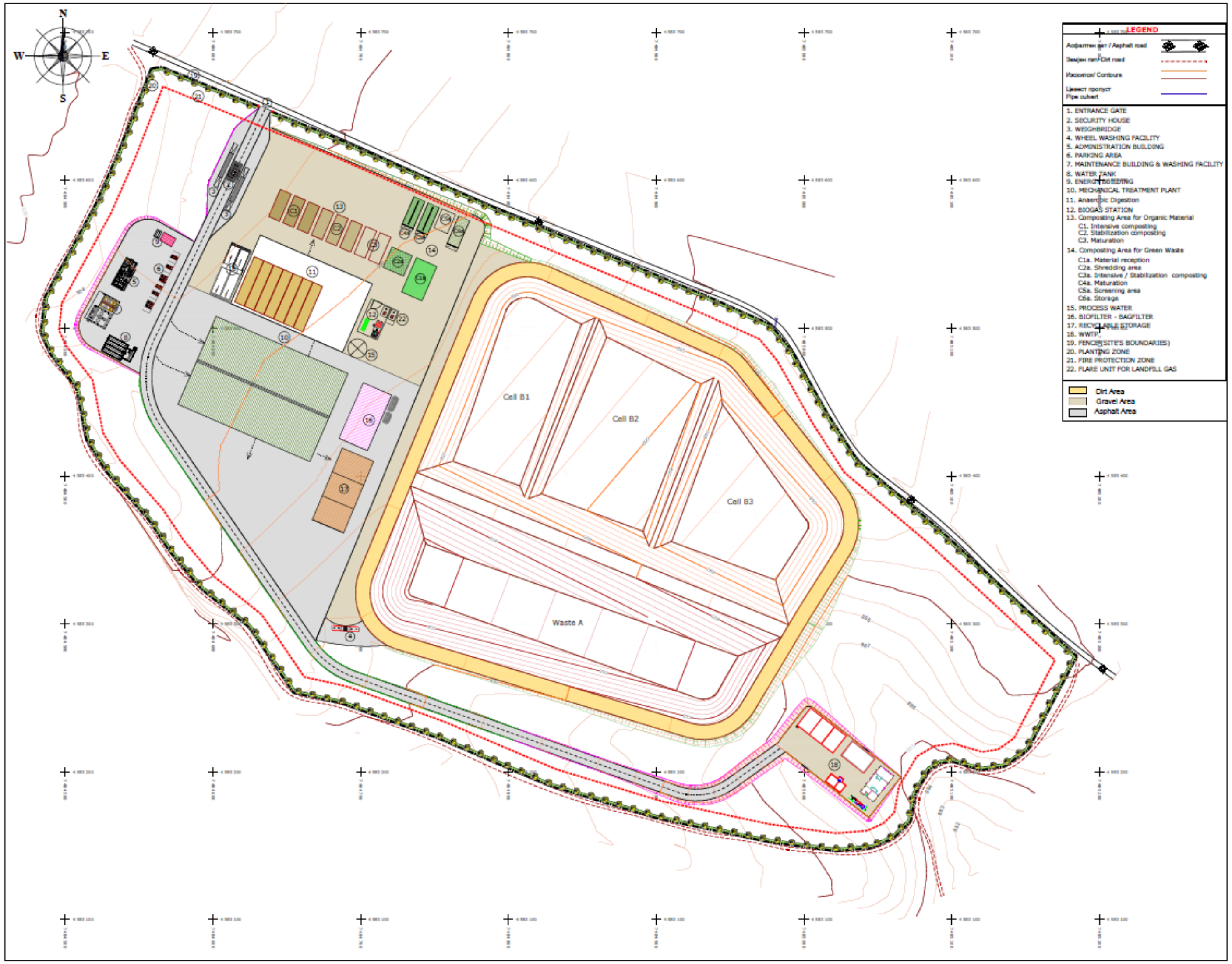


Figure 7-72: General layout of the Waste Management Center (Phase B)

The area allocated for the construction of the various parts is as follows:

Table 7-51: Area allocated for the WMC facilities

WMC FACILITIES	AREA (m^2)
Mechanical Treatment Plant	6,300
Biological Treatment area	19,710
Recyclables storage	1,200
Landfill (A phase) (2D)	29,770
Administration Building	155
Maintenance Building and Washing Facility	255
Waste Water Treatment area	2,785
Totalarea for facilities	**60,175**
Totalplotarea	**208,718**

The following tables present the overall mass balance of the MBT plant and landfill site.

Table 7-52: Mass Balance of MBT Plant of Residual Waste Bin (Scenario 3b)

TotalMass	Quantities (t/y)	Percentage
Input waste to Mechanical Separation (Residual Waste Bin)	**41,668**	**100.0%**
MechanicalSeparation		
Recyclables	*3,109*	*7.4%*
Residues	*6,250*	*15.0%*
RDF	*8,334*	*20.0%*
Special MunicipalWaste	*105*	*0.3%*
ToAnaerobicDigestion	*23,870*	*57.3%*
Input waste to Anaerobic Digestion	23,870	57.3%
Anaerobic digestion	23,870	57.3%
Water	3,891	16%
Totalquantitytodigester	27,761	
Biogas	3,748	14.0%
Dischargeafterdigester	24,013	86.0%
Input to Biostabilization (Aerobic Composting)	*10,806*	*45.0%*
Waste Water that delivered to WWTP	*11,286*	*47.0%*
ProcessWater	*1,921*	*8.0%*
Biostabilization (AerobicComposting)	10,806	100.0%
H_2O &CO_2losses	*2,702*	*25.0%*
CLO	*8,105*	*75.0%*
Residuestolandfill	**14,355**	

Biogasyield	*100 Nm^3/t of waste input*	
Totalbiogas	*2.387.000*	*Nm^3/year*
Energy value (Energy value Biogas=5.5KWh/m^3)	*13.128.500*	*kWh/Nm^3*
Electricity production (Theor. Electrical Efficiency 38%)	*4.989*	*MWh/year*
	0.56	*MW*
Heat production (Theor. Thermal Efficiency 40%)	*5.251*	*MWh/year*
	0.60	*MW*

Table 7-53: Expected quantities and recovery rates in Mechanical Treatment of Residual Waste Bin

Fraction	Totreatment	% Recovery	% FinalRecovery
Paper/Cardboard /Composite	7.1%	28%	2.0%
Plastic	8.8%	40%	3.5%
Glass	2.6%	20%	0.5%
Metal	1.7%	85%	1.4%
Total	**20.2%**		**7.4%**

Table 7-54: Mass Balance of Mechanical Treatment of Recyclables Waste Bin

TotalMass		Quantities(t/y)	Percentage
Input waste to Mechanical Separation (RecyclablesWasteBin)		**13,874**	**100.0%**
MechanicalSeparation		13,874	
Recyclables			*85%*
	paper and cardboard	*5,169*	*37%*
	glass	*1,859*	*13%*
	Fe	*488*	*4%*
	Al	*311*	*2%*
	plastic	*3,966*	*29%*
ResiduestoLandfill		***2,081***	***15%***

Table 7-55: Mass Balance of Windrow Composting of Green waste

TotalMass	Quantities (t/y)	Percentage
Inputtowindrowcomposting (GreenWaste)	**3,591**	**100.0%**
Compost	*2,155*	*60%*
Losses	*1,436*	*40%*

Table 7-56: Total quantities that will be landfilled

Total quantities that will be landfilled	Quantities (t/y)
Residues from Mechanical and Biological Treatment of Residual waste bin	6,250
Residues from Mechanical treatment of Recyclables waste Bin	2,081
CLO for landfilling	8,105
Totalwastethatlandfilled	**16,436**

Note: The quantities that mentioned in the above table correspond to average quantities for period 2021-2046

7.1.5.2.1 Mechanical Treatment

The Mechanical Treatmentis designed to accept an average of 41,668 t/y of mixed municipal waste (residual waste bin). The facility is designed to be flexible to sort 13,874 t/y ≈13,875 t/y of the source separated recyclables from recyclables waste bin, during different operation hours.

The following diagram presents the stages of mechanical treatment process with quantities in t/y (Average 2021-2046).

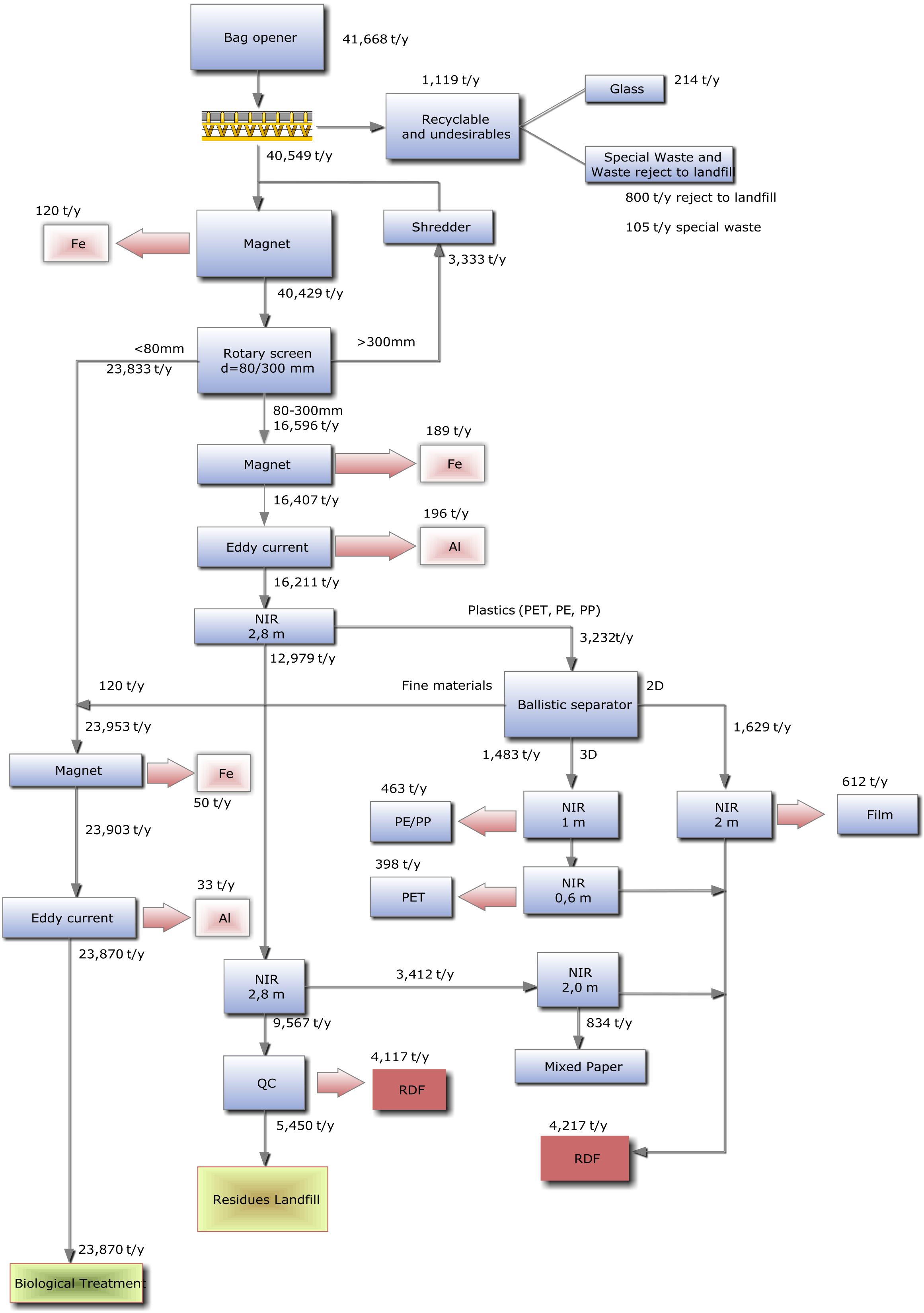


Figure 7-73: Flow-Diagram of mechanical treatment plant – Residual Waste Bin

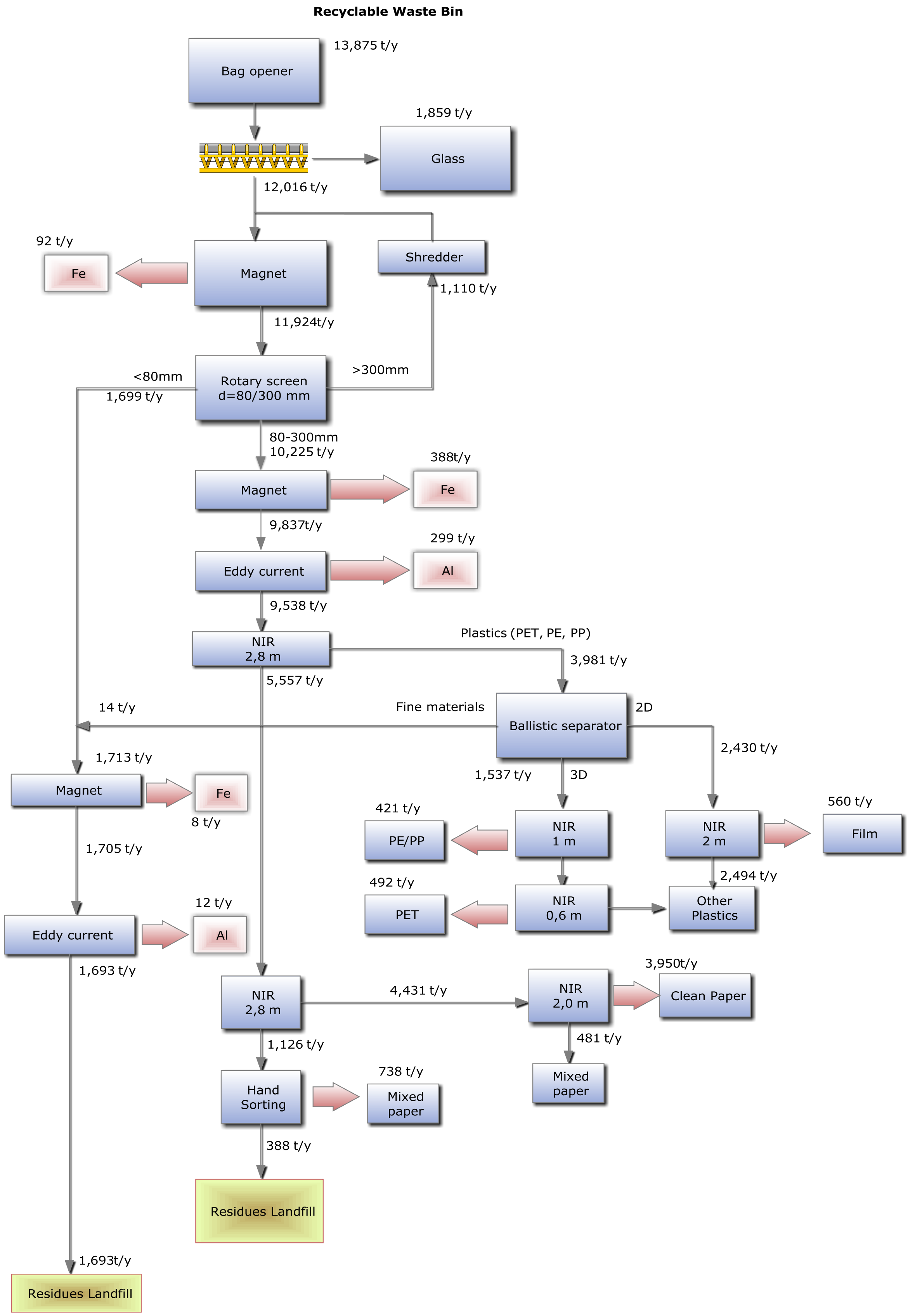


Figure 7-74: Flow-Diagram of mechanical treatment plant – Recyclables Waste Bin

According to the above flow diagram, the operational system of MBT will be as follows:

After residual waste collection vehicles are weighted and recorded, they will unload residual waste in the waste bunker, which has a store capacity for incoming residual waste for three (3) days. Thus,providing contingency, in case the mechanical processing equipment is not available.

Moreover, a second bunker has been foreseen in order to store incoming waste, from recyclable waste bin, for three (3) days. The sorting of source separated recyclables will be carried out in the same sorting line, with the one described for residual waste.

The reception area will be equipped with one bridge – crane for the loading of the incoming waste into the next stage of the treatment process and, also, for the removal of large items. The removal of hazardous/large materials ensures minimum interruptions of the plant operation.

The crane will feed the hopper of the bag opener. The bag opener units shall be capable of opening and emptying a very high percentage of waste containing plastic bags, and shall be suited to accept a wide range of materials, e.g. packaging materials, biowaste, residuals etc.

Throughout the whole mechanical separation process, the materials will be transported from one process stage to another by the use of conveyor systems.

The first hand picking cabin, right after the bag opener, will remove unwanted and /or bulky materials not removed by the crane. This initial operation will prevent overloading of conveyors, the drum etc with these bulky material which could block the production line and therefore lead to down time. This cabin also will help the recovery glass, which is often "lost" to landfill because of breakage during operation.

The next steps will beferrous metal recovery and screening. From experience it is also known that in residual waste bin, the dry fraction is liable to heavy contamination due to the way waste (mixed) are collected, the manner and time of their transport to the treatment plant. It is therefore a priority to remove this 'organic fraction' from the main waste stream as early on in the processing as possible. This will be achieved by the drum screen, which enables the separation of the materials into three fractions by use of two different sized sieving holes, as follows:

- the mainly organic 'small fraction' (< 80mm)
- the 80mm to 300mm material fraction
- the remaining >300mm of the materials which are passed though the end of the sieve drum, where upon they are fed via a conveyor system to the 'pre-shredder'. The use of this 'pre-shredder' is to break down materials over 300mm in dimension which are not able to be easily processed by the optical separators. After being broken down by this shredder these materials are then 'looped back' into the separation process before the drum screen separator by a conveyor system.

The 80-300mm fraction prior its transfer to the non ferrous separator will be subjected to magnetic separation to recover ferrous metals and to avoid damage to the eddy current separator. After the separation of ferrous metals, the fraction will be led to the 'eddy current' aluminium separator.

Then, the Near Infrared Red (NIR) sorter recovers the plastic materials from80-300mm waste fraction. This sorter increases the efficiency of ballistic separator by directing mainly plastics there.The ballistic separator further separate this plastic fraction by weight.
With the vibrations of the separator, the bulky '3D' materials (PET, mixed bottles, other plastics such as PE / PP) 'roll' toward the lower edge of the inclined sorting surface, while the light '2D' materials (such as plastic films) will be moved along and collected at the upper end of the device.

Conveyors then move these fractions of waste to sets of optical separators. Each NIR further separates the different waste streams into cleaner (higher quality) products (mixed paper, RDF, PP/PE, PET etc.).

The separated recyclables will be compressed and baled into individual parcels through compression provisions. In thesedevices the followingmaterialswillbedriven:

- Paper, cardboard and paper categories, i.e. printed paper, packaging etc.
- Metals
- Plastic materials such as PET, plastic sheet and different plastics

Also, the RDF will bebaled by using the same baler as above.

The fraction < 80mm is biologically treated in an anaerobic digestion (AD) unit. Prior to this, it will be subjected to magnetic and eddy current separation to reclaim any remaining scrap ferrous and non ferrous metals and to avoid heavy metal contamination during the process of biological treatment. The ferrous metals will be removed firstly, this also therefore protecting the eddy current separator from possible damage caused by FE metals. Once ferrous materials have been removed from the <80mm organic stream, they will be passed on to the 'eddy current' aluminium separator. Then, the organic fraction will be led to anaerobic digestion (AD) unit.

The AD unit will produce biogas and digestate. Then the digestatewill be biostabilised to produce compost – like output (CLO), which will be disposed to the landfill. AD takes place in closed sealed boxes whereas biostabilisaton takes place in aerated static pile covered by membrane.

Analytical technical description of Mechanical treatment is given also in relevant annex of the present chapter.

7.1.5.2.2 Reception Area for residual waste bin

As mentioned above, the average daily amount of residual waste is:

Qdmean = 41,668 t/y / 300 d/y = 139t/d

Considering a safety factor for the daily seasonal variation of 10%, the daily input for the Reception Unit is:

Qdes = 139 t/d x 1,10 = 153 t/d

To ensure the availability of sufficient temporarily storage space - waiting area for incoming waste collection vehicles, the volume of waste to be treated is calculated at an estimated density of 0.3t/m3. Therefore the minimum volume required for the storage of waste daily is:

Vd = 153t : 0.3 t / m3 = 510 m3

To ensure sufficient volume for storing the incoming waste prior to treatment over a period of 3 days, the reception unit should have a volume of at least equal to:

Vd(3days) = 510 m3 x 3 days = 1,530 m3

7.1.5.2.3 Reception Area for recyclable waste bin

As mentioned above, the average daily amount of source separated recyclables waste (recyclable waste bin) is:

Qdmean = 13,875 t/y / 300 d/y = 46 t/d

Considering a safety factor for the daily seasonal variation of 10%, the daily input for the Reception Unit is:

Qdes = 46 t/d x 1,10 = 51 t/d

To ensure the availability of sufficient temporarily storage space - waiting area for incoming waste collection vehicles, the volume of waste to be treated is calculated at an estimated density of 0.25t/m^3. Therefore the minimum volume required for the storage of waste daily is:

Vd = 51 t : 0.25 t / m^3 = 202 m^3

To ensure sufficient volume for storing the incoming waste prior to treatment over a period of 3 days, the reception unit should have a volume of at least equal to:

Vd(3days) = 202 m^3 x 3 days = 606 m^3

7.1.5.2.4 Mechanical treatment

In order to dimension the mechanical treatment unit, the following assumptions have been taken into consideration:

- ⇒ Operation: Six days (6 days) per week
- ⇒ Total operating days per year: 300 days / year (6 days/week*52 weeks/year = 312 days/year, 312 days - 12 days of potential emergency conditions = 300 days/year)
- ⇒ The commingled recyclables will be sorted in the sorting line of the residual waste during different operation hours
- ⇒ Oneoperationalline 15t/h

Based on the above data – assumptions, the following table presents the dimensioning of the MechanicalTreatment Unit that will ensure the proper functioning of the Unit.

Table 7-57: Dimensioning of Mechanical Treatment Unit

Description	Normal Operation
Incoming amount of residual waste (Residual waste Bin)	41,668 t/y
Incoming amount of source separated recyclables (Recyclable waste Bin)	13,875 t/y
Days of Operation	300 days / year
Daily Capacity for residual waste	139t/d
Daily Capacity for recyclable waste	46t/d
Capacity of line	1 line, 15t/h
Number of shifts	2

7.1.5.2.5 Storage for recyclable materials

The storage building is calculated to accept the total of all recovered materials (from the sorting of residual waste bin and the sorting of recyclable waste bin) for a period of 15 production days.

Table 7-58: Storage Area for Recyclables Productsform the sorting of residual waste bin

Material	Baler (setoutputdimensions) (wxhxl)	Area per bale (m^2)	Specific Weight (kg/m^3)	Weight per Bale (tn)	Recovered Materials (t/d)	N_o of bales per day	No of bales for approx. 15 days	No of bales staked (4 stacks on height)
Paper / Cardboard	0.75 m x 0.85m x1.1m	0.825	450	0,32	2,78	9	135	34
Plastic			350	0,25	4,91	21	315	79
Ferrous			600	0,42	1,20	3	45	11
Alluminium			350	0,25	0,76	4	60	15
RDF			350	0,25	27,78	114	1710	428
Area for bales (20% safety factor)								$561m^2$

The glass will be stored in containers with nominal capacity of 24 m^3.

Table 7-59: Storage Area for Glass

Description	Quantities
Glassquantities per day	0.71 t/d
Estimated density	1.00 t/m^3
Volumetric Flow	0.71 m^3/d
Nominal Capacity of containers	$24m^3$
Filling Factor	75%
Effective capacity	$18m^3$
Containers for 15 days' storage	1
Area for each container (lxwxh)	6mx2.5mx2.4m
Total area for storage of containers	$15m^2$
TOTAL AREA (safety factor 20%)	**18 m^2**

Table 7-60: Storage Area for Recyclables Products form the sorting of recyclable waste bin

Material	Baler (setoutputdimensions)	Area per bale (m^2)	Specific Weight (kg/m^3)	Weight per Bale (tn)	Recovered Materials (t/d)	N_o of bales per day	No of bales for approx. 15 days	No of bales staked (4 stacks on height)
Paper / Cardboard	0.75 m x 0.85m x1.1m	0.825	450	0,32	17,23	55	825	206
Plastic			350	0,25	13,22	54	810	203
Ferrous			600	0,42	1,63	4	60	15
Alluminium			350	0,25	1,04	5	75	19
Area for bales (20% safety factor)								$438m^2$

The glassform the sorting of recyclable waste bin will be stored in containers with nominal capacity of 24 m^3.

Table 7-61: Storage Area for Glassform the sorting of recyclable waste bin

Description	Quantities
Glassquantities per day	6.20 t/d
Estimateddensity	1.00t/m^3
Volumetric Flow	6.20 m^3/d
Nominal Capacity of containers	24m^3
Filling Factor	75%
Effective capacity	18m^3
Containers for 15 days' storage	6
Area for each container (lxwxh)	6mx2.5mx2.4m
Total area for storage of containers	90m^2
TOTAL AREA (safety factor 20%)	**108 m^2**

The calculations reveal that a storage building of approx. **1.200 m^2** caters for this 15 days production capacity which also includes extra area enabling ease and safety of movements.

7.1.5.2.6 Biological treatment (anaerobic digestion of organic fraction of residual waste)

After the mechanical treatment process and recovery of recyclable materials and RDF, the 57.3% of the initial amount enters the Biological Treatment Plant (Anaerobic Digestion) for the production of biogas and digestate. The digestate resulting from AD are treated through a biostabilization process for the production of compost like output (CLO).

The Compost Like Output (CLO) is transferred and disposed to the landfill site.
The biological process goes through two distinct phases. The 1st phase (anaerobic digestion) takes places in digesters with useful capacity of 520m^3. The biogas is blown to a CHP unit for the production of electricity and heat. The digester's filling is achieved by wheel loader. After a period of 30 days the material is directed via wheel loader to biostabilisation. The biostabilisation phase takes place in aerated static piles covered with membrane. After a period of the 56 days the CLO is finally led to the landfill, for disposal.

The selected process method is indicative and non – binding and it is used for the purposes of this feasibility study.
Analytical technical description of Biological treatment is given in the relevant annex of the present chapter.The design assumption used in the proposed biological plant are described in the following table:

Table 7-62: Input designparameters

Description	Values
Input organic fraction to biological treatment	23,870 t/year
Operation	365 days/year
Material Densities	0.6 t/m^3
Biological Stages	• Anaerobic Digestion (1st phase) • Biostabilisation of the digestate (2nd phase)
Retention time in anaerobic digestion (1st phase)	30days
Retention time in biostabilisation (2nd phase)	56 Days (3 stages) 1. High ratecomposting 3 weeks - 21 days 2. Stabilisation 3 weeks – 21 days 3. Maturation 2 weeks – 14 days

According to the above data-assumptions the minimum features for each unit of biological treatment are calculated as follows:

a. Anaerobic Digestion (1st phase)

For the purposes of this feasibility study, the anaerobic digestion (1st phase) takes place in closed boxes with useful volume of 520 m^3. The calculation for the number of anaerobic digesters proceeds as follows:

Table 7-63: Dimensioning of the number of Anaerobic Digesters

Dimensioning of the number of anaerobic digesters	
Materialtoanaerobicdigestion	23,870 t/y
Specificdensity	0.60 t/m^3
Volume of material to anaerobic digestion	39,783 m^3/y
Retentiontime	30days
AnnualWorkingCycles	12
Reactorsdimensions	length 30m width 6,5m useful height 2,7 m Usefulvolumeaprox. 520m3
Average Material per cycle (m^3)	3,315 m3
Number of reactors	7

b. Biostabilization (2nd phase)

For the purposes of this feasibility study, the biostabilisation phase of digestate takes place in a static aerated piles covered by membrane. The biostabilisation goes through three different stages and the number of necessary pilesin each stage are calculated as follows:

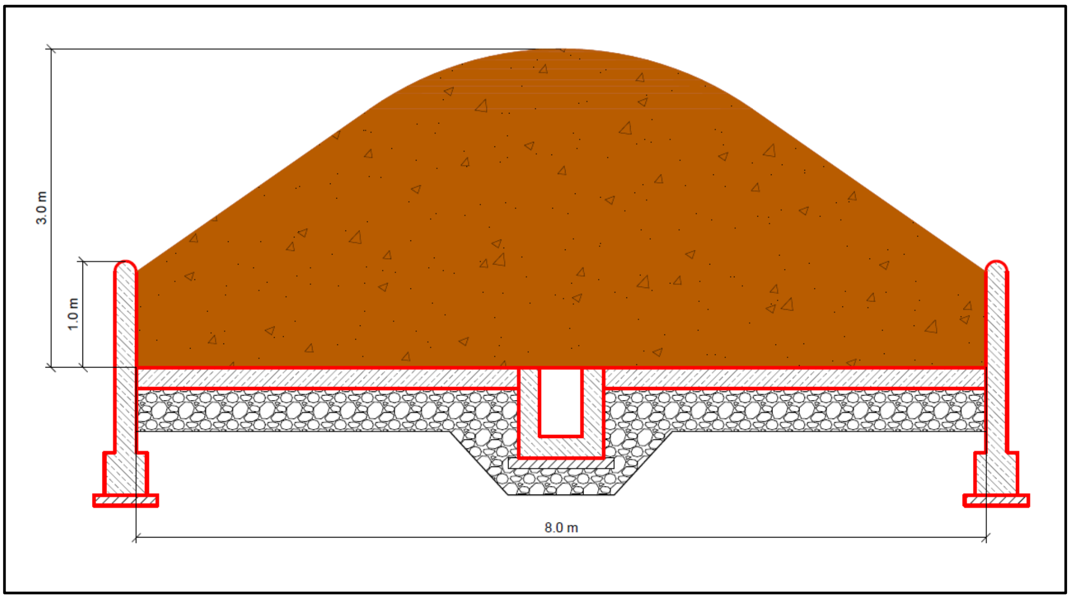


Figure 7-75: Static pile (Section)

Table 7-64:Dimensioning of the number of piles for biostabilisation

Dimensioning of the number of piles for biostabilisation	
Biostabilisation (Stage I – High Rate)	**Stage I**
Material to Stage I – High Rate	10,806t/y
Specificdensity	0.65t/m3
Volume of material to Stage I – High Rate	16,620m3/y
Retentiontime	21 days
AnnualWorkingCycles	17
PileDimensions	length 20m width 8m height 3m Usefulvolume 320m^3
Material per cycle (m^3)	978 m^3
Number of piles	3
Biostabilisation (Stage II – Stabilisation)	**Stage II**
Material to Stage II – Stabilisation (20% mass losses)	8,645t/y
Specificdensity	0.65t/m3
Volume of material to Stage II – Stabilisation	13,300m3/y
Retentiontime	21 days
PileDimensions	length 20m width 8m height 3m Usefulvolume 320m^3
AnnualWorkingCycles	17
Material per cycle (m^3)	782 m^3
Number of cells	3
Maturation	**Stage III**
Material to maturation(5% mass loss stage II)	8,213t/y
Specificdensity	0.65t/m3
Volume of material to maturation	12,635m3/y
Retentiontime	14 days
AnnualWorkingCycles	26
PileDimensions	length 20m width 8m height 3m Usefulvolume 320m^3
Material per cycle (m^3)	486 m^3
Number of cells	2

7.1.5.2.7 Windrow Composting for green waste

The composting plant shall be designed to treat **3,591 tonnes** of green waste per year. For the purposes of this feasibility study, the selected composting method will be the same as the biostabillisation method of organic waste derived from residual waste i.e. membrane covered aerated static pile technology.

The minimum features for each unit of biological treatment are calculated as follows.

Table 7-65: Dimensioning of windrow composting for green waste

1st phase composting	
Materialtocomposting	3,591 t/y
Specificdensityaftershreeding	0.45 t/m^3
Volume of material to composting	7,980 m^3/y
Retentiontime (days)	21days
AnnualWorkingCycles	17
PilesDimensions	Length: 20m Width: 8m Height: 3m Useful volume:320 m^3
Material per cycle (m^3)	469
Number of Reactors	1
2nd phase maturation	
Materialtomaturation	2,873 t/y
Specificdensityaftercomposting	0.45 t/m^3
Volume of material to maturation	6,384m^3/y
Retentiontime (days)	21 days
AnnualWorkingCycles	17
PilesDimensions	Length: 20 m Width: 8 m Height: 3 m Useful volume: 320 m^3
Material per cycle	376 m^3
Number of cells	1

The composting / maturation area should provide sufficient space, in front of cells, for wheel loader movements.

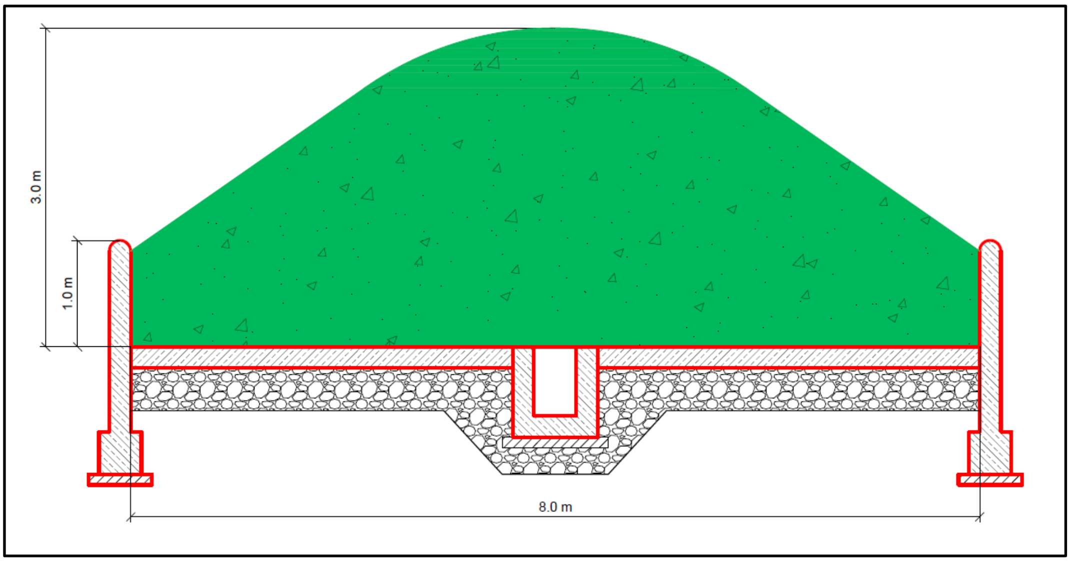


Figure 7-76: Pile of green waste

In regard to the storage area, it should provide sufficient space for at least 3 weeks (21 days). Therefore the storage capacity shall be as follow:

Table 7-66: Dimensioning of the storage area

Dimensioning of the storage area	
Materialtostorage	2,155 t/y
Days of operation	365days/year
Dailycapacity	5.9 t/d
Storagetime	21days
Specificdensity of compost	0.45 t/m^3
Volume of material in storage (for 3 weeks)	276m^3/d
Totalarea	160 m^2

7.1.5.3 Water balance

The daily water consumption in the WMC is,as follow:

1. Anaerobic digestion, 31,0 m^3/d
2. Washes of floors, mechanical equipment and trucks, 2 m^3/d
3. Personnel needs, 5 m^3/d
4. Biofilter, 5,5 m^3/d
5. Irigation, 1m^3/d

Total: 44,5 m^3/d

Based on the above, needs for the washes and personnel (aprox. 7m3/d) will be covered by the potable water supply network.

The water amount for anaerobic digestion, biofilter and irrigation will be covered partly or totally from the WWTPeffluent, based on the particular daily needs, as well as the quality demands. In case that the purified wastewater is temporally not available, the needs will be covered by potable water.

The surplus water amounts that may remain will be directed to a nearby receiver.

7.1.5.4 Site infrastructure such as access roads, fencing, service and staff building, storage areas or buildings

The proposed main facilities (MBT, MRF, green waste composting plant) will be in the same area as the new regional landfill and the necessary infrastructure will be the same as those described in detail in previous paragraph of the present chapter.

7.1.5.5 Equipment (waste compactors, turning machines, screening plants, trucks etc.)

For the sound everyday operations of other treatment facilities in the specific CWMF, the following, diesel engine, mobile equipment is chosen (detailed data concerning quantities and budget of the chosen mobile equipment is presented in the next paragraphsof the present Chapter:

a) Wheeled loader: Wheeled loaders are foreseen for three positions:

- Mechanical Treatment Facility
- Biological Treatment Facility
- Windrow composting Facility

Figure 7-77: Wheeled Loader

Wheeled loaders are proven machines for the handling of waste materials in MRFs, scrap yards, etc where they can lift recyclables or large pieces of junk metal to the feed line. For the biological plant and C&D plants they are used for the feed of materials.

The size of the wheel loader must take into account the necessity of movements within the area and openings. This vehicle will be mainly situated within the waste reception area for the loading of materials into the feeding hopper. The main advantage of this machinery is its large range of movements and the combined ability to manoeuvre the waste in the reception area. For the handling of waste wheeled loaders can be fitted with grappler buckets. Indicative technical characteristics of a wheeled loader are:

- Number of axles: 2 (4 wheel drive)
- Fuel Type: Diesel
- Power: > 90 kW
- Gross weight: ≥ 11 t
- Light material Bucket: > 3 m^3
- Includes Quick coupler and grappler buckets

b)Forklift: An internal combustion diesel powered forklift is used due to its ability to be refuelled instantly therefore being ready to continue working with minimal downtime. Internal combustion forklifts stand up to certain types of hard usage better than electric lifts, specifically when used for pushing or towing loads, instead of only lifting. These types of fork lift are also suitable for outdoor use.

Figure 7-78: Forklift

This machinery is planned for two main uses within the facilities. First, this vehicle will be required to 'push though' the temporary material storage bins located below the hand picking cabin, loading the raising conveyor with products to be bailed. For this purpose the vehicle is to be provided with an appropriate quick connection accessory to facilitate this. Second, it is used for the manoeuvring of the baled recyclable products, for the stacking / handling of the product bales and also for the loading of these bales onto the third party collection vehicles. Indicative technical characteristics of a forklift are:

- Number of axles 2 (4 wheel)
- Fuel Type Diesel
- Power 59 HP
- Lifting Capacity 3 tons
- Lifting Height 3 m
- Environmental Certification EPA Tier3 and EU Stage IIIA compliant engine

c) Transport truck with hook lift (for residuals disposal):The role of this vehicle is the transport of various materials (wasteresidues, recovered metals) originating from the treatment to the appointed unloading areas. As concerns the waste materials from the separation process, the vehicle will collect the loaded containers and discharge to the sanitary landfill. The truck is supplied with a railed loading space and grips for the gripping and supporting of containers. The containers are loaded and unloaded onto the vehicle by means of a lifting hook, which is also capable of tipping the containers. The truck must comply with local regulations to drive on public roads. Indicative technical characteristics of a transport truck with hooklift are:

- Number of axles 4 - 8X4 wheel drive
- Power 380 HP
- Max gross weight 33 tons
- Environmental Certification Euro 6
- Hook lift: 20 t

Figure 7-79: Container transport vehicle

d) Mechanical sweep cleaner for external / internal use (1m^3)

These compact type sweep cleaners are foreseen for cleaning all confined spaces and areas with limited access. It is the perfect machine for sweeping larger premises e.g., factory sites. The sweepers are electrical and are equipped with water tanks and sprayers used to loosen particles and suppress dirt particles to ensure virtually dust-free sweeping in critical areas. The brooms gather debris into a main collection area from which it is vacuumed and pumped into a large tilting steel hopper to holds the debris and which allows easy discharge into skips or bins. The mobile equipment will be accompanied with all consumables and spare parts.

Figure 7-80: Mechanical sweep cleaner

7.1.5.6 Staffing

This section presents the indicative personnel requirements for the MBT and MRF facilities, as well as the windrow composting of green waste.

Regarding the weighing and data obtaining form the incoming trucks, the personnel required (as well as their task) are the same with what is described in the Staffing paragraph of the previous chapter, as the other facilities are going to be located at the same area as the new landfill.

For the mechanical treatment, the works mainly include the following:

- Operation of crane with grab for feeding the downstream systems
- Supervision of the receiving waste
- Removal (if any) of any bulky waste from the reception ditch and putting them in the appropriate container
- Monitoring for the presence of any unwanted waste, after opening the bags
- Activation of unwanted waste removing system when it is deemed necessary and de-activation of the removing system when unwanted waste is removed
- Pre-sorting of waste streams that are either held in primary screens (sizeable) or in secondary screens. The pre-screening will be in classes of materials that have been selected
- Transfer of recovered materials in the storage area
- Other works required

For the biological treatment, the works mainly include the following:

- Monitoring the functioning of the feeding system of the biological treatment unit
- Monitor and tuning critical operating parameters of the process
- Other works required.

Table 7-67: Personnel requirements

Minimum specified requirements for the operation of the Mechanical and Biological Treatment facility(MBT)	
Position title	*Indicative number of personnel*
1. General Manager	1
2. MBT operator	2
3. Electrical/Mechanical installation technician	2
4. Weighbridge operator	2
5. General secretary/administrator	2
6. Drivers	6
7. General tasks workers	30
Minimum specified requirements for the operation of the windrow composting for green waste	
Position title	*Indicative number of personnel*
1. Truck operator-driver	1
2. General tasks worker	1

The main tasks of basic skills are explained below:

1) General Manager:
Primary responsible of all facilities, coordinates and supervises all operations and personnel, and makes all necessary arrangements with the Authorities. Unit supervisor must be an Engineer with knowledge on technical projects and pollution control projects in particular.
The responsibilities of the positions are indicative:

- Monitor, check and intervene in the daily operation program of the Unit.
- Draw up a weekly work plan and arrange for replacement positions in case of absence of employees due to sickness or leave.
- Arrange, in partnership with the Operation Authority of the project for equipment and supply for the Unit with the required materials.
- Arrange for the collection of data and information that will be requested by the Authority.
- Inform and address others who visit the unit.
- Recommend for everything concerning the proper operation of the unit and the better organization of the site.
- Personally supervise the operation of the unit.

2) MBT operator
Responsible for the overall smooth operation of the plant and for the implementation of the environmental monitoring program by performing sampling and checks made on the spot.

3) General secretary/administrator
Primarily responsible for the proper operation of all units from an administrative point of view.

4)Weighbridge Operator
Has the following responsibilities:
Updating the PC via magnetic card:

- Vehicle Registration Number
- Date
- Time

Weighing and recording data in the PC

- Gross weight
- Net weight
- Serial number weighing

- Password for gate destination of waste collection truck

Print Entry Form with the above data

Additionally, he has the responsibility of guarding and monitoring of the area in general. Fully responsible for the safety of the facilities and equipment of the Unit.

- Protect the area from any third party intervention.
- Prohibit the entry and presence in the area of unauthorized persons and vehicles for which a decision to prohibitive them is issued by the Authority.
- Monitor or assist, incoming vehicles, vehicles entry, cover loads of open vehicles and the types of loads.

5)Electrical/Mechanical installation technician

Undertake the testing of machinery and equipment and perform basic maintenance tasks. Some of these duties may be assigned to the same person (i.e. general labourer duties - maintenance technician).

6) General tasks workers

Responsible for the sorting of waste and promoting it by type for further processing.

7) Drivers

Undertake the handling of all vehicles - equipment needed to operate the plant.

7.1.5.7 Environmental Monitoring.

The central monitoring and control system is designed to incorporate the 'feeds' from the main control systems regulating the processing activities within the WMC. The design of the automation system is based on required objectives. In this context it has been foreseen the installation of a series of automatic control, measurement and management systems that will cover:

- The supervision and management of the landfilling environmental operations.
- The supervision and management of the MBT.
- The supervision and management of the wastewater treatment plant.
- The supervision and management of the support buildings where necessary, indicatively:

- Weighbridge
- Wheel wash
- Fire alarm extinguishing system
- Sewage pumping station
- Alarm detectors
- Outdoor lighting
- etc

The central control centre of the installation is located in the administration building and consists of a network of PCs with the necessary peripherals and appropriate software for the automatic supervision and operation of all the individual facilities utilising the process commonly known as supervisory control and data acquisition (SCADA). The PCs will collate all the crucial information concerning the operational state of individual facilities of WMC and will carry out all the necessary procedures for the smooth operation. All the localised automated control panels and the control stations within each facility, via the use of Ethernet hub switches, will be connected a single network of optical fibbers that run throughout the establishment. With this set up the control programming of individual production processes is possible from within the central control station or from the localised control rooms.

The central control panels located in the administration building and the localised control rooms are equipped with all the necessary hardware and software for the control of operations. At the central control panel, placed in the provided room within the administration building and also at the localised control panels there is a flow diagram and indicators for the operational control and management of all the installed machinery and devises. Where required, optical and audio alarm signals are placed.

7.1.5.8 Price schedules

The cost of mechanical and biological treatment are affected by a number of different parameters as:

- The capacity of each unit
- The type and complexity of technology
- The degree of automation of production process
- The requiredinfrastructure

The table below presents our estimations regarding the investment cost of Mechanical and Bilogical Treatment. The detailed investement cost have been calculated taking into consideration the results of the detailed design study for the landfill of Pelagonija region as it has been developed up to now. The detailed investment cost that is presented in the following table does not include contingencies and VAT.

Table 7-68: Investment Cost of Mechanical Treatment

No	Item	Unit	Quantities	Unit Cost (€)	Cost (€)
1.	**Mechanical Treatment of Mixed Municipal Waste**				
1.1	**Mechanical Equipment**				
1.1.1	Bridge - crane	item	1	400,000	400,000
1.1.2	Bag Opener	item	1	235,000	235,000
1.1.3	Trommel Screen d=80/300mm	item	1	180,000	180,000
1.1.4	Magnet	item	3	40,000	120,000
1.1.5	Shredder	item	1	250,000	250,000
1.1.6	Eddy Current Separator	item	2	80,000	160,000
1.1.7	Balistic Separator	item	1	165,000	165,000
1.1.8	NIR 2,8m	item	1	250,000	250,000
1.1.9	NIR 1m PE/PP	item	1	140,000	140,000
1.1.10	NIR 0,6m PET	item	1	130,000	130,000
1.1.11	NIR 2m film	item	1	190,000	190,000
1.1.12	NIR 2,8m paper	item	1	250,000	250,000
1.1.13	NIR 2m	item	1	190,000	190,000
1.1.14	Baler with PET perforator for paper & plastic	item	1	350,000	350,000
1.1.15	Baler for metals (FE & NE)	item	1	150,000	150,000
1.1.16	Sorting Cabin	item	1	100,000	100,000
1.1.17	Conveyors	m	700	2,000	1,400,000
1.1.18	Commisioning (supply, istallation, transportation, test)	item	1	500,000	500,000
		Subtotal 1.1. Mechanical Equipment			**5,160,000**
1.2	**Buildings Constructions (Civil works)**				
1.2.1	Excavations	m^3	12,600	2.3	28,980
1.2.2	MBT Metallic building	m^2	6,300	400	2,520,000
1.2.3	Storage for recyclables	m^2	1,200	250	300,000
		Subtotal 1.2. Buildings Construction			**2,848,980**
1.3.	**Infrastructure**				
1.3.1	Electrical and mechanical installation (fire protection, sewage, electrical cables, etc)	item			
1.3.1.1	General electrical / electronic installations	item	1	150,000	150,000
1.3.1.2	Fire detection and protection installations	item	1	70,000	70,000

No	Item	Unit	Quantities	Unit Cost (€)	Cost (€)
1.3.1.3	Sewage and plumbing installation	item	1	50,000	50,000
1.3.1.4	Automation System	item	1	100,000	100,000
1.3.1.5	Others	item	1	20,000	20,000
1.3.2	Asphalted and gravel areas	m^2	13000	25	325,000
	Subtotal 1.3. Infrastructures				**715,000**
1.4	**Mobile Equipment**				
1.4.1	Transport truck with hook lift	item	1	120,000	120,000
1.4.2	Sweeper	item	1	100,000	100,000
1.4.3	Forklift	item	1	30,000	30,000
1.4.4	Container 24m3 for residues, glass and organic	item	10	8,000	80,000
1.4.5	Container for ferrous, non ferrous products and others (1,1m3)	item	12	300	3,600
	Subtotal 1.4. Mobile Equipment				**333,600**
1.5	**Trial Operation**				
1.5.1	Trial Operation for 3 months	unit	1	120,000	120,000
	Subtotal 1.5. Trial Operation				**120,000**
1.6	**Dedusting - deodorization - MBT**				
1.6.1	Dedusting - deodorization - Civil works for biofilter	item	1	111,000	111,000
1.6.2	Dedusting - deodorization - Electrical works	item	1	80,000	80,000
1.6.3	Dedusting - deodorization - Mechanical works (Air ducts galv steel 2mm, Bagfilter, centifugal fan, biofilter packing media, dampers, pumps, fittings, etc)	item	1	429,000	429,000
	Subtotal 1.6. Dedusting - deodorization - MBT				**620,000**
	Subtotal 1. Mechanical Treatment of Mixed Municipal Waste				**9,797,580**

Table 7-69: Investment Cost of Biological Treatment

No	Item	Unit	Quantities	Unit Cost(€)	Cost (€)
2	**BIOLOGICAL TREATMENT**				
2.1	**Biological Treatment**				
2.1.1	**Civil Works**				
2.1.1.1	Construction of digesters, hall, roofing etc	item	7	200,000	1,400,000
2.1.1.2	Steel construction for digesters	item	1	35,000	35,000
2.1.1.3	Water tank, percolate tank for digesters etc	item	1	250,000	250,000
2.1.1.4	Concrete base and side walls for composting cells	m^3	1,000	250	250,000
2.1.1.5	*Asphalted and gravel areas*	m^2	11,000	15	165,000
2.1.1.6	Other works	item	1	20,000	20,000
	Subtotal 2.1.1 Civil Works				**2,120,000**
2.1.2	**Plant and Machinery**				
2.1.2.1	Enery recovery from biogas (pipping, biogas tank, CHP 500kW, dewatering system, transformer station, flare etc)	item	1	500,000	500,000
2.1.2.2	Valves, aggregates etc for anaerobic digestion	item	7	100,000	700,000
2.1.2.3	Commisioning (planining, supply, installation, transportation, test) for anaerobic digestion	item	1	600,000	600,000
2.1.2.4	Semi - permeable mebrane, fans, channels, etc for composting cells (20 m x8m x2,5m) (lxwxh)	item	8	85,000	680,000
2.1.2.5	Auxialiary machine (towed mobile winder) for composting cells	item	1	70,000	70,000
2.1.2.6	Testing and other works for composting cells	item	8	5,000	40,000

No	Item	Unit	Quantities	Unit Cost(€)	Cost (€)
	Subtotal 2.1.2 Plant and Machinery				**2,590,000**
2.2	**Electrical and mechanical installation (fire protection, sewage, plumbing, electrical cables etc)**				
2.1.1	General electrical / electronic installations	item	1	135,000	135,000
2.1.2	Control system	item	1	200,000	200,000
2.1.3	Sewage and plumbing installation	item	1	50,000	50,000
2.1.4	Other works	item	1	10,000	10,000
	Subtotal 2.2.Electrical and mechanical installation (fire protection, sewage, plumbing, electrical cables etc)				**395,000**
2.3	**Mobile Equipment**				
2.3.1	Wheeled front end loader	unit	1	110,000	110,000
	Subtotal 2.3. Mobile Equipment				**110,000**
2.4	**Trial Operation**				
2.4.1	Trial Operation for 3 months	unit	1	90,000	90,000
	Subtotal 2.4. Trial Operation				**90,000**
2.5	**Deodorization - Anaerobic Digestion**				
2.5.1	Dedusting - deodorization - Civil works	item	1	5,000	5,000
2.5.2	Dedusting - deodorization - Electrical works	item	1	30,000	30,000
2.5.3	Dedusting - deodorization - Mechanical works (Air ducts galv steel 2mm, centifugal fan, Scrubber two stages, dampers, pumps, fittings, etc)	item	1	240,000	240,000
	Subtotal 2.5. Deodorization - Anaerobic Digestion				**275,000**
	Subtotal 2: Biological Treatment				**5,580,000**

Table 7-70: Investment Cost of Windrow Composting for Green Waste

No	Item	Unit	Quantities	Unit Cost (€)	Cost (€)
3	**WINDROW COMPOSTING FOR GREEN WASTE**				
3.1	**Civil Works**				
3.1.1	Concrete base and side walls for composting cells	m^3	190	250	47,500
3.1.2	Shreeder area - asphalted area C2a	m^3	40	250	10,000
3.1.3	Shedeed area - Reception of green waste (C1a)	m^2	380	390	148,200
3.1.4	Asphalted and gravel areas	m^2	3,500	15	52,500
3.1.5	Other works	item	1	10,000	10,000
	Subtotal 3.1. Civil Works				**268,200**
3.2	**Plant and Machinery**				
3.2.1	Semi - permeable mebrane, fans, channels for composting cells	item	1	85,000	85,000
3.2.2	Testing equipment & other works	item	1	5,000	5,000
	Subtotal 3.2 Plant and Machinery				**90,000**
3.3	**Infrastructure**				
3.3.1	Electrical and mechanical installation (fire protection, sewage, plumbing, electrical cables etc)				
3.3.2	General electrical / electronic installations	item	1	20,000	20,000
3.3.3	Sewage and plumbing installation	item	1	5,000	5,000
3.3.4	Other works	item	1	10,000	10,000
	Subtotal 3.3. Infrastructure				**35,000**
3.4	**Mobile Equipment**				
3.4.1	Wheeled front end loader	unit	1	110,000	110,000
3.4.2	Shredder	item	1	60,000	60,000
3.4.3	Drum Screen	unit	1	80,000	80,000
	Subtotal 3.4. Mobile Equipment				**250,000**
3.5	**Trial Operation**				
3.5.1	Trial Operation	unit	1	25,000	25,000
	Subtotal 3.5. Trial Operation				**25,000**
	Subtotal 3. WINDROW COMPOSTING FOR GREEN WASTE				**668,200**

7.2 Human resources and promoter organization

7.2.1 Institutional setup and operation of the proposed waste management system

Institutional framework is an essential issue for waste management. Without such a framework can't be function well over the long term. In addition, if waste services are designed to be effective, the authorities must have the capacity and the organizational structure to manage finances and services in an efficient and transparent manner.

Different models for institutional framework on country level have been examined and the model which the beneficiary country decided to follow after extensive consultation with the stakeholders, is based on the basic aspect of partial regionalization.

This scenario is the closest to the existing situation. Includes collection and transport services up to the Transfer stations, for the municipalities that include Transfer stations, or up to the CWMF for the municipalities which are not foreseen the construction of a Transfer station remaining under the competence of local PUEs. An intermunicipal waste management enterprise will manage the operation of the Transfer stations and of the Central Waste Management Facility. The PUEs and the Intermunicipal Waste Management Enterprise will be managed from the Regional Centre.

According to the Law on Waste Management (LoWM) (Article 23) competencies of the Regional Centre are:

- Preparing the regional plan
- Proposing projects
- Developing the regional system
- Implementing and managing projects
- Providing contracting services and facilities for handling municipal and other types of non-hazardous waste within regional system
- Coordinating planning and implementing activities
- Provides professional and technical assistance to municipalities for waste management in the preparation of programs and projects for waste management
- Monitor the amount and quality of services rendered within the regional system
- Preparing an annual report of the regional center
- Prepares an annual work program of the Regional Centre

Regional Centers have a clearly defined role in the regional concept of waste management. In practice the RCs are not established yet.

The method of financing Regional Centers is defined in the LoWM, article 123, paragraphs 1 and 4. According to the Law the municipal council may set a fee for waste management in the amount of 1% to 2% of the price for the service for collection and transportation of municipal waste to finance the realization of the goals for waste management set out in the plans and programs of waste management of municipalities, regional plans for waste management, as well as for the financing of regional centers for waste management of at least 40%.Key responsibilities on the municipal level remain the same.

The following table presents a brief overview of the activities within the proposed model:

Table 7-71: Overview of the waste management activities in the proposed model

Activity	Local Companies (PUEs)	Regional Enterprise (IMWME)
Waste collection	Yes, current activity	No
Transport of the collected waste to the transfer stations or to the Central Waste Management Facility for those municipalities that will not served from a TS	Yes	No
Waste transport from the transfer station to the regional landfill	No	Yes, new activity
Collection of separate waste at source (recyclables, green waste) and transport to the Transfer stations or to the Central Waste Management Facility for those municipalities that will not served from a TS	Yes, new activity	No
Operation of Transfer Stations	No	Yes, new activity
Waste treatment and disposal on CWMF	No	Yes, new activity

The following diagram illustrates the aforementioned proposed model.

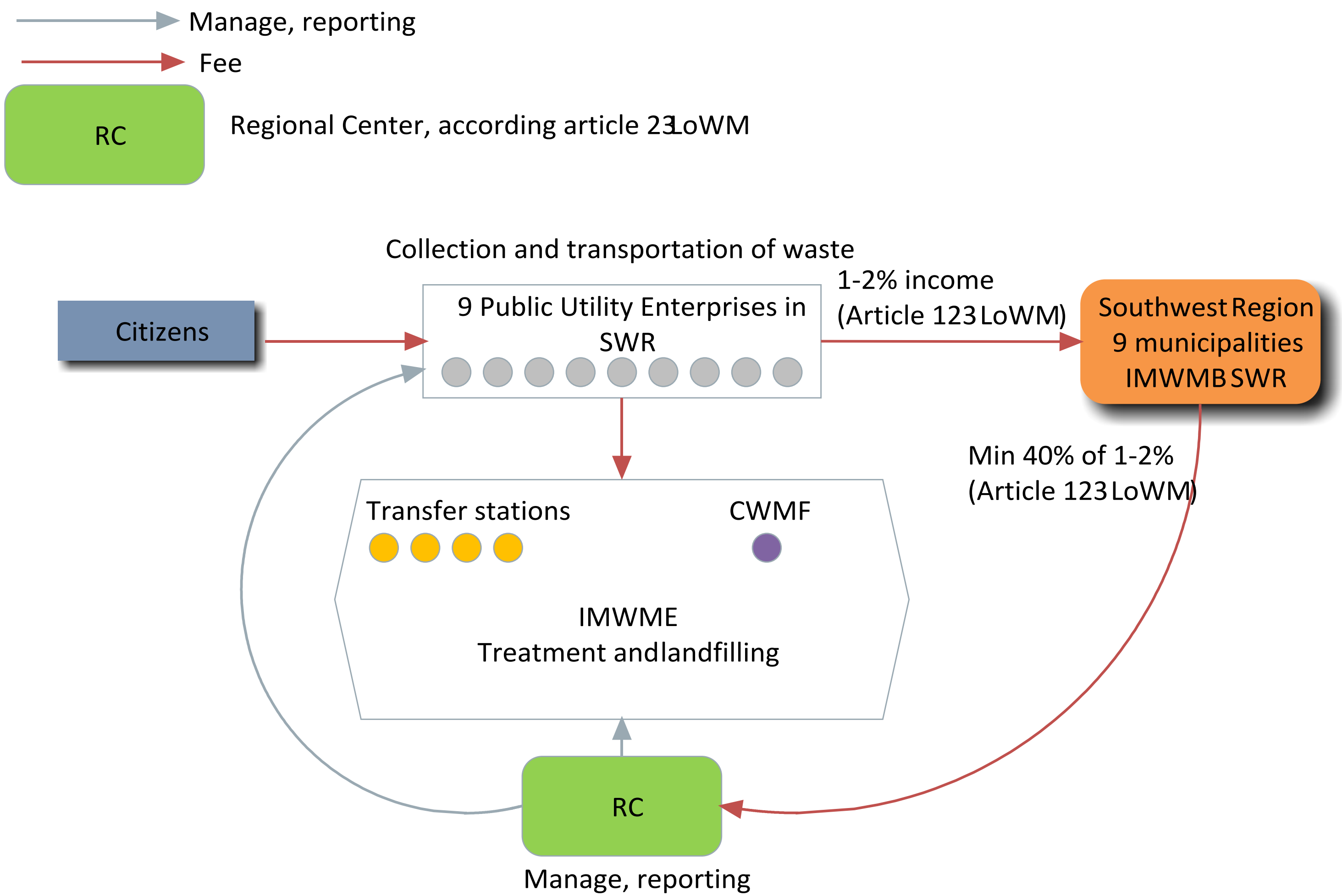


Figure 7-81: Proposed Model

7.2.2. Personnel requirements

This section presents the indicative personnel requirements for the intermunicipal waste management enterprise and for the regional center.

Central Administration – Intermunicipal Waste Management Enterprise	
Position title	*Indicative number of personnel*
1. Director	1
2. Assistant Director	1
3. Project Manager	1
4. Head of Engineering projects	1
5. Head of Finance and Accounting	1
6. Etc.	2

Central Administration – Regional Center	
Position title	*Indicative number of personnel*
1. Director	1
2. Secretary	1
3. Board	1

Concerning the personnel requirements of TSs and CWMF these data are presented in the relevant chapters (Chapter 7 and chapter 9 correspondingly).

7.2.3. Training procedures

The theoretical training of staff should be at least for the following areas:

- ✓ General information on waste management
- ✓ General description of WMC and TS facilities
- ✓ Description of the WMC and TS units
- ✓ Description of all plant machinery
- ✓ Operation manuals of machinery
- ✓ Maintenance Manuals - Parts - Analysis of Faults.
- ✓ Health and Safety

In particular the staff training will be done in modules and by groups of workers. The minimum topics given in the following table:

N / A	TRAINING MODULE
1	Legislative framework for waste management
2	Operating Basics CWMF - General education facilities
3	Detailed presentation of flowchart functions
4	Internal Processes – Duties List
5	Hygiene and safety-emergency
6	Administrative operations, financial management and operational costs
7	Fundamentals for equipment maintenance, maintenance schedule, maintenance repair operations, parts and service equipment
8	Environmental monitoring function laboratory measurements-analyzes and processing results, results database, project monitoring reports
9	Weighing incoming waste and outgoing materials weightings recorded in a database
10	Techniques and landfill operations, cover material, maximizing available space
11	Techniques of Leachate treatment unit-Sampling Techniques - Quality Control - Outputs - Disposal
12	Landfill Equipment - Machinery and Equipment Supporting Equipment-Use of Equipment

N / A	TRAINING MODULE
13	Monitoring and Maintenance Project (fences, drainage, street cleaning etc) - Management of Vehicle and Personnel - Transfers

Finally, it should be noted that there will be the possibility of holding seminars, educational visits/trips and anything else necessary to further educate and train staff on technology, use and operation of equipment or recovery systems.

The administrative bodiesof the Intermunicipal Waste Management Enterprise consists of the administrative Board, the Executive Committee and the President. The chairman of the board is elected by the members.
The administrative Board has the following responsibilities:

- Approve the operational plan upon recommendation of the Executive Committee,
- Determines the annual membership contributions of municipalities,
- Approves the financial statements of the enterprise,
- Establish the internal rules and rules of procedure,
- Adopt its internal organization and service
- Consults public authorities or competent bodies upon requesting its opinion.

7.2.4. Competence of the promoter: general competences;project implementation competences

The following figure illustrates the proposed organizational scheme for the new intermunicipal waste management enterprise.

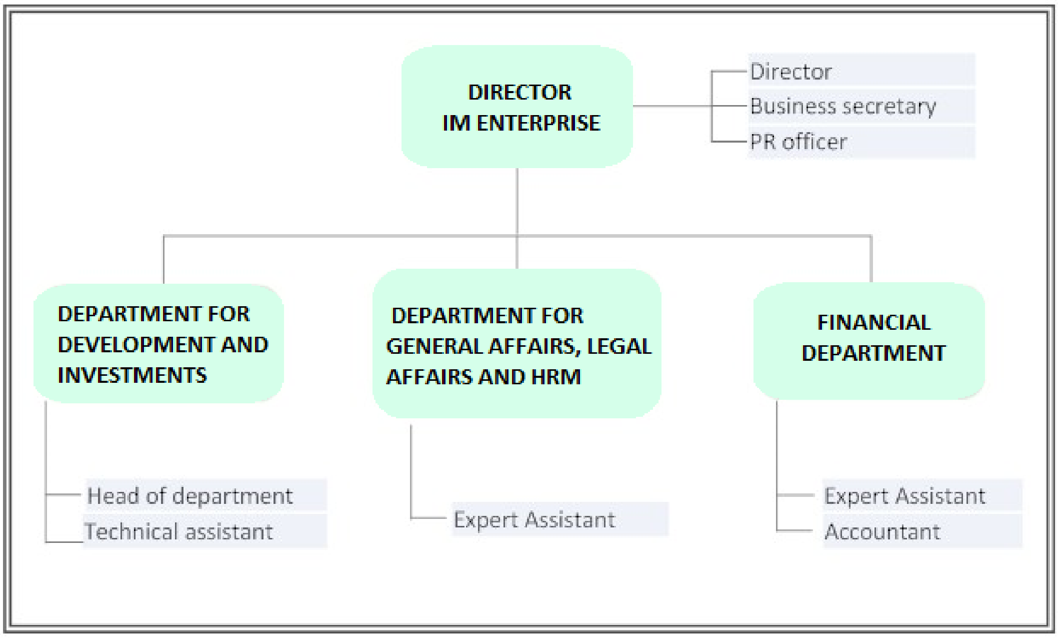


Figure 7-82: Organizational scheme for project preparation

7.3. CAPEX, OPEX and reinvestment cost determination

The table below presents our estimations for the WMC. The detailed investment cost that is presented in the following table does not include contingencies and VAT.

Table 7-72: Total Project Cost, price in EUROS

Project Component	Total Project Cost, EURO
Mechanical Treatment	9,797,580
Biological Treatment	5,580,000
Residual Landfill (WWTP included)	3,732,393
Infrastructure works	1,434,234
Windrow Composting for Green Waste	668,200
Transfer Station Struga	1,018,078
Transfer Station Debar	968,692
Transfer Station Kichevo	1,109,550
Transfer Station Ohrid	1,245,542
Collection Equipment	4,554,644
Public Utilities	360,000
Acquisition of land	830,000
TOTAL	**33,698,914**

During the thirty years analysis period (2017-2046), replacement and reinvestments costs were taken into account. The main parameter for the timing of such investments was the useful life of the assets. The reinvestment cost has been presented in the table below:

Table 7-73: Breakdown of Reinvestment Cost, in Euro (constant price 2017)

REINVESTMENT COST - Non Eligible Cost								
(in constant EUR)	**2021-2026**	**2027**	**2028**	**2029-2031**	**2032**	**2033-2038**	**2039**	**2040-2046**
Land acquisition								
Acquisition of land of WMC & Transfer Station	0	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Civil construction								
Mechanical Treatment		0	0	0	0	0	0	0
Biological Treatment	0	0	0	0		0		0
Residual Landfill (WWTP not included)		653,000	1,253,178	0	0	0	0	0
Waste Water Treatment Plant								
Infrastucture works	0	0	0	0	0	0	0	0
Windrow Composting (for green waste)	0	0	0	0	0	0	0	0
Transfer Station Struga	0	0	0	0	0	0	0	0
Transfer Station Debar	0	0	0	0		0		0
Transfer Station Kichevo	0	0	0	0	0	0	0	0
Transfer Station Ohrid								
Collection Equipment	0	0	0	0	0	0	0	0
Public Utilities (Access Road)	0	0	0	0	0	0	0	0
Total	**0**	**653,000**	**1,253,178**	**0**	**0**	**0**	**0**	**0**
Plant and machinery								
Mechanical Treatment	0	0	0	0	2,617,200			0
Biological Treatment	0	0	0	0	1,318,400			0

REINVESTMENT COST - Non Eligible Cost								
(in constant EUR)	**2021-2026**	**2027**	**2028**	**2029-2031**	**2032**	**2033-2038**	**2039**	**2040-2046**
Residual Landfill (WWTP not included)		0	0	0	5,128			0
Waste Water Treatment Plant	0		400,000		51,890			
Infrastucture works	0	0	0	0	296,167			0
Windrow Composting	0	0	0	0	54,000			0
Transfer Station Struga	0	0	0	0	31,380			0
Transfer Station Debar	0	0	0	0	31,380			0
Transfer Station Kichevo	0	0	0	0	31,380			0
Transfer Station Ohrid					31,380			
Collection Equipment	0	0	0	0	1,211,918			0
Public Utilities (Access Road)	0	0	0	0	0			0
Total	**0**	**0**	**400,000**	**0**	**5,680,224**			**0**
Mobile Equipment								
Mechanical Treatment	0	0	0	0	357,600	0	0	0
Biological Treatment	0	0	0	0	128,000	0	0	0
Residual Landfill (WWTP not included)	0	0	0	0	505,000	0	0	0
Waste Water Treatment Plant								
Infrastucture works	0	0	0	0	0	0	0	0
Windrow Composting	0	0	0	0	255,000	0	0	0
Transfer Station Struga	0	0	0	0	259,130	0	0	0
Transfer Station Debar	0	0	0	0	392,249	0	0	0
Transfer Station Kichevo	0	0	0	0	415,624	0	0	0
Transfer Station Ohrid					469,960			
Collection Equipment	0	812,896	0	0	2,823,332	0	812,896	0
Public Utilities (Access Road)	0	0	0	0	0	0	0	0
Total	**0**	**812,896**	**0**	**0**	**5,605,895**	**0**	**812,896**	**0**
Contingencies								
MechanicalTreatment	0	0	0	0	130,860	0	0	0
BiologicalTreatment	0	0	0	0	65,920	0	0	0
Residual Landfill (WWTP not included)	0	65,300	125,318	0	513	0	0	0
Waste Water Treatment Plant	0	0	20,000	0	2,595	0	0	0
Infrastucture works	0	0	0	0	0	0	0	0
Windrow Composting	0	0	0	0	29,617	0	0	0
Transfer Station Struga	0	0	0	0	2,700	0	0	0
Transfer Station Debar	0	0	0	0	3,138	0	0	0
Transfer Station Kichevo	0	0	0	0	3,138	0	0	0
Transfer Station Ohrid	0	0	0	0	3,138	0	0	0
Collection Equipment	0	0	0	0	3,138	0	0	0
Public Utilities (Access Road)	0	0	0	0	60,596	0	0	0
Total	**0**	**65,300**	**145,318**	**0**	**305,352**	**0**	**0**	**0**
Totals excluding intangibles								
MechanicalTreatment	0	0	0	0	3,105,660	0	0	0
BiologicalTreatment	0	0	0	0	1,512,320	0	0	0
Residual Landfill (WWTP not included)	0	718,300	1,378,496	0	510,641	0	0	0
Waste Water Treatment Plant		0	420,000		54,485	0	0	
Infrastucture works	0	0	0	0	0	0	0	0
WindrowComposting	0	0	0	0	325,784	0	0	0
Transfer Station Struga	0	0	0	0	311,700	0	0	0

REINVESTMENT COST - Non Eligible Cost								
(in constant EUR)	**2021-2026**	**2027**	**2028**	**2029-2031**	**2032**	**2033-2038**	**2039**	**2040-2046**
Transfer Station Debar	0	0	0	0	293,648	0	0	0
Transfer Station Kichevo	0	0	0	0	426,767	0	0	0
Transfer Station Ohrid	0	0	0	0	450,142	0	0	0
Collection Equipment	0	812,896	0	0	504,478	0	812,896	0
Public Utilities (Access Road)	0	0	0	0	4,095,846	0	0	0
Total	**0**	**1,531,196**	**1,798,496**	**0**	**11,591,471**	**0**	**812,896**	**0**
Intangible components								
Technical Assistance - Supervision during implementation & Publicity								
Public Utilities (connection of power supply network, water supply network etc)								
Grandtotal	**0**	**1,531,196**	**1,798,496**	**0**	**11,591,471**	**0**	**812,896**	**0**

7.3.2. Waste collection

The following table presents the total investment cost for collection equipment (bins and trucks).

Table 7-74: Total cost for collection equipment €

No	Item	Unit	Quantities	Unit Cost (€)	Cost (€)
1	**Collection Cost**				
1.1	**Collection Bins 1,1m3**				
1.1.1	1,1 m^3 metal bin	item	2,221	341	757,361
1.1.2	1,1 m^3 plastic bin	item	2,704	240	648,960
1.1.3	120 lt plastic bin	item	5,995	28	167,860
1.1.4	Bins for home composting	item	4,029	39	157,131
	Subtotal 1.1 Collection bins				**1,731,312**
1.2	**Collection trucks**				
1.2.1	RCV, Collection truck 14 m^3	item	16	116,128	1,858,048
1.2.2	RCV, Collection truck 6 m^3	item	2	79,672	159,344
1.2.3	Green waste collection tipping truck 6 m^3	item	10	80,594	805,940
	Subtotal 1.2 Collection trucks				**2,823,332**
	Subtotal 1: Collection Equipment				**4,554,644**

7.3.3. Transfer Stations

The following table presents the total investment cost for TSs. Analytical calculations are presented in Annex 1 of chapter 6.

Table 7-75: Total investment cost for TSs

No	Item	Unit	Quantities	Unit Cost (€)	Cost (€)
2	**TRANSFER STATIONS**				
2.1	**TS Struga**				
2.1.1	**Civil works**				
2.1.1.1	Fence	m	1,029	51	52,411
2.1.1.2	Entrance gate	items	1	1,268	1,268
2.1.1.3	Plateau and roads (incl flood works)	sqm	4,650	69	334,651
2.1.1.4	Administration building	sqm	60	500	30,000
2.1.1.5	Water supply	items	1	11,061	11,061
2.1.1.6	Sewerage system	items	1	4,825	4,825
2.1.1.7	Electrical instrallations (lighthing, electricity, phone, fire fighting)	items	1	116,724	114,628
2.1.1.8	Hopper	items	2	39,547	85,227
2.1.1.9	Landscaping (incl. earthworks)	items	1	63,814	63,814
				Subtotal 2.1.1 Civil Works	**680,498**
2.1.2	**Equipment**				
2.1.2.1	Weighbridge	items	1	28,000	28,000
2.1.2.2	Skid Steer Loader	items	1	30,000	30,000
2.1.2.3	Oil separator	items	1	20,450	20,450
2.1.2.4	Skip	items	1	1,550	1,550
				Subtotal 2.1.2. Equipment	**80,000**
2.1.3.	**Mobile Equipement**				
2.1.3.1	Truck with hook lift	items	1	133,119	133,119
2.1.3.2	Press containers 24 m3 (for mixed waste)	items	3	23,375	70,125
2.1.3.3	Press containers 24 m3 (for recyclable waste)	items	2	23,375	46,750
2.1.3.4	Containers 24 m3 (for green waste)	items	1	7,586	7,586
				Subtotal 2.1.3. Mobile Equipement	**257,580**
				Subtotal 2.1. TS Struga	**1,018,078**
2.2	**TS Debar**				
2.2.1.1	Fence	m	605	51	30,849
2.2.1.2	Entrance gate	items	1	1,268	1,268
2.2.1.3	Plateau and roads (incl flood works)	sqm	4340	50	216,024
2.2.1.4	Administration building	sqm	60	500	30,000
2.2.1.5	Water supply	items	1	11,476	11,476
2.2.1.6	Sewerage system	items	1	4,825	4,825
2.2.1.7	Electrical instrallations (lighthing, electricity, phone, fire fighting)	items	1	98,557	98,557
2.2.1.8	Hopper	items	2	37,074	74,147
2.2.1.9	Landscaping (incl. earthworks)	items	1	30,847	30,847
				Subtotal 2.3.1 Civil Works	**497,993**
2.2.2	**Equipment**				
2.2.2.1	Weighbridge	item	1	28,000	28,000
2.2.2.2	Skid Steer Loader	item	1	30,000	30,000
2.2.2.3	Oil separator	item	1	20,450	20,450

No	Item	Unit	Quantities	Unit Cost (€)	Cost (€)
2.2.2.4	Skip	item	1	1,550	1,550
				Subtotal 2.2.2 Equipment	**80,000**
2.2.3	**Mobile Equipement**				
2.2.3.1	Truck with hook lift	items	2	133,119	266,238
2.2.3.2	Press containers 24 m3 (for mixed waste)	items	3	23,375	70,125
2.2.3.3	Press containers 24 m3 (for recyclable waste)	items	2	23,375	46,750
2.2.3.4	Containers 24 m3 (for green waste)	items	1	7,586	7,586
				Subtotal 2.2.3.1. Mobile Equipement	**390,699**
				Subtotal 2.2. TS Debar	**968,692**
2.3	**TS Kichevo**				
2.3.1	**Civil works**				
2.3.1.1	Fence	m	677	51	34,522
2.3.1.2	Entrance gate	items	1	1,268	1,268
2.3.1.3	Plateau and roads (incl flood works)	sqm	4315	70	300,575
2.3.1.4	Administration building	sqm	60	500	30,000
2.3.1.5	Water supply	items	1	8,459	8,459
2.3.1.6	Sewerage system	items	1	4,825	4,825
2.3.1.7	Electrical instrallations (lighthing, electricity, phone, fire fighting)	items	1	115,525	115,525
2.3.1.8	Hopper	items	2	40,917	81,834
2.3.1.9	Landscaping (incl earthworks)	items	1	38,468	38,468
				Subtotal 2.3.1 Civil Works	**615,476**
2.3.2	**Equipment**				
2.3.2.1	Weighbridge	items	1	28,000	28,000
2.3.2.2	Skid Steer Loader	items	1	30,000	30,000
2.3.2.3	Oil separator	items	1	20,450	20,450
2.3.2.4	Skip	items	1	1,550	1,550
				Subtotal 2.3.2 Equipment	**80,000**
2.3.3	**Mobile Equipement**				
2.3.3.1	Truck with hook lift	items	2	133,119	266,238
2.3.3.2	Press containers 24 m3 (for mixed waste)	items	4	23,375	93,500
2.3.3.3	Press containers 24 m3 (for recyclable waste)	items	2	23,375	46,750
2.3.3.4	Containers 24 m3 (for green waste)	items	1	7,586	7,586
				Subtotal 2.2.3.1. Mobile Equipement	**414,074**
				Subtotal 2.3. TS Kichevo	**1,109,550**
2.4	**TS Ohrid**				
2.4.1	**Civil works**				
2.4.1.1	Fence	m	661	51	33,716
2.4.1.2	Entrance gate	items	1	1,268	1,268
2.4.1.3	Plateau and roads (incl flood works)	sqm	4920	70	342,243
2.4.1.4	Administration building	sqm	60	500	30,000
2.4.1.5	Water supply	items	1	9,401	9,401
2.4.1.6	Sewerage system	items	1	4,825	4,825
2.4.1.7	Electrical instrallations (lighthing, electricity, phone, fire fighting)	items	1	111,369	111,369
2.4.1.8	Hopper	items	2	32,955	65,911
2.4.1.9	Landscaping (incl earthworks)	items	1	98,399	98,399
				Subtotal 2.4.1 Civil Works	**697,132**
2.4.2	**Equipment**				

No	Item	Unit	Quantities	Unit Cost (€)	Cost (€)
2.4.2.1	Weighbridge	items	1	28,000	28,000
2.4.2.2	Skid Steer Loader	items	1	30,000	30,000
2.4.2.3	Oil separator	items	1	20,450	20,450
2.4.2.4	Skip	items	1	1,550	1,550
	Subtotal 2.4.2 Equipment				**80,000**
2.4.3	**Mobile Equipement**				
2.4.3.1	Truck with hook lift	items	2	133,119	266,238
2.4.3.2	Press containers 24 m3 (for mixed waste)	items	5	23,375	116,875
2.4.3.3	Press containers 24 m3 (for recyclable waste)	items	3	23,375	70,125
2.4.3.4	Containers 24 m3 (for green waste)	items	2	7,586	15,172
	Subtotal 2.4.3.1. Mobile Equipement				**468,410**
	Subtotal2.4. TS Ohrid				**1,245,542**
	TOTAL				**4,341,862**

Note: The investment cost of TSs include cost for trial operation

The operational cost for each one of the TSs is presented in the following table.

Table 7-76: Total operational cost for TSs.

Transfer Stations	Residual Waste (t/y)	Recyclables (t/y)	Green waste (t/y)	Total Waste (t/y)	Unit Cost (€/t)	Total Cost (€/a)
TS Struga	9,026	3,006	778	12,810	7.72	99,884
TS Debar	5,758	1,917	496	8,172	13.77	113,887
TS Kichevo	10,853	3,614	935	15,402	8.05	126,387
TS Ohrid	15,534	5,172	1,339	22,025	6.49	147,516
			Total	**58,409**	**8.35**	**487,673**

7.3.4. Waste treatment and disposal

7.3.4.1. Operating Cost

The operating cost has been calculated for each waste treatment component: i.e. mechanical sorting plant, biological plant, landfill, infrastructure works.
Within each element the cost is divided in fixed and variable cost in order to achieve a better projection and differentiation of growth rates.

- **Fixed Cost:** The fixed cost comprises labour (worker skilled/unskilled, driver, engineers/chemists/supervisors), maintenance, administrative cost, insurance, control and monitoring. All elements of the total fixed cost are projected flat.
- **Variable cost:** The variable cost evolves mainly with each tone of waste, e.g. fuel cost and energy. Variablecostisassumedtoremainflat.

For the calculation of the operational cost of the various waste management facilities, the following cost categories have been considered:

<u>**Maintenance costs**</u>**:** The annual maintenance cost for all facilities is calculated based on a certain percentage of the investment cost, which is assumed:

- 4% for mechanical sorting and biological treatment
- 1.5% for landfill and

- 1% for infrastructure

Labour cost: The labour costs have been calculated based on typical salaries for different staff categories, including in the various insurances, taxes, employers' contribution, etc.

Table 7-77: Assumption for labour cost

CATEGORY	Mechanical Treatment	Biological Treatment	Landfill	Infrastructure Works
WORKER UNSKILLED	30	3	1	1
WORKER SKILLED	7	5	3	-
ENGINEERS/ CHEMISTS/ SUPERVISORS	2	1	-	-

Energy – Fuel: Electricity and fuel is needed for the operation of the mechanical separation, biological treatment, the landfills, as well as for the infrastructure facilities. The unit consumption factors have been adopted by the Consultant's experience from supervision of similar facilities and projects.

Table 7-78: Assumption for Fuel & Energy consumptions

	Energy (KWh/t) @ 0.140 EUR/KWh	Fuel (l/t) @ (0.856EUR/l)
Mechanical treatment	30,00	3,00
Anaerobic Digestion	50,00	0.1
Biostabiliasation	10	1
Windrow composting	5	5
Landfill	15,00	5,00
Infrastructureworks	80.000 kWh/year	5.000 l/year

The cost of kWh was taken equal to 0.140€ (Source of data: Eurostat). The cost of diesel fuel was taken equal to 0,856 € per litre (Source of data: Europe Portal Energy https://www.energy.eu/fuelprices/).

Monitoring: Forthe necessary environmental monitoring (noise, dust, odours etc) at work/ perimeter of the site and ensuring product quality are adopted.

Aftercare/Insurance: The aftercare/insurance cost has been calculated as a percentage of the investment cost, i.e. 0.70% of investment cost.

Cost for transportation and disposal of RDF: The respective transportation cost for RDF at a suitable cement industry has been calculated, where a typical distance of 170km was adopted. The costs of RFD transport and disposal was estimated equal to 22.6€/t.

The average operating cost from operation during the period 2021-2046, is presented in the following table:

Table 7-79: Average Annual Operating Cost for period 2021-2046

OPERATING COST	(Average 2021-2046) (€/year)	(Average 2021-2046) (€/t)
Mechanical Treatment of Residual Waste Bin	874,918	21.0
Mechanical Treatment of Recyclable Waste Bin	213,668	15.4
Biological Treatment	520,022	21.8
Windrow Composting of Green Waste	57,451	16.0
Landfill	227,231	13.8
Infrastructure works	49,902	1.2
Other operating costs (transportation & disposal cost of RDF)	188,683	22.6
Total Operating Cost, EUR	**2,131,874**	**51.2**

The figure shows the estimated operating cost of each unit, in EUR.

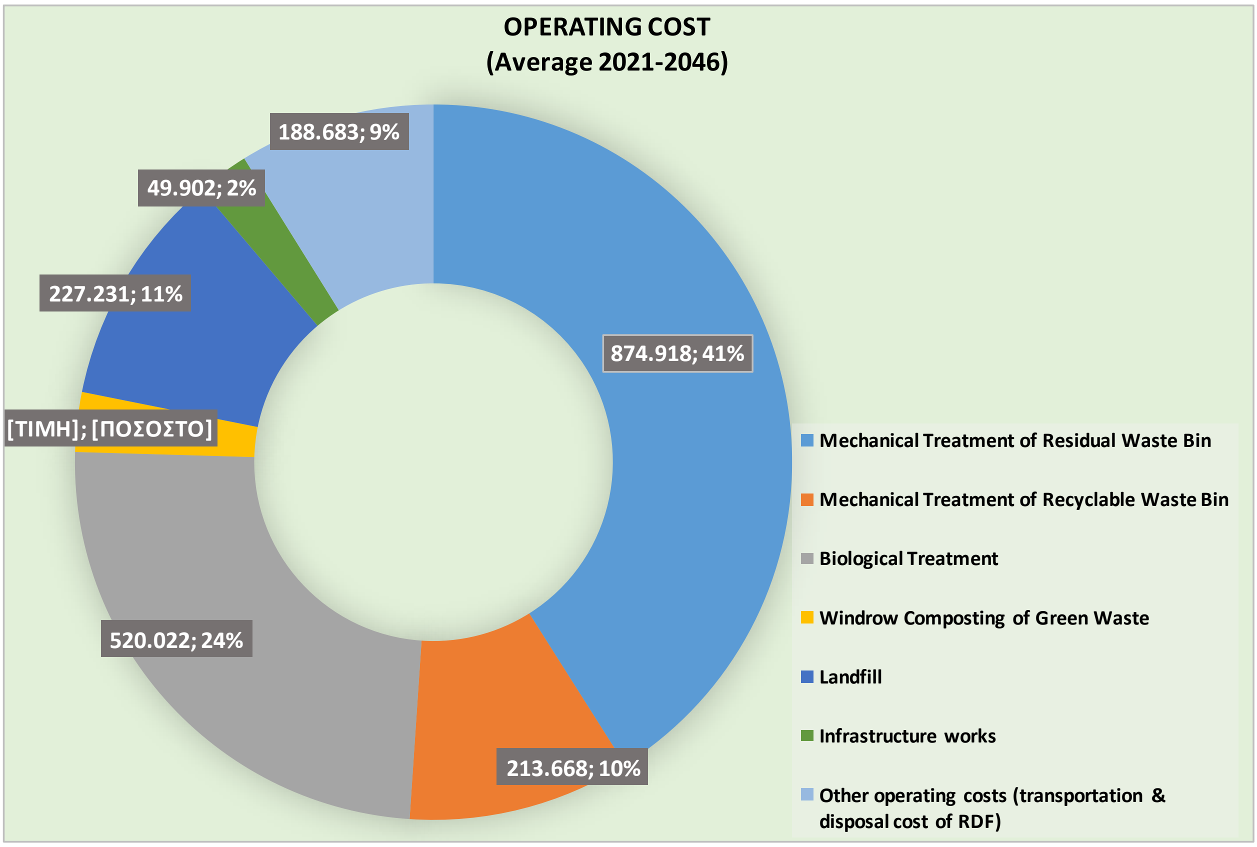


Figure 7-83: Average Operating Cost of each treatment unit

7.3.4.2. Revenues

As for REVENUES, the following operational sources have been predicted which are the “revenues from the proposed tariffs”, the revenues of “recyclables sales” from MBT and from source separated recyclables and the revenues from energy.

Revenues from Recyclables, Compost and Energy

The revenues of “recyclables sales” from MBT took into account the market values of the recyclables as well the cross contaminations of recyclables resulting in lower quality since there are recovered from mixed municipal waste. Thus, the market values of recyclables that they have been used at the following calculations are shown in the following table:

Table 7-80: Market value of recyclables

Sell prices for recyclables and products	Price
Al	600 €/t
Fe	140 €/t
Plastics	50 €/t
Paper/Cardboard	15€/t
Glass	2 €/t

The revenues of “recyclables sales” from source separated recyclables took into account the average market values of the recyclables. Thus, the market values of recyclables that they have been used at the following calculations are shown in the following table:

Table 7-81: Market value of recyclables

Sell prices for recyclables and products	Price
Al	600 €/t
Fe	140 €/t
Plastics	100 €/t
Paper/Cardboard	30 €/t
Glass	2 €/t

The produced electricity from anaerobic digestion will cover a part of the energy needs of the plant. The surplus electricity will be fed to the grid. The energy balance is shown in the table below.

Table 7-82: Energy Balance

Electrical consumption	kWh/year (Average 2021-2046)
Mechanical Separation for residual waste bin	1.250.033
Biological treatment	1.432.218
Landfill for residues	82.179
Infrastructure works	80.000
Mechanical Separation for recyclables waste bin	416.222
Windrow Composting	17.955
Total consumption	3.278.608
E_{el} from Anaerobic Digestion	**4.988.892**
Surplus of E_{el}	**1.710.284**

The price of electricity for the anaerobic digestion is 0.180 €/kWh for 15 years according to the National legislation (Office Gazette no 56 of 17-04-2013) and for the rest years equal to 0.07€/KWh (source: EUROSTA data).

Moreover due to the fact that collection and recycling of packaging waste will be covered by the producers (Producers' responsibility), the collective schemes will be subsidize the cost for the collection and recovery of packaging waste. The revenues from collective schemes is assumed equal to 20€/ t.

Revenues from proposed tariffs

In devising the future tariff in the service area, the principles for setting user charges (tariffs) for solid waste management services need to be taken into account, including: polluter pays principle full cost recovery and affordability issues.

Polluter pays principle
Foremost among the principles for setting user charges for solid waste management services is adherence to the polluter pays principle (PPP). According to PPP, the generators of the waste (polluters) should pay the costs of waste collection, transportation and treatment and disposal.Full implementation of the PPP means that the user charges are based on all the MSW management costs. The financial calculations in this feasibility study / CBA assume that PPP is implemented, but in a phase-wise manner in the initial years considering the affordability of households.

Full-cost recovery
The principle of full-cost recovery holds that waste tariffs should cover the costs of solid waste management, both the collection, transportation and treatment& disposal of waste. Tariffs should recover the total cost of service, including capital and operating cost and maintenance and financing cost. Full cost recovery means that the operating, maintenance and capital costs (depreciation and debt service) need to be included in the calculation of tariffs.

Affordability
Insofar as possible, solid waste tariffs should be affordable for household customers. The concept of affordability refers to the ability of particular consumer groups to pay for a minimum level of a certain service.Up to now in the country there is no national guideline to determine the affordability threshold concerning waste management.

Levelized Unit Cost (LUC)

In order to calculate the full cost recovery tariff the LUC has been calculated. The index of Levelized Unit Cost (LUC) expressed in €/t and calculated by dividing the net present value of the facility's net cost flows over the reference period (including the investment and O&M cost, net of revenues from sale of by-products) by the discounted quantity of waste treated in that same period, using a financial discount rate of 4%. This index is presented in "New Guide to cost – benefit analysis of investment project by European Commission, December 2014".

The following table illustrates the LUC Cost estimation and the related revenues, for selected years, after imposing of an adequate tariff, as mentioned above.

Table 7-83: LUC/DPC Calculation "With project"

LUC/DPC Calculation With Project		**NPV**
Discount rate	4.0%	
Investment Cost Total (reinvestments included)	EUR	**41,134,765**
Operating Cost	EUR	**86,442,443**
Revenues	EUR	28,210,099
Total Cost	EUR	99,367,109
Total Waste input into the system	t/year	840,000
LUC, Investment	EUR/t.	49
LUC, O&M	EUR/t.	103
LUC, net O&M	EUR/t.	69
LUC, Total	EUR/t.	118

<u>Revenues from Tarrifs</u>

The Polluter Pays Principle (PPP) is one of the principles of Community environmental policy and applies throughout the European Union. The simplest way to implement PPP is to introduce **<u>a full cost recovery waste tariff</u>**, which means a tariff high enough to recover the full costs of services provided, including capital and operating costs as well as management and administrative costs of the system. **(i.e. Tariff is equal to LUC)**

However, according to the "Guidance on the methodology for carrying out Cost-Benefit Analysis", *when the affordability of tariffs is considered, stakeholder may artificially cap the level of charges to avoid a disproportionate financing burden for the users, thus ensuring that the service or good is affordable also for the most disadvantaged groups*.

The minimum requirement is that tariffs should at least cover operating and maintenance costs as well as a significant part of the assets' depreciation. An adequate tariff structure should attempt to maximise the project's revenues before public subsidies, while taking affordability into account.

Moreover, according to the "Application of the Polluter Pays Principle (PPP) in Waste Management Projects" of JASPERS Staff Working Papers, August 2011, it has to be considered that where household income levels are generally low or household income is unevenly distributed, residential waste tariffs can be temporarily set below full cost recovery levels.

Taking into account the aforementioned for the present project, the tariffs to the users of the project are proposed to be as follows:

- Commercial users are considered to cover the total Levelized Unit Cost / DPC since the first year.
- Households, will pay prices which in the first years will cover the operating cost. Gradually the price will be increased and about 2043 will cover the Full LUC.

Total Revenues

The prices assumed constant during the analysis period in the level of 2017. The following table illustrates the Total Revenues after the completion of the project construction and start of operation.

Table 7-84: Revenues of "With project" scenario, prices in EUROS (constant price in 2017)

Year	Revenues - user fees	Revenues - sale of recyclables	Revenues - Savings due to own consumption & sales of energy	Revenues from Cllection Schemes	Total Revenues
2021	4,267,616	1,073,872	748,045	177,054	6,266,586
2022	4,149,804	1,078,343	751,392	177,775	6,157,313
2023	4,238,436	1,082,997	754,868	178,525	6,254,826
2024	4,330,183	1,087,842	758,479	179,307	6,355,811
2025	4,425,186	1,092,887	762,232	180,122	6,460,428
2026	4,519,971	1,097,182	765,558	180,806	6,563,516
2027	4,618,318	1,101,726	769,059	181,530	6,670,633
2028	4,720,397	1,106,530	772,744	182,298	6,781,969
2029	4,826,392	1,111,606	776,622	183,110	6,897,729
2030	4,936,497	1,116,966	780,700	183,969	7,018,132
2031	5,016,391	1,114,918	779,616	183,605	7,094,530
2032	5,098,490	1,112,947	778,582	183,254	7,173,274
2033	5,182,851	1,111,051	777,598	182,915	7,254,415
2034	5,269,530	1,109,229	776,663	182,589	7,338,012
2035	5,358,587	1,107,480	775,777	182,275	7,424,120
2036	5,443,577	1,104,485	583,988	181,756	7,313,806
2037	5,530,851	1,101,566	582,684	181,251	7,396,352
2038	5,620,465	1,098,722	581,417	180,758	7,481,362
2039	5,712,476	1,095,953	580,186	180,277	7,568,892
2040	5,806,941	1,093,257	578,992	179,809	7,658,999
2041	5,897,841	1,089,509	577,243	179,168	7,743,760
2042	5,991,122	1,085,838	575,532	178,540	7,831,031
2043	6,086,840	1,082,244	573,858	177,925	7,920,867
2044	6,906,151	1,078,725	572,220	177,322	8,734,419
2045	6,885,756	1,075,280	570,619	176,733	8,708,388
2046	6,860,018	1,071,005	568,578	176,006	8,675,608

The figure shows the estimated revenues, in EUR/y.

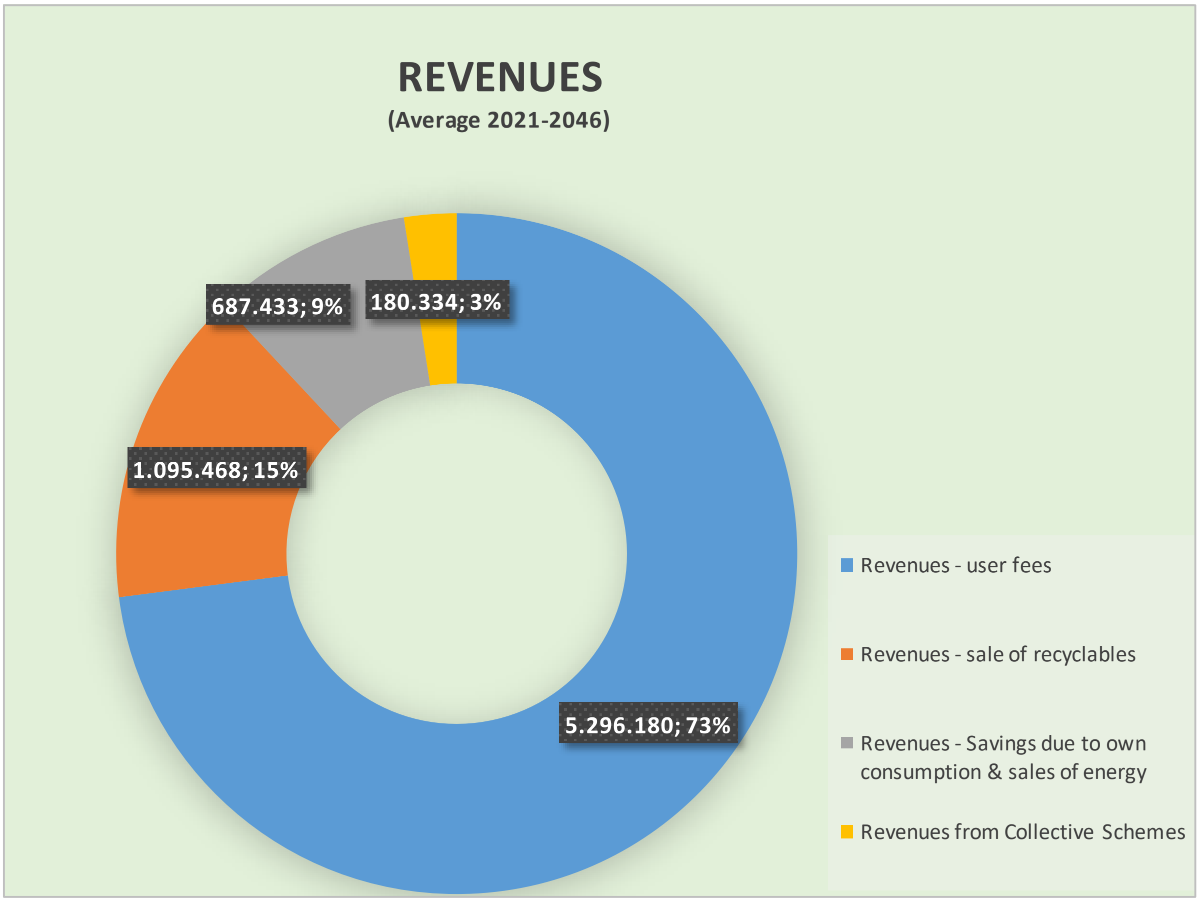


Figure 7-84: Average Revenues

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

8. ENVIRONMENTAL AND SOCIAL ASSESSMENT

8.1 SECTOR LEGISLATION (SEA, EIA) - IMPLEMENTATION OF EIA PROCESS

8.1.1 Sector legislation (SEA, EIA)

SEA is a planning tool designed to ensure that environmental consequences from the implementation of the planning documents (strategies, plans and programmes), and the decisions included within are identified and assessed during planning documents preparation and before plan adoption. SEA improves the information basis for planning, because it gives insight into possible consequences, as well as identifying alternative options and measures that can avoid negative impacts. SEA provides a framework for public debate on the possible approaches in the development of the plan, likely consequences from each alternative and creates legal obligation for the results from the assessment and the debate to be included in the adoption of the plan.

The SEA procedure is prescribed in the Law on Environment (LE) ("Official Gazette of the Republic of Macedonia" No. 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/13, 44/15 and 39/2016) Chapter X – Assessment of the effects of certain strategies, plans and programmes on the environment. Pursuant to Article 65, Paragraph 2 of the LE, when it comes to PDs in the waste management area, the implementation of strategic environmental impact assessment, including impact on human health (strategic assessment) is compulsory.

In addition, the SEA procedure is regulated in a number of bylaws, such as:

1. Ordinance on the criteria on the basis of which the decision as to whether a given planning document is likely to have a significant effect on the environment and human health shall be issued ("Official Gazette of the Republic of Macedonia" No. 144/07);
2. Ordinance on the strategies, plans and programmes, including amendments to such strategies, plans and programmes, that are subject to a mandatory procedure for assessment of their impact on the environment and human health ("Official Gazette of the Republic of Macedonia "No. 153/07 and 45/11);
3. Ordinance on the content of the report on the strategic environmental assessment ("Official Gazette of the Republic of Macedonia "No. 153/07);
4. Ordinance on the public participation in the process of preparation of environmental regulations and other acts as well as environmental plans and programmes ("Official Gazette of the Republic of Macedonia "No. 147/08 and 45/11);
5. Rulebook on the format, contents and form of the decision for implementation or non-implementation of strategic assessment and the form for the need for implementation or non-implementation of strategic assessment ("Official Gazette of the Republic of Macedonia "No.122/11);
6. Rulebook on the manner of carrying out cross-border consultations ("Official Gazette of the Republic of Macedonia "No. 110/10);

Other laws and bylaws related to waste management and relevant for development of SEA are:

- Rulebook on the quantity of biodegradable ingredients in the waste that is allowed to be disposed ("Official Gazette of the Republic of Macedonia "No. 108/09);
- Rulebook on the general rules on handling the municipal and other types of non-hazardous waste ("Official Gazette of the Republic of Macedonia "No.147/07);
- List of waste types ("Official Gazette of the Republic of Macedonia "No. 100/05);
- Rulebook on the manner and requirements for functioning of integrated waste disposal network ("Official Gazette of the Republic of Macedonia "No. 7/06);
- Rulebook on the manner and conditions for waste storing, including requirements that must be met by the sites where waste is being stored ("Official Gazette of the Republic of Macedonia "No. 29/07);

- Law on Waters ("Official Gazette of the Republic of Macedonia" No. 87/08, 6/09, 161/09, 83/10, 51/11, 44/12, 23/13, 163/13, 52/16);
- Law on Ambient Air Quality ("Official Gazette of the Republic of Macedonia "No. 67/04, 92/07, 35/10, 47/11, 100/12, 163/13);
- Law on Nature Protection ("Official Gazette of the Republic of Macedonia "No. 67/04, 14/06, 84/07, 35/10, 47/11, 148/11, 59/12, 13/13, 163/13, 63/16);
- Law on Environmental Noise Protection ("Official Gazette of the Republic of Macedonia "No. 79/07, 163/13).
- Law on Management with Packaging and Packaging Waste (Official Gazette of the Republic of Macedonia No.161/09, 17/11, 47/11, 136/11, 39/12, 163/13, 146/15)
- Law on Management with Batteries and Accumulators, and Waste Batteries and Accumulators (Official Gazette of the Republic of Macedonia No.140/10, 47/11, 148/11, 39/12, 163/13, 146/15); and
- Law on Management with Electrical and Electronic Equipment and Waste Electrical and Electronic Equipment (Official Gazette of the Republic of Macedonia No.06/12, 163/13, 146/15)

In addition to the current national legal instruments regulating the SEA issue, also used in the development of this Report were the recommendations from the Directive for Strategic Environmental Assessment (2001/42/EC), including models, recommendations, positive experiences and methodologies in this area by EU member states.

The beneficiary country has developed an integral system for implementing EIA system. Namely, the Law on Environment (Official Gazette of the Republic of Macedonia no. 53/05, 81/05, 24/07, 159/08, 83/09, 48/10 and 124/10) in its Chapters X and XI stipulates the procedure for implementation in general terms (all stages of the EIA/SEA processes).

EIA procedure is regulated in detail in the following subsidiary legislation and based on Article 77 of this Law, the ministry adopted the following bylaws:

- **Regulation** on the format and content of the application because of failure to take a decision to approve or reject the project implementation "Official Gazette" no. 130/11.
- **Regulation** on the format and content of the application because of failure to take a decision approving or which does not approve the elaborate "Official Gazette" no. 130/11.
- **Rules** on the types and amount of the costs for conducting the assessment of the impact of the project on the environment that the Investor "Official Gazette" no. 116/09.
- **Decree** amending the Decree on determining projects and the criteria on the basis of which the need for conducting the assessment of environmental impact "Official Gazette" no. 109/09.
- **Decree** on the activities that must be developed elaborate and it is approved by a competent authority for practicing professionals working in the field of environment "Official Gazette" no. 80/09.
- **Decree** on the activities that must be prepared to investigate and is approved by the competent mayor, the mayor of the City of Skopje and the mayors of the municipalities in the City of Skopje "Official Gazette" no. 80/09.
- **Rulebook** on the form and content of the study on environmental protection, the procedure for their approval, and the manner of keeping the register of approved reports "Official Gazette" no. 50/09.
- **Rules** on the composition of the commission and the manner of its work program and manner of taking the exam, the fee for taking the exam fee and to establish and maintain the list of experts and the manner of acquiring and losing the status of expert to assess the impact of the project on the environment, as well as the manner and procedure for inclusion and exclusion from the list of experts "Official Gazette" no. 93/07.
- **Rules** for the content of the report on the environmental situation "Official Gazette" no. 35/06.
- **Rules** on the information contained in the notification of the intention to carry out a project and the procedure for determining the need for assessment of the project's impact on the environment "Official Gazette" no. 33/06.

- **Rules** for the content of the requirements to be fulfilled by the study to assess the impact of the project on environment "Official Gazette" no. 33/06.
- **Rules** on the form, content, procedure and manner of preparation of the report on the adequacy of assessment study of the project on the environment, and the procedure for authorization of persons from the list of experts to assess the impact on the environment, to prepare the report "Official Gazette" no. 33/06.
- **Rules** for the content of the publication of the notice of intention to implement the project, the decision about the need to assess the impact of the project on the environment, the study to assess the impact of the project on the environment, the report on the adequacy of the assessment study the impact of the project on the environment and the decision granting approval or rejection for the project, and the way of public consultation "Official Gazette" no. 33/06.
- **Regulations** on the amount of the costs for conducting impact assessment of the project on the environment, which reimburses developer "Official Gazette" no. 33/06.
- **Decree** determining the projects and criteria on the basis of which the need for conducting the assessment of environmental impact "Official Gazette" no. 74/05.

Apart from the above, there are also other primary relevant legal acts and laws in accordance with the Law on Environment:
- Law on environment (Official Gazette of the Republic of Macedonia no. 53/05)
- Law on Nature Protection (Official Gazette of the Republic of Macedonia no. 67/2004)
- Law on Waste Management (Official Gazette of the Republic of Macedonia no. 68/2004)
- Law on Ambient Air Quality (Official Gazette of the Republic of Macedonia no. 67/2004)
- Law on environmental noise (Official Gazette of the Republic of Macedonia no. 79/07)

8.1.2 Implementation of EIA process

The construction of the Regional Waste Management Centre in Southwest region is proposed to be constructed at the site G2 near settlements of Godivje and Laktinje and administratively belongs to Municipality of Debartsa. An Environmental Impact Assessment Study for the Integrated Waste Management System in Southwest Region is planning to be conducted according to the national and EU legislation for EIA study.

The authorized person shall submit the EIA report to the MoEPP in written form. The MoEPP shall, within 5 days from the receipt of the EIA report, submit the EIA report to the competent ministries, and to the LSG unit on the territory of which the project would be realized and publish the report within 5 days. The minister of environment shall prescribe the content of the EIA report with by –law. The MoEPP shall issue a decision on approval or refusal of the application for realization of the project within 40 days from the publication of the EIA report. The MoEPP shall, within 45 days from the publication of the EIA report, submit the decision to the investor, competent ministries, and to the LSG unit on the territory of which the project would be realized. The decision shall be made available to the public within 5 days from the date of its issuance. The decision shall have a legal effect for a period of two years with an extension option, provided that no significant changes have occurred during the realization of the project regarding the conditions of the area affected, new information related to the main content of the EIA study and development of new technology that may be used in the project.
The MoEPP is obliged to:

1. Publish the notification in two national daily newspapers and on the MoEPP web site
2. Publish the decision regarding the need for EIA in two national daily newspapers, on the MoEPP web site, as well as in a MoEPP notice board
3. Announce that the EIA study is prepared and available to the public in two national daily newspapers etc.
4. Publish the EIA report in two national daily newspapers and on the MoEPP web site.

5. Publish the decision on granting approval or refusal of the project realization in two national daily newspapers, on the MoEPP web site, as well as on a MoEPP notice board
6. Announce the time and the place of the public hearing in two national daily newspapers etc.

The MoEPP shall organize a public hearing at least 5 days before the expiry of the deadline for the submission on opinions on the EIA report and ensure availability of information needed to the public participation in the public hearing, as well as provide participation of NGOs. The MoEPP may postpone the public hearing unless the Investor, the person who prepared the study and the EIA report do not participate, and in that case it is obliged to set a new date which will be at least 5 days after the day on which the public hearing was discontinued.

8.2 BASELINE ASSESSMENT – ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

8.2.1 Introduction

In Southwest region, there are 33 protected areas of nature. The designated area Pesochanska Reka is the closest designated area to G2 site in a distance of approx. 4.2km W of the site and the emerald area "Belchishko Blato" with code MK0000014 is the closest emerald area in a distance of approx. 7.5km S of the site.

Therefore, the Waste Management Centre will not pose an environmental threat to the protected area. The location of the Region's CWMF is not in the area of cultural and historical heritage.

The main environmental data taking into consideration for the EIA Study for the site G2 – Debartsa municipality are presented at the following paragraphs.

Four Transfer Stations (TS) will be established in Southwest region:

- in Struga municipality near settlement of Struga. The closest Emerald site is "Ohridsko Ezero" (MK0000024) in a direct distance of approx 2 km south of the proposed site.
- in Kichevo municipality (in a distance of approx. 0.3km from Oslomej settlement. The closest Emerald site is Mavrovo site (MK0000007) in a direct distance of approx 15 km.
- in Debar municipality near settlement of Debar. The closest Emerald site is "Mavrovo" (MK0000007) in a direct distance of approx 5.6 km northeast of the proposed site.
- In Ohrid municipality northwest of Ohrid settlement. The closest Emerald site is "Ohrid lake" (MK0000024) in a direct distance of approx. 1 km southwest of the proposed site

Figure 8-1: Location of the CWMF in G2 site, Debartsa municipality

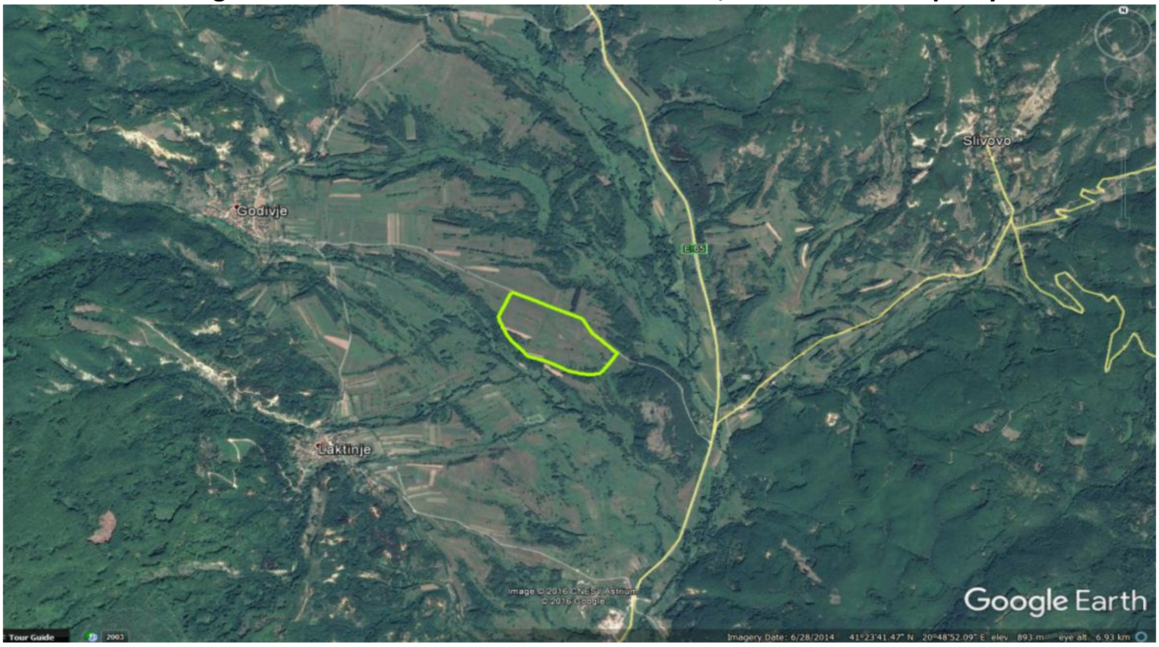


Figure 8-2: Location of TS in Debar Municipality

Figure 8-3: Location of TS in Kichevo municipality

Figure 8-4: Location of TS in Struga municipality

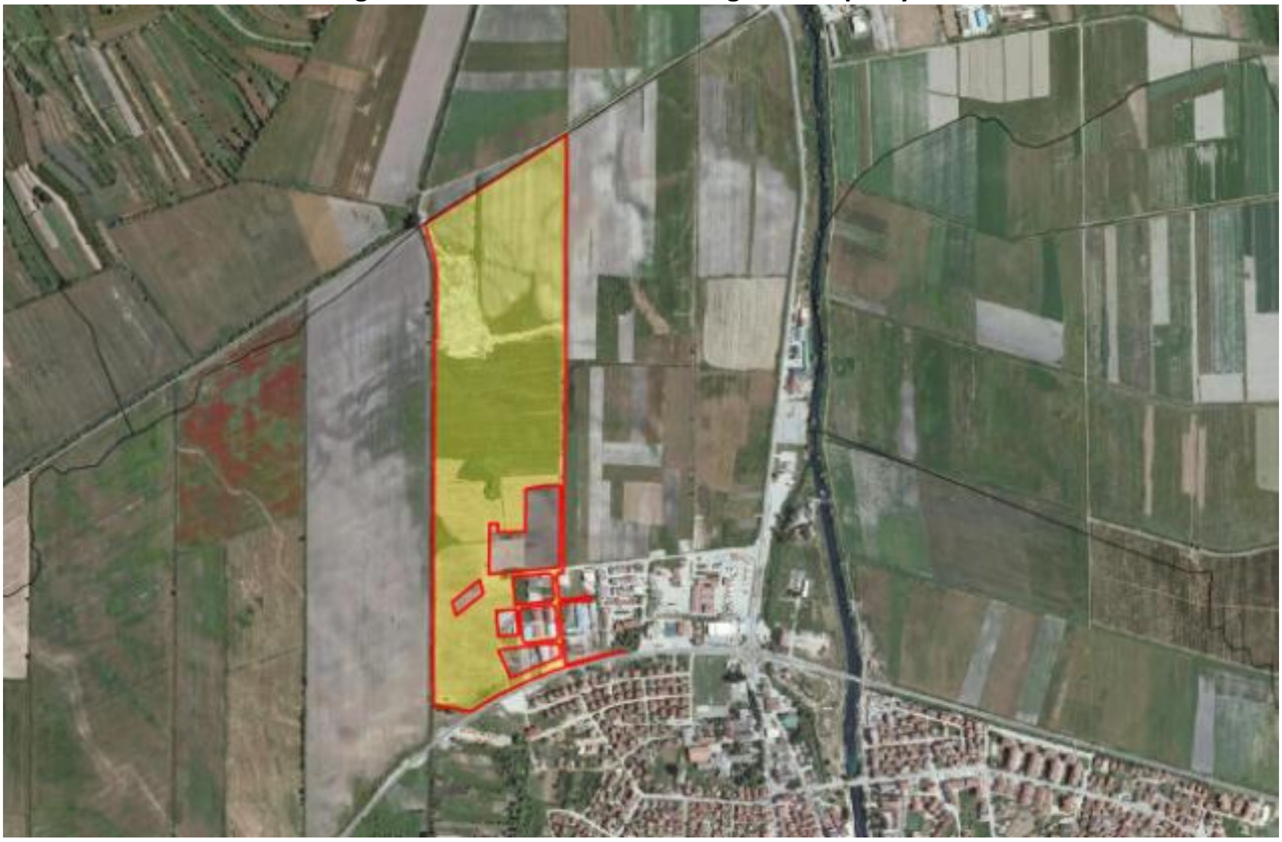
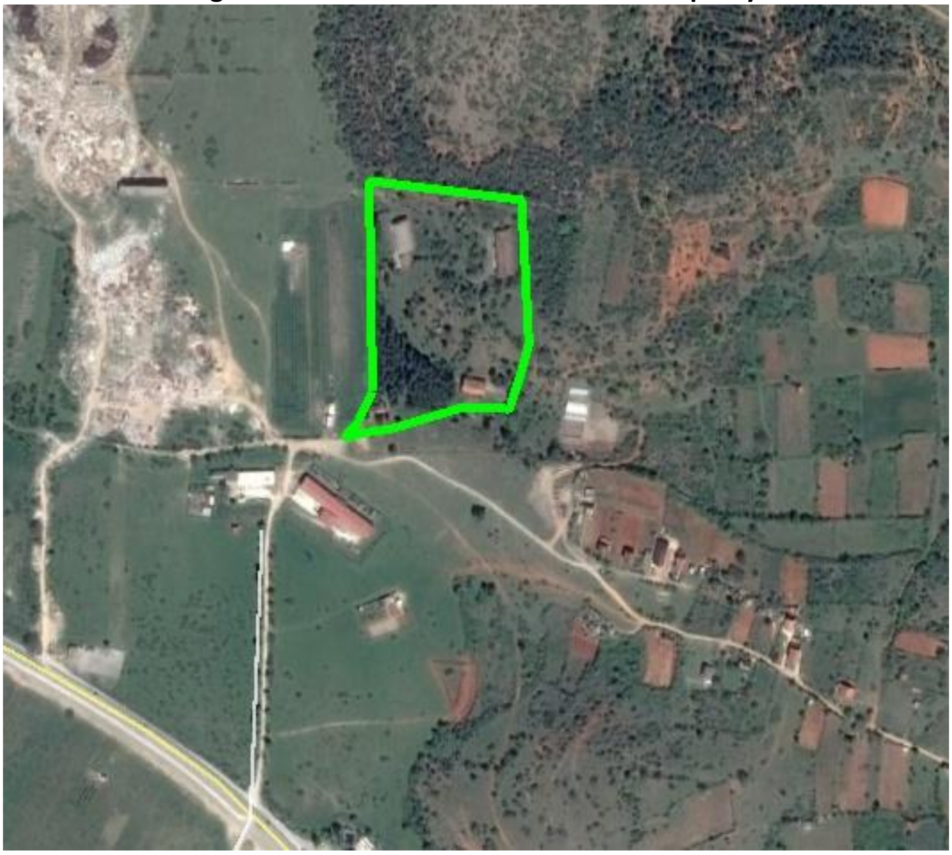


Figure 8-5: Location of TS in Ohrid municipality



8.2.2 Climate and meteorological data

As a continental country, the most important climatic factors in the Republic of Macedonia consist of the geographical position, relief, proximity to the surrounding seas and atmospheric currents.

Republic of Macedonia lies in the temperate heat zone and is closer to the equator than to the North Pole. So there is enough heat for the development of flora and fauna in the majority of the year. Due the geographic location, a four seasons are clearly expressed. Summer lasts from June 22 to September 23, and winter from 22 December to 21 March.

The Proximity of the Aegean Sea of just 60km and the Adriatic Sea of 80km, have a profound effect on the climate characteristics in the Republic of Macedonia. This is especially evident in the valley of the Vardar and Strumica Rivers, where hot and humid air masses penetrate form the sea side.
Relief with his height and direction of extension has a significant impact on the local climate. High mountains in the western and southern part of the Republic of Macedonia prevent hot and humid marine influences to penetrate deeper inside the continental part. Their penetration is only possible through the valleys of the Vardar, Strumica and Drim Rivers. On the other hand, moderate mountains and broad valleys in the north, allow infiltration of cold air masses from the north. Therefore, even in winter, the southern parts of the country could have very low temperatures. Besides mountains, climate is significantly influence with valleys disposition. Some of the valleys are surrounded by mountains on all sides and in the winter low parts can be very cold. Some valleys are filled with the lakes that do not allow the surrounding air to heat much in the summer or to cool much in winter.

Temperate continental climate with quite weak Mediterranean influences stretches along the valley of the Vardar, Demir Kapija on south, to Skopje and Kumanovo in the north, then along Bregalnitsa to the east of Kocani and along the river Crna and Mariovo to the west. Here, winter ice is more common.
Climate in Debartsa is sharper variant of moderate continental climate due to the considerable altitude (mountain air).

The project team requested and gathered hydrometeorological data from the Ministry of Agriculture, Forestry and Water Management of the beneficiary country. According to the data from precipitation and meteorological stations in proximity of the site, the following have been established:

	Jan	Feb	March	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Average monthly temperature (°C)	1.6	2.6	7.1	11.8	15.9	19.6	22.1	22.0	17.1	12.1	7.0	2.5
Average monthly precipitation (mm)	105.0	104.7	89.0	78.4	79.4	51.6	45.4	29.0	75.5	117.9	118.4	128.8

The data were provided from the stations located in the municipality of Kichevo and refer to the years 2003 – 2014. According to the data, the average annual temperature is 11.8 °C, the lowest temperature was -1.7 °C recorded in February of 2003, and the highest was 24.7 °C recorded in July of 2012.

Regarding precipitation, for a of 20 year period (1997-2016), the average annual precipitation is 85.3 mm, the lowest was 0.0 mm recorded in August of 2000, and the highest was 302.5 mm recorded in December of 2005.

8.2.3 Geological, Hydrogeological, Seismotectonic and Geotechnical characteristics of the site

8.2.3.1 Geological characteristics

Southwest region belongs to West area of the geotectonic unit which is characterized with its own specific lithological composition, tectonic structure and degree of metamorphism.

In general the following rock formations are presented to the area:

- **Paleozoic,** represented by *Phylite schists (Sqse)*, *Meta - sandstones and meta - conglomerates (Sq)*: Meta - sandstones are almost the most present lithological member, *Phylitoide (FD)*: In this group are included mainly phylite, and less present are slates, sandstones, sericite - quartz schists etc., *Conglomerates and sandstones (D)*: Conglomerates are built of pieces of quartz, meta - sandstones, meta - quartzites and small grains of potassium feldspars and plagioclases, *Marble series (MD)*: In this series are present several types of marbles: plated, massive, and dolomite marbles, and finally *Metamorphosed diabase and spilite (ββ)*.
- **Mesozoic**, built by *Triassic sediments* ($T_2^{1,2}$), *Triassic sediments* ($T_{2,3}$) and *Upper Cretaceous sediments* ($K_2^{2,3}$).
- **Cenozoic,** represented by *Pliocene* ($Pl_{2,3}$): Pliocene sediments are developed on large area within the Prespa, Ohrid, Piskupshtina and Debarca basin and partially are covered with Quaternary sediments.
- **Quartenary** consists of *Moraine sediments (gl)*, *Terra Rosa (ts)*: It is developed in karstified areas with Triassic limestones. Developed is on Galicica and Petrina, *Proluvium (pr)*, *Slope breccia and Alluvium (a)*.

The geological composition of the area of the Municipality of Debarca is real mosaic of different rocks from different age, from Palaeozoic to Quaternary. According to data from BGM (Basic Geological Map) 1 - Kicevo Sheet (scale 1:100 000), study area (“Godivje-G2”) and its immediate vicinity is composed of Pliocene sediments with small thickness and presented with marls, different clay-gravel and sands. Those sediments transgressively cover metamorphic rock from Paleozoic age as well as carbonate rocks of Mesozoic age.

Area planed for landfill (and associated facilities) construction covers 234 807m^2. Entire area was prospected and litologhical units composing the area were determined. Units found are presented at detailed area map.

Area of interests is a flat surface with the presence of a shallow depression in its south– eastern parts.The entire area is composed of Pliocene sediments (usually represented by claysh marls and gravel), but it should be noted that in the south east and south west parts of the area those Pliocene sediments are covered with diluvia materials with undetermined thickness.

Geological prospection in G2 site also includes general determination of site geotechnical characteristics, concluding that:

- Rocks present within the study area, in terms of their hydrogeological function, can be classified as hydrogeological insulators (diluvia sediments composed of dusty clays) and hydrogeological complexes (Pliocene sediments).
- Landslides, rockslides, gully’s and ravines where not determined and terrain can be classified as a stable in natural conditions. Occurrences of active landslides were also not determined.

Analytical description is included in Chapter 7 of the present study.

Regarding Debar municipality where TS Debar will be established, it is built mostly of Cretaceous sediments, located mostly in central parts. Eastern parts include Paleozoic schists and Triassic sediments, while on the west Pliocene and Jurassic rocks (sediments) are found. Quaternary sediments can be found on over the area. According to desktop study and the on site visit, the main geological features of the TS site are thick proluvial sediment built of sandy clays, humus and scattered pieces of flysch sediments.
Regarding Struga municipality where TS Struga will be established, it is mostly built of Paleozoic schists and Triassic sediments, as much as Pliocene and Quaternary sediments. According to desktop study and the on site visit, the study area consists decomposed material including lake - marsh sediments and humus.

Regarding Kichevo municipality where TS Kichevo will be established, it includes large number different soil types, mostly dominated by Chromic luvisol on saprolite, Cambisol and Fluvisol. According to desktop study and the on site visit, the study area is built of Pliocene sediments (sands and clays with lignite series).

Regarding Ohrid municipality where TS Ohrid will be established, it is mostly built of Paleozoic schists and Triassic sediments, as much as Pliocene and Quaternary sediments. According to desktop study and the site visit, terrain of the study area is built of compact and massive limestones of Triassic age and it is located in a sloping area relatively steep towards northeast.

8.2.3.2 Seismotectonic characteristics

The study area is located within the western part of the Republic of Macedonia and belongs to Western Macedonian geotectonic unit.

It should be noted that Debarca ridge was formed in middle Pliocene, when the terrain was covered with intensive radial movements. Faults within the ridge have North - South and East - Westorientation and are filled with Pliocene and Quaternary sediments. Large number of anticline and syncline structures can be noted around the ridge, and most remarkable are;

- Slatinska anticline on southeast,
- Preseka syncline and Vrbjanska anticline on the north, and
- Slavejska anticline on southeast.

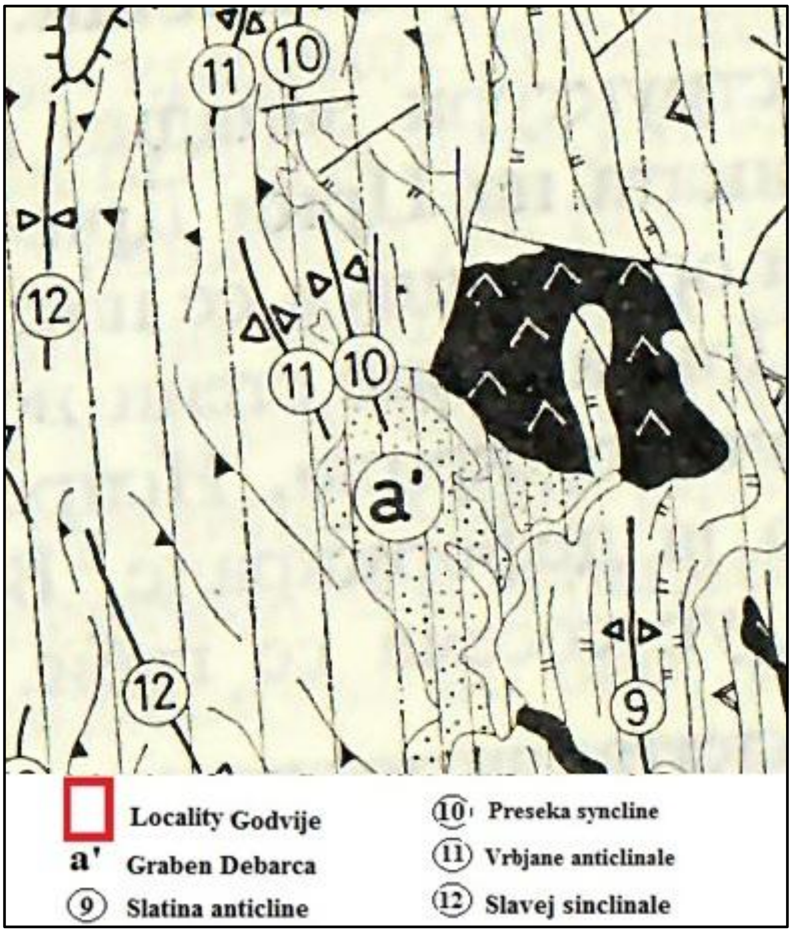


Figure 8-6: Tectonic map of the broader area of the study area

8.2.3.3 Hydrogeology and hydrology

In Southwest region, from hydrogeological point of view, there are terrains with different water permeability. According the geological structure, there are types of wells with free level formed in the environment with inter-grain porosity, i.e. in Quaternary and Pliocene sediments. In the Eocene sediments, materials are hydrogeological complexes with individual layers with a collector and isolation hydrogeological function.

In depth, these rock masses are more compact and have function of hydrogeological collector, and in depth are hydrogeological isolators. As relatively waterless areas, the investigated terrain include slightly bound semi - petrified rock masses represented by Eocene sediments. Within the allocated types of wells, in terms of the groundwater regime (feeding, movement of groundwater, discharge and groundwater level), it can be concluded that, based on the geological structure of the field, a major factor for the formation of wells are persistent and occasional river flows and streams and atmospheric precipitation (rain, snow), which represent the main source of wells nourishment.

In the group of hydrogeological collectors are included proluvial - alluvial formations. Characteristic for them is typical super - capillary porosity. Proluvial sediments, depending of percentage of clay, could be relatively hydrogeological collectors.

In the group of hydrogeological insulators are classified gneisses (Gm) and micaschists (Smg), characterized by tight cracks and almost always are filled with dusty sandy clay. Eocene sediments, flysch series, represent hydrogeological complexes. Vertically changed hydrogeological isolators represented by marls and slates and relatively hydrogeological collectors -sandstones. Generally, they are waterless terrains. The main hydrological occurrence of this area is the river Vardar and its

tributaries. In the dry year period, it is possible their waterways to reduce the flow of water, but not to dried.
This shows that, along the flow of the river Vardar and its tributaries on the terrain, there are characteristic geological pre-conditions for formation of well zone. Namely, it is expected that the wellzone is formed in very wide belt along the flow of the river Vardar. In that part, it is of boundary type, with free level, which is in hydraulic connection with the level of the water in the rivers. According hydrogeological function, represented rock masses (soil materials) represent the most typical hydrogeological complexes and hydrogeological insulators and less to hydrogeological collectors. As hydrogeological collectors appear sandy - gravel sediments. Because of the large presence of hydrogeological complexes and hydrogeological insulators, along the trace, atmospheric precipitations practically, are not infiltrated in the ground, but part of them evaporate, and other part, through the dry ravines, is infiltrated in the river flows, and certain amounts of surface water with the influence of groundwater, formed wet zones, i.e. zones of occasionally flooding of the terrain, as modern geological phenomena and processes that need to undertake appropriate measures for drainage of groundwater.
According to hydrogeological function, the present rock masses (soil materials) represent the most typical hydrogeological complexes composed mostly of hydrogeological insulators. Sandy - gravel sediments appear as only hydrogeological collectors. Because of the large presence of hydrogeological complexes (mostly hydrogeological insulators), along the trace, atmospheric precipitations practically, are not infiltrated in the ground. Part of them evaporates, and other part, through the dry ravines, is infiltrated in the river flows. Certain amounts of surface water with the influence of groundwater, form wet zones, i.e. zones of occasional flooding, as modern geological phenomena that require appropriate drainage measure.
According the structure type of porosity of the rocks that appear, four types of wells are separated:

- Boundary spring;
- Fissure type of wells;
- Karst type of wells;
- Terrains with low yield and waterless terrains.

Boundary springs–are type of wells formed in the rock masses with capillary porosity. Water masses of these wells are compressed, because the pores are directly next to each other and multiply connected. Boundary springs are formed in: diluvial, proluvial, alluvial and lake sediments and river terraces.
Fissure type of wells - are formed within masses with fissure porosity. Water is spread along the cracks as a set of "water veins", which are connected only where cracks crosses. Among the water veins there are waterproof rock masses, i.e. monolites. Fissure types of wells from the catchment area of the Crna river are formed in clastic, igneous and metamorphic rocks with Paleozoic and Mesozoic age.
Karst type of wells - are formed in carbonate rocks and layers. This specific type of wells occurs in terrains with karst porosity (channels and caverns). They can have free level and level under the pressure. Large dimensions of the karst pores, their connection and high level of water permeability make possible fast wells charging and discharge. Karst types of wells are feed directly with infiltration of atmospheric and surface waters along the channels and pores. Karst types of wells have large fluctuation of the groundwater level and large velocity, therefore they can be easily polluted and their natural purification is difficult.
Waterless terrains are presented with Jurassic, Cretaceous and Eocene flysch. Flysch sediments (which, in term of hydrogeology, are waterproof) present waterless terrain, with rare occurrences of fissure springs which are characterized with small yield (0.10 l/s).

Regarding G2 site, Stream Vrbjanska passes 500 m east of the site, and Sateska River flows in vicinity. Sateska River is the largest river in the region and therefore the main drainage artery. There are no wells for groundwater pumping within or near the site considered. The main recipients are relatively large rural settlements (Pesochani and Trebenishte) but the distance along the stream is more than 10 km from the site. There is a highly permeable alluvial environment within the site (a part of Sateska River

alluvium). Terrain is flat and without significant slopes, but due to the central position in the valley it has a large catchment area (over 400ha or $4km^2$).
Hydrogeological conditions within the study area were analyzed in order to determine possibilities for high groundwater levels occurrence within the future regional landfill site, as well as to determine the need for surface and ground waters protection measures. Analysis includes;

- hydrogeological function of rocks,
- types of hydrological - hydrogeological occurrences.

Rock types found within study area, can be classified according to their hydrogeological function as:

- hydrogeological complexes whichinclude Pliocene sediments
- hydrogeological insulators which include diluvia sediments composed of dusty clays

Within the hydrogeological complex, gravelsin Pliocene sediments are typical collectors with inter-granular porosity and they allow infiltration of surface waters to the zone with constant underground water level or layers of clayish marl or clayas typical hydrogeological insulators. Within this complex, boundary springs are formed. Site prospection indicates that gravels are mixed with clay and clayish marl, which make their filtration coefficient significantly lower.

The largest part of the study area is composed of clayish marls or their surface disintegrations. Those formations are hydrogeological insulators with filtration coefficient k = 0.01 – 0.1 m'/day. Also diluvia sediments composed of dusty clays and humus matter can be classified as insulators that prevent rapid infiltration of surface waters. This is supported with notation of small wet area in the lowest parts of the site (south-eastern). This area actually presentthe lowest part of the erosion basin and all atmospheric waters are drained to this zone, but due to low water permeability of the surface, small temporary wetlands are formed.

Regarding Debar Municipality where TS Debar will be established, it includes terrains with karst and fissure types of wells with medium to high yielding. Small parts include wells with high yielding, limestone wells with low yielding and waterless terrains. The most important watercourse within the municipality is the Crn Drim River, but there are many small rivers as tributaries.

Regarding Struga Municiplaity, where TS Struga will be established, it includes mostly terrains with karst and fissure types of wells with medium to high yielding and around Crn Drim flow wells with high yielding. Also, there are limestone terrains with wells with low yielding and waterless terrains.

Regarding Kichevo Municiplaity, where TS Kichevo will be established, it includes terrains with karst and fissure types of wells with medium to high yielding. Along the watercourses, wells with high yielding are found. About 20 % of the area are limestone terrains with wells with low yielding and only about 5 % are waterless terrains. Municipality of Kichevo belongs to the upper catchment area of Treska River, so together with Zajaska River they are the biggest water flows in the area.

Regarding Ohrid Municiplaity, where TS Ohrid will be established, it i includes terrains with karst and fissure types of wells with medium to high yielding and small parts include wells with high yielding. The other part of the area includes terrains with limestone wells with low yielding (yellow color) and about 10% are waterless terrains. The catchment area of the Ohrid Lake has over 40 rivers: 23 on Albanian and 17 on Macedonian territory. However, most of them are dry during the summer. The rivers Sateska, Koselska, Susica and Cherava are the most important rivers that drain into the lake.

8.2.4 Natural features

8.2.4.1 Land use features

Land cover and land usage in the "Southwest" region are presented according to CORINE Land COVER for period 2006 – 2012 period. According to CORINE methodology, geophysical cover of the Earth's surface is approac^h ed from two different angles:

- Land cover, which essentially concerns the nature of features (forests, crops, water bodies, bare rocks, etc.).
- Land usage, which is concerned with the socio-economic function (agriculture, habitat, environmental protection) of basic surfaces.

According to this nomenclature, in Southwest region, under forests are 189,438 km^2 of the total surface area. The category agricultural areas take 136,574 km2 of the total area Rest of the surface are covered with semi natural or artificial areas. According to CORINE Land COVER, major changes between 2006 and 2012 can be noted in artificial areas and forests and semi-natural areas, accompanied by decreased agricultural areas and water areas.
The statistical data on agricultural area in the Republic of Macedonia, by regions, show that in 2014 the largest part of agricultural area was concentrated in the Pelagonija Region, covering 20.8% of the total area. The same year, the lowest production of wheat, 15,021t, was registered in the Southwest Region.
Land usage indicator shows the basic land structure, i.e. how much of the land is used as agricultural land and how large is the area under forest or used for other purpose. According to the CORINE methodology, agricultural land usage includes cultivated land and pastures. Cultivated land is additionally classified as arable land and gardens, orchards, vineyards and meadows.
Numerical data for agricultural land usage and production rates (crops, fruits, grapes) as much as data about forests by species, ownership and usage are compiled from latest statistical reports available (www.stat.gov.mk) and include the year 2014 if not otherwise indicated. It must be noted that analysis of last three consecutive years (2012, 2013 and 2014) indicates stability, as no significant differences from year to year occurred.

Regarding the G2 site, according to Corine land cover 2012, the land occupation of the site and the wider area is characterized as land principally occupied by agriculture, with significant areas of natural vegetation and complex cultivation patterns. According to the site visit, the proposed site can be characterized as occupied by land with ordinary ecological features.

Regarding TS Debar, according to Corine Land Cover 2012, the site is occupied bu complex cultivation patterns, According to the site visit, there is has a large paved area and it's surrounding area is occupied by agricultural land and meadows.

Regarding TS Struga, according to Corine Land Cover 2012 the site is located within non irrigated arable land. According to the site visit the site is in immediate vicinity with a non compliant municipal landfill.

Regarding TS Kichevo, according to Corine land cover 2012, the site is situated on mine excavation site with a part of transitional woodland-shrub. Regarding the land usage of the wider area, the site is situated in a degraded mining area currently used as an uncontrolled dumpsite.

Regarding TS Ohrid, according to Corine Land Cover 2012, the occupation land and the wider area is a complex cultivation patterns and land principally occupied by agriculture. According to the site visit, the site is in close vicinity with a non compliant municipal landfill and has some small buildings (empty wharehouses).

8.2.4.2 Nature and biodiversity

The biological diversity of the country is characterized by great heterogeneity and a high level of endemic and relict species and is located at the top of the list of European countries, labeled "European Hotspots". This is due to its central geographical position of the Balkan Peninsula, and the explosion of the territory in the past to the impacts during the Pleistocene. Large temperature fluctuations before, during, and after the ice age, caused multiple dramatic migrations of wildlife, which largely perpetuated these spaces. Such massive intensification left a deep imprint on the recent flora and fauna of the wider European area, including the territory of the beneficiary country.
According to today's knowledge about the different taxonomic groups of species biodiversity so far has registered about 2,000 species of algae, 2,000 fungi species and 450 lichen, 3,200 species of vascular plants, about 500 taxa mosses, 13,000 taxa of invertebrates, 85 fish species, 14 amphibian species, 32 reptile species, 335 bird species and 89 mammal species. Especially important among them have endemic species - about 150 endemic algae, about 120 endemic vascular plants, 700 endemic invertebrates and 27 species of fish.
In the territory of the beneficiary country there are about 120 types of habitats, from the third level of EUNIS classification, belonging to 28 types of ecosystems. Some of them, like Ohrid and Prespa Lake are extremely important not only nationally, but also in European level.
The first study on the status of biodiversity in the country was developed and published in 2003 as the first national report to the Convention on Biological Diversity, and in 2004 was made the Strategy and Action Plan for protection of biodiversity of the country.
Between the years 2003 - 2014 produced three national reports to the Convention on Biological Diversity, and in 2014 began the process of revision of the National Biodiversity Strategy and Action Plan. In 2014 was made the fifth national report to the Convention on Biological Diversity, which was adopted by the Government, while the process for revision of the National Biodiversity Strategy and Action Plan.

Diversity of species per category given below:

- Bacteria: the taxonomic terms is very poorly studied. According to current data are known about 100 taxa identified (with pathogenic bacteria).
- Algae: considered as a group whose diversity is still considered to be insufficiently known. In the period 2004-2015 was described over 160 new species siliceous algae, mainly from Ohrid and Prespa, and in these lakes is intensively researched for family Charophyceae.
- Fungi: in the country are relatively well explored, with over 2000 registered fungi. Of lichens that are relatively less explored are about 450 known species.
- The flora of higher plants: It is represented by more than 3700 species. Represent the most numerous groups of flowering plants with over 3200 species and mosses with about 500 species, while other groups are represented by fewer species.
- Invertebrates: the largest group of fauna in the territory is represented by over 13,000 species.
- Sponges: studied only in our three natural lakes. Determined total of 10 taxa, of which 6 are endemic taxa. Particularly interesting endemic species of sponges from the lake and endemic species from Lake Prespa (Spongilla prespensis).
- Nemathelminthes type: represented by about 870 species, such Mollusca registered a total of 320 taxa (92 of which are endemic), while type Annelida covers about 180 taxa (53 endemic). The most numerous group among them is the type Arthropoda with 11,800 species. Class Arachnida known 560 species, while chelicerata showed the presence of 825 taxa. Class Crustacea (crustaceans) is one of the best studied groups of organisms, about 490 taxa, while the class of insects (Insecta), including better studied groups is the order Lepidoptera (butterflies), with the total number of registered 2,295 taxa. Published a catalog of runners (Coleoptera, Carabidae) which contains data on 571 species and 234 subspecies (Hristovski & Guéorguiev 2015).
- Vertebrates and mammals: in the country are represented by 552 species, 28 of which are

non-indigenous, while the fish with 85 species (19 introduced). Amphibians are represented by 14 species, while reptiles are known 32 species. Bird fauna consists of 349 taxa (335 species and 14 subspecies), while 10-11 species are considered unreliable. In the beneficiary country is confirmed 90 species of mammals, of which 81 species are indigenous, while nine species are considered alien.

Despite the presence of numerous Balkan endemic plants and animal species in the territory of the beneficiary country, there are numerous local endemics which exclusively develop on the territory.
Among the lower plants, a group with the highest degree of endemism is algae with 200 endemic taxa. Most of them are registered in Ohrid and Prespa Lake, a small number in Dojran and Shar Planina.
Higher plants possess a number of Balkan endemic, as well as numerous local endemics and subendemics. The largest number (sub) endemic species have been observed in angiosperms (over 110 species). The most important centers of endemism are considered high mountains - Galichica Jakupica-Karadjica, Korab Pelister, Shar Planina, gorges of the rivers Vardar, Treska, Black River, Pcinja, Babuna and some parts of lowland - Mariovo surroundings of Prilep, Treskavec Kozjak Pletvar, Sivec, the surroundings of Kavadarci - Alshar and stepolikoto area between Veles, Stip and Negotino.
With about 550 fauna endemic taxa, the beneficiary country with its small territory is one of the most important centers of endemism fauna in Europe. In the group of sponges are known 6 endemic taxa.

Habitats and vegetation

The Southwest Region is typical by its rich flora and fauna. According to the most recent census of the forest fund, the areas covered in forests in this region are 183105 ha. The forest fund includes deciduous trees that exist on different floors. There is the floor of oak forests, chestnut forests and the beech forest which are the most present. The evergreen forests participate with 7.74% in the total forest fund. This structure is relatively unfavorable but it is still a significant potential for development of the wood industry.

The habitats of the plants consist of swamps/ bogs thrive in the Ohrid – Struga valley and in the Belchishko bog. In addition to their importance for tourism they are also part of the stability of specific ecosystems. The fauna is present with different species of large and small wild animals, feathered animals and fish. They are the basis for hunt and fishing activities.

According to Corine land cover 2012, the land occupation of the site and the wider area is characterized as land principally occupied by agriculture, with significant areas of natural vegetation and complex cultivation patterns.

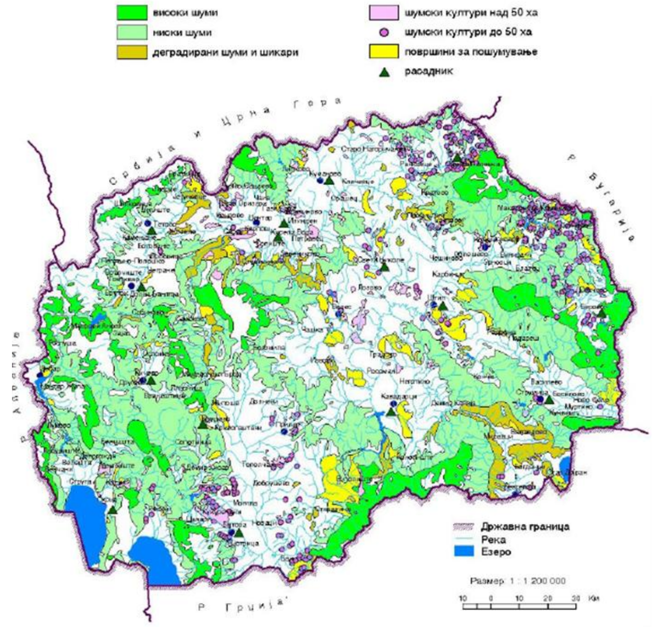


Figure 8-7: Forest ecosystems in the Republic of Macedonia per type of cultivation

Fauna and Flora of the future CWMF area

Habitats

The main habitat types in the CWMF and the wider area are:

1. Natural forests and scrubland. Forests and scrublands are divided into three main habitat types:
   - Oak forest (forest of pubescent oak and oriental hornbeam),
   - Beech forest, and
   - Riparian habitats.

2. Meadows. Most of the meadows in the area (wet and moderately humid), are regularly and more or less intensively managed, while a smaller part is extensively managed or abandoned years ago. Meadows in the lowlands are characterized by more anthropogenic features, while those prevalent in parts of the forest edge or in the valleys are extensive.

3. Wetlands. There are several types of water bodies in the area of interest.

4. Anthropogenic habitats

More information about habitat types is given in relevant Annex.

Flora

The area of interest has very poorly explored flora, except for the area within Belchishko Swamp and Kichevo Valley. There are very little data that are incidental findings. Data on the flora of the area (the nearest data are for Kichevo valley) are derived from available floristic literature and from others research. In assessing the data used and the results of the study on the status of biological diversity in the Republic of Macedonia, the Strategy and Action Plan for protection of biological diversity in the Republic of Macedonia, and other documents pertaining to the assessment of environmental impact in this area. Based on all this plant species in the investigated area and its surroundings were evaluated. In Kichevo valley there are various representatives of floral elements, such as European, Central, Alpine, Arctic-Alpine, Boreal, and other sub-Mediterranean and endemic species. Here are Macedonian endemics (*Dianthus jugoslavicus, Dianthus prilepensis and Thymus jankae var. Ilinicae*) which are firstly described for this region. Rare and important plant species of particular interest are the following: *Solenanthus scardicus, Centaurea grbavacensis, Erodium guicciardii, Thymus rohlenae, Ramonda serbica, Ramonda nathaliae, Aesculus hyppocastanum, Juniperus foetidissima, Corylus colurna, Stachis serbica,* *Stachis plumose, Alkanna noneiformis, Alkanna stribrnyi, Fritillaria gussichiae, Genista nissana* and others. None of these were found in investigated area.

Fauna

Taking into account the number of habitats in the study area, significant number of vertebrate species has been recorded or expected. Also, owing to the biggest conservation interest on European level for these groups, a big number is considered important. It should be pointed out that high number species, mentioned here as important in relation to their coverage by the annexes, are frequent and widely distributed in the beneficiary country.

Fauna and Flora of the future TS Debar area

The TS Debar area is in immediate vicinity with a non compliant municipal landfill. According to the EUNIS Habitat Classification this type of habitat belongs to:

Habitat types J: They are primarily human settlements, buildings, industrial developments, the transport network, waste dump sites. Includes highly artificial saline and non-saline waters with wholly constructed beds or heavily contaminated water (such as industrial lagoons and salt works) which is virtually devoid of plant and animal life.

The nearest area, east from the existing non compliant municipal landfill, where the TS will be situated is arable land. Monoculture plantations have less biodiversity value than the individually planted fields. Contrary to the economic significance of the farmlands, their significance for biodiversity is minor. Some fields are divided with borderlines of different types of bushes and orchards. Most common are: *Prunus cerasifera*, *Pyrus* spp., *Populus* spp., *Robinia pseudoacacia, Juglans regia*. Most common mammals are: white-chested hedgehog (*Erinaceus concolor*), European mole (*Talpa europea*), Levant vole (*Microtus guentheri*), striped field mouse (*Apodemus agrarius*), wood mouse (*Apodemus sylvaticus*), house mouse (*Mus domesticus*), beech marten (*Martes foina*), Macedonian mouse (*Mus macedonicus*), brown hare (*Lepus europeus*), red fox (*Vulpes vulpes*), European badger (*Meles meles*). Common species of birds are: *Melanocorypha calandra*, *Galerida cristata*, *Oenanthe oenanthe*, and various other species use them for nesting. Toads (*Bufo bufo, B.viridis)* are most common species of amphibians in this habitat. Common butterflies are: *Gonepteryx rhamni, Nymphalis antiopa, Vanessa atalanta, Colias crocea,* and beetles: *Amara aenea, Brachinus explodens, Harpalus affinis, H. rufipes, Chlaenius vestitus, Pterostichus niger, P. nigrita, Carabus coriaceus, Bembidion lampros, Cicindela campestris.*

Nearby could be found abandoned arable lands. They differ from arable mostly in flora composition. Tree species are: *Anthemis arvensis, Bromus* spp.*, Cynodon dactilon, Lolium* spp.*, Hordeum vulgare, Arctium lappa, Hyosciamus niger, Cichorium intybus, Xantium spinosum, Onopordon* sp., *Cirsium* spp. Representatives of bushes are: *Paliurus spina christi, Rosa* spp.*, Prunus spinosa* and others.

Fauna and Flora of the future TS Struga area

The TS Struga area is in immediate vicinity with a non compliant municipal landfill. According to the EUNIS Habitat Classification this type of habitat belongs to:

Habitat types J. They are primarily human settlements, buildings, industrial developments, the transport network, waste dump sites. Includes highly artificial saline and non-saline waters with wholly constructed beds or heavily contaminated water (such as industrial lagoons and salt works) which is virtually devoid of plant and animal life.

The nearest area, where the TS will be situated is arable land. Monoculture plantations have less biodiversity value than the individually planted fields. The monotypic structure of the communities, and the ecological conditions controlled by humans, using pesticides and fertilizers, dictate the development of biocenose with less species diversity. Contrary to the economic significance of the farmlands, their significance for biodiversity is minor. Some fields are divided with borderlines of different types of bushes and orchards. Most common are: *Prunus cerasifera*, *Pyrus* spp., *Populus* spp., *Robinia pseudoacacia, Juglans regia*. Most common mammals are: white-chested hedgehog (*Erinaceus concolor*), European mole (*Talpa europea*), Levant vole (*Microtus guentheri*), striped field mouse (*Apodemus agrarius*), wood mouse (*Apodemus sylvaticus*), house mouse (*Mus domesticus*), beech marten (*Martes foina*), Macedonian mouse (*Mus macedonicus*), brown hare (*Lepus europeus*), red fox (*Vulpes vulpes*), European badger (*Meles meles*). Common species of birds are: *Melanocorypha calandra*, *Galerida cristata*, *Oenanthe oenanthe*, and various other species use them for nesting. Toads (*Bufo bufo, B.viridis)* are most common species of amphibians in this habitat. Common butterflies are: *Gonepteryx rhamni, Nymphalis antiopa, Vanessa atalanta, Colias crocea,* and beetles: *Amara aenea, Brachinus explodens, Harpalus affinis, H. rufipes, Chlaenius vestitus, Pterostichus niger, P. nigrita, Carabus coriaceus, Bembidion lampros, Cicindela campestris.*

Nearby could be found abandoned arable lands. They differ from arable mostly in flora composition.Tree species are: *Anthemis arvensis, Bromus* spp*., Cynodon dactilon, Lolium* spp*., Hordeum vulgare, Arctium lappa, Hyosciamus niger, Cichorium intybus, Xantium spinosum, Onopordon* sp., *Cirsium* spp. Representatives of bushes are: *Paliurus spina christi, Rosa* spp*., Prunus spinosa* and others.

<u>Fauna and Flora of the future TS Kichevo area</u>

The TS Kichevo area is in immediate vicinity with a non compliant municipal landfill. According to the EUNIS Habitat Classification this type of habitat belongs to:

<u>Habitat types J:</u> They are primarily human settlements, buildings, industrial developments, the transport network, waste dump sites. Includes highly artificial saline and non-saline waters with wholly constructed beds or heavily contaminated water (such as industrial lagoons and salt works) which is virtually devoid of plant and animal life.

In the surrounding, conifer tree plantation (mostly pine) could be found. Black pine tree is very well acclimatized to the soil and climate conditions in the region under consideration, and it is very often used in plantations. It is planted mainly on the southern slopes of the hills. Forest plantations in the area are represented by plantations of black pine (*Pinus nigra*). Black pine plantations were built in the past as a measure for afforestation of barren lands and prevent erosion and for the mine of TEC Oslomej. Besides black pine, these plantations can be found stems of white pine (*Pinus sylvestris*). In the floors of shrubs and herbaceous plants are found types of surrounding habitats: *Quercus pubescens, Quercus cerris, Quercus frainetto, Rubus sanguineus, Carpinus orientalis, Ranunculus ficaria, Trifolium pratense, Crocus weldenii, Helleborus odorus.* Mammals that could be seen here are: Pine marten (Martes martes) and the rock mouse (*Apodemus mystacinus*) are the most typical species registered in the pine plantations. Presence of red squirrel (*Sciurus vulgais*) is also expected. The size and structure of the Black pine forests in the area do not allow permanent presence of some specific bird species for coniferous forests. Thus, the fauna of birds originates from the neighboring forests. The most significant bird is eagle *Circaetus gallicus*, which nests in these plantations. There are no typical representatives from amphibians and reptilians in this habitat. The species from these classes are the same as the neighboring habitats.

Often recorded butterflies in conifer trees are: *Kirinia roxelana, Hipparchia statilinus and H. syriaca.* However, species characteristic for woodland clearings can be also spotted in this habitat: *Coenonympha arcania, Pyronia tithonus, Pararge aegeria, Pyrgus alveus, Anthocharis cardamines, Satyrium spini, Vanessa atalanta, Phengaris arion*.

<u>Fauna and Flora of the future TS Ohrid area</u>

The area is dominated by oriental hornbeam woods.These woods occur between 700 to 1000 m, stretching along the shoreline just above Lake Ohrid. This habitat includes the Sub-Mediterranean shrub communities which thrive in milder climates. Most of this type of forest has been degraded due to its proximity to urban areas, the proximity of the existing non compliant landfill. Vegetation is not in good condition, heavily degraded, urbanised or used for agriculture or heavy grazing. Insects characteristic for this habitat are Otiorhynchuspierinus, Phyllobiuslateralis, Calosomasycophantus, Carabus (Procerus) gigas and Lucanuscervus. Forests are not typical habitats for butterflies, but sporadically they can meetColiascrocea, Vanessa atalanta and others. The most characteristic amphibian species are: Bufobufo, Pseudepidaleaviridis, Hylaarboreaetc.

From the Reptiles, characteristic species are green lizards (Lacertaviridis) and the Balkan green lizard (Lacertatrilineata), and the snakesZamenislongissimus and Platycepsnajadum. The most common turtle is Eurotestudohermanni. Frequent inhabitants of oak forests are the following bird species: Turdusmerula, Garrulusglandarius, Fringillacoelebs, Parus major, Erithacusrubecula.

Mammals that could be seen here are Erinaceusroumanicus, Crocidurasuaveolens, Myotismystacinus, Nyctalusleisleri, Eptesicusserotinus, Plecotusauritus, Apodemusflavicollis, Vulpesvulpes, Mustelanivalis, Martesfoina, Melesmeles, Felissilvestris, Susscrofa etc. In the surrounding, conifer tree plantation (Pine and Cupressus) could be found. Black pine tree is very well acclimatized to the soil and climate conditions in the region under consideration, and it is very often used in plantations. It is planted mainly on the southern slopes of the hills. Forest plantations in the area are represented mostly by plantations of Pinusnigraas well as Cuperssusarizonica. Conifer plantations were built in the past as a measure for afforestation of barren lands and prevent erosion.

8.2.5 Architectural historical and cultural heritage

There are no protected structures of cultural and historical heritage at the location and the surrounding area of the R1 site and TS Debar site.

In the settlement of Struga with is located south of the TS Struga site, there are situated five point of interest. Namely:

- ✓ Point of interest with code 87 “National Museum Dr.Nikola Nezlobinski”
- ✓ Point of interest with code 93 “The Anthem of Republic of Macedonia”
- ✓ Point of interest with code 94 “Vlado Maleski”
- ✓ Point of interest with code 97 “Memorial House of the Brothers Miladinov”
- ✓ Point of interest with code 99 “The Poetry Park”

All the aforementioned point of interest are situated north – north east of the site in a distance of approx 1,5 to 2 km.

In Kichevo settlement which is located north-northwest of the TS Kichevo site four points of interest are situated, namely:

- St. Paul’s’ and St. Peter’s Church
- The Museum of Kichevo
- The Second Brigade Locomotive
- The memorial Ossuary

In the settlement of Ohrid with is located southeast of the TS Ohrid area, there are situated four point of interest. Moreover, southwest of the study area there is a point of interest. Namely:

- ✓ Point of interest with code 70 “The church of st. Sofia”.
- ✓ Point of interest with code 75 “Cave church of st. Erasmus”.
- ✓ Point of interest with code 80 “Gutenberg Workshop”.
- ✓ Point of interest with code 84 “Institute for Protection of Cultural Monuments - the National Museum”.
- ✓ Point of interest with code 85 “Grigor Prlichev Cultural Centre”.

All the aforementioned point of interest are situated south of the site in a distance of approx. 1 to 4 km.

Reported cultural heritage related sites in the Southwest region are listed below:

Table 8-1: Cultural monuments in the Southwest region

Cultural and historical heritage	Site	Debar (km)	Struga (km)	Ohrid (km)	Kichevo (km)	Godivje (km)
Municipality of Centar Zhupa						
Kodjadjik	Sites from the Pre-Roman period	13	27.5	35.5	36.5	18.5
Municipality of Debarca						
Gorno Sredoreche	Neolith sites	38.6	19.5	19	32.7	11
Municipality of Makedonski Brod						
Devina Tower – Devich	Towers and fortresses	60.1	61.4	59.1	20.3	39
The City of Kale Stolovatec – Belica	Towers and fortresses	67.4	76	74.3	28.1	51.7
Municipality of Ohrid						
Varosh	Traditional city architecture	52.5	13.4	3.2	53.8	31.2
The Robevci House	Traditional city architecture	52.9	13.9	3.6	53.9	31.3
The Uranija House	Traditional city architecture	52.9	13.9	3.6	53.9	31.3
Sv. Bogorodica Perivlepta (XIIICentury)	Churches and monasteries	52.7	13.7	3.4	53.7	31.1
Plaoshnik	Early Christian Period	52.7	13.5	3.4	54	31.4
Studenchishta	Early Christian Period	54.6	15.7	5.7	54.9	32.7
Hajdar Pasha Mosque (XVcentury)	Islamic culture monuments	51.4	12.4	2.1	53.2	30.3
Zejnel Abidin Pasha Mosque (XVIICentury)	Islamic culture monuments	52.6	13.8	3.4	53.5	31
The Ohrid Fortress	Towers and fortresses	52.5	13.1	3	54.8	30.8
The Bay of the bones – pile dwellings	Neolith sites	65	24.6	16.3	66.4	44.5
Sv. Naum and St. Pantelejmon – Plaoshnik (IX Century)	Churches and monasteries	52.7	13.5	3.4	54	31.4
Sv. Sofia (XI Century)	Churches and monasteries	52.8	13.8	3.5	54	31.4
Sv. Jovan Bogoslov – Kaneo (XIII Century)	Churches and monasteries	52.7	13.5	3.4	54.2	31.5
Sv. Erazmo (XIV Century)	Churches and monasteries	48.7	9.6	1.1	51.8	28.3
Sv. Stefan – Medieval period	Churches and monasteries	57.1	17.4	7.8	57.8	35.6
Municipality of Struga						
Sv.Ilija-Delogozhda	Sites from the Pre-Roman period	34.9	8.1	13.7	43	17
Usta (Copper age)	Neolith sites	43.2	2	8.9	51	27.8
Radolishta	Early Christian Period	42.1	4.8	12.7	56.3	29.7
Oktisi	Early Christian Period	35.3	6.5	17.5	50	25.8
Old part of the city	Traditional city architecture	43.1	2	8.8	51	27.7
Crkveni Livadi – Vranishta (Bronze age)	Neolith sites	39.4	1.8	12	50	24

8.2.6 Settlements and population

The proposed site G2 administratively belongs to Municipality of Debartsa and it is located southeast of Godivje settlement in a distance of approx. 1.3km, northeast of Laktinje settlement in a distance of approx. 1.2km, southwest of Slivovo settlement in a distance of approx. 2.6km and northwest of Arbinovo settlement in a distance of approx. 2.6km. The above mentioned distances refer to approximate straight line/direct distance.

The closest settlements to the G2 site are Godivje and Laktinje settlements. According to the Census of 2002 Godivje settlement had 92 inhabitants and according to State Statistic Office's estimation in 2015 had 68 inhabitants. Laktinje settlement according to the Census of 2002 had 82 inhabitants and according to State Statistic Office's estimation in 2015 had 61 inhabitants.

The closest settlement to the TS Debar site is Debar settlement. According to the Census of 2002 the settlement had 14,561 inhabitants and according to State Statistic Office's estimation in 2015 had 15,359 inhabitants.
The closest settlement to the TS Struga site is Struga settlement. According to the Census of 2002 the settlement had 16,559 inhabitants and according to State Statistic Office's estimation in 2015 had 17,038 inhabitants.

The closest settlement to the TS Kichevo site is Kichevo settlement. According to the Census of 2002 the settlement had 27,067 inhabitants and according to State Statistic Office's estimation in 2015 had 27,245 inhabitants.

The closest settlement to the TS Ohrid site is Ohrid settlement. According to the Census of 2002 the settlement had 43,305 inhabitants and according to State Statistic Office's estimation in 2015 had 40,551 inhabitants.

8.2.7 Transportation network

According to the Development Programme of Southwest region (2010-2015), the region is relatively well covered by national, regional and local roads. The road network is relatively well developed in terms of the length of local roads. Main roads, linking this region with other regions are the state road A2 Skopje Gostivar - Kicevo - Struga - Albania border and the state road A3, connected to A2 - Ohrid - Resen.

Regarding the quality of the road network in the region, the Development programme states that extremely poor conditions are prevailing, especially for the road A2.

Several sections of the main roads in the Southwest Region were built up to 30 and 40 years ago and they are in extremely poor condition and inadequately maintained and reconstructed in time. Such are the sections Straza - Kicevo - Podmolje (M-4), Ohrid - beech (M-5) and Gradsko - Prilep; Bitola - Resen - Ohrid (R-106 M-5).[1] The length of the local road network in the Southwest region is 1,296 km or 13 % of the roads in the beneficiary country.

Regarding the CWMF site, it can be easily accessed through the road E65 which connects Ohrid settlement with Kichevo settlement, and then following the local paved road to Godivje settlement. For the final access to the site about 100m needs improvement works.

[1] Strategy For Regional Development Of The Republic Of Macedonia 2009-2019

8.3 POTENTIAL ENVIRONMENTAL IMPACTS – MITIGATION MEASURES – MONITORING AND ENVIRONMENTAL ACTION PROGRAMME

8.3.1 Introduction

Regional project for waste management will be useful at social and environmental level. The proposed waste management system will contribute to a significant improvement of environmental conditions in the region. First of all with the proposed ISWMS leads to valorization of waste through recovery, recycling and energy utilization, minimizing the waste that will be finally disposed to a landfill.

A compliant landfill meeting all national and EU requirements will allow the long term safe disposal of the remaining waste. Through this the closure and rehabilitation of all existing dumpsites and non compliant landfills, will be achieved. For avoiding or minimizing any possible impact, all adequate measure will be taken.
It should be noted also that currently all the generated MSW is being disposed in uncontrolled non compliant municipal landfills and dumpsites. Because of that very negative impacts are generated to flora and fauna. The establishment of the ISWMS will allow the closure and rehabilitation of all uncontrolled disposal sites and will lead to the safe disposal of the residues to a compliant landfill, resulting to a strongly positive impact on various recipients (i.e. flora and fauna, landscape and visual environment, cultural and historical heritage, air quality, noise and vibrations, water quality, hydrology, soil etc.). This improvement concerns not only at regional level but also at local level as currently at the boundaries of the proposed location (for establishing Central Waste Management Facilities) an existing non compliant municipal landfill operates.
Concluding, ISWMS is an Environmental Project, and it‘s total environmental and social balance is strongly positive.
The project "Preparation of necessary documents for establishing of an Integrated and Financially Self-Sustainable Waste Management System in Pelagonija, Southwest, Vardar and Skopje Regions” includes also a Environmental Impact Assessment Study (EIA) . The overall objective of the project is to achieve an integrated and financially self-sustainable waste management system in those Regions. The EIA study includes description of the expected emissions (e.g. air, waste water, solid waste etc.) and an assessment of likely environmental impacts of significance in the construction and operation phases as well as a description of the mitigation measures in respect of adverse impacts.

This section provides an overview of a preliminary assessment of possible impacts on the environment.

8.3.2 Potential environmental impacts during construction

Construction activities typically generate many kinds of impacts. The preparation of the site, earthworks, possible construction works for better access to the site are likely to result in (1) dust emissions and other air pollutants (2) noise and vibration, (3) vegetation removal and degradation, (4) soil compaction (5) the possible release of pollutants in soil, groundwater and surface water bodies.

Impacts on air, water and soil could occur during the construction, which will be limited to the surrounding area of the project and to the access roads. Similar impacts are expected during the construction phase of the TSs, keeping in mind that the construction site of each TS is at much smaller scale in comparison with the CWMF construction site.These effects do not represent a significant environmental threat, and most of them are limited during the construction period.

8.3.2.1 Impact on water

Likely impacts to surface waters and groundwater may result from the construction phase of the project (CWMF and TSs), since there will be generation of liquid waste. The generated liquid waste can be categorized as follows:

a) Municipal waste water, deriving from the staff's sanitary facilities, calculated to approximately 1.5 m^3 / d. Since there will be collection and management in an appropriate way, it will not pose a threat to the environment.

b) Surface runoff burdened with suspended soil particles and/or pollutants. Impacts of surface runoff water are expected to be minor since the construction phase is a "one time phenomenon" and when the construction ends, the nuisance will stop. It should be mentioned that flood protection works that are included in the design of the CWMF are going to be established at the same time as the rest of the works, and this leads to addressing flood phenomena.

c) Hazardous liquid waste (from machinery and vehicles) resulting from the maintenance and refueling of equipment and vehicles used on site.
These effects, is not expected to be very likely to occur, as, the quantity of generated pollutants is expected to be small and the construction site will have the appropriate design and emergency plan. Hazardous waste will be collected in suitable storage containers and will be directed for further treatment so no impact is expected.

Finally, there could be the incident of disturbance of groundwater level as a result of excavation works. In that case, safe drainage and evacuation of the pumped groundwater should take place in order to avoid possible suffusion phenomena.

8.3.2.2 Air quality impact

Earthworks are a major source of dust emissions in the air, while emissions of other air pollutants (SO_2, NOx, CO, CO_2) are inevitable from the operation of construction and transportation machinery for construction activities.

Regarding exhaust emissions within the construction area, the relatively small number of vehicles and machines combined with their distance from residential areas (approx. 2km, from the nearest settlement of Rosoman) and existing land uses in the study area which are primarily agriculture with a deterioration due to the existence of non-compliant municipal landfill in the R1 site, ensure that the impact on air quality will be negligible.
Air pollution from dust is localized in the area of operation of the machinery. The dust spreading in the environment primarily depends on the meteorological conditions on the study area, especially from the direction of the wind. These impacts on air are temporary and will cease upon completion of construction works. In the EIA study, there are calculations regarding the maximum expected dust concentration in various distances from the CWMF site.

Regarding noise, from the construction of the CWMF and the improvement of the access road arises from two main sources.

- the traffic of heavy vehicles carrying various loads, such as sand, silt materials etc. within or outside of the construction site bountaries
- the various vehicles and machinery working on site (excavating machines, loading excavated material etc.).

The permissible noise levels are determined by the environmental legislation for noise protection ("Official Gazette" no. 79/07).The EIA study includes calculation regarding the noise nuisance parameters.

8.3.2.3 Soil impact

Potential soil impact, is expected during the excavation works and humus layer removal. Also soil erosion may occur (especially the areas situated in sloping areas) through excavation works leading to soil instability and landslides, removal of vegetation, earthworks and the use of heavy machinery during construction activities.

Soil contamination can occur due to leakage of liquid substances from vehicles and machinery such as fuel, motor oil, antifreeze etc., also, due to inadequate management of sanitary and other wastewater. Impact on the ground could also originate from the improper disposal of waste material from excavation works.

8.3.2.4 Impact on cultural and historical heritage

In the site of future CWMF and TS as well as in the close wider area of the project, there are no protected elements of cultural and historical heritage.

8.3.2.5 Impact on flora, fauna and ecological network

The proposed site is situated on land characterized mainly as complex cultivation patterns and secondly with land principally occupied by agriculture, with significant areas of natural vegetation as well as the wider area. According to the site visit, the proposed site can be characterized as occupied by land with ordinary ecological features. During construction no significant impacts will be caused to fauna and flora, which will be mainly constrained within the site boundaries and the impact concern the extraction of vegetation. The vegetation on the site location is sparse and low without any ecological importance, so the impact is expected to be insignificant. Also the study area is not located in an environmental protected area so no impact is expected.

The Transfer station in Struga municipality mainly occupies non irrigated arable land according to the Corine Land Cover 2012. The wider area of the site is characterized as permanently irrigated land and industrial or commercial units in the south of the site. The vegetation in the site is very sparse and low and no important species of flora and fauna is detected. Also the site does not fall within the boundaries of a protected area and the nearest is “Lake Ohrid”, in a distance of approx. 1.8km.

The second site where the transfer station will be established (Kichevo municipality) occupies land with pastures and complex cultivation patterns according to the Corine Land Cover 2012. In the wider area there are transitional woodland shrubs and natural grasslands. The vegetation in the site is very sparse and low and no important species of flora and fauna is detected. Also the site does not fall within the boundaries of a protected area (the nearest is in a distance of 7.4 km “Krushino”).

The third site where the transfer station will be established (Debar municipality) occupies land with complex cultivation patterns according to the Corine Land Cover 2012. In the wider area there are transitional woodland shrubs and broad-leaved forest in the east of the site. The vegetation in the site is very sparse and low and no important species of flora and fauna is detected. Also the site does not fall within the boundaries of a protected area (the nearest is in a distance of 3.3km (“Kosovrasti”).

From the above is concluded that the impacts during the construction period will be insignificant and will not pose a threat to important species of flora, fauna and protected areas.

8.3.2.6 Impact on landscape and visual environment

As far as the landscape, the site of the future CWMF will change the original identity of the area in terms of aesthetics and will be a new element of its physiognomy something that happens with all kind of works. The project area is located in proximity with agricultural land. The closest settlements to the site are the settlement of Godivje and Laktinje, in a distance of approximately 1.2 to 1.3km.

The access to the area of the site is very easy. The site is located close to road E-65, which connects Kichevo settlement with Ohrid settlement. The site is visible from the access road E-65 (regional road). Also the optical isolation from the settlement of Laktinje and Godivje is moderate.The operation of the CWM facilities will increase the traffic in the main road, due to the trucks, but this increase will not be significant and the impact can be characterized as low.

Another impact during the operation of CWM facilities is the aesthetic deterioration. All the necessary measures will be taken in order the Central Waste Management Facilities not to be visible from the road E-65.

The impacts will be limited during the construction period due to the produced dust and are characterized as short-term medium impacts.
The Transfer station in Struga municipality is situated in a distance of approximately approx. 500m from the regional road which connects Struga settlement with Vranista settlement. The optical isolation from the road is in a low level and also low level optical isolation from the settlement of Struga.
The second site where the transfer station will be established (Kichevo municipality) is situated on the sideway of the regional road connecting Kichevo and Oslomej settlements. The optical isolation from the road is in a low level. Also the optical isolation for the nearby settlement (Oslomej) in a distance of approx. 0.3km, is in a low level too.
The third site where the transfer station will be established (Debar municipality) is situated in the sideway of the road connecting Debar and Bilate settlements. The optical isolation from the road is in a low level. Also the optical isolation for the nearby settlement (Debar) in a distance of approx. 0.9km, is in a low level too.

From the above it is considered that the level of the impact could be characterized as medium.

8.3.2.7 Impact from traffic

The proposed main site can be accessed through the regional road E-65 which connects Kichevo settlement with Ohrid settlement, and is located near of this road. Also no additional road works are required. Also the Transfer station in Struga municipality is situated in a distance of approximately 500m from the main access regional road which connects Struga settlement with Vranista settlement, the second transfer station (Kichevo municipality) is situated on the sideway of the regional road connecting Kichevo and Oslomej settlements and the third TS in Debar municipality is situated in the sideway of the road which connects Debar and Bilate settlements.

During the construction, there may be negative effects on the environment in terms of increasing traffic near or through the settlements due to the movement of vehicles and trucks, loaded with the equipment and materials. Due to transportation of materials the traffic conditions will be affected. The population will be affected from the nuisance that is caused in any kind of construction works.
The construction works should be limited in daytime and these effects are limited during construction period and will not have significant environmental impact.

8.3.2.8 Social impact

The impact on the population during the construction is related with noise and vibrations, dust or mud on the roads. Due to increased frequency of transportation and traffic, the traffic conditions may change near the location of the CWM facilities and transfer stations. The population will be affected from the nuisance that is caused in any kind of construction works. On the other hand positive results will also occur for the population, because employment opportunities will be created for many specialties. These are temporary impacts and will last until the completion of construction works.

8.3.2.9 Risk of Accidents

In case of improper construction site organization, environmental accidents and consequently negative impact on the environment can occur. Those are primarily related to:

- collisions of vehicles and machinery during entry and exit of the access road to the local and regional roads of the area
- fire (due to negligence of workers - smoking, work with appliances that spark, etc.)
- accidents caused by force majeure (lightning, earthquakes, extremely adverse weather conditions, technical failure and / or human error)

During construction, special attention should be paid to handling flammable materials, in order to prevent the occurrence of fire especially in summer time when ideal conditions for their development are created. In case of emergencies, workers are required to adopt suitable measures and actions (human health measures, emergency measures etc.) in order to face and prevent the current situation.

8.3.2.10 Conclusion

From all the afore mentioned it results that the majority of the impacts are of low to medium significance short term, reversible and localized, and are limited within the site and the construction period of the WMF and TSs. Regarding landscape, where the impacts will be permanent, it should be considered that The alteration of landscape in such projects is inevitable. The topography of the area is already considered in the general design and preliminary layout of the project, so no major impacts on landscape are expected. The employment opportunities should also be considered as positive impact of the social environment.

8.3.3 Potential environmental impacts during operation phase

This section provides an overview of the identification of possible impacts on the different sectors of environment and their preliminary assessment due to the operation of the Central Waste Management facilities and the operation of the Transfer Stations in the region.

8.3.3.1 Impact on water/hydrology/soil

The basic impacts on water quality, hydrology and soil from different parts of the CWMF are presented below.

MBT/MRF/*Windrow composting and other main facilities*: In a Mechanical - Biological Treatment, as well as the other facilities of the CWMF, wastewater that can be produced during the operational phase obtained from the following processes:

- Washing floors, mechanical equipment and trucks

- Reception area
- Waste reception area, where the waste reception bunkers, may accumulate liquid residues
- During the operation of the antipollution system (deodorants - dedusting), liquid waste may produced from gas treatment (biofilter)
- During the biological process (treatment of organic fraction and composting of green waste)

All quantities of wastewater will be led to the WWTP for further treatment. With the proper collection and treatment, there will be no impacts to surface and groundwater.

Also during the operation of MBT/MRF, solid waste will be produced from (i) mechanical treatment and (ii) Composting of digestate and (iii) composting of green waste.

Due to the fact that the above residues are disposed on landfill, there is no impact derived from them.

Landfill: Leachate in the landfill can be derived as a product of the water passed through layers of waste subjected to aerobic and anaerobic microbial decomposition.

The leachate will be collected and treated with the appropriate method, in order to be discharged according EU and national regulations. No impacts will be occurred.

Solid waste will not be produced in landfill. The impact will be positive due to the fact that the landfill will accept all residues from Integrated Waste Management System.

Other infrastructure: Wastewater can be derived from (i) washing of the machinery and the ground of the plant and (ii) facilities for staff and visitors. This wastewater will be collected and treated with the appropriate method, in order to be discharged according EU and national regulations. No impacts will be occurred.

Transfer stations: Transfer stations will produce wastewater from the following (i) washing of the ground area, (ii) for staff and visitor's facilities and (iii) special wastewater from machine oils and other liquids derived from truck service. Also leachate will be produced from compaction of waste. The leachate will be properly collected and treated and not be discharged in an uncontrolled manner.
During the operation of transfer stations, small quantities of solid waste will also be produced from staff activities and from the discharge of used spare parts (tires, etc.) but the impacts are of no importance.

Significant will be the positive impacts on water quality/hydrology/soil due to the closure and rehabilitation of existing non compliant municipal landfills and dumpsites and due to the establishment of a compliant ISWMS.

Considering all the above, all types of waste water before discharge into the environment will be purified to levels that comply with the legislation of the beneficiary country (Law on water Official Gazette no. 87/08 and Regulations of discharge and limitations of wastewater Official Gazettes no. 108/11, 81/11, 73/11). Finally there are no impacts expected on soil and possible underground waters of the site and the wider area of CWMF.

8.3.3.2 Air quality impact

Waste treatment will include mechanical and biological treatment (MBT) with AD process, recycling of materials (MRF) and composting facilities (composting of digestate and windrow composting of green waste). All these processes will lead to air emissions (dust, odour, exhaust gas emissions, bioaerosols etc.). Impacts for each of the facilities concerning the operation phase analyzed below.

MBT/MRF: The main air emissions from the mechanical pre-treatment of waste at MBT and MRF facilities will be particulates, odours, bioaerosols and dust.

Biological treatment (Anaerobic digestion): The main air emissions from the biological treatment will be H_2S, CO_2, NH_3 and other volatile organic compounds (VOCs), bioaerosols, particulates and odours.

Biological treatment (Composting): The main air emissions from the composting treatment will be H_2S, CO_2, bioaerosols, particulates and odours.

Landfill: Municipal solid waste landfills are the source of landfill gas which is a result of anaerobic decomposition of the organic materials and is primarily consists of CO_2 and CH_4, which are main Greenhouse Gases. Also the landfill gas is explosive, tends to migrate out of the landfill and if uncontrolled can cause vegetation decline.
Also during the landfill operation dust from the daily covering procedure can occur.
All the aforementioned impacts could be prevented as the landfill will be equipped with gas collection system, which efficiency will be appropriate monitored.

Transfer stations: Small quantities of dust can be released during unloading of waste in transfer stations, but no significant impacts will be occurred. The impacts from TS, due to possible odours are very low.

Collection and transportation of waste: Waste collection and transportation system can release greenhouse gas emissions to the air and can create noise pollution. The proposed collection and transportation system will include small trucks which will reload the waste into large vehicles in transfer stations, in order the waste to be transported in CWMF. The collection routes will be optimized in order the travel distance and number of routes be minimized, by avoiding passing through the urban areas on their ways to the CWMF. Hence collection and transportation system is not expected to generate additional negative effects on air quality.
Significant will be the positive impacts on air quality due to the closure and rehabilitation of existing non compliant municipal landfills and dumpsites and due to the establishment of a compliant ISWMS.

Noise can be produced from different parts of the CWMF. More specific:

MBT/MRF: During the operation of the MBT/MRF, noise produced from loading equipment, shredders, air separators, deodorization/dedusting system, conveyors, balers etc. Also noise produced from the traffic of waste trucks directing from and to the main facilities.
Landfill: Noise produced from the traffic of trucks which unload the residues to the landfill. Also the compression of residues, the covering of waste and other soil activities contribute to the increase of the noise level.
Considering that the Central Waste Management Facilities are located in a distance of approx. 1.3 km far from populated areas and the noise limits will not exceed the allowable level according the national and EU regulations, the impact of noise and vibration can be considered negligible.

Transfer stations: Noise can be produced during the procedure of loading and pressing the waste and during the transportation of trucks. These impacts are not expected to be significant and in any case the levels will be according the national and EU regulations.

8.3.3.3 Impact on flora, fauna and ecological network

According to Corine Land Cover the site of the Central Waste Management Facilities is characterized mainly as complex cultivation patterns and secondly with land principally occupied by agriculture, with significant areas of natural vegetation. According to the site visit, the proposed site can be characterized as occupied by land with ordinary ecological features. Also the site is not situated in a protected area and the closest area is in a great distance approx. 4.2 km (> 3km). In addition no important habitat which could include special species of flora and fauna is detected on and near the site. In general the impacts on flora and fauna are characterized as low, result during the construction period and no new impacts will be created during the operation period.

As mentioned above, the transfer stations will be established on sites which are not fall within the boundaries of protected areas. Also the vegetation on the sites are very low without any ecological importance so the impact are expected to be insignificant.

Significant will be the positive impacts on flora and fauna due to the closure and rehabilitation of existing non compliant municipal landfills and dumpsites and due to the establishment of a compliant ISWMS.

8.3.3.4 Impact on landscape and visual environment

The wider area of the site where CWM facilities (MBT, MRF, Green waste composting plant, landfill and other facilities) will be established is characterized as complex cultivation patterns. The closest settlement to the site is Laktinje settlement in a distance of approx. 1.2 km and Godivje settlement in a distance of approx. 1.3 km.

The access to the area of the site is very easy. The site is located close to road E-65, which connects Kichevo settlement with Ohrid settlement. The site is visible from the access road E-65 (regional road). Also the optical isolation from the settlement of Laktinje and Godivje is moderate. The operation of the CWM facilities will increase the traffic in the main road, due to the trucks, but this increase will not be significant and the impact can be characterized as low.

Another impact during the operation of CWM facilities is the aesthetic deterioration. All the necessary measures will be taken in order the Central Waste Management Facilities not to be visible from the road E-65.

The Transfer station in Struga municipality is situated in a distance of approximately approx. 500m from the regional road which connects Struga settlement with Vranista settlement. The optical isolation from the road is in a low level and also low level optical isolation from the settlement of Struga.
The second site where the transfer station will be established (Kichevo municipality) is situated on the sideway of the regional road connecting Kichevo and Oslomej settlements. The optical isolation from the road is in a low level. Also the optical isolation for the nearby settlement (Oslomej) in a distance of approx. 0.3km, is in a low level too.

The third site where the transfer station will be established (Debar municipality) is situated in the sideway of the road connecting Debar and Bilate settlements. The optical isolation from the road is in a low level. Also the optical isolation for the nearby settlement (Debar) in a distance of approx. 0.9km, is in a low level too.

In general the impacts from the operation of the transfer station to the landscape and the aesthetic of the environment could be characterized as medium due to the deterioration of the wider area.

Significant will be the positive impacts on landscape and visual environment due to the closure and rehabilitation of existing non compliant municipal landfills and dumpsites and due to the establishment of a compliant ISWMS.

8.3.3.5 Impact on cultural and historical heritage

In the location of the sites where CWM facilities (MBT, MRF, Green composting plant, landfill and other facilities) and TS will be established as well as in the wider area, no cultural and historical monuments and archaeological sites detected. No effect on cultural and historical heritage expected due to the operation of the CWM facilities.

Significant will be the positive impacts on cultural and historical heritage due to the closure and rehabilitation of existing non-compliant municipal landfills and dumpsites and due to the establishment of a compliant ISWMS.

8.3.3.6 Social impacts

The main impacts on population are given below for each of the operation facilities:
Central Waste Management Facilities:
Central Waste Management Facilities will have positive impacts to the socioeconomic characteristics of the area, due to the fact that:

- ✓ They will lead to the effective management of waste and to new career opportunities which will consequently have positive effect in the economic growth of the area.
- ✓ They ensure environmental benefits from the reuse, recycling and energy recovery of waste.
- ✓ With the application of the relevant EU and national regulations concerning waste treatment plants and disposal facilities, no impact will occur to staff and people of the surrounding area.

Transfer stations:

- ✓ The operation of transfer stations will cause positive impacts in the social characteristics of the wider area, taking into consideration that the current project is a project regarding the protection of environment.
- ✓ With the application of the relevant EU and national regulations concerning the operation of Transfer stations, no impact will occur to staff and people of the surrounding area.

8.3.3.7 Impact on climate

The impact of solid waste management on the global warming equivalence of European greenhouse gas emissions originate mostly from CH_4 released as biodegradable waste decay under the airless (anaerobic) conditions in landfills. About a third of anthropogenic emissions of CH_4 in the EU can be attributed to this source. In contrast, only 1% of N_2O emissions and less than 0.5% of CO_2 emissions are associated with solid waste disposal. For this reason it is often assumed that reducing the amount of CH_4 emitted from landfills would have the greatest potential for reducing the overall climate change impacts of solid waste management. Taken into consideration that in this region all the produced solid municipal waste is disposed on non compliant municipal landfills and dumpsites, without any treatment, it is perceived that the current situation is burdened regarding greenhouse gas emissions.

Any reduction in greenhouse gas emissions from waste management practices will have been brought about through avoided landfill emissions, reduced raw material extraction and manufacturing, recovered materials and energy replacing virgin materials and fossil-fuel energy sources.

Through the operation of the proposed ISWMS greenhouse gas emissions will be avoided through:

- ✓ Material recovery from waste and recycling
- ✓ Energy recovery from biogas combustion produced in anaerobic digestion
- ✓ Energy recovery from incineration of RDF produced from mixed waste
- ✓ The energy recovery from landfill gas

The impacts in climate change can be characterized as positive due to the fact that the released GHG emissions will be reduced in comparison with the current situation.

8.3.3.8 Risk of accidents

Accidents may occur due to fire, explosions, earthquakes and strong rainfalls. Due to the energy resulting biogas system, the possibility of large fires and explosions during operation of CWMF is minimized. Environmental impacts main concerns of prolonged and heavy rainfall are minimized by the proper canal network, the size of the working landfill surface, the carrying capacity of buffers and other measures that facilitate the functioning of the technological process in the optimal framework.

8.3.4 Potential environmental impacts during operation

The establishment of Central Waste Management facilities in the region is characterized as high importance regarding the protection of the environment simultaneously upgrading human life quality.

A primary assessment of the impacts was carried out, for both construction and operation phase of the facilities, depending on the type of the impact, the duration, the level of the impact and its reversibility. The impacts assessment is presented on the following tables.

CONSTRUCTION PHASE									
Category of assessment	**Level of assessment**	**IMPACTS**							
		Surface and ground water	**Soil and geology**	**Air quality And Climate**	**Human beings/Social environment**	**Fauna and flora**	**Landscape**	**Cultural and historical heritage**	**Material assets**
Type	Positive				√				
	Negative	√	√	√		√	√		
	Neutral							√	√
Significance	High								
	Medium	√	√						
	Low			√	√	√	√		
	Negligible							√	√
Duration	Permanent						√		
	Temporary	√	√	√	√	√		√	√
Reversible	Non reversible								
	Partially reversible					√	√		
	Totally reversible	√	√	√	√			√	√
Cumulative/Synergistic	Possible			√					
	Impossible	√	√		√	√	√	√	√

OPERATION PHASE (considering CWMFs and TSs)										
Category of assessment	**Level of assessment**	**IMPACTS**								
		Surface and ground water	**Soil and geology**	**Air quality**	**Climate**	**Human beings/Social environment**	**Fauna and flora**	**Landscape**	**Cultural and historical heritage**	**Material assets**
Type	Positive				√	√				
	Negative	√	√	√				√		
	Neutral						√		√	√
Significance	High									
	Medium	√	√	√						
	Low				√	√		√		
	Negligible						√		√	√
Duration	Permanent	√	√	√	√	√	√	√	√	
	Temporary									√
Reversible	Non reversible				√					
	Partially reversible			√		√	√	√	√	
	Totally reversible	√	√							√
Cumulative/Synergistic	Possible	√	√	√	√			√		
	Impossible					√	√		√	√

OPERATION PHASE (considering CWMFs, TSs & Closure and rehabilitation of non-compliant municipal landfills and dumpsites)									
Category of assessment	Level of assessment	IMPACTS							
		Surface and ground water	Soil and geology	Air quality and Climate	Human beings/Social environment	Fauna and flora	Landscape	Cultural and historical heritage	Material assets
Type	Positive	√	√	√	√	√	√	√	√
	Negative								
	Neutral								
Significance	High	√	√	√	√		√		
	Medium					√		√	
	Low								√
	Negligible								
Duration	Permanent	√	√	√	√	√	√	√	√
	Temporary								
Reversible	Non reversible	√	√	√	√	√	√	√	
	Partially reversible								√
	Totally reversible								
Cumulative/Synergistic	Possible	√	√	√			√		√
	Impossible				√	√		√	

8.3.5 Mitigation measures

8.3.5.1 Environmental mitigation measures during construction phase

During the construction period of CWMF and Transfer Stations, mitigation measures will be applied in order to prevent, minimize and control the impacts on air quality, impacts from noise and vibration, impacts on soil and impacts on water quality/hydrology. Some basic measures that should be applied are:

- Careful handling of waste.
- Regular maintenance of vehicles.
- Regular wetting of excavation areas when needed.
- Regular maintenance and operation of all machinery/worksite vehicles.
- Installation of noise barriers at appropriate locations if needed.
- The waste should be collected and stored properly in order to led for disposal in a proper environmental and sanitary manner.
- During the design of CWMF the earthwork balance will be taken into consideration (cut and fill quantities). Excess material can be used for covering material during operation phase and in case of even remaining excess, it will be intended to be used in other public works. Otherwise it will be disposed properly.
- Ensure the collection of sanitary wastewater through mobile sanitary facilities and their final treatment.
- Appropriate covering of the construction materials for minimizing the dust, when needed.

8.3.5.2 Environmental mitigation measures during operation phase

This paragraph provides an overview of the identification of possible mitigation measures in order to minimize potential impacts during the operation of the Central Waste Management facilities and the Transfer Stations in the region.

Biodiversity, landscape and visual environment
The main impact on the biodiversity is the extraction of vegetation mainly observed in the construction period. The main mitigation measures for the operation for the CWMF and Transfer Station are the following.

- Fencing of the area in order animals cannot enter in to it.
- Establishment of perimeter plantations.
- Strict compliance with proper rules concerning operational phase in order to prevent nuisance in surrounding area.
- Gradual restoration of the new landfill site with plantation.

Air quality
The main air emissions mainly produced from the operation of the MBT plant (H_2S, CO_2, CH_4, N_2O, NH_3, VOCs, bioaerosols, etc.), the landfill (dust, odour), and from the operation of the trucks directing from and to the CWM facilities and Transfer stations. The main mitigation measures for the operation are presented below.

MBT/MRF/Composting units:

- Appropriate air antipollution systems (i.e. dedusting and deodorization systems) will be established, in order to minimize the air emissions according the legislation.
- The reception area should be restricted and constructive isolated in order to minimize the dispersion of dust and odour.
- Cleaning of waste treatment areas and roads and spraying of dust when is needed.
- Usage of appropriate treatment method in order to minimize air emissions through composting process.
- Monitoring of the air emissions.

Landfill:

- The appropriate landfill gas collection and treatment system will be established. Landfill gas extraction should start as soon as possible following the waste disposal.
- Dust minimization through wetting when needed.

Other infrastructure:

- Perimeter plantation with vegetation in order to minimize the spreading of dust.
- Spraying with water, if necessary, different areas within the site of the center to prevent dust generation.
- Appropriate covering of the materials and substances that may cause dust, when needed.

Noise and vibrations
The main mitigation measures in order to reduce impacts generated from noise and vibrations in the operation phase of the CWMF and Transfer Stations are listed below:

- The process lines and equipment will be designed and constructed in accordance with national and EU noise regulations.
- The main mechanical facilities and machines which produce noise should be restricted and isolated in closed facilities for the minimization of noise.
- The noise level outside the CWMF will be very low.
- Regular service of the machinery and trucks and replacement when it is necessary.

- Establishing of a monitoring system in order to prevent and minimize the noise level.
- The staff will take all noise protection measures.

Water quality / hydrology / soil
The main proposed mitigation measures that should be adopted are given below:
Central Waste management facilities

- Construction of a sealing system to the landfill in accordance with the national and EU regulations.
- Construction of an appropriate WWTP where all wastewater streams will be treated efficiently.
- Establishment of drainage system of pipes laid on waterproof basins which will collect leachate from landfill.
- Construction of a peripheral ditch around the site in order to collect rainwater.
- Residues from the operation of the MBT plant, will be collected and disposed to landfill. These residues will be transferred to landfill in covered trucks in order the spread of small parts to the surrounding area to be avoided.
- Water resulting from washing should be processed at least by the oil separator.
- Special waste water (machine oils and other liquids derived from the maintenance of trucks) should be collected and be appropriate managed.
- Perimeter plantation of area is also proposed to prevent the escape and spread of light objects out of the landfill area.
- Works for final coverage for minimizing water precipitation in landfill body.

Transfer stations

- The waste will be unloaded directly to a hopper system and then in bigger containers which are closed (except green waste) and the leachate which will be derived from the compaction of waste inside them, could not escape.
- Appropriate measures will be taken for avoiding dispersion of waste during unloading (wind protection measures).
- Special wastewater (machine oils and other liquids derived from the service of trucks) should be collected and be appropriately managed.

8.3.6 Monitoring and environmental program

In order to implement the measures for reduction of the negative impact and to implement the positive impacts from the activities for regional waste management in the region, it is necessary to establish a monitoring system each for a variety of environmental parameters. Monitoring is crucial to be established in CWMF, including MBT, Landfill, WWTP, TS etc.

8.3.6.1 Water and soil

The quality of treated water from the waste water treatment control should be in accordance with the legislation (mentioned above) and a monitoring system should be established measuring the quality during the operation of CWMF on the parameters: pH, suspended solids, biological oxygen demand (BOD_5), chemical oxygen demand (COD), total organic carbon (TOC), low volatility lipophilic substances (total oils and fats), total hydrocarbons, adsorbed organic halogens (AOX), ammonia (NH_3), nitrates, nitrites, total nitrogen (N), total phosphorous (P), arsenic (As), copper (Cu), barium (Ba), iron (Fe), Selenium (Se), zinc (Zn), cadmium (Cd), chromium (Cr^{6+}), total chromium (Cr), manganese (Mn), lead (Pb), nickel (Ni), mercury (Hg), phenols and Volatile aromatic hydrocarbons (BTX). If the quality is not

achievable, the waste water will be transported into the nearest wastewater system. The system should be established in the exit of the treated waste water from the waste water treatment plant.
Monitoring the process before and after the construction of the facilities monitoring mainly the results from hydrogeological and hydrological surveys of the locations. Before the construction of CWMF and transfer stations in the region, there should be performed a test on a "zero" water sample from points (one upstream and two downstream from the CWMF location and transfer stations, whose location will be determined by a hydrogeologist when creating the Main Project), in accordance with the Ordinance on sanitary quality of drinking water on the following parameters: pH, suspended solids, BOD_5, COD, total organic carbon (TOC), hardly volatile lipophilic substances (total oils and fats), total hydrocarbons, adsorbed organic halogens (AOX), Volatile aromatic hydrocarbons (BTX), phenols, ammonia (NH_3), nitrates, nitrites, total nitrogen (N) , total phosphorus (P), arsenic (As), copper (Cu), barium (Ba), zinc (Zn), cadmium (Cd), total chromium (Cr), chromium (Cr^{6+}), manganese (Mn), nickel (Ni), lead (Pb), selenium (Se), iron (Fe), mercury (Hg) and mineral oils, and microbiological tests. The measurements in monitoring wells should be carried out once a month in the first year of operation of the CWMF and transfer stations. If the values of the measured parameters do not change, the continuation of the measurement of these parameters may be conducted once in three months. After closure of the CWMF, all measurements should be carried out twice a year (every six months).
Other monitoring elements may include:

- Monitoring of the process of generation, collection, selection, recycling, reuse and disposal of the waste concerning the quantities.
- Monitoring of the degree of pollution of the waste water from other parts of the plants/ installations and the machinery.
- Monitoring of the quality of leachate from the landfill inside of the CWMF (fully analyzed in chapter 7).
- Monitoring of the quality of surface and ground waters.
- Monitoring of the process of construction of the drainage system and the system for capturing of the rain waters.
- Records of the total forest area that has been cut, expressed in m^3.
- Results from the soil quality analyses.

8.3.6.2 Air

1. Measure, every 3 months, the concentration of non-methane VOCs, ammonia (NH3), hydrogen sulfide (H2S) and dust particles, using a biofilter.
2. Measure, every 3 months, the concentration of nitrogen compounds (NOx) and solid particles of dust at the biogas plant.
3. Analysis of the Results from meteorological surveys and monitoring. The measurements of the meteorological parameters may include precipitation, air temperature, wind, moisture evaporation should be monitored in accordance with the Ordinance on methods and conditions of waste disposal, categories and operational requirements for waste landfills.
4. Measurements of general and specific indicators of air pollution on the project location should be carried out at the sampling station continuously during the period of construction and operation and once per month for five years after the closure of CWMF. Ensure that test results are available to the public.
5. Other monitoring elements may include:
   - Monitoring to what extent the objectives from the national and international legislation have been met.
   - Monitoring the quantity of fuel spent on transportation of the waste.
   - Monitoring the records from controls of technical operation status of the engaged machinery.

- Results from measuring of emissions of harmful pollutants from the waste management plants and buildings, including results from measuring of emissions of harmful pollutants at the landfills.
- Recording Number of days when the concentrations of harmful pollutants emitted in the atmosphere from the installations and plants are exceeded.
- Monitoring and recording the number of exceeding of the quantity of greenhouse gasses expressed in $CO_{2\text{-eq}}$ on national level as well as the number of accidents in the plants.
- Monitoring and recording of the number of complaints filed by the people as a result of the disrupted health and disrupted quality of the environment.
- Number of incidents related to the management with plants and installations for waste management concerning the air emissions (combustion and fire accidents in landfill etc.).

8.3.6.3 Waste

1. Monitoring of the process of generation, collection, selection, recycling, reuse and disposal of the waste concerning the quantities. Data should be recorded in accordance with current legislation related to waste management and the Ordinance on the methods and conditions of waste disposal, categories and operational requirements for waste landfills, concerning the type and quantity of waste (volume and / or weight) recorded daily into record sheet for vehicles entering the landfill.
2. Monitoring and recording the accidents during the operation of the CWMF (combustion of waste, operational problems of the waste management system and the machinery, fire in landfill, run off of biogas etc.

8.3.6.4 Noise

1. If it is needed to perform construction works during night time, it is necessary to conduct noise measurements in the outdoor area of the most vulnerable places as well as in some points inside the populated areas.
2. After completion of construction and before the beginning of CWMF operations, there should be conducted noise measurement at critical emission points, in accordance with a study on the environmental impact and the main design of noise protection. Measurements should be repeated when changing conditions of the equipment / facilities that effect noise during operation.
3. Recording the defective machinery and trucks increasing the noise level than the permissible and replace when it is needed.

8.3.6.5 Biodiversity and landscape

General monitoring for biodiversity and landscape may include:

- Number of remedied and closed municipal and unregulated landfills and dumpsites
- Results from the survey on protection of the biodiversity
- Number of destroyed natural habitats
- Trends of loss of the biodiversity
- Trends of increase and/ or reduction of endemic species
- Damages reported for particular locations

8.4 GHG FOOTPRINT CALCULATIONS

8.4.1 Introduction

Greenhouse gases that can be included within the footprint include the seven gases listed in Kyoto Protocol, namely: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), per fluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen fluoride (NF_3). The following process/activities usually generate GHGs that may be accounted for using the methodologies:

- CO_2-stationary combustion of fossil fuels, indirect use of electricity, oil/gas production and processing, flue gas desulphurization (limestone based), aluminum production, iron and steel production, nitric acid production, ammonia production, adipic acid production, cement production, lime production, glass manufacture, municipal solid waste incineration, transport (mobile combustion).
- CH_4-biomass combustion or decomposition, oil/gas production and processing, coal mining, municipal solid waste landfill, municipal waste water treatment.
- N_2O-stationary combustion of fossil fuels/biomass, nitric acid production, adipic acid production, municipal solid waste incineration, municipal waste water treatment, transport (mobile combustion).
- HFCs-refrigeration/air conditioning/insulation industry.
- PFCs-aluminium production.
- SF_6-electricity transmission systems, specific electronics industries (e.g. LCD display manufacture).
- NF_3-plasma and thermal cleaning of Chemical Vapor Deposition reactors

Total emissions of these gases are counted in units of CO_2 equivalent. The following table presents examples of sources of direct GHG emissions by activity type.

Table 8-2: Selected examples of sources of direct GHG emissions by activity type

Activity	GHG Type	Potential sources of emission
Combustion for energy	CO_2, N_2O	Energy related GHG emissions from combustion: boilers/burners/turbines/heaters/furnaces/incinerators/kilns/ovens/dryers/engines/flares/any other equipment or machinery that uses fuel, including vehicles.
Combustion gas scrubbers	CO_2	Process CO_2 from flue gas de-sulphurisation (limestone based) units
Oil/gas production, processing and refining	CO_2, N_2O, CH_4	Energy related GHG emissions from combustion: boilers/process heaters and treaters/internal combustion engines and turbines/catalytic and thermal oxidizers/coke calcining kilns/firewater pumps/emergency standby generators/flares/incinerators/crackers. Process related GHGs from: hydrogen production installations/catalytic regeneration (from catalytic cracking and other catalytic processes)/cokers (flexi-coking, delayed coking). Fugitive losses of CH_4.
Iron and steel production	CO_2, N_2O	Coke ovens: raw materials (coal or petrol coke)/conventional fuels (e.g. natural gas)/process gases (e.g. blast furnace gas (BFG))/other fuels/waste gas scrubbing. Metal roasting, sintering or pelletisation: raw materials (calcinations of limestone, dolomite and carbonatic iron, e.g. $FeCO_3$)/conventional fuels (natural gas and coke)/process gases/process residues used as input material including filtered dust from the sintering plant, the converter and the blast furnace/other fuels/waste gas scrubbing. Production of pig iron and steel including continuous casting: raw materials (calcinations of limestone, dolomite and carbonatic iron, e.g. $FeCO_3$)/conventional fuels (natural gas, coal and coke)/reducing agents/process gases/consumption of graphite electrodes/other fuels/waste gas scrubbing.
Cement and lime manufacture	CO_2	Calcination of limestone in the raw materials/conventional fossil kilns fuels/alternative fossil-based kiln fuels and raw materials/biomass kiln fuels (biomass wastes)/non kiln fuels/organic carbon content of limestone and shales/raw materials used for waste gas scrubbing.
Glass production	CO_2	Glass production: decomposition of alkali- and earth alkali carbonates during melting of the raw material/conventional fossil fuels/alternative fossil-based fuels and raw materials/biomass fuels (biomass wastes)/other fuels/carbon containing additives including coke and coal dust/waste gas scrubbing.
Paper and pulp	CO_2	Pulp and paper manufacture: power boilers, gas turbines, and other combustion devices producing

Activity	GHG Type	Potential sources of emission
manufacture		steam or power for the mill/recovery boilers and other devices burning spent pulping liquors/incinerators/lime kilns and calciners/waste gas scrubbing/fossil fuel-fired dryers (such as infrared dryers).
Aluminium production	CO_2, N_2O	CO_2 from combustion sources. Process related GHG emissions: CO_2 from anode consumption/CO_2 from anode and cathode baking/PFCs from anode effects (or events). Other process-related emissions that may occur, depending on the facility configuration, include: CO_2 from coke calcinations/SF_6 from use as a cover gas/SF_6 from use in on-site electrical equipment.
Nitric acid production	CO_2, N_2O	CO_2 from combustion sources and process related.
Ammonia production	CO_2	CO_2 from combustion sources and process related.
Adipic acid production	N_2O	CO_2 from combustion sources and process related.
Biological waste treatment plants	CH_4	CH_4 from anaerobic digestion of biodegradable waste.
Municipal solid waste incineration	CO_2, N_2O	GHGs from MSW combustion.
Municipal solid waste landfills	CH_4	CH_4 from anaerobic digestion of biodegradable waste.
Refrigeration/Air conditioning/Insulation industry	HFCs	Fugitive losses of HFCs
Power transmission	SF_6	Transmission losses will be derived from the power production combustion sources and have an associated emission of CO_2. Fugitive losses of SF_6.
Specific electronics industry (semiconductors, LCD)	PFCs, NF_3	Fugitive losses of PFCs and NF_3.

Source: EIB Induced GHG Footprint, The carbon footprint of projects financed by the Bank, Methodologies for the Assessment of Project GHG emissions and Emissions Variations, Version 10.1

The rows with blue colour represent the activities included in the proposed waste management system.

8.4.2 Project boundaries

The project boundaries defines what is to be included in the calculation of the absolute, baseline and relative emissions. The EIB methodologies use the concept of “scope” as defined by the WRI GHG Protocol ‘Corporate Accounting and Reporting Standard’, when defining the boundary to be included in the emissions calculation.

For the definition of the scope of GHG emissions to be taken into account in a carbon footprint calculation, the literature has generally accepted the approach developed by the WRI/WBCSD GHG Protocol, which differentiated between the following types of emissions:

- Scope 1: Direct GHG emissions. Direct GHG emissions physically occur from sources that are operated by the project within the project boundary. For example emissions produced by industrial processes and by fugitive emissions inside the project boundary.
- Scope 2: Indirect emissions. Scope 2 accounts for GHG emissions from the generation of electricity that is consumed by the project. The indirect emissions are produced outside the project boundary (i.e. at power plant level) but since a project has control over consumption and can improve it with energy efficiency measures, emissions should be allocated to the project.
- Scope 3: Other indirect GHG emissions. Scope 3 emissions are a consequence of the activities of the project but that occur from sources not operated by the project (i.e. indirect emissions outside the control of the operator, such as emissions by suppliers).

According EIB methodology for the assessment of Project GHG emissions and emission variations, only scope 1 and scope 2 GHG emissions of projects are normally included in the footprint exercise.

Jaspers suggests considering scope 1 and 2 emissions as well as avoided emissions as a consequence of material or energy recovery by the project. Avoided emissions create a net benefit to society that clearly has to be included as an economic benefit of the project.

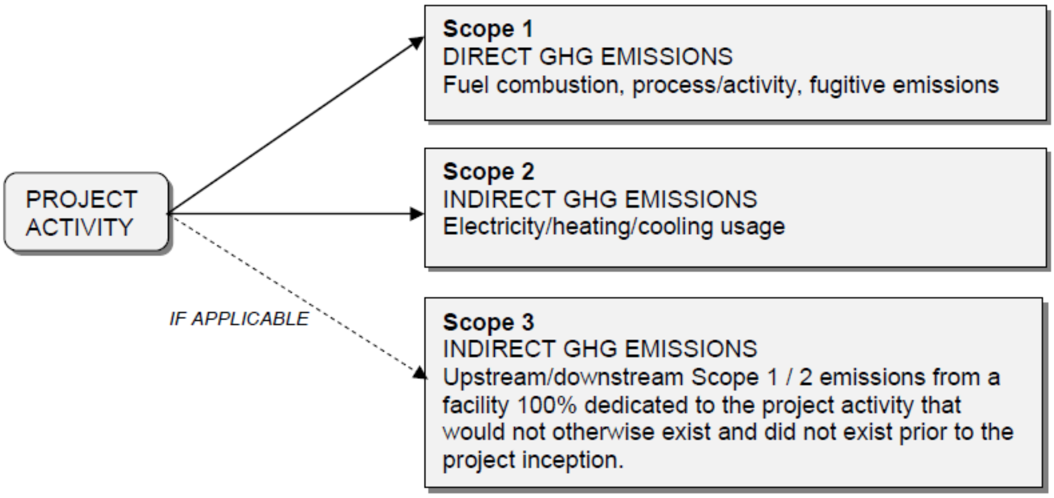


Figure 8-8: Project scope – all projects excluding road, rail and urban public transport infrastructure

The following table provides an overview of the scope of GHG emissions produced by different waste management activities.

Table 8-3: Scope of GHG emissions produced by different waste management activities

Activity	Net direct GHG emissions (scope 1)	Indirect GHG emissions (scope 2)	Avoided GHG emissions
Material Recovery Facility (MRF)	CO_2 released from fuels consumed in waste collection and transportation to and from the facility	CO_2 from grid electricity consumption	CO_2 avoided through material recovery from waste and recycling
	CO_2 released from fuels consumed in waste collection and transportation to and from the facility		
Biological treatment (composting-anaerobic digestion)	CO_2 released from fuels consumed in waste collection and transportation to and from the facility	CO_2 from grid electricity consumption	CO_2 avoided through energy recovery from combustion of biogas produced in anaerobic digestion
	CH_4 and N_2O released in anaerobic processes during waste treatment		
	CO_2 released from fuels consumed in waste treatment facility (i.e. by vehicles)		
MBT	CO_2 released from fuels consumed in waste collection and transportation to and from the facility	CO_2 from grid electricity consumption	CO_2 avoided through material recovery from waste and recycling
	CH_4 and N_2O released in anaerobic processes during biological treatment		CO_2 avoided through energy recovery from incineration of RDF/SRF produced from mixed waste
	CO_2 released from fuels consumed in waste treatment facility (i.e. by vehicles)		CO_2 avoided through energy recovery from combustion of biogas produced in anaerobic digestion
Incineration	CO_2 released from fuels consumed in waste collection and transportation to and from the facility	CO_2 from grid electricity consumption	CO_2 avoided through energy recovery from incineration of waste
	CO_2 released in waste incineration (fossil carbon only, biogenic carbon not included)		
	N_2O released in waste incineration		
	CO_2 released from fossil fuels added in waste incineration		
	CO_2 released from other fuels consumed in waste treatment facility (i.e. by vehicles)		
Landfill	CO_2 released from fuels consumption in waste collection and transportation to and from the facility	CO_2 from grid electricity	CO_2 avoided through energy recovery from landfill gas
	CH_4 released from landfill		
	CO_2 released from fuels consumed on the landfill site (i.e. by vehicles)		

Source: Calculation of GHG emissions in waste and waste to energy projects (Jaspers staff working papers, November 2013)

8.4.3 Quantification process and methodologies

The following figure illustrates the overall series of activities to quantify the EIB carbon footprint for investment projects and the associated relative emissions compared to the baseline.

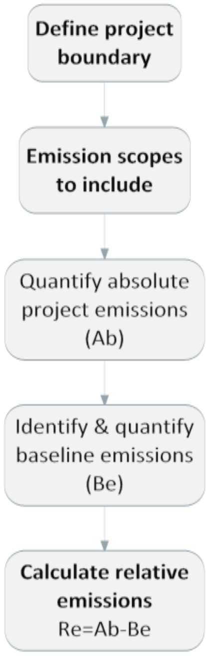


Figure 8-9: Project carbon footprint calculation flow

The EIB Carbon Footprint Methodologies provide a series of emissions factors from which greenhouse gas emissions can be calculated. These have been derived from internationally recognized sources, e.g. WRI/WBCSD GHG Protocol and IPCC Guidelines for National GHG Inventories.

In order to calculate the relative GHG emissions for selected scenario (Scenario 3b: two bins collection system with MRF plant, MBT plant with AD and windrow composting plant), a model that developed by Jaspers (this model is mentioned in the document *Guide to CBA Analysis of Investment Projects, 2014-2020*) regarding waste management facilities has been used. The methodology that has been used for the evaluation of this model is largely compatible with the EIB’s Carbon Footprint Methodology (EIB, 2012).

8.4.4 Specific assumptions used for GHG emissions calculation

8.4.4.1 Assumptions regarding carbon contents of MSW

In order to estimate the GHG emissions released from different waste management practices, assumptions are necessary as regards the carbon contents of the different waste fractions treated in the different projects. The following table shows the different waste fractions considered in the model as well as their carbon contents (total carbon, degradable/dissimilable organic carbon and fossil carbon).

Table 8-4: Carbon content of distinct mixed waste components

	Total Carbon (TC) in distinct MSW components (% of wet mass)	Degradable organic carbon (DOC) in distinct MSW components (% of wet mass)	Dissimilable Organic Carbon (DOCf) in distinct MSW components (% of wet mass)***	Fossil Carbon (FC) in distinct MSW components (% of wet mass)
Food waste	15%	15%	75%	0%
Garden waste	24%	24%	50%	0%
Wood*	45%	30%	50%	0%
Textiles	39%	20%	30%	19%
Paper+Cardboard	33%	33%	35%	0%
Plastics	61%	0%	0%	61%
Metal	0%	0%	0%	0%
Glass	0%	0%	0%	0%
Other**	24%	19%	39%	8%

Source: AEA Study (Waste Management Options and Climate Change, 2001)
**Estimated data based on data from different sources examined by Jaspers*
***Calculated by Jaspers based on disaggregated data presented in the AEA Study*
****The dissimilable Organic Carbon is calculated as a percentage of DOC percentage*

8.4.4.2 Assumptions regarding GHG emissions from waste collection and transportation

The GHG emissions due to waste collection and transportation depend on the distance travelled by waste collection and transport vehicles, the vehicle type and size of payload. The AEA study provides a simplified method to quantify GHG emissions from collection and transportation of waste, which uses general, fixes assumptions on vehicle types used, payloads and km travelled. The average emission factors that have been used are summarized in the following table.

Table 8-5: Assumptions regarding GHG emission factors for collection and transportation of waste for different treatment options of scenario 3b

GHG emission factors for waste collection and transport		
Separately collected metal to sorting and recycling	0.010	t CO_2(eq)/ t recycled material
Separately collected plastic to sorting and recycling	0.015	t CO_2(eq)/ t recycled material
Separately collected paper/cardboard to sorting and recycling	0.010	t CO_2(eq)/ t recycled material
Separately collected glass to sorting and recycling	0.010	t CO_2(eq)/ t recycled material
Separately collected biowaste to composting	0.008	t CO_2(eq)/ t recycled material
Mixed Waste to MBT	0.005	t CO_2(eq)/ t recycled material
Mixed waste to landfill	0.007	t CO_2(eq)/ t recycled material

Source: AEA Study (Waste Management Options and Climate Change, 2001)

8.4.4.3 Assumptions regarding GHG emissions from waste treatment

The following table presents the emission factors and assumptions for the calculation of GHG emissions released from different waste treatment processes.

Table 8-6: Assumptions regarding GHG emission factors for different treatment options that included in the project

GHG emission factors for anaerobic digestion		
CH_4 emissions from anaerobic digestion	0.001	t CH_4/t BDW (wet mass)
CH_4 share in biogas	60%	
CO_2 share in biogas	35%	
GHG emission factors for landfilling		
Methane correction factor (MCF) (with project)	1	
Methane correction factor (MCF) (without project)	1	
Volumetric CH_4 fraction in landfill gas (F)	50%	
Volume of CH_4 recovered per year for energy use of flaring (RG) (with project)	75%	
Volume of CH_4 recovered per year for energy use of flaring (RG) (without project)	75%	
Fraction of CH_4 released that is oxidized below surface within the site (OX) (with project)	10%	
Fraction of CH_4 released that is oxidized below surface within the site (OX) (without project)	10%	
Share of collected methane flared (with project)	100%	
Share of collected methane flared (without project)	100%	
Flare efficiency	90%	
CO_2 emissions from operations at the landfill	1.2	CO_2/t of waste

Source: IPCC (2006) and AEA Study (Waste Management Options and Climate Change, 2001)

8.4.4.4 Assumptions regarding avoided GHG emissions through recycling of recovered materials

The following table shows the specific emission factors applied to calculate avoided GHG emissions through recycling of materials recovered from waste.

Table 8-7: Assumptions regarding avoided GHG emissions through recycling of materials recovered from waste

GHG emission factors for material recycling	Value	Unit
Fe metal	-1.521	t CO_2(eq)/t recycled material
Non-Fe metal	-9.108	t CO_2(eq)/t recycled material
PET	-0.530	t CO_2(eq)/t recycled material
HDPE	-1.800	t CO_2(eq)/t recycled material
Glass	-0.287	t CO_2(eq)/t recycled material
Paper/Cardboard	-0.634	t CO_2(eq)/t recycled material

Source: AEA Study (Waste Management Options and Climate Change, 2001)

8.4.4.5 Assumptions regarding avoided GHG emissions through recovery of energy from waste

Due to the fact that the proposed technology treatment that will be established in the future CWMF, include energy production (heat or electricity) from waste, in the GHG calculator has been used the Electricity –country grid emission factor including grid losses for electricity imported from grid and the Electricity-Country grid emissions factor excluding grid losses for electricity exported to grid.

Table 8-8: Assumptions regarding GHG emissions avoided through recovery of energy from waste

	Value	Unit
Electricity –Country grid emission factor incl. grid losses (for electricity imported from grid) Croatia, Medium Voltage Grid +4%	0.854	t CO_2(eq)/MWh
Electricity-Country grid emissions factor excl. grid losses (for electricity exported to grid)	0.820	t CO_2(eq)/MWh

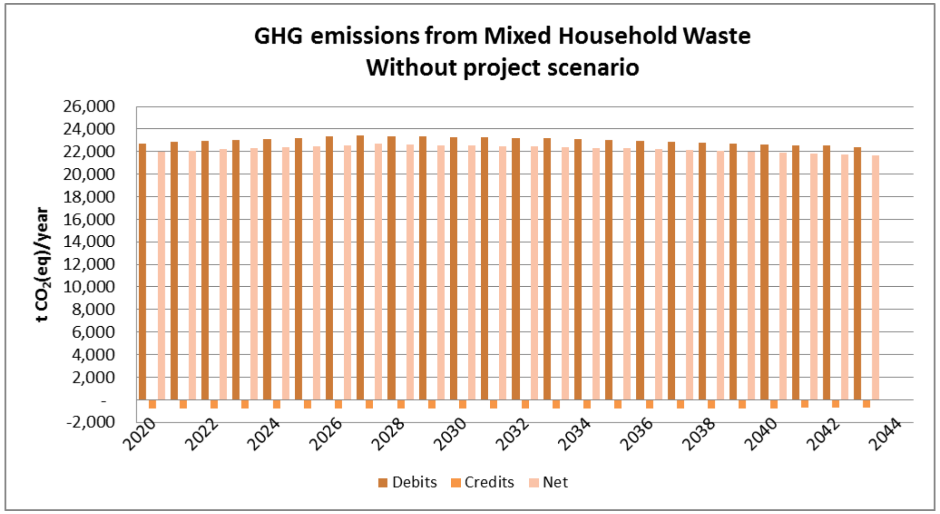
8.4.5 Results from GHG emission calculations

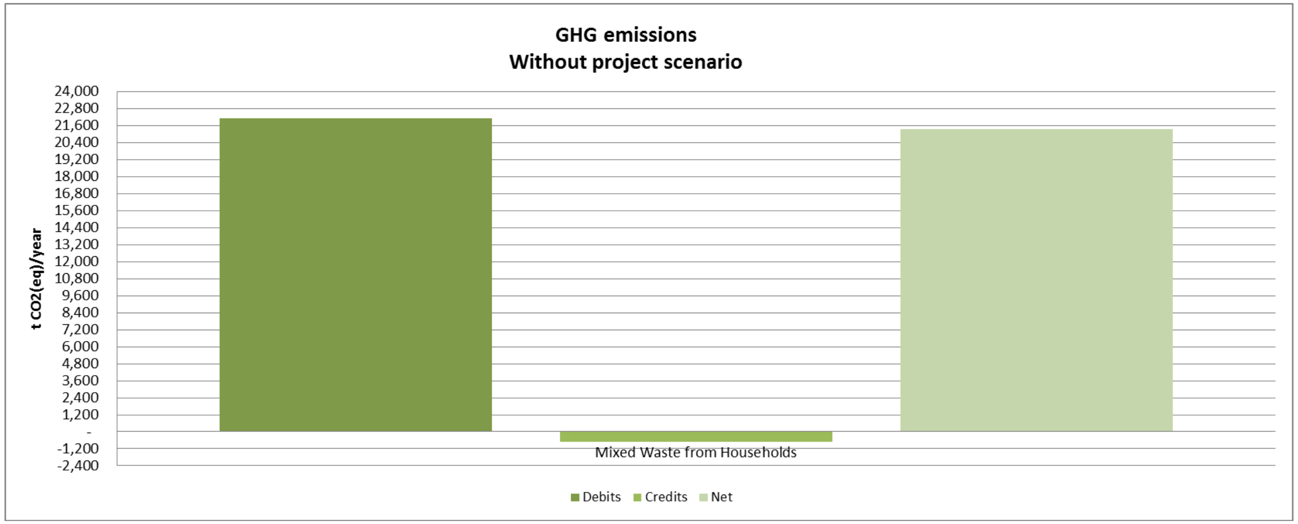
8.4.5.1 GHG emission calculations in without project scenario

The following table summarizes the net average GHG emissions, in t CO_2(eq), for the different components of the waste management system in the baseline (without-project) scenario.

Table 8-9: GHG emissions, avoided GHG emissions and Net GHG emissions (average 2021-2046), in t CO_2 (eq) in without project scenario

WITHOUT PROJECT SCENARIO	
Mixed Waste from Households	
GHG emissions from waste collection and transport (t CO_2(eq))	438
GHG emissions from waste treatment (t CO_2(eq))	-
GHG emissions from landfills (t CO_2(eq))	21,779
GHG emissions avoided through recycling of materials recovered from waste (t CO_2(eq))	-
GHG emissions avoided through recovery of energy from waste (t CO_2(eq))	-
Total net GHG emissions (t CO_2(eq))	***22,217***
TOTAL WITHOUT PROJECT SCENARIO GHG EMISSIONS (t CO_2(eq))	***22,217***


GHG emissions from Mixed Household Waste
Without project scenario
t CO_2(eq)/year
26,000
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
-2,000
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
Debits
Credits
Net

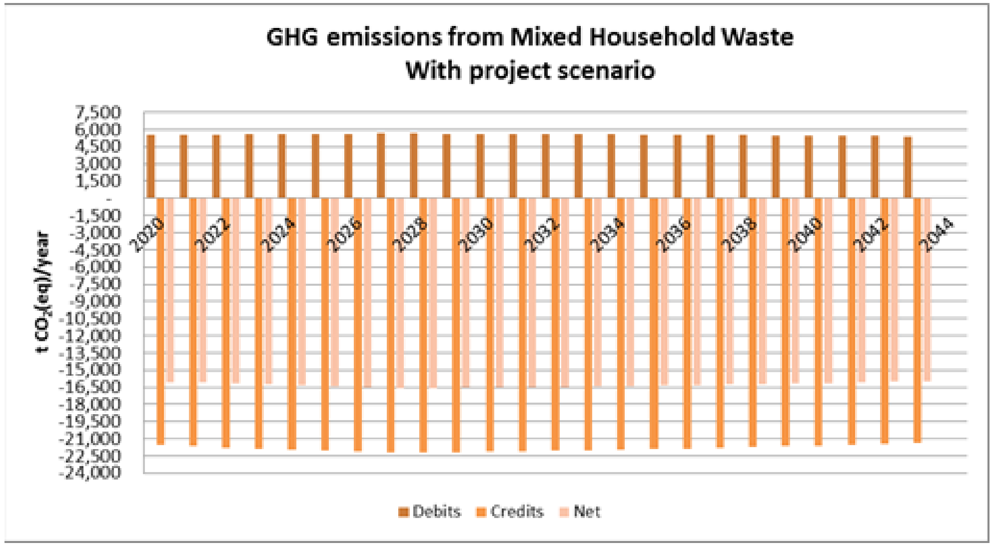

GHG emissions
Without project scenario
t CO2(eq)/year
24,000
22,800
21,600
20,400
19,200
18,000
16,800
15,600
14,400
13,200
12,000
10,800
9,600
8,400
7,200
6,000
4,800
3,600
2,400
1,200
-
-1,200
-2,400
Mixed Waste from Households
Debits
Credits
Net

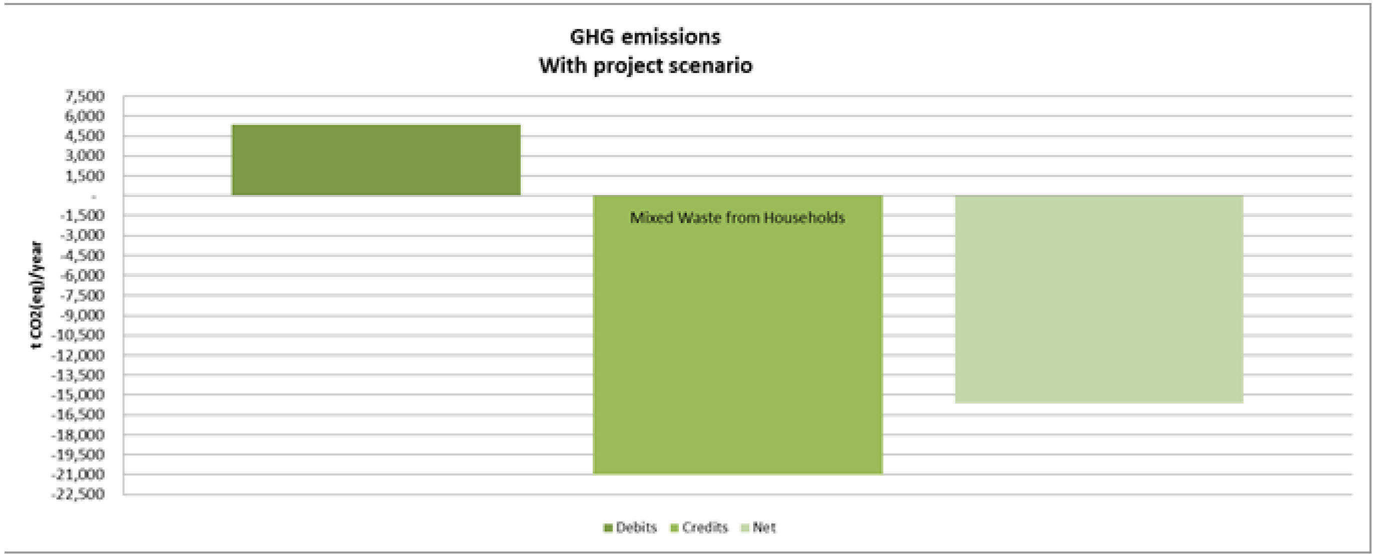
8.4.5.2 GHG emission calculations in with project scenario

The following table summarizes the net average GHG emissions, in t CO_2 (eq), for the different components of the waste management system in the with-project scenario.

Table 8-10: GHG emissions, avoided GHG emissions and Net GHG emissions (average 2021-2046), in t CO_2(eq) in with project scenario

WITH PROJECT SCENARIO	
Mixed Waste from Households	
GHG emissions from waste collection and transport (t CO_2(eq))	372
GHG emissions from waste treatment (t CO_2(eq))	3,074
GHG emissions from landfills (t CO_2(eq))	2,114
GHG emissions avoided through recycling of materials recovered from waste (t CO_2(eq))	-17,652
GHG emissions avoided through recovery of energy from waste (t CO_2(eq))	-4,178
Total net GHG emissions (t CO_2(eq))	**-16,271**
TOTAL WITH PROJECT SCENARIO GHG EMISSIONS (t CO_2(eq))	***-16,271***


GHG emissions from Mixed Household Waste
With project scenario
t CO2(eq)/year
Debits
Credits
Net


GHG emissions
With project scenario
t CO2(eq)/year
Mixed Waste from Households
Debits
Credits
Net

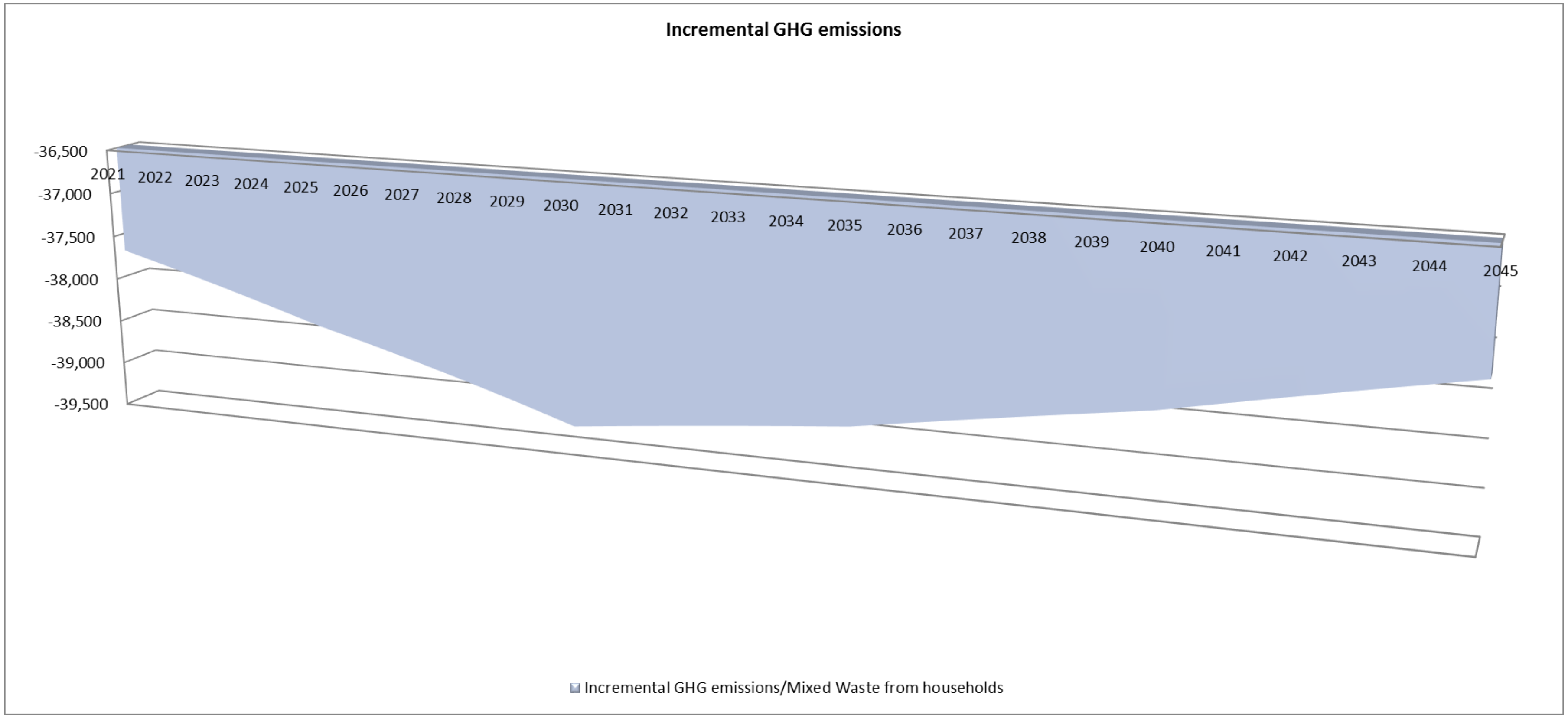
8.4.5.3 GHG emissions-Incremental calculations

Incremental GHG emissions can be calculated if we subtract the GHG emissions in with project scenario from GHG emissions without project scenario.

The following table presents the incremental GHG emissions for the different components of the waste management system.

Table 8-11: Incremental Approach

INCREMENTAL APPROACH	
Mixed Waste from Households	
GHG emissions from waste collection and transport (t CO_2(eq))	-66
GHG emissions from waste treatment (t CO_2(eq))	3,074
GHG emissions from landfills (t CO_2(eq))	-19,665
GHG emissions avoided through recycling of materials recovered from waste (t CO_2(eq))	-17,652
GHG emissions avoided through recovery of energy from waste (t CO_2(eq))	-4,178
Total net GHG emissions (t CO_2(eq))	
TOTAL INCREMENTAL GHG EMISSIONS (t CO_2(eq))	***-38,488***


Incremental GHG emissions
-36,500
-37,000
-37,500
-38,000
-38,500
-39,000
-39,500
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
Incremental GHG emissions/Mixed Waste from households

8.4.5.4 Reduction in GHG emissions-Contribution of the Project

The following table presents the total net GHG emissions, from the present project which have been calculated by Jasper's calculation model.

Table 8-12: Project's Net GHG emissions

With Project Scenario	2016	2020	2025	2030	2035	2040	2043
Net GHG emissions, t CO_2-eq	21,109	-16,035	-16,406	-16,499	-16,342	-16,122	-15,969

The percentage of reduction in year 2020 in greenhouse gas (GHG) emissions with the scenario of the implementation of the project, compared by year 2016 year, has been calculated to 160%.

8.5 CLIMATE CHANGE ADAPTATION / RESILIENCE

8.5.1 Background on Climate change

The increase in global surface temperature is the most obvious aspect of anthropogenic climate change. In case the future greenhouse gas emissions remain at current levels or increase, further warming up would appear and it will start many changes within the global climate system, probably even larger ones than it was observed in the 20th century. The average temperature for the European land area for the last decade (2002-2011) is 1.3°C above the pre-industrial average, which makes the increase over Europe faster than the global average. Moreover, significant economic losses and human facilities associated with extreme weather events, such as heat waves, droughts and heavy precipitation, have been registered.

Even small climatic changes can have significant implications. The hot summer of 2003 across Europe was a 1 in 500 year event. It led to more than 35,000 deaths and economic impacts in many countries. By 2040, due to rising temperatures, this is expected to be a 1 in 2 year event.

Projected changes in temperature and precipitation across the EU region in the coming decades are shown in the following figures. The key points can be summarized as follows:

- Wintertime temperature increases are expected to be greater in north-east Europe (+2.5-3.0 °C by the 2050s) than in south-west.
- Summertime temperatures may increase in south Europe by up to 2.5°C by the 2050s. Given that these countries already experience some of the hottest summer temperatures in the region, these increases are expected to have detrimental impacts on many most industry sectors, the environment and society.
- Average winter precipitation is projected to increase in Europe. Some countries in northern Europe may see in excess of 25% increase by the 2050s. However, some in southern Europe are more likely to experience decreases, with consequential impacts on water users.
- Average summer precipitation is projected to decrease generally in southern Europe, with some countries projected to see decreases of up to 50% by the 2050s. Couples with higher summer temperatures this could lead to increased water stress, impacting particularly on high water use sectors.

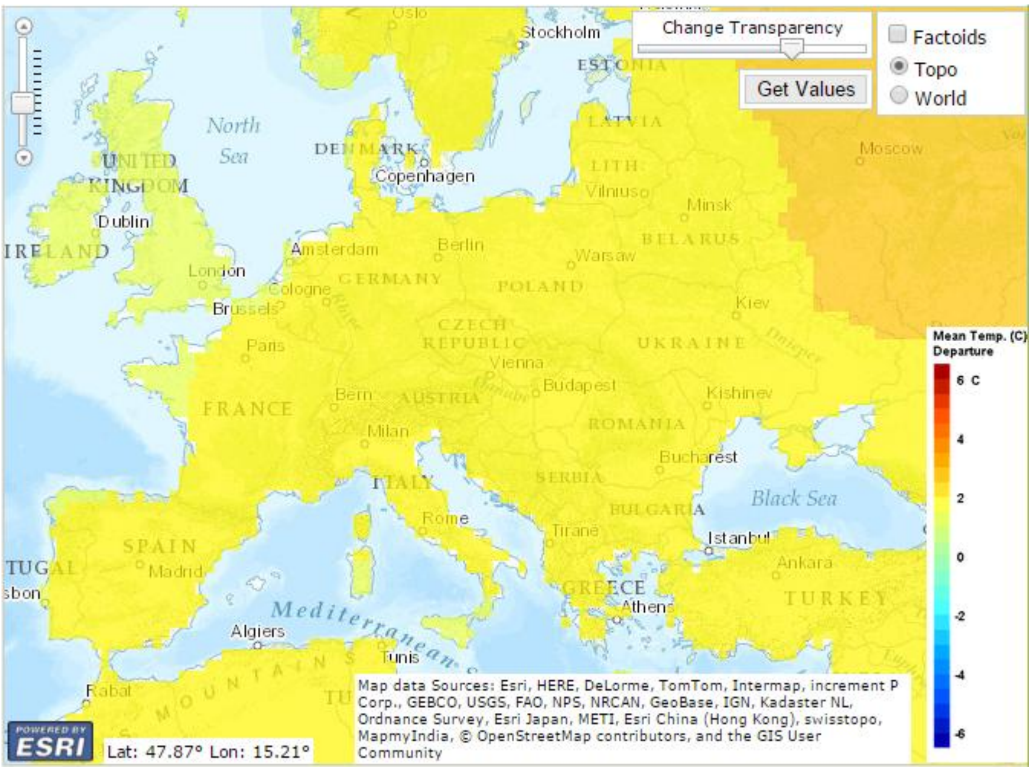


Figure 8-10: Temperature change projected by the middle model as compared to the 1961-1990 baseline average[2]

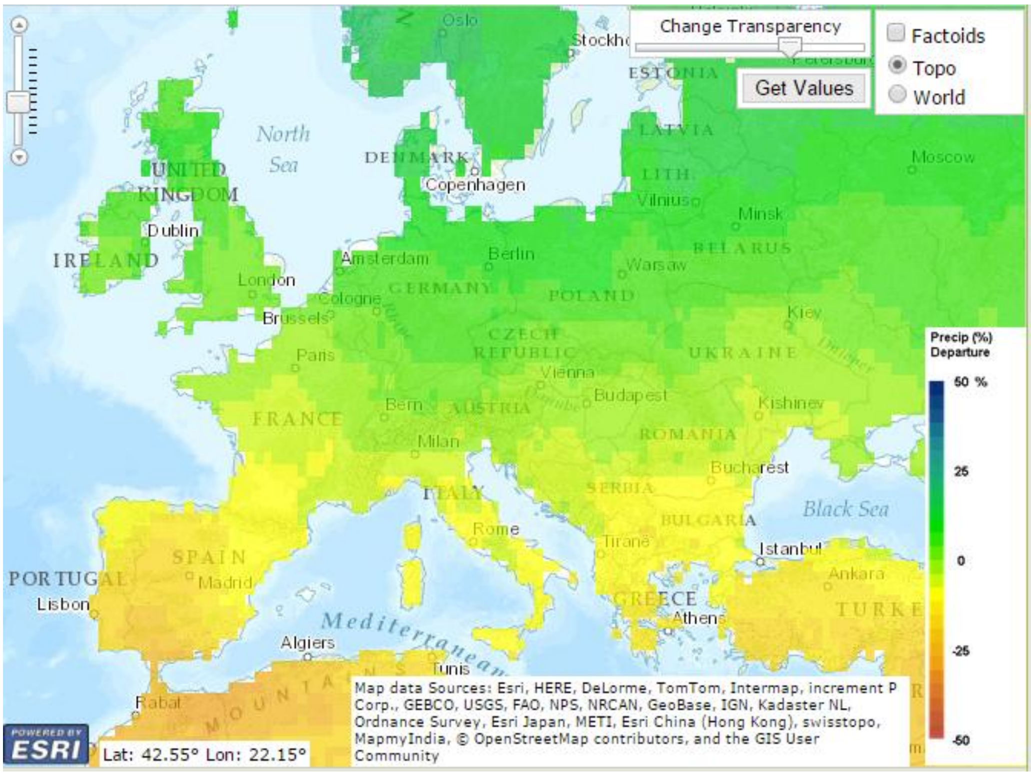


Figure 8-11: Precipitation change projected by the middle model as compared to the 1961-1990 baseline average

[2] Climate Wizard data portal http://www.climatewizard.org/

Climate stressors can impact solid waste facilities both directly and indirectly. For example, while higher temperatures may directly alter decomposition rates, climate change may also affect access to roads, ports and energy, indirectly liming the collection of waste and operation of waste management sites.

Flooding poses the biggest threat to solid waste infrastructure. Without proper water catchment systems around a landfill, heavy rain events can degrade the landfill, causing breaks in the containment structure that allow debris and leachate to escape from the landfill and contaminate local resources. Flooding from extreme storms may undermine landfill foundations, releasing leachate into groundwater or block collection routes, sweep waste into waterways, and cause waste to clog other infrastructure. Landfills near the coast or in low-lying areas are vulnerable to sea level rise and storm surge. Water infiltration of the pit can lead to an overflow of waste from the landfill. Saltwater infiltration from below can deteriorate the impermeable lining of sanitary landfill facilities.

Temperature increases may necessitate more frequent waste collection schedules and rigorous landfill management practices, as odours will be stronger. Higher temperatures and drought may also increase the risks of fire at waste facilities.

These and other climate change risks vary in relative importance, with a range of cost implications, compounding effects and impacts on development objectives.

The following table presents examples of potential climate change impacts on Solid Waste Management infrastructure and services.

Table 8-13: Examples of potential climate change impacts on Solid Waste Management infrastructure and Services

	Collection	Processing	Disposal
Temperature change	Increased odor and pest activity requiring more frequent waste collection	Overheating of sorting equipment	Altered decomposition rates
	Overheating of collection vehicles requiring additional cooling capacity, including to extend engine life		Increased maintenance and construction costs due to melting permafrost
			Increased risk of fire at disposal sites
	Greater exposure of workers to flies, which are a major cause of infectious diseases (flies breed more quickly in warm temperatures and are attracted to organic waste)		
Precipitation change	Flooding of collection routes and landfill access roads, making them inaccessible	Increased need for enclosed or covered sorting facilities	Increased flooding in/around sites
	Increased stress on collection vehicles and workers from waterlogged waste		Increased leachate that needs to be collected and treated
			Potential risk of fire if conditions become too dry and hot
Sea Level Rise	Narrowed collection routes	Damage to low-lying processing facilities	Deterioration of impermeable lining
	Potentially increased waste in concentrated area as people crowd into higher elevations within and urban area	Increased need for sorting and recycling to minimize waste storage needs	Water infiltration of pit leading to possible overflow of waste
	Permanent flooding of collection, processing and disposal infrastructure		
Storm Surge	Temporary flooding of and diminished access to roadways, rails, and ports for waste collection, sorting and disposal		
	Closure of facilities de to infrastructure damage		
Extreme Wind	Dispersal of waste from collection sites, collection vehicles, processing sites and landfills		
	Reduced access to collection and landfill access routes due to damage and debris		

8.5.2 General characteristics of the beneficiary country’s climate

The climate on the beneficiary country is characterized as continental Mediterranean. Further information in paragraph 8.2.2.

8.5.3 Observed Climate Change in the beneficiary country

Detection of climate variations and changes in air temperature and precipitation over the area of the beneficiary country since the beginning of the 20th century has been performed according to the long-term meteorological measurements that started during the 19th century at meteorological stations in different climate regions, data extracting from the hydrometeorological institute of the beneficiary country (Ristevski P. et al - Estimation of Climate Change Impacts in Republic of Macedonia, http://www.meteo.gov.mk/).

Characteristics of the changes of temperatures and precipitation are shown for 5 meteorological stations of Republic of Macedonia (Skopje, Bitola, Prilep, Shtip and Demir Kapija) for annual values for January and July values for the period from 1926 to 2000. It means that the only data for region with continental-sub-Mediterranean climate are available, as well as region with hot continental climate.

Air temperature

Changes in thermic regime of the air in the period from 1926 to 2000 during January are rapid changeable values and in the period from 1926 to 1938 are over average ones. The hottest period occurred in the period from 1970 to 1972 when air temperatures were measured and on appropriate way leveled and which are in the limits between 4.1 °C in Skopje and Bitola, 3.8 °C in Prilep, 5.3 °C in Shtip to 6.1 °C in Demir Kapija. The lowest values were recorded 1942 (-6.6 °C in Bitola and Prilep, -6.7 °C in Skopje, -4.5 °C in Shtip and -4.6 °C in Demir Kapija), 1975 (-7.7 °C in Bitola and -4.8 °C in Prilep), 1993 (-7.2 °C in Bitola and -4.9 °C in Prilep) and in January 2000 (-6.8 °C in Bitola and -5.4 °C in Prilep).

During July greater stabilities of the values appeared where the higher values than average ones appeared in the period from 1926 to 1964 and from that time determined decreasing of temperatures began in that month which last to 1988 when the maximum appeared which is between 25.6 °C in Bitola to 25.7 °C in Prilep, 27.1 °C in Shtip, 28.2 °C in Demir Kapija to 27.0 °C in Skopje. The lowest value of long cold period appeared 1976 when average air temperature was 19.8 °C in Bitola and Prilep, 21.4 °C in Shtip, 22.8 °C in Demir Kapija to 21.3 °C in Skopje.

The hotter years in 20th century happened in Republic of Macedonia in the period of the beginnings of the analysis (1926) to 1966 when period with determined decreasing of air temperature began and lasted to 1991. From that period determined trend of increasing of annual air temperature has appeared. The lowest value of air temperature appeared 1975 when the following annual values were recorded: 10.1 °C in Bitola, 10.6 °C in Prilep, 12.6 °C in Shtip, 13.0 °C in Demir Kapija to 12.0 °C in Skopje.

Precipitation

Changes in precipitation in Republic of Macedonia are investigated also for the five above mentioned meteorological stations: Bitola, Skopje, Prilep, Shtip and Demir Kapija for the annual values for the most precipitative months: November and May as well as for the driest month in Republic of Macedonia (August).

On the basis of annual sums of precipitation common trend of decreasing of precipitation can be remarked especially from 1984 which are more expressive in the eastern parts of Republic of Macedonia. The common decreasing of precipitation occurred at May precipitation especially from 1980 (for example in Prilep and Shtip) as well as at November precipitation in the period from 1984 until now.

August monthly sums of precipitation are very changeable values and they vary from year to year at each station. The change of precipitation in Bitola and Prilep is characteristic. The most characteristic dry period was between 1984 and 1994.

According to the report "Third National Communication on Climate Change" an analysis was made of the variability of key climate elements (air temperature, precipitation, solar radiation etc) in the country for the period from 1926 to 2012. Data for this period were collected at the meteorological stations in Skopje, Shtip, Bitola, Prilep and Demir Kapija. These metering station with shorter data series in the country. Experts also analysed the period from 1951 to 2012 with data collected at metering stations with shorter data series in Lazaropole, Ohrid, Prilep, Berovo, Kriva Palanka, Gevgelija and Strimica. Were also analysed individually (Source: www.unfccc.org.mk).
Comparisons were based on three 30-year series, and the periods from 1971 to 2000 and from 1981 to 2010 were compared with the period from 1961 to 1990. Decade values for the periods from 1931 to 2010 were also compared with the period from 1961 to 1990. The results concerns air temperature, precipitation and extreme temperature.

Air Temperature
Analysis of the multi-year variation of the mean annual temperature shows that in the 1950 decade, relatively higher air temperatures were measured in all meteorological stations on the whole territory of the beneficiary country. After this period, there was a relatively colder 20-year period (1971-1993), while in the most recent 20 years (1994-2012) the mean annual temperature has been constantly higher than the multi – year average. The multi – year variation of the average annual air temperature during this 87 – year period given in the table below.

Table 8-14: Temperatures at various meteorological stations

Station	Multi-year variation of average annual air temperature for the period 1926 to 2012	Average mean annual temperature for the period 1961-1990	The difference in the average annual air temperature for the whole period (1926-2012) compared to the average annual temperature for the period between 1961 and 1990
Bitola	10.1°C and 13.2°C	11.0°C	0.4°C
Skopje	10.8°C to 14.3°C	12.1°C	0.3°C
Shtip	11.2°C to 14.3°C	12.6°C	0.4°C
Prilep	10.1°C to 14.3°C	11.1°C	0.3°C

The warmest years recorded on the territory of the country for the period between 1951 and 2012 and for which data from all meteorological stations are available are 1952, 1994, 2007, 2008 and 2010. Among the ten warmest years from the period 1951-2012, five of the last six most recent years are included (2007, 2008, 2009, 2010 and 2012). The highest maximum air temperatures in the country in most of the meteorological stations were measured on july 24, 2007. At the meteorological station in Demir Kapija, unprecedented 45.7^{0}C was measured, which is the highest air temperature ever measured on the territory since the beginning of meteorological measurement. The highest mean monthly temperatures in July were measured in 1988, 2007 and 2012.

The five coldest years measured in almost all meteorological station are 1973, 1976, 1980, 1983 and 1991. The lowest value of the minimum air temperature on the territory of the country is -30.4^{0}C and it was measure on January 7, 1993 in Bitola.
General conclusion that can be reached based on the analysis is that the periods from 1971 to 2000 and from 1981 to 2010 are warmer compared to the period from 1961 to 1990. According to the following figure, the most recent thirty years period (1981 – 2010) is the warmest, and the differences in the average mean annual temperature in comparison with the period from 1961 to 1990 range from 0.2^{0}C to 0.5^{0}C. This increase in the temperature is consistent with the results from reports from the broader region.

Figure 8-12: Average air temperature. Deviation of the average of two periods 1971-2000 and 1981-2010 from the 1961-1990 period

<u>Precipitation</u>

A similar analysis of precipitation for the different regions of the country by years and by seasons with special focus on May and November as the months with the most rainfall throughout the year indicated a general trend of decrease in rainfall. However, due to the fluctuations in levels of precipitation from year to year, it is difficult to establish the exact amount of this decrease in annual precipitation totals.

The quantity of total annual precipitation for the period 1971-2000 and the period 1981 – 2010 at all meteorological stations in the county is lower than for the period 1961-1990 with the exception of the meteorological station in Bitola. The following figure indicates the less precipitation at most meteorological stations during the 1971-2000 period compared to the other two periods.

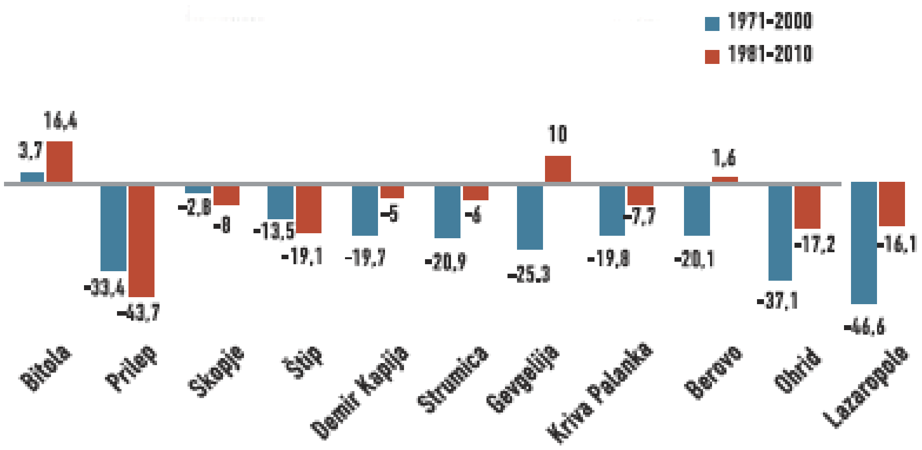


Figure 8-13: Total average precipitation. Deviation of the thirty year average in two periods 1971 – 2000 and 1981 – 2010 from the 1961 – 1990 period

Annual reduction in precipitation is expressed most strongly at the meteorological stations in Prilep, Ohrid and Lazaropole. Changes in precipitation by months and by seasons vary. A higher decrease in precipitation across the country has been observed in spring. In all stations in autumn and in some stations in summer there is an increase in the precipitation in the two periods from 1971 to 2000 and from 1981 to 2010.

<u>Extreme temperatures</u>

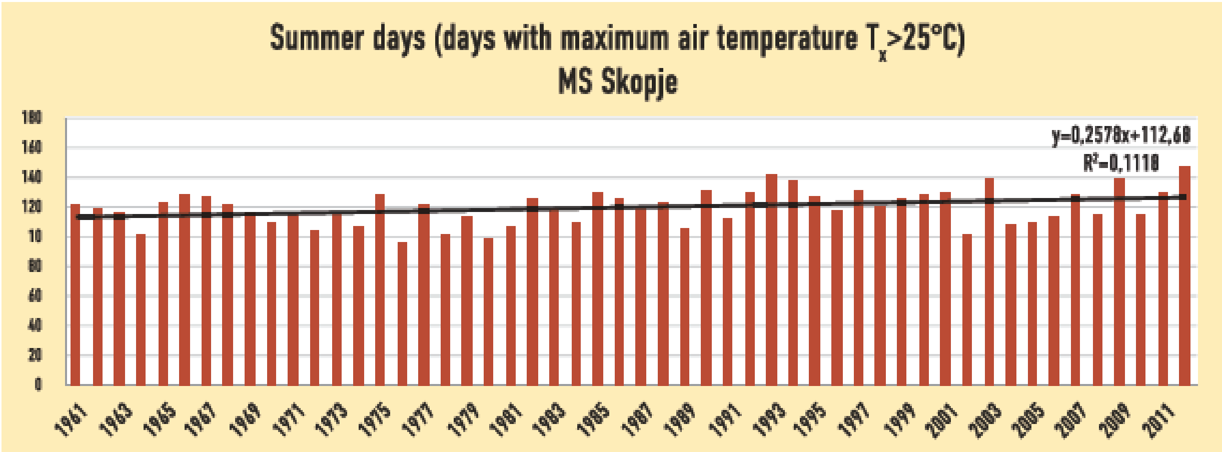
This section presents analysis of extreme air temperature conditions recorded in the beneficiary country, including the occurrence of the heat waves and cold waves, tropical and summer days, and frost and ice days. Daily maximum and minimum air temperatures were taken from statistics from 11 main meteorological stations for period from 1961 to 2012. Researchers paid special attention to Skopje, Shtip and Bitola (as the most representative stations for the main climate regions) and at (Strumica, Demir Kapija and Gevgelija (as representative stations for the southeast region, the most vulnerable to climate change).

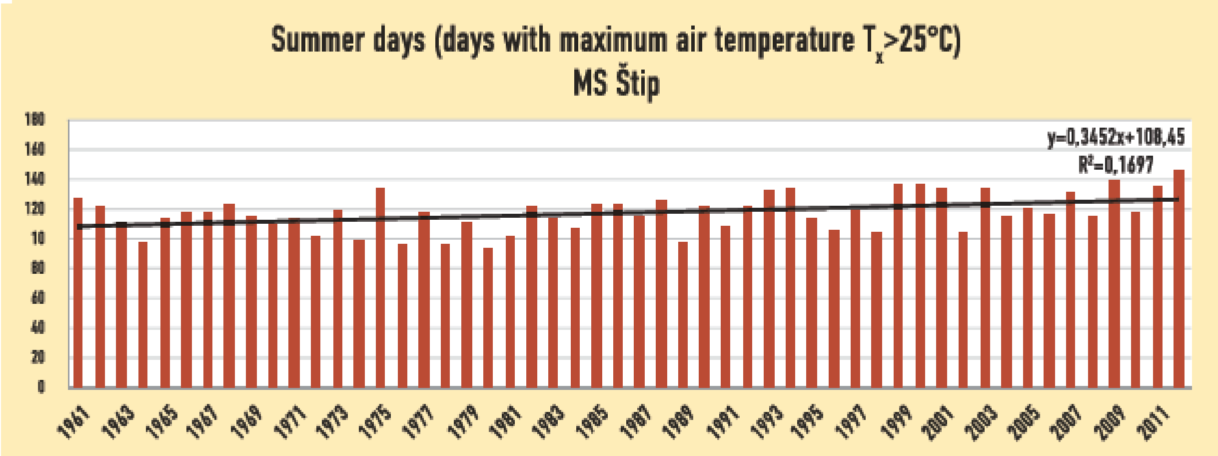
On the basis of maximum daily air temperature values, it was concluded that the frequency of heat waves decreases in correlation to the length of their duration, with the most frequently occurring heat waves being those of the shortest duration.

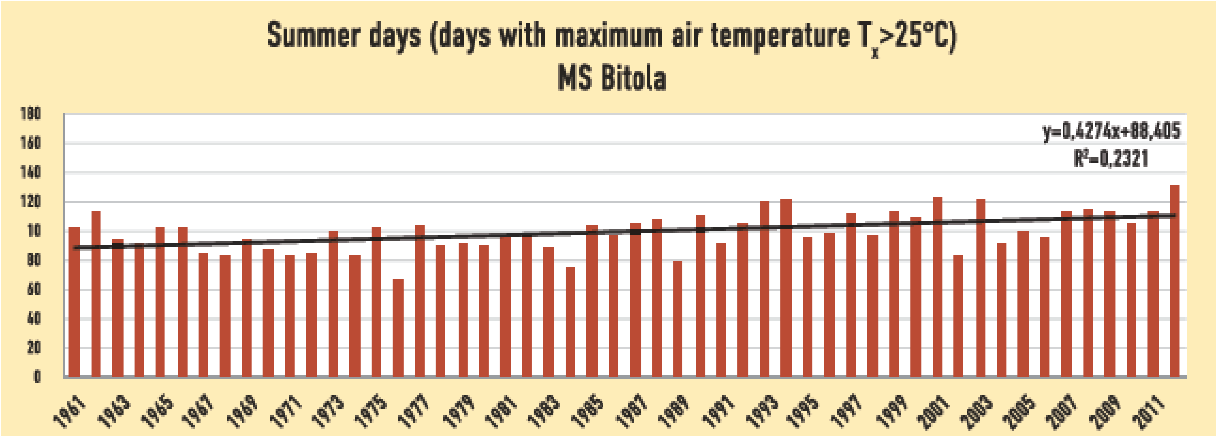
Researchers also found that the total number of recorded waves was unevenly distributed over time. Increases in frequency were also observed in various cities. In contrast to the period 1961-1987, a heat wave is recorded almost every year starting in 1987. It can also be noted that the greatest frequency of heat waves has occurred in the last ten years, with maximum occurrences at the greatest number of stations in 2012 and 2007. During 2012, 10 heat waves were recorded in Kriva Palanka, 8 in Skopje, Shtip, Lazaropole and Demir Kapija, 7 in Gevgelija and Berovo, 6 in Bitola, 5 in Strumica and Prilep and 3 in Ohrid.

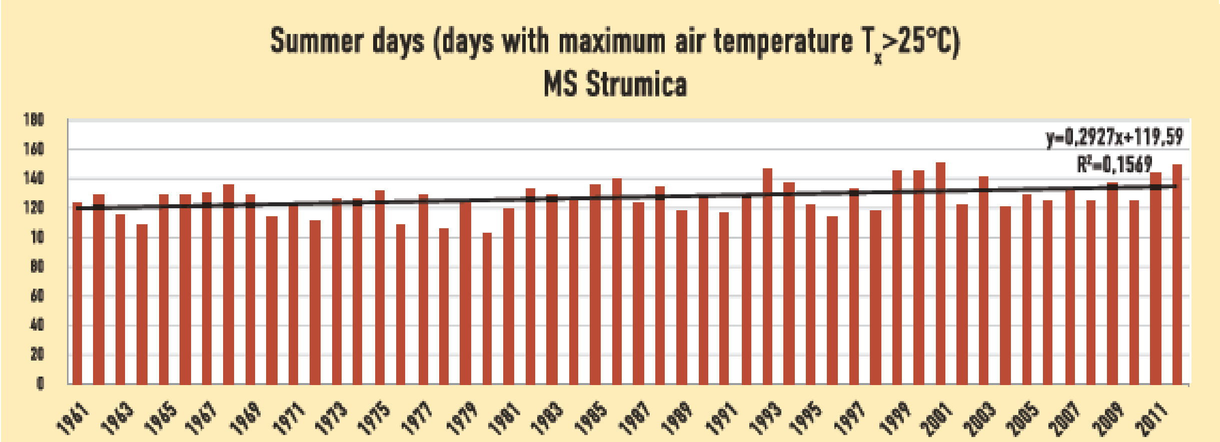
The following figure shows the number of summer days by years recorded the five main meteorological stations for the period 1961 to 2012 illustrating that the number of summer days has significantly increased in recent years as compared to the number at the beginning of the analysed period. Similarly there has been a significant increase in the number of tropical nights in recent years.

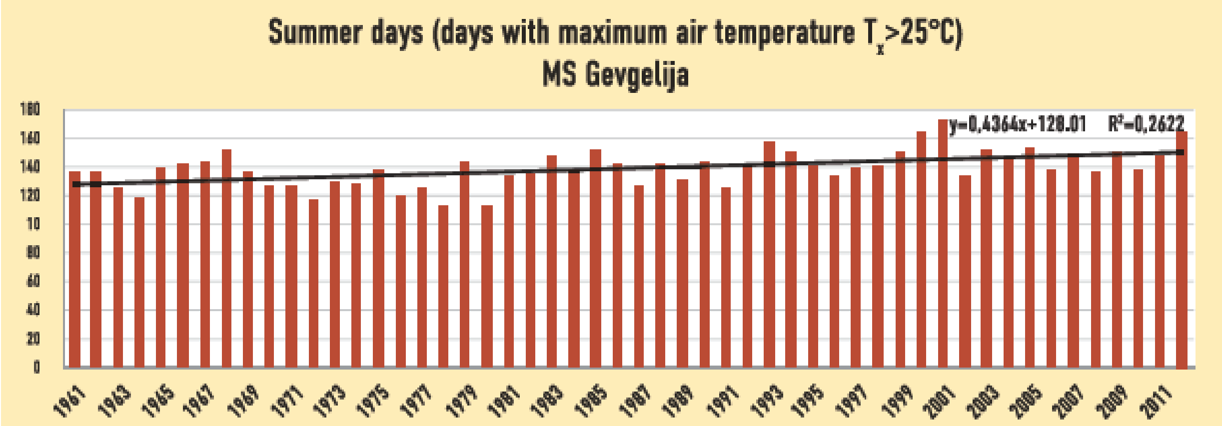
Figure 8-14: Summer days (days with a maximum air temperature of Tx>25°C in Selected areas for the period 1961 – 2012











8.5.4 Climate changes in the 21st century

In this paragraph information and data extracted from the report "Third National Communication on Climate Change" (Source: http://www.unfccc.org.mk/Default.aspx?LCID=207).

The climate change projections developed for the beneficiary country as part of the preparation of the Third National Communication were carried out with the help of the MAGICC/SCENGEN software package. Most climate projections use storylines and the associated emissions scenarios published by the IPCC in 2000 in the Special Report on Emissions Scenarios (SRES) (Nakicenovic and Swart, 2000).The SRES emission scenarios are organized into families, which contain scenarios that are based in similar assumptions regarding demographic, economic and technological development. The six families of emissions scenarios discussed in the IPCC's Third Assessment Report (TAR) and Fourth Assessment Report (AR4) are A1F1 ("fossil intensive"), A1B ("base"), A1T ("technology"), A2, B1 and B2.

Furthermore an assessment of air temperature and precipitation changes has been made for the period 2025-2100, comparing these changes to those in the period 1961-1990, which was chosen as a point of reference. In accordance with the recommendations of the software for removing inter-annual fluctuations and indeterminacies, the results obtained represent a mean state for the thirty-year period, with the central year selected to represent the period. Assessments were made for four characteristics years:

- 2025, the central year for the period 2011-2040
- 2050, the central year for the period 2036-2065
- 2075, the central year for the period 2061-2090
- 2100, representing the central year for the period 2086-2100

On the basis of average global changes in temperature for a certain year, scenarios are generated for the beneficiary country that estimate changes in the amounts of temperature and precipitation in the selected years by employing the SCENGEN component as the generator of scenarios. Data from the 18 models were used in the estimation, generating complete results suitable for further use. The generated scenarios have a spatial resolution of 2.5° x 2.5°. In regard to the geographical location to Macedonia, it is covered by two quadrants (A and B) of generated scenarios out of the 10,368 that cover the whole planet. Results were generated for two central points: A (41.25^0 N, 21.25^0 E) and B (41.25^0 N, 23.75^0 E). Data generated at point A are valid for the largest part of the territory while the data generated at point B are only valid for the eastern part. Scenarios were generated for the four characteristic years, for each central point, for each of the three values of climate sensitivity and for each of the six scenarios. Values were produced for air temperature and precipitation changes as follows: for twelve months from January to December and for four seasonal periods. The values obtained for changes in air temperature and precipitation for each year are averaged for the three values of climate sensitivity and for each scenario.

Air temperature

The following table shows the mean air temperature changes at central point A. All of the values presented are positive, meaning that an increase in air temperature is predicted in the period 2025-2100. Temperature changes are given below. The data indicate an increase in air temperature throughout the whole period 2025-2100. These changes are greatest in the summer period. The changes marked with "high" and "medium high" have the highest gradient of increase (for the period between 2025 and 2100). The changes marked with "low" are develop more moderately.

An examination of the highest, medium and lowest changes predicted for the mean monthly air temperature for central point A, per month and per year for 2025, 2050, 2075, and 2100 revealed the following:

- For all the selected years, all changes in air temperature are positive, meaning an increase in mean monthly temperatures
- The intensity of changes is greatest in the warmest period of the year from the May to October, when a significant difference appears in temperature changes between adjacent months.
- Inter-monthly changes in air temperature are more moderate in the coldest period of the year from November to April.
- In July there is a primary and in February a secondary (almost twice as small) maximum of changes
- In April there is a primary and in December a secondary (almost twice as small) minimum of changes.
- The greater changes in temperature predicted in February in comparison to the changes in March and April indicate a possible levelling of the average monthly temperatures in this period.

An analysis of quarterly changes shown in the model for point A led to the following additional conclusions:

- It is probable that there will be a continuous increase in temperature in the period 2025-2100
- Compared with the period 1961-1990, the predicted changes for the period 2025-2100 will be most intense in the warmest period of the year. Thus summers will be warmer and warmer, and the rise in temperature greater. The air temperature is also expected to increase, through with less intensity, in the coldest period of the year.
- It is possible that the average monthly temperatures at the winter into spring will be levelled in this period.

A similar process was used to determine results for central point B in order to describe changes in air temperature and precipitation in the easternmost part of the country. The analysis made for the results at point A were also valid for the results at point B, with the exception of minor differences in the change values. Although these differences between predicted air temperature changes at central point A and central B appear slight, they range from -0.3^{0}C to 0.2^{0}C. The differences indicate the influence of local geographic situations on climate conditions and changes. Nevertheless, these differences are not so dramatic to require significantly different measures to be taken for adaptation to climate change and mitigation related to increased average air temperature in the future for points A and B. For the whole territory of the beneficiary country, only the results generated from central point A (which is representative of almost three quarters of the country) could be used with a great certainty.

Table 8-15: Predicted changes in air temperature for central point A (41.25^{0}N, 21.25^{0}E) for the years 2025, 2050, 2075 and 2100, presented both separately for the four annual seasons and annually (Year/A)

	DJF /A				MAM /A				JJA /A				SON /A				Yeat/A			
	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100
High	1.1	2.4	3.8	5.0	1.4	3.0	4.6	6.2	2.4	4.8	7.9	10.0	1.5	3.0	5.0	6.7	1.6	3.3	5.3	7.1
Medium high	0.9	1.9	3.0	3.9	1.1	2.4	3.6	4.8	1.9	3.8	6.2	8.2	1.2	2.4	3.9	5.2	1.3	2.6	4.2	5.5
Medium	0.8	1.5	2.2	2.7	1.0	1.8	2.7	3.3	1.7	3.0	4.6	5.8	1.1	1.9	3.0	3.7	1.2	2.0	3.1	3.9
Medium low	0.7	1.0	1.5	1.7	0.9	1.3	1.9	2.1	1.6	2.1	3.4	3.9	1.0	1.3	2.2	2.5	1.1	1.4	2.2	2.5
Low	0.5	0.8	1.1	1.1	0.7	0.9	1.4	1.4	1.2	1.5	2.4	2.7	0.7	1.0	1.6	1.8	0.8	1.0	1.6	1.7

DJF=winter, MAM=spring, JJA=summer, SON=autumn

Table 8-16: Overview of projected changes in precipitation at Central Point A for the 4 years selected

	DJF /A				MAM /A				JJA /A				SON/A				Yeat/A			
	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100
Low	-1	-3	-2	-1	-2	-5	-7	-9	-4	-12	-29	-36	-1	-5	-8	-9	-2	-6	-8	-8
Medium low	-1	-4	-3	-2	-2	-6	-10	-12	-6	-15	-38	-47	-1	-7	-10	-13	-3	-8	-10	-12
Medium	-3	-6	-7	-9	-3	-8	-13	-17	-13	-25	-46	-57	-2	-9	-14	-20	-4	-10	-15	-19
Medium high	-4	-8	-11	-16	-4	-9	-17	-23	-20	-38	-54	-66	-4	-11	-21	-27	-5	-11	-21	-27
High	-5	-10	-14	-20	-5	-12	-21	-29	-25	-48	-68	-80	-5	-14	-25	-34	-6	-14	-25	-33

DJF=winter, MAM=spring, JJA=summer, SON=autumn

Precipitation

The above table indicates, all values are negative. This means that a decrease in precipitation is predicted in the period 2025-2100. In all seasons and the annual level there is a decrease of precipitation quantities, with the maximum decrease in the summer season. The following conclusions can be drawn from the data:

- For all selected years, all precipitation changes are negative. (This means a decrease in mean precipitation sums)

- In areas with high levels of change, there is only one insignificant increase in precipitation (1%) in February (in 2015).
- In the areas with low changes, there is an increase in precipitation in February for all years (up to 5%), in April (for 2025), and in July and November for 2025.
- In the areas of medium changes there is a slight (up to 3%) increase in precipitation for all years in February for 2025
- The intensity of changes is greatest in the warm part of the year. In July and August, the intensity of changes may reach 100%, meaning these months will probably have no precipitation at all
- In the cold period of the year, decreases in precipitation of up to 40% of the average monthly quantities are predicted.

An analysis of the data by season produced the following findings and conclusions:

- A decrease in average precipitation quantity
- For all years (2025-2100) there is a maximum decrease in precipitation in summer (June, July and August)
- In summer the precipitation decrease will be greater and faster than in other seasons
- Decreases will be more moderate in the cold part of the year
- It is probable that there will be a continuous decrease in the quantity of precipitation in the period 2025-2100
- The predicted changes will be most intense in the warm part of the year, meaning summers will be drier and some summers months (July and August) may have no precipitation. (In the previous period with archived data, some months were also recorded as having had no precipitation)
- A less intense decrease in precipitation is expected in the cold part of the year

The results for Central point B describe the change in the quantity of precipitation in the eastern most part of the territory. The analysis carried out of results for Central Point A is also valid for results in Central Point B, with the exception of a slight difference in the changes. Although these differences are slight (less than 1%), the data indicate that there will probably be a greater decrease in precipitation in the parts of the territory covered by point A than in the easternmost part. In the other part of the year, the difference between changes in Central point A and Central Point B range from +1% to -6%. This indicates greater decrease in precipitation in the eastern parts of the country in the warmer part of the year, especially in summer, than in any other part of the territory. These differences are indicative of the influence of the local geographical situation on climate conditions and changes. However they are not dramatic and generally do not require significantly different measures and activities to adapt and mitigate climate change. This means that the results generated for Central Point A, which covers almost three quarters of the territory, could be used with great certainty for the whole territory of the Republic of Macedonia.

In general, the characteristics of projected changes in air temperature and precipitation for the period of study were as follows:

- Changes are predicted throughout the whole 2025-2100 period, and an increase in temperature is probable
- The temperature increase will be most intensive and significantly in the summer, and summer will probably be increasingly warmer
- It is likely that the spring and summer temperature changes (and therefor the average seasonal air temperatures in the eastern part of the country) will be higher compared to the rest of the country
- There will be a continual decrease in precipitation. The greatest changes, in the warm part of the year, will be perceptible at the seasonal and annual level. At the monthly level, a total lack of precipitation is probable in July and August, while in February there will be a minimal increase

when compared with the average values. However, this increase will not be noticeable at the annual level

- In the warm part of the year the projected precipitation changes in the eastern part of the country are more severe than in the rest of the country
- For reasons summarized in the sections above on temperature and precipitation findings, the results generated for Central Point A, which is representative of almost three quarters of the country, can be used with a fair amount of certainty for the whole territory.

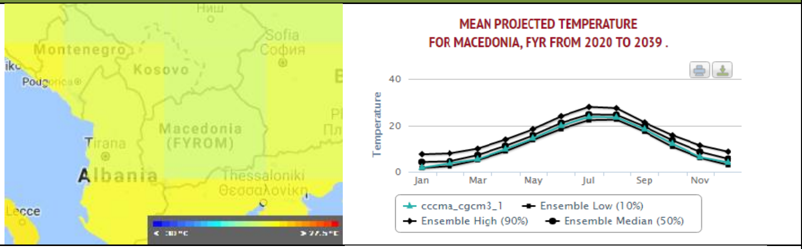
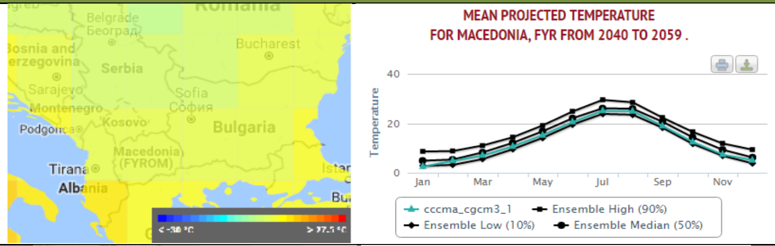
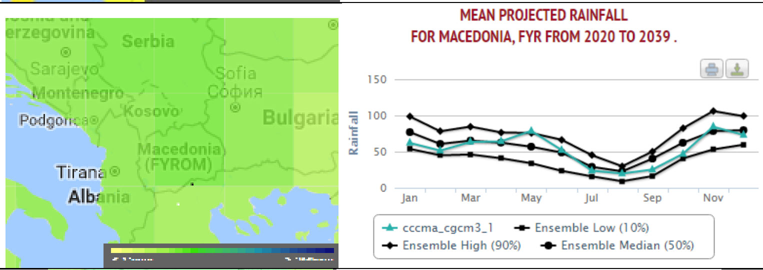
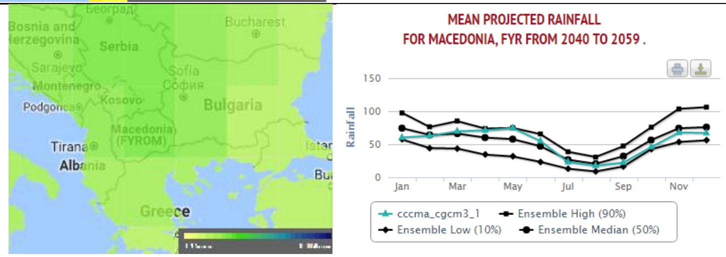
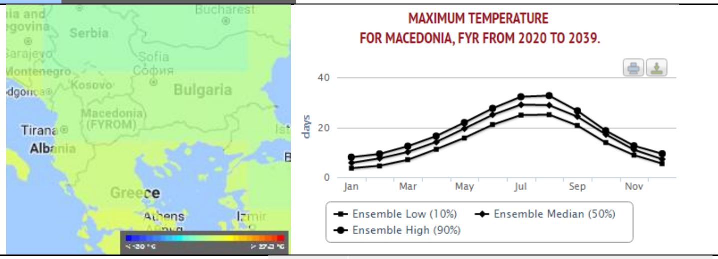
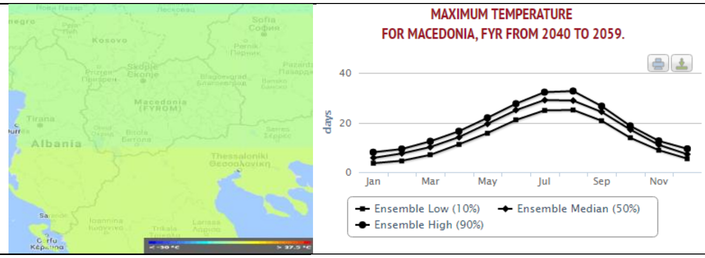
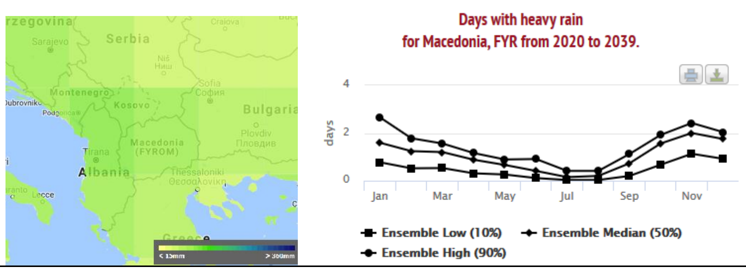
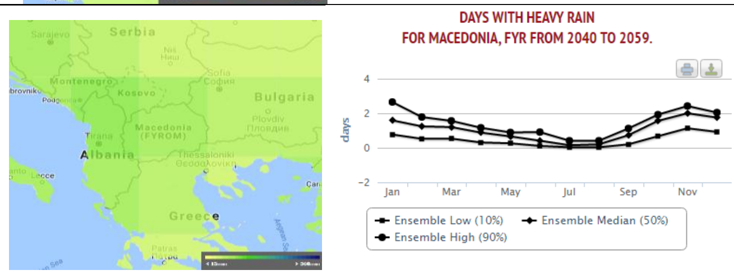
In accordance with the methodology of the study, involving averaging the results of six basic scenarios, the presented results should be taken inly as guidance. The significance and influence of the absolute values for the temperature and precipitation changes, as well as the differences between these changes, will depend on the macro and micro locations of the regions taken into consideration.
Future climate science research results for the beneficiary country for several variables and time periods are provided by the World Banks Climate Change Knowledge Portal (CCKP). The portal consists of a Google map interface and information on historical climatology, climate change projections -from the IPCC Fourth Assessment Report ensemble of Global Circulation Models (GCMs) - and climate related information.

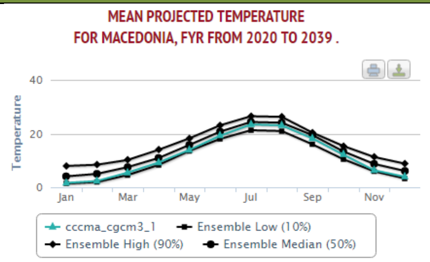
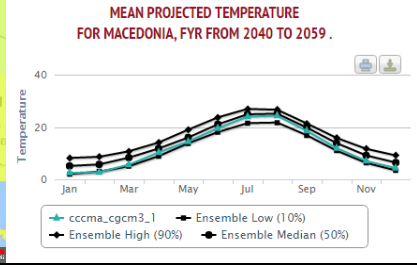
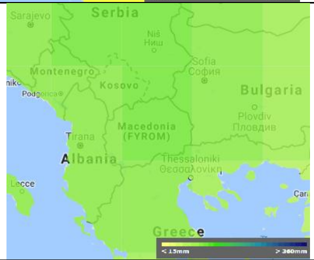
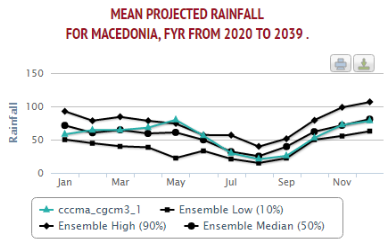
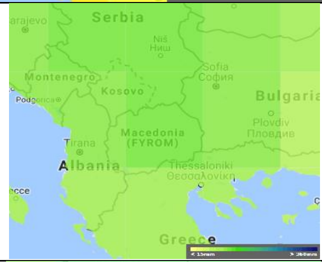
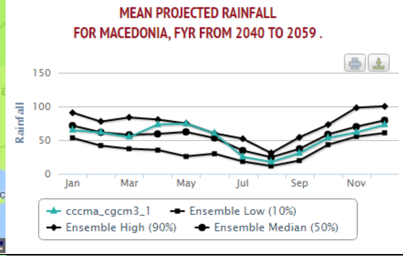
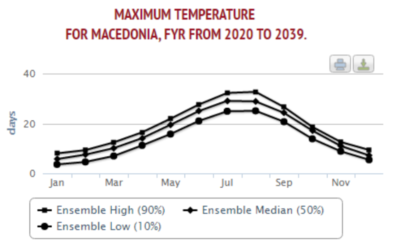
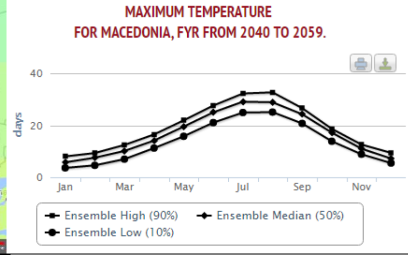
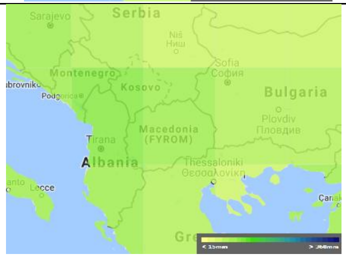
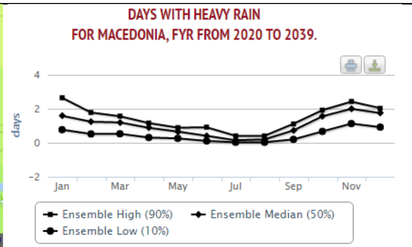
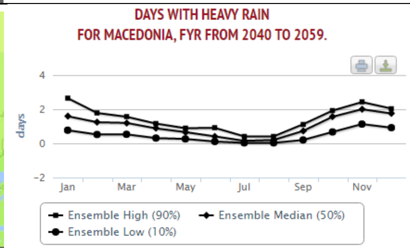
The following table shows projected changes calculated from a 40 year historical control period covering the years 1960-1999 for four variables for time periods 2020-2039 and 2040-2059 according to two SRES emissions scenarios families, A2 and B1 where:

A2: The A2 scenario describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is primarily oriented and per capita economic growth and technological change more fragmented and slower than in other scenarios.

B1: The B1 family describes a convergent world with the same global population, which peaks in the mid-century and declines thereafter, as in A1, but with rapid change in economic structures toward a service and technological change more fragmented and slower than in other scenarios.

Table 8-17: Future climate change projections for the beneficiary country

<table>
<tr><th colspan="3">Scenario A2</th></tr>
<tr><th></th><th>2020-2039</th><th>2040-2059</th></tr>
<tr><td>Temperature</td><td>
</td><td>
</td></tr>
<tr><td>Rainfall</td><td>
</td><td>
</td></tr>
<tr><td>Maximum Temperature</td><td>
</td><td>
</td></tr>
<tr><td>Heavy Rain</td><td>
</td><td>
</td></tr>
</table>

Scenario B1		
	2020-2039	**2040-2059**
Temperature	 	 
Rainfall	 	 
Maximum	 	 
Heavy Rain	 	 

8.5.5 Policy framework, priorities and measures for climate change, mitigation and adaptation to climate change

The Republic of Macedonia is a party to the United Nations Framework Convention on Climate Change (UNFCCC) as a non-Annex I country and party to the Kyoto Protocol without a quantified emissions limits and reduction commitment (QELRC). However, the country has acceded to the Copenhagen Accord, and it submitted a list of mitigation actions (without quantifying the associated emission reductions) based on these actions.

The **Ministry of Environment and Physical Planning (MOEPP)** is the key governmental body responsible for development of climate change policies. MOEPP has been designated as the National Focal Point to the UNFCCC and as Designated National Authority (DNA) for Kyoto Protocol implementation and is therefore the key governmental body responsible for coordinating implementation of the provisions of the Convention and the Protocol. Other ministries that have responsibilities related to climate change are: Ministry of Agriculture, Forestry and Water Economy, Ministry of Economy, Ministry of Transport and Communication, and Ministry of Finance. Most of these ministries have appointed Climate Change Focal Points, who are responsible for mainstreaming climate change into respective policies, strategies and programmes. In addition, the Ministry of Health established a National Committee for Climate Change and Health in 2009 to serve as the responsible body for surveillance activities and decision-making in that area.

Key ministries in charge of individual policies affecting mitigation are the Ministry of Environment and Physical Planning, the Ministry of Economy which implements many of the policies, activities and projects that directly and indirectly impact climate change mitigation in the energy sector, the Ministry of Agriculture, Forestry and Water Economy who is in charge of the policies and their implementation for the agriculture and forestry sectors vis-à-vis climate change mitigation and adaptation and the Ministry of Transport and Communications. Additionally, the National Climate Change Committee has an information collection and coordinating role for climate change policies.

In January 2000, the **Climate Change Project Office** was set up within MOEPP. In addition, a **National Climate Change Committee** (NCCC) was established by the Government consisting of representatives of all relevant stakeholders: government bodies, academia, private sector and civil society. The NCCC is a participatory platform aimed at providing high-level support and guidance for overall climate change policies in the country. Moreover, a **National Council for Sustainable Development** has also been established to advise on economic affairs.

At the legislative level, climate change issues are incorporated into the Law on Environment, including details on the preparation of GHG emissions inventories as well as an action plan on measures and activities to abate the increase of GHG emissions and to mitigate the adverse impacts of climate change. The **Law on Environment** stipulates that a National Plan for climate change is to be adopted for the purpose of stabilizing GHG concentrations at a level that would prevent any dangerous anthropogenic impact on the climate system within a timeframe sufficient to allow ecosystems to naturally adapt to climate change, in accordance with the principle of international cooperation and the goals of the national social and economic development. In July 2013, changes in the Law on Environment were adopted, and a new article (188) has been added regarding the national system of GHG emissions inventories. This article foresees that a national system of inventories of GHG emissions will be established and that this system will provide a database of relevant information for the preparation of GHG inventories as well as monitoring of the implementation of agreements regarding climate change. This system incorporates collection, processing, assessment, verification and quality assurance and management of uncertainty, as well as storage, use, distribution and presentation of data and information derived from entities holding data for anthropogenic emissions by sources and sinks of greenhouse gases in the atmosphere.

Recognizing the important steps forward in the institutionalization of climate change issues and the mainstreaming of climate change in the national and sectorial development policies, the development of three National Communications to the UNFCCC, supported by GEF and UNDP, has contributed to strengthening these integration processes as well as to informing the international community on the actions taken by the country to address climate change issues. The First, Second and Third National Communications on Climate Change were published in 2003, 2008 and 2014, respectively.

According to the progress report for the beneficiary country – European Commission 2014, the country needs to develop a comprehensive policy and strategy on **climate change**, in accordance with the expected EU 2030 policy framework for climate and energy. The third national communication on climate change was submitted to the United Nations Framework Convention on Climate Change. The country regularly associated itself with EU positions in the international context, but has not yet put forward a mitigation commitment for 2020, as required by the Copenhagen Accord. The country needs to put forward by the first quarter of 2015 its intended nationally determined contribution to the 2015 Climate Agreement, consistent with those of the EU and its Member States.
Progress was made in developing the national adaptation plan: the indicators for vulnerability to climate change were designed for eight sectors, ten local authorities drafted their socioeconomic assessments of the vulnerability of the population and an early warning system for floods was set up. The Law on the Environment was amended in order to provide for the data collection and management system used for the preparation of national inventories of greenhouse gas emissions. Aligning national legislation with the Monitoring Mechanism Regulation should be a priority. Measures to raise awareness and promote cooperation between stakeholders were introduced, but need to be further strengthened.
The country participated regularly in the Environment and Climate Regional Accession Network project. The Interinstitutional Climate Change Working Group needs to be strengthened considerably in order for it to be able to address the need for more effective action on climate issues in a sustainable manner, not only on a project-by-project basis.
Negligible efforts were made to strengthen the administrative capacity for implementation and enforcement of legislation, which thus continues to be largely insufficient, both at national and local level. Coordination between the relevant bodies remains ineffective. Stakeholders are still not sufficiently involved in decision-making. Enforcement of legislation is not yet efficient. The environmental monitoring and information system is inadequate. Investment in the sector remains low relative to current needs. Environmental protection and climate change requirements are still not sufficiently integrated into policymaking and policy implementation in other areas.

Although has achieved some progress towards harmonisation to the EU acquis there is still a considerable amount of implementing legislation that needs to be prepared. For a successful implementation of the EU acquis there is a need to strengthen human and institutional capacity, especially within the area of environmental impact assessments, monitoring, integrated pollution control and climate change. There is also a need to strengthen environmental capacity within local authorities.

National and regional development priorities and objectives

At the national level, the Republic of Macedonia focuses on several types of objectives in the areas of environment and climate: strategic, legislative, and institutional/organizational. A cross-cutting priority is accession to the EU, which is at the core of the development goals of Macedonia and a main driving force behind its objectives. The EU integration agenda has generated momentum for political, economic and social reforms and contributed to building consensus on important policy issues across sectors. While EU accession poses great challenges in terms of human capacity at the national and local level and identifying financial means for investments in key sectors, it also provides opportunities for the creation of more integrated, cross-cutting policies and better utilization of available resources.

Climate change is receiving more and more attention in national policy, especially since the finalization of the TNC. Recommendations from the TNC have been included in other strategic documents, studies, and sectoral policies that have been revised/developed, such as:

- The Action plan for the National Strategy for Sustainable Development
- Strategy for Energy Development
- Law on Biofuels
- National Strategy on Health and Environment (currently as a draft version)
- National Strategy for Agriculture and Rural Development for 2014-2020
- Study for Adaptation of Agriculture sector to Climate Change
- Study for Adaptation of Animal Production to Climate Change

At the strategic level, environmental policy (as a component of sustainable development policy and in and of itself) is covered by the National Strategy for Sustainable Development (in which the energy sector and climate change are identified as the main contributors towards national sustainable development, adopted in 2010). An action plan for implementation of the Strategy is being developed (with support from UNDP and USAID), and it should be finalized in February 2015. It will include short-term measures that should be implemented or initiated in the period 2015-2018. The Second National Environmental Action Plan is also a key environmental policy.

In the past decade, a number of relevant laws, regulations and strategies that incorporate climate change considerations have been adopted, such as:

The Strategy for Energy Development in the Republic of Macedonia for the Period 2008-2020 with a Vision to 2030 (2010) (currently being revised);

- Renewable Energy Sources Strategy of Macedonia till 2020 (2010);
- The National Strategy for Energy Efficiency in the Republic of Macedonia till 2020 (2010);
- National Environmental Investments Strategy (2009);
- National Environmental Approximation Strategy (2008);
- National Health Strategy for Adaptation in Health Sector (2010);
- A National CDM Strategy, 2008-2012 (2007);
- The National Agriculture and Rural Development Strategy 2007-2013; and
- The National Strategy for Climate Change Adaptation in Agriculture (under development).

The Strategy for Energy Development offers a set of ambitious and specific numerical targets for 2020 following the EU climate change policy track, e.g. reducing the energy intensity of the economy by 30% relative to 2006 or increasing the share of renewables (including hydropower and wood heat) to more than 20% of total final energy. The contribution of renewable energy sources (excluding biomass) to total primary energy is expected to grow by 119% over the period 2011 – 2050, primarily due to expected additional wind capacity. However, half of the country's electricity is still projected to come from lignite-fired plants, both in 2020 and in 2030, and the overall total electricity demand is projected to grow by around 52% by 2030.

The Government has also adopted eight Laws on Ratification of five Protocols under the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution and they are in parliamentary procedure at the moment (National Programme for Adoption of the ***Acquis Communautaire,*** 2012). In previous years, work was aimed at increasing the reliability of data in order to enable a gradual transition to a more sophisticated greenhouse gas inventory with a higher tier of analysis. The differences in terms of data collection have been analysed, and a proposal for a legal solution has been submitted.

As far as the international policy, The Republic of Macedonia has been a non-Annex I country party to the United Nations Framework Convention on Climate Change (UNFCCC) since 1997 and a signatory to the Kyoto Protocol since 2004. It acceded to the Copenhagen Accord in 2009 and has agreed to take non-binding Nationally Appropriate Mitigation Actions (NAMAs) in the context of sustainable development, supported and enabled by technology, financing and capacity-building.

As previously stated, accession to the European Union is a priority for Macedonia. It was the first country in the region to sign a Stabilization and Association Agreement (SAA) with the EU in April 2001, and in December 2005 the Presidency of the European Council granted Macedonia candidate status for the EU. Legislative and regulatory activities related to the accession process include the Ohrid Framework Agreement, the Law on Local Self-Government, the Action Plan on Accession Partnership, and the National Programme for Adoption of the ***acquis communautaire*** in the environment sector. As a member of the EU, Macedonia would be obligated to participate in the EU Emissions Trading System (EU ETS).

The National GHG Inventory

The Republic of Macedonia has conducted a national inventory of anthropogenic emissions by sources and removal by sinks of greenhouse gases (GHGs) emitted to or removed from the atmosphere over a period of time. The inventory includes a database of six direct gases; CO2, CH4, N2O, PFCs, HFCs and SF6, and four indirect gases; CO, NOx, NMVOC and SO2. The purpose of the inventory is to identify the major sources and removals/sinks of greenhouse gases with greater confidence and thus enable more informed policy decisions with respect to appropriate response measures. Reliable GHG inventories are essential both at national and international level for assessing the community's efforts to address climate change and progress towards meeting the ultimate objective of the UNFCCC, for evaluating various mitigation options and calculating long-term emission projections.

The inventory is based upon updated work from Macedonia's Third National Communication on Climate Change (TNC). The GHG inventory under the TNC considered the time frame 2003–2009 and was prepared in accordance with the 1996 Revised IPCC Guidelines for National Greenhouse Gas Inventories and the 2000 IPCC Good Practice Guidance. The inventory has been updated to consider the period 2010 – 2012 and has been developed using the newest IPCC 2006 Inventory Software. The activity data for the year 2012 is taken from the preliminary published national statistical data, since the definitive national statistical data were not published while the FBUR GHG inventory was developed. Additionally, the entire previous series of data from 1990 to 2009 were revised according to the requirements of the 2006 software, thus adding value to the quality of the national greenhouse gas inventory and enabling comparable series of data for the whole inventory period (i.e. 1990-2012). During the elaboration of the Second Biennial Update Report (SBUR) for the fullfilment of the obligations under the United Nations Framework Convention on Climate Change (UNFCCC), an update of the GHG Inventory for 2013-2014 will be developed according to 2006 IPCC guidelines, and the Inventory for 2012 will be recalculated using official data for this year from the State Statistical Office (SSO) that were published after the submission of the FBUR. The data used for 2012 in the FBUR were also from the SSO, but were not final as the final data is always published with a delay of 1.5 – 2 years, and the final official data may vary in some cases up to 30% from the initial published data for respective year. The final data for 2012 from SSO were available in March 2014 – and the FBUR was submitted in Feb 2014. Therefore, there is a need to revise the inventory for 2012 to reflect the final official data from the State Statistical Office for the year 2012.

As part of this inventory, Country Specific Emission Factors for key source categories that contribute more than 95% to the total GHG emissions of the inventory have been updated. Most of the activity data were available from the State Statistical Office (MAKSTAT), Energy Balances, National Reports from the Ministry of Agriculture, Forestry and Water Economy (MAFWE), the Ministry of Environment and Physical Planning (MOEPP) and other relevant institutions. Some data were obtained from industries and from the FAO database. For emission factors, 90% of values are country-specific (CS) and IPCC default values were used taking into account expert judgment.

An uncertainty analysis consisting of running the Monte Carlo algorithm on the inventory data was also performed for each CO2-emitting category for the whole period 1990 – 2012. The analysis was conducted by using the built-in functionality of the 2006 IPCC software. The overall results showed that the uncertainty in the GHG inventory is 3.13% and the trend uncertainty is 5.41%.

GHG inventory preparation was coordinated by the Ministry of Environment and Physical Planning and managed by a GHG inventory team with support from a national technical advisor and the National Communication Support Programme (NCSP). NCSP provided review from an experienced consultant that highlighted improvements in preparing an extensive, detailed and complete series of emissions data.

The institutional structure shown in the following figure ensures sustainability in preparing GHG inventories. Additionally, training materials were prepared for each sector, including a step-by-step process for completing inventory tables, explanations of good practices and sources of data and emission factors.

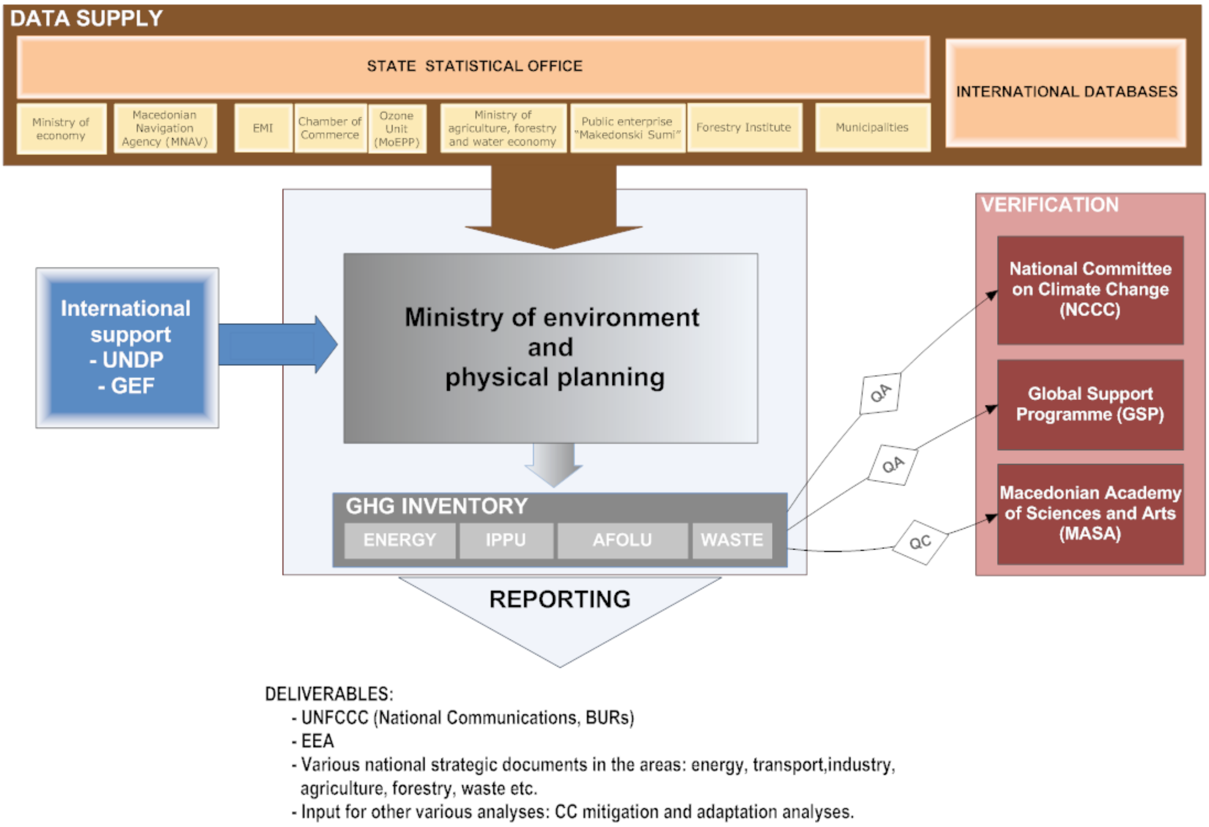


Figure 8-15: MRV Scheme for GHG inventory preparation

The national structure for the development of the National GHG inventory is described:

- **The Ministry of Environment and Physical Planning**, responsible for supervising the national inventory process and reporting the emissions to UNFCCC
- **The Project Management Unit**, responsible for managing and coordinating the First Biennial Update Report on climate change
- **The GHG Inventory Team**, composed of experts responsible for preparing the GHG inventory in four different sectors (Energy, IPPU, AFOLU and Waste)

- **A National Technical Advisor**, responsible for training and transfer of knowledge to the GHG inventory team and for supervision and verification of the GHG inventory
- **The Global Support Programme (GSP)**, responsible for supporting and revising the GHG inventory

According to the "Preparation of the GHG Inventory for the Third National Communication to the UNFCCC – National Inventory Summary Report", Final version 2013, for the beneficiary country, data for the contribution of the waste sector to the GHG emissions are giving below.

The revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories provide an outline of two methods for estimating emissions of CH_4 from solid waste disposal sites: the default method (Tier 1) and the first order Decay (FOD) method (Tier 2). The main difference between these two methods is that the FOD method produces a time – dependent emission profile that reflects the true pattern of the degradation process over time. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (GPG 2000, IPCC, 2000) describes two methods for estimating CH_4 emissions from SWDS: the mass balance method (Tier 1) and the First Order Decay (FOD) method (Tier 2). In the IPCC Guidelines, the use of the mass balance method is strongly discouraged as it produces results that are not comparable with the FOD method which produces more accurate estimates of annual emissions. Instead of the mass balance method, the Tier 2 and FOD methodology is suggested. The following sources are used for GHG emissions for the waste sector: CH_4 emissions from solid waste disposal sites, CH_4 emissions from solid waste disposal sites, CH_4 emissions from residential/commercial wastewater and sludge, CO_2 emissions from waste incineration and N_2O emission from human sewage and domestic/industrial wastewaters.

Summarized data are presented in the following table, giving annual emissions of CH_4, N_2O and CO_2 equivalent emissions (kt) from the Waste sector. These values show that the waste sector has become a significant source of emissions at 7% of total GHG emissions in the country and needs to be addressed more thoroughly in the future. Some 89% of these emissions are CH_4 emissions from solid waste disposal sites (SWDS) incineration and wastewaters, 5% are N_2O from human sewage, incineration and waste waters, and 7.4% are CO_2 emissions from incineration.

Table 8-18: Summary from the waste sector (CO2-eq kt) in the period 2003-2009

Year	2003	2004	2005	2006	2007	2008	2009
CH_4 emissions [kt] Solid Waste Disposal Sites	726. 78	728. 53	732. 69	745. 30	755. 45	767. 44	778. 70
CH_4 emissions [kt] Wastewater Handling	46.44	49.77	48.43	46.32	44.29	44.54	40.96
CH_4 Emissions from Waste Incineration [kt]	15.61	15.6	15.65	15.67	15.66	15.75	15.76
Total $C0_2$eq. emissions from Industries (kt CO_2 eq.)	17.22	20.58	19.11	16.59	14.91	15.12	11.55
Total CH_4 emissions (kt CO_2eq.)	806,05	814,53	815,88	823,88	830,31	842,85	846,96
N_2O emissions [kt] Wastewater Handling	43.02	44.16	42.74	43.85	46.13	43.77	44.67
N_2O Emissions from Waste Incineration [kt]	0.71	0.71	0.71	0.71	0.71	0.72	0.77
Total N_2O emissions (kt CO_2eq.)	43.73	44.87	43.45	44.56	46.84	44.48	45.44
CO_2 emissions from waste incineration[kt]*	64.91	65.07	65.18	65.28	63.95	65.65	65.99
Total emissions (kt CO_2eq.)	**849,78**	**859,40**	**859,33**	**868,44**	**877,16**	**887,33**	**892,40**

* According to IPCC GPG 2000, CO_2 emissions from the incineration of biogenic waste should not be included in total GHG emission calculations and reporting.

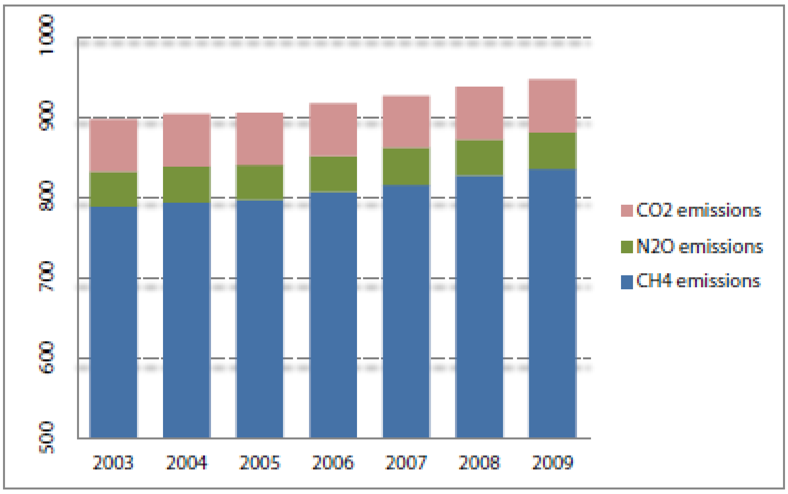


Figure 8-16: Summary of emissions from the Waste sector CO_2-eq. [kt]

Table 8-19: Percentage of GHG emissions (%) from different subsectors

Year	2003	2004	2005	2006	2007	2008	2009
Total CO_2 emissions	7.23	7.20	7.20	7.12	6.90	7.00	6.97
Total CH_4 emissions	87.90	87.84	88.00	88.02	88.04	88.26	88.23
Total N_2O emissions	4.87	4.96	4.80	4.86	5.06	4.74	4.80
Emissions from Wastewater Handling	9.97	10.39	10.07	9.83	9.76	9.42	9.04
Emissions from Solid Waste Disposal Sites	80.98	80.60	80.92	81.26	81.57	81.83	82.24
Emissions from Waste Incineration	9.05	9.01	9.01	8.90	8.67	8.76	8.71

Source: "Preparation of the GHG Inventory for the Third National Communication to the UNFCCC – National Inventory Summary Report", Final version 2013

Most of the GHG emissions in this sector come from solid waste disposal sites (methane emissions), while emissions from incineration and wastewater handling have an equal importance in total emissions. Emissions from this sector slowly increased during the inventory period, since the increased population produces higher emissions from the disposal and incineration of municipal solid waste.

Measures for the emissions and mitigation of climate change

Policies and measures for reduction of the emissions and mitigation of the climate change are in the function of fulfilling the beneficiary country's international obligations under the Kyoto Protocol Convention and the EU acquis and the starting point for long-term development of the economy with low emissions of greenhouse gases.

As mentioned above, the beneficiary country acceded to the UNFCCC in 1998 and to the Kyoto Protocol in 2004. The MOEPP is the focal point for the UNFCCC, and also the Designated National Authority for the CDM. The Climate Change Project Office was set up in 2000 and sits as a unit within the MOEPP, driving work on climate change within the ministry. The National Climate Change Committee (NCCC) is separate from the MOEPP and is composed of representatives of government (including inter-alia, ministries of the Environment, Finance, Transport, Economy, Education and Science, Health and Agriculture, Forestry and Water), NGOs, the private sector and research organisations. The function of the NCCC is to oversee national policies on climate change and to ensure that these policies are consistent with national development strategies and priorities. Implementation of environmental policy occurs through a wide range of public and private sector entities, and the MOEPP is only the coordinator of environmental policy. Macedonia has started to integrate climate change into national strategic planning documents and laws. Article 4 of the Law on the Environment explicitly mentions 'Restraining greenhouse gas emissions in the atmosphere' and encouraging the use of clean technologies and renewable energy. In the Law on the Environment it is stipulated that Macedonia should adopt a National Plan on Climate Change, but this has not yet been developed. The Second National Environmental Action Plan (NEAP) and the National Strategy for Sustainable Development (NSSD) both documents include climate change, with Energy and Climate being identified as key elements in achieving the goals of the NSSD The focus in the NSSD are to develop a less carbon intensive energy sector (through both switching supply and increasing efficiency) and to engage strongly with the CDM. Adaptation is recognized in the strategy but is secondary to mitigation. Measures in the strategy to conserve and manage natural resources will also improve the adaptive capacity of ecosystems.

The focus of the government has been on mitigation rather than adaptation to climate change, however there is an Inter-Sectoral Adaptation Action Plan which includes integrating adaptation into the management strategies for different sectors, establishing early warning and monitoring systems and building the capacity of different actors through training and the provision of additional funding. Decentralization is a key pillar of the national strategies of Macedonia, and as such it is local government and other local actors who will be tasked with the implementation of many of these plans. The government recognizes the need to rapidly build the capacity in these actors if national environmental strategies are to be successfully implemented.

EU membership can be considered as the overall strategic objective for current development policies in Macedonia, and strategy documents such as the 2nd National Environmental Action Plan are aimed at the requirements in the EU acquis, and harmonisation of environmental policies. The second National Communication has strengthened national capacity on preparing greenhouse gas inventories; however several institutional and legislative measures need to be adopted to further strengthen and embed this procedure. This inventory will serve as the background for the establishment of a GHG registry, which is a country requirement for EU accession. There will need to be some amendments to the existing Law on the Environment and Law on Energy in order to pave the way for a Law on GHG allowance trading so that the Emission Allowance Trading Directive can enter into legislation. A pilot emissions trading scheme will be adopted for 2 years in order to prepare local actors to participate in the EU emissions trading scheme. It is unclear what effect Macedonia becoming a member of the EU would have on the EU's targets for a 20% reduction in emissions by 2020, to be achieved by country specific reductions, and whether a target would be imposed on the country. If new countries are included in this target then there will be negotiations to set a target that takes into account national circumstances. It is extremely unlikely the beneficiary country would be obliged to make the full 20% reduction, but may be required to ensure that its emissions do not grow over the period, for example. In the area of energy and climate in the Republic of Macedonia appears to be progressing well towards the requirements for EU integration.

Waste sector

The Waste sector is one of the key GHG emission sources in the beneficiary country. Waste management in the country was recently recognized as an issue of concern and a concentrated effort was put forward in order to mitigate its adverse impacts on the environment and society.

The First and Second National Environmental Action Plan, as well as The Law on Waste Management give the general policy directions on waste management and constitute regulation acts that provide general rules applying to main issues on non-hazardous and hazardous waste and on special waste streams. The National Waste Management Strategy is another programme document that defines the fundamental directions in waste management.

Most of the GHG emissions in the Waste sector come from Solid Waste Disposal Sites (SWDS), while emissions from incineration and wastewater handling have an equal importance in total emissions.

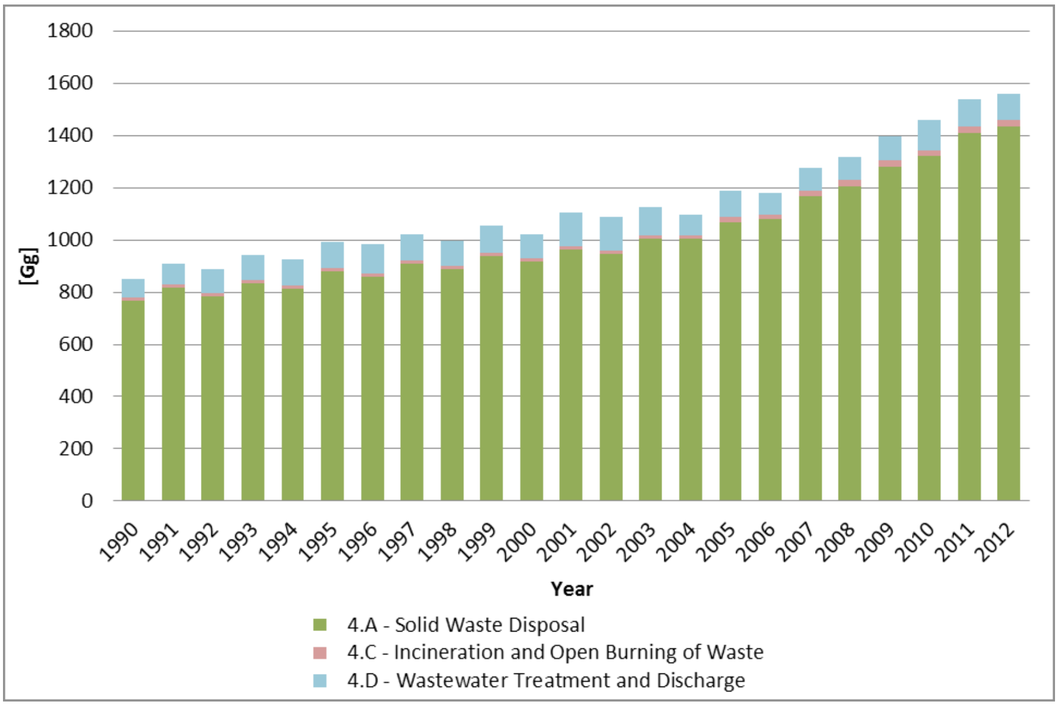


Figure 8-17: Waste Sector GHG emissions, 1990 – 2012 [Gg CO2-eq.]. (Source First Biennial update report on Climate Change, MOEPP, 2013)

Waste sector emissions mainly consisted of CH_4 (methane) emissions (94%). Typically, CH_4 emissions from SWDS were the largest source of greenhouse gas emissions in the Waste Sector. CH4 emissions from wastewater treatment and discharge were also significant. N_2O emissions were the second biggest source of waste sector GHG emissions. Incineration and open burning of waste containing fossil carbon, e.g., plastics, were the most important sources of CO_2 emissions in the Waste Sector.
In almost all cases of waste management, there is an upward trend of emissions due to population growth and an improving economy. Higher personal incomes have resulted in a higher waste generation per capita:

Solid waste disposal: Solid waste disposal sites (SWDS) produce methane (CH_4), biogenic carbon dioxide (CO_2), non-methane volatile organic compounds (NMVOCs) as well as smaller amounts of nitrous oxide (N_2O), nitrogen oxides (NOx) and carbon monoxide (CO). For the period 1990 – 2012 SWDS were responsible for an average of 89.9% of the overall GHG emissions of the waste sector. Almost 100% of the SWD emissions consisted of CH_4 emissions.

Incineration and open burning of waste: Similar to other types of combustion, incineration and open burning of waste contribute to GHG emissions. Relevant gases emitted from incineration include CO_2, methane (CH_4) and nitrous oxide (N_2O). Normally, emissions of CO_2 from waste incineration are more significant than CH4 and N2O emissions. For the period 1990 – 2012 the open burning of waste was responsible for an average of 1.4% of the overall GHG emissions of the waste sector. Approximately 36% of the emissions of this sector consisted of CO2 emissions, while CH_4 emissions represented 63.5% of the emissions. The share of N_2O emissions was negligible – 0.02%.

Waste water treatment and discharge: The emissions from the wastewater treatment and discharge originate from Domestic Wastewater Treatment and Discharge and Industrial Wastewater Treatment and Discharge. The emissions of this subsector represented approximately 8.7% of the total waste sector emissions during the period 1990 – 2012. The GHG emissions of this subsector were comprised of two main gases: CH_4 emissions (61.8%) and N_2O emissions (38.2%).

Similar to the other forms of waste, domestic wastewater treatment and discharge emissions have been in line with population growth. In contrast, as described in Section 3.4 on Industrial processes, emissions from the Industrial wastewater treatment and discharge have had a highly fluctuating trend; industrial waste emissions proved to be highly dependent on industrial production rates which were variable between 1990 and 2012. Future emissions for the Wastewater Treatment and Discharge will be more detailed, since the industry will report directly in the EMI software.

Waste sector emissions were estimated in accordance with the most recent IPCC 2006 Guidelines and 2006 Inventory Software. As already mentioned, the Tier 2 First Order Decay (FOD) methodology was applied for estimation of the waste sector GHG emissions when a long enough time series was available (generally 50 years). If data was missing, the Tier 1 method and a MSW disposal rate of 0.79 kg per capita per day were used. For both Tier 1 and Tier 2 calculations, the FOD methodology was applied by default, as imposed by IPCC 2006 guidelines. Historical data have been taken from official censuses from 1950, 1962, 1971, 1981, 1991, 2002 and current population estimations from the State Statistical Office. Data for the missing years were obtained by extrapolation (Source First Biennial update report on Climate Change, MOEPP, 2013).

Data was also taken from the GHG Inventory for the Second National Communication for 1999–2002 which consisted of the inventory of N_2O emissions from human sewage and methane emissions from sub-sectorial sources, including solid waste disposal sites, domestic/ commercial organic wastewater and sludge, and industrial wastewater and sludge. Activity data were taken from State Statistical Office publications, MOEPP reports, FAO statistics and the UN Statistical database.

According to the report "Third National Communication on climate change", total annual quantities of waste generated in the country are 26,218,257 t of which the biggest parts (95%) are related to: extraction and processing in the mining industry (66%), agriculture waste (21%) and waste from thermal processing industry (8%). The remaining waste is industrial, construction and municipal waste, medical waste and waste water treatment waste.

All data extracted from the "Third National Communication on climate change". The baseline scenario for the waste sector was developed and emissions are calculated using TIER2 methodology and taking into account disposed waste from year 1981 onward projected until 2030 based upon expected population and economic growth. The basic assumption is that there will be no investment in new landfills but that existing sites will only have maintenance costs that amount 3.45 euro/t on average. The following figure shows the expected trajectory of GHG emissions from the waste sector in the baseline scenario. There are five different Waste Management Regions, according to the report, proposed for the development of the regional landfills:

- WMR1: Skopje region
- WMR2: East, Northeast and Vardar regions
- WMR3: Southeast region
- WMR4: Pelagonija and Southwest regions
- WMR5: Polog region

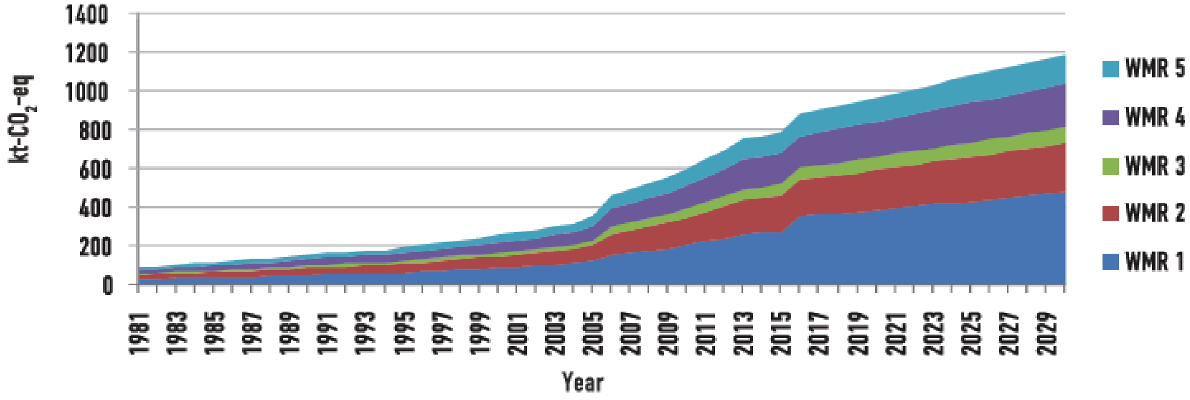


Figure 8-18: The baseline scenario of GHG emissions in the waste sector sorted according to waste region

Mitigation measures in the waste sector

The proposed measures for reduction of GHG emissions target two types of landfills: existing non – compliant landfills and new regional landfills. Additional mitigation measures are possible for wastewater treatment from households and industry but were not analysed for the purposes of the TNC.

From the wastewater treatment sector for households, the mitigation measure is generally the development of new sewage system in the settlements that are not covered with organized collection of sewage and upgrading of the existing sewage systems. These measures are mainly driven by the Government policies, prioritization in municipalities and foreign funds. Since they are not easily predicted, these measures are not analysed further.

For the wastewater treatment sector for industry, the mitigation measure is the implementation industrial wastewater treatment plants which are already a part pf IPCC requirements and they need to complete their applications by the year 2019. Since these emissions are only 1.58% of total waste emissions and depend on private investments of industries, they are not analysed further in this document.

For municipal solid waste management, the National Waste Management Strategy (2008 2020) prescribes the establishment of the new regional municipal waste management systems in accordance with EU requirements on landfilling and the implementation of an integrated approach. In this plan, new regional landfills would be opened in all Waste Management Regions. The overall aim of the Waste Management Strategy is as much as possible to reduce waste sent to the landfills. In practice this means collection, transportation and disposal of waste, waste treatment and eventual use of Refuse Derived Fuel as fuel in cement facilities as a final stage of the waste management cycle. The closing of existing landfills and development of new regional landfills are connected because the closure and remediation measures for the existing non-compliant landfills cannot be implemented if there is no construction of the new regional landfills. Therefore there are five basic measures for GHG mitigation in the waste sector:

Measure 1: Closing and covering the existing non – compliant landfills followed by gas extraction and flaring. The current practice of the municipal landfills is only to unload the waste without compaction and covering activities. Based on the special study of the National Waste Management Plan 1 – (2006 – 2012) there are 55 landfills which are not in accordance with the EU standards. For these existing landfills the most feasible option suggested by waste experts worldwide and prescribed in the NWMP1 is to cover the whole disposal area and introduce gas extraction and flaring, converting methane emissions to CO2 which has significantly lower global warming potential. Burning one ton of CH4 results in an 87% reduction of CO2-eq which is a significant GHG reduction. The RWMP and Integrated WMS which will applied in Southwest region includes the closure and rehabilitation of non-compliant landfill. This will contribute to the reduction of GHG emission of uncontrolled disposal waste.

Measure 2: Mechanical and biological treatment (MBT) in new landfills. This measure involves the sorting of waste for removal of metals, plastics and glass. It is necessary step for any other treatment (composting, anaerobic treatment, or RDF development). The future CWMF will include Mechanical Biological treatment with AD, and Material Recovery Facility plant with sorting of recyclables. Also a new landfill according national and EU regulations will be constructed.

Measure 3: Anaerobic treatment (composting) in new landfills. The process of composting simply requires making a heap of wetted organic matter and breaking down the materials into humus over a period of weeks or months usually including closely monitored inputs of water, air, and materials. Aerobic bacteria manage the chemical process by converting the inputs into heat, carbon dioxide and ammonium. There is a reduction of GHGs by reducing methane emissions and instead resulting in CO2 emissions. New landfill will be constructed in Southwest region according national and EU regulations.

Measure 4: Anaerobic treatment of organic waste. This measure involves the placement of organic material in anaerobic digesters with subsequent energy production. There is a reduction of GHGs by reducing methane emissions and instead resulting in CO2 emissions. The burning of the methane can also displace fuel sources with higher GHG content such as coal.

Measure 5: The production of RDF. The production of RDF involves converting combustible waste materials to an engineered fuel.

Studies for the "Third National Communication" examined five scenarios which are the subject of analysis done in this project. The following table describes the costs and GHG benefits of each of these scenarios.

Table 8-20: Economic and environmental effectiveness of the mitigation scenarios

Scenario	Costs (2012 MEUR)	Expected cumulative emissions (kt CO_2-eq)	Cumulative GHG reduction (kt CO_2-eq)	Marginal abatement costs (EUR/t CO_2-eq reduced)
Reference-Baseline	26	26.679	/	/
First scenario: - Closure and reclamation of existing landfills with burning of the landfill gas on flare - Introduction of MBT technology with composting	165	7.476	19.203	7,21
Second scenario: - Closure and reclamation of existing landfills with burning of the landfill gas on flare - Introduction of MBT technology using anaerobic digestion with production of electricity	217	6.840	19.839	9,61
Third scenario: - Closure and reclamation of existing landfills with burning of the landfill gas on flare - Introduction of MBT technology using anaerobic digestion with production of electricity - Production of RDF intended for cement industry (only for WMR1)	226	4.692	21.987	9,08
Fourth scenario: - Closure and reclamation of existing landfills with burning of the landfill gas on flare - Introduction of MBT technology with composting - Production of RDF intended for cement industry (only for WMR1)	174	5.328	21.351	6,91

It can be concluded that fourth scenario has the best performance from economic point of view, even though the reductions of GHG emissions are not the best ones. The difference of emission reductions between the third and fourth scenario is 636kt CO2eq, which is only 3% less reductions from the scenario with the highest reductions (third scenario). However the specific costs of the fourth scenario are 6.91 euro/t CO2-eq, which is the least expensive. The third scenario has costs of 9.08 euro/t CO2-eq which is 31% higher.

Therefore it appears that the combination of landfill gas burning and MBT plant with selection of recyclables, composting of biodegradable waste and production of RDF intended for the cement industry is the best option for a mitigation scenario for the country. If there are possibilities in the future to produce RDF for thermos power plants in other regions, the situation will be even better.

Table 8-21: Mitigation activities in the waste sector, expected results, investment parameters and risks

Mitigation activity	Expected results	Financial support for Implantation	Indicators	Verification sources	Risks	Lump sum investment (MEUR 2012)
Change of technology at a cement factory to receive fuel (5-15%) from RDF by 2016	Reduction of CO_2-eq emissions by 80%, use of renewable source as fuel (up to 15% of total fuel used)	Private investment	Annual reduction of the amount of GHGs expressed in t CO_2 eq/year; Substituted fuel with RDF (%)	Environmental permit, Inspections	Mutual agreement with the regional landfill must be made and costs of transport and disposal agreed, change of company's policy to use another alternative fuel, non-acceptance of new technology by the locals	1
Installed RDF system at the regional landfill by 2016		Public Private Partnership	Annual reduction of the amount of GHGs expressed in t CO_2 eq/year, jobs created	Environmental permit, Inspections	Installation incomplete due to lack of finances, postponing obligations in environmental permit	5
Mechanical treatment (MT) followed by a biological aerobic treatment (composting) in new 5 regional landfills all regions by 2020	Reduction of CO_2-eq emissions by 76%	Public Private Partner-ship, IPA funds, other donors	Annual reduction of the amount of GHGs expressed in t CO_2 eq/year; Number of landfills opened with MBT + composting, new jobs created	Environmental permit, Inspections	Non-compliance with legislation, lack of funds	265
Closure and reclamation of existing landfills with burning of the landfill gas on flare by 2020 in all regions	Closure of landfills, reduction of CO_2-eq emissions and odours	IPA funds, municipal budget, other donors	Annual reduction of the amount of GHGs expressed in t CO_2 eq/year; Non-compliant landfills closed and flares installed	Sate Inspectorate (MoEPP), Municipalities	Lack of funds, awareness of local administration and local people	3

According to the "First Biennial update report on climate change", mitigations actions for the waste sector giving in the table below:

Table 8-22: Mitigation actions according the First Biennial update report

Actions	Description	Gases	Indicators	Projections	Methodology
Mitigation action 37: Closing and covering the existing non-compliant landfills followed by gas extraction and flaring	This Action involves the closure, covering and flaring of methane gas within 4 large landfills in Macedonia	CH_4	• Tonnes of CH_4 flared per year • kt CO_2-eq reduced per year	11,450 kt CO_2-eq reduced by 2020	• There are four municipal landfills which need urgent closure and rehabilitation: Kicevo, Ohrid, Kriva Palanka, and Gevgelija. • The action involves covering the whole disposal area and introducing gas extraction and flaring, converting methane emissions to CO_2. • Production of electricity as an option is not chosen because there is uncertainty in landfill gas quantities.
Mitigation action 38: Mechanical and biological treatment (MBT) in new landfills with composting	This Action involves the sorting of waste for removal of metals, plastics and glass. It is a necessary step for any other treatment (composting, anaerobic treatment, or RDF development).	CH_4	• Tonnes of CH4 reduced per year • Kt CO2-eq reduced per year	7,678 kt CO2-eq reduced by 2030	This measure involves the sorting of waste for removal of metals, plastics and glass. It is a necessary step for any other treatment (composting, anaerobic treatment, or RDF development).
Mitigation action 39: Mechanical and biological treatment (MBT) in one new landfill with composting plus production of Refuse-Derived Fuel (RDF) intended for cement industry	This Action involves the production of RDF from waste streams and then use in the cement industry as a source of energy instead of using fossil fuels.	CH_4, CO_2	• Tonnes of CH4 reduced per year • GWh produced using RDF displacing other energy sources • kt of CO2 reduced from displacement of other energy sources • kt CO2-eq reduced per year	5,890 kt CO2-eq reduced cumulatively by 2030	• The production of RDF involves converting combustible waste materials to an engineered fuel. • The RDF system provides additional GHG reduction because all the carbon contained in the waste is incinerated instead of put into landfills – which can reduce methane emissions and displace fuel sources with higher-GHG content such as coal.

8.5.6 Integrating climate resilience into the conventional asset lifecycle

Even if the 2°C limit is kept, substantial impacts on society, human health and ecosystems are projected to occur. Climate change can increase existing vulnerabilities and deepen socioeconomic imbalances in Europe. Impacts of climate change, such as an increased frequency of extreme weather events or changing water and air temperatures may impact on the stability and the functioning of infrastructure. Adaptation to and mitigation of climate change are therefore both needed.

The term Adaptation to Climate Change refers to adjustments in natural and human systems in response to actual or expected climate change impacts, which moderate harm or exploit beneficial opportunities (IPCC, 2007). Adaptation can thus be justified as a way of reducing the negative impacts of climate change and can take a variety of forms. It can involve a set of proactive and planned measures consciously undertaken to meet anticipated climate changes. “Adaptation to climate change is an ongoing and reiterative process that includes information development, awareness raising, planning, design, implementation and monitoring” (Stockholm Environment Institute, 2008, p. 38).

Adaptation is necessary to avoid or reduce the negative impacts and to explore any potential benefits of climate change. The goals of adaptation are to alleviate current impacts, reduce sensitivity and exposure to climate-related hazards, and increase resistance to stress factors (Warren & Egginton, 2008).

Although infrastructure is generally constructed in a manner that is resilient to the weather conditions of the past, climate change is already happening and its effects will continue to have far-reaching consequences for human and natural systems. Adaptation action is needed to protect people, buildings, infrastructure, businesses and ecosystems. Due to the varying severity and nature of climate impacts between regions in Europe most adaptation initiatives will be taken at national, regional or local level.

The European commission (Directorate – General Climate Action) has issued a Guideline with primary objective to help developers of physical assets and infrastructure incorporate resilience to current climate variability and future climate change within their projects. The Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient forms part of the overall EU effort to mainstream climate change adaptation, following on from the White Paper on Adapting to Climate Change published by the Commission in 2009. The Commission strongly encourages the use of the Guidelines, both in EU-funded projects and more widely, as they are designed to provide support to developers of physical assets and infrastructure.
The Guideline proposes seven modules that make up the climate resilience toolkit and are summarized in the following table.
The seven modules that make up the climate resilience toolkit are summarized in the following table. The modules provide common methodologies which can be applied at several stages during the project development. Modules 1 to 4 have both ‘high level’ and ‘detailed’ versions. The high level versions are rapid screening exercises undertaken early in the project development cycle, and the detailed versions are applied later in the cycle, if necessary, when more information is available about the project as a basis for analysis.

Table 8-23: Seven modules in the climate resilience toolkit

Module No.	Module name	High level and detailed versions?
1	Sensitivity analysis (SA)	Yes
2	Evaluation of exposure (EE)	Yes
3	Vulnerability analysis (incorporating the outputs of modules 1 and 2) (VA)	Yes
4	Risk assessment (RA)	Yes
5	Identification of adaptation options (IAO)	No
6	Appraisal of adaptation options (AAO)	No
7	Integration of adaptation action plan into the project (IAAP)	No

Source: Non-paper Guidelines for Project Managers-Making vulnerable investments climate resilience

The present study (Feasibility Study) is a part of Plan and Design stage, and the main objectives of climate resilience analysis are the consideration and articulation of the climate vulnerabilities and risks associated with the development covering all areas of feasibility: project inputs (availability and quality), project location and site, financial, economic, operations and management, legal, environmental and social. The relevant modules (according the above table) that must be followed are

- Modules 1-3, Sensitivity analysis, evaluation of exposure, vulnerability analysis.
- Module 4, Risk assessment
- Module 5, Identification of adaption measures
- Module 6, Appraisal of adaptation options

8.5.6.1 Module 1: Identification of the climate sensitivities of the project

Module 1:

The sensitivity of the project should be determined in relation to a range of climate variables and secondary effects/climate related hazards. The following table provides a list of factors to consider.

Table 8-24: Key climate variables and climate-related hazards

Primary climate drivers	Secondary effects/climate
1. Annual/seasonal/monthly average (air) temperature (1) 2. Extreme (air) temperature (frequency and magnitude) (2) 3. Annual/seasonal/monthly average rainfall (3) 4. Extreme rainfall (frequency and magnitude) (4) 5. Average wind speed (5) 6. Maximum wind speed (6) 7. Humidity (7) 8. Solar radiation (8)	1. Sea level rise (9) 2. Sea/water temperatures (10) 3. Water availability (11) 4. Storm (tracks and intensity) including storm surge (12) 5. Flood (13) 6. Ocean pH (14) 7. Dust storms (15) 8. Coastal erosion (16) 9. Soil erosion (17) 10. Soil salinity (18) 11. Wild fire (19) 12. Air quality (20) 13. Ground instability/landslides/avalanche (21) 14. Urban heat island effect (22) 15. Growing season length (23)

The sensitivity of the project options to key climate variables and hazards should be systematically assessed through the lens of four key themes encompassing the main components of a value chain as follows:

- On-site assets and processes
- Inputs (water, energy, others)
- Outputs (products, markets, customer demand)
- Transport links

The focus is on determining the sensitivity of project options to climate variables in relation to each of these four themes.
The following table presents the sensitivity matrix for Southwest region CWMF&TSs.

The aim of the sensitivity analysis is to identify the relevant climate hazards for the given specific type of project, irrespective of its location. The sensitivity analysis looked at varius components of the project and also how the project operated within the wider network or system. The assessment was undertaken separately for the varius elements of the project, including the four sensitive themes which are presented in the table.

Table 8-25: Sensitivity matrix for CWMF&TSs

		Climate variables / climate-related hazards																						
Project type	**Sensitivity theme**	Incremental air temperature increase	Extreme temperature increase	Incremental rainfall change	Extreme rainfall change	Average wind speed	Maximum wind speed	Humidity	Solar radiation	Relative sea level rise	Seawater temperature	Water availability	Storms	Flooding (coastal & fluvial)	Ocean pH	Dust storms	Coastal erosion	Soil erosion	Soil sality	Wild fire	Air quality	Ground instability/ landslides	Urban heat island	Growing season
Waste Management Center	On-site assets and processes	MEDIUM	HIGH	MEDIUM	HIGH	NO	HIGH	MEDIUM	MEDIUM	NO	NO	HIGH	HIGH	HIGH	NO	MEDIUM	NO	MEDIUM	NO	HIGH	NO	HIGH	NO	NO
	Inputs (water, energy, others)	HIGH	MEDIUM	HIGH	HIGH	NO	MEDIUM	MEDIUM	MEDIUM	NO	NO	HIGH	MEDIUM	MEDIUM	NO	NO	NO	MEDIUM	MEDIUM	MEDIUM	NO	NO	NO	NO
	Outputs (products and markets)	MEDIUM	MEDIUM	MEDIUM	MEDIUM	NO	MEDIUM	NO	MEDIUM	NO	NO	NO	MEDIUM	MEDIUM	NO	NO	NO	NO	NO	MEDIUM	MEDIUM	NO	NO	NO
	Transport links	MEDIUM	MEDIUM	MEDIUM	HIGH	NO	MEDIUM	MEDIUM	NO	NO	NO	NO	HIGH	HIGH	NO	MEDIUM	NO	MEDIUM	MEDIUM	HIGH	NO	HIGH	NO	NO

Climate sensitivity	NO	MEDIUM	HIGH

Note:
High sensitivity: Climate variable/hazard may have significant impact on assets and processes, inputs, outputs and transport links.
Medium sensitivity: Climate variable/hazard may have slight impact on assets and processes, inputs, outputs and transport links.
No sensitivity: Climate variable/hazard has no effect.

8.5.6.2 Module 2: Evaluation of exposure to climate hazards

Module 2:
Once the sensitivities of the project have been identified, the next step is to evaluate exposure of the project and its assets to climate hazards in the location where the project will be implemented.
Exposure analysis aims in the identification of the relevant hazards of the project location, irrespective of the project type. For example, flooding could be an important climate hazard for a location next to a river in a low-lying flood plain. The analysis can be split in two parts, i.e. exposure to the current climate and exposure to the future climate. Climate model outputs can be used to understand how exposure may change in the future.

Assess exposure to baseline/observed climate

Exposure data should be gathered for climate variables and related hazards to which assets have high or medium sensitivity from Module 1. In each case the information required will be made up of spatial data relating to observed data.

The following table presents the exposure to baseline/observed climate of the CWMF&TSs.

Table 8-26: Assess exposure to baseline/observed climate for CWMF&TSs

		Climate variables / climate-related hazards																						
Project type	**Sensitivity theme**	Incremental air temperature increase	Extreme temperature increase	Incremental rainfall change	Extreme rainfall change	Average wind speed	Maximum wind speed	Humidity	Solar radiation	Relative sea level rise	Seawater temperature	Water availability	Storms	Flooding (coastal & fluvial)	Ocean pH	Dust storms	Coastal erosion	Soil erosion	Soil salinity	Wild fire	Air quality	Ground instability/ landslides	Urban heat island	Growing season
Exposure to baseline/observed climate																								
Waste Management Center	On-site assets and processes																							
	Inputs (water, energy, others)																							
	Outputs (products and markets)																							
	Transport links																							

Climate sensitivity	NO	MEDIUM	HIGH

Note:

High sensitivity: Climate variable/hazard may have significant impact on assets and processes, inputs, outputs and transport links.

Medium sensitivity: Climate variable/hazard may have slight impact on assets and processes, inputs, outputs and transport links.

No sensitivity: Climate variable/hazard has no effect.

Assess exposure to future climate

Table 8-27: Assess exposure to future climate for CWMF&TSs

		Climate variables / climate-related hazards																						
Project type	**Sensitivity theme**	Incremental air temperature increase	Extreme temperature increase	Incremental rainfall change	Extreme rainfall change	Average wind speed	Maximum wind speed	Humidity	Solar radiation	Relative sea level rise	Seawater temperature	Water availability	Storms	Flooding (coastal & fluvial)	Ocean pH	Dust storms	Coastal erosion	Soil erosion	Soil salinity	Wild fire	Air quality	Ground instability/ landslides	Urban heat island	Growing season
Exposure to future climate																								
Waste Management Center	On-site assets and processes																							
	Inputs (water, energy, others)																							
	Outputs (products and markets)																							
	Transport links																							

Climate sensitivity	NO	MEDIUM	HIGH

Note:

High sensitivity: Climate variable/hazard may have significant impact on assets and processes, inputs, outputs and transport links.
Medium sensitivity: Climate variable/hazard may have slight impact on assets and processes, inputs, outputs and transport links.
No sensitivity: Climate variable/hazard has no effect.

8.5.6.3 Module 3: Assess vulnerability

Vulnerability assessment aims in the identification of the relevant climate hazards for the given specific project type at the foreseen location. This is done by combining the outcome of the analysis of sensitivity and exposure, respectively.

Module 3:
Vulnerability (V) is calculated as follows:
V=SxE, where S is the degree of sensitivity that asset has and E is exposure to baseline climate conditions/secondary effects. The following table presents the vulnerability classification matrix for each climate variable/hazard which could impact the project.

Table 8-28: Vulnerability classification matrix for each climate variable/hazard which could impact the project (baseline climate)

	Exposure			
		No	**Medium**	**High**
Sensitivity	**No**	2,5,7,8,9,10,14,15,16,18,20,22,23		
	Medium	11,17,19	1,3,21,6	4
	High		12,13	

Vulnerability level

(green)	**No**
(orange)	**Medium**
(red)	**High**

Table 8-29: Vulnerability classification matrix for each climate variable/hazard which could impact the project (future climate)

	Exposure			
		No	Medium	High
Sensitivity	No	5,9,10,14,15,16, 18,20,22,23		
	Medium	17	1,2,3,7,8,11,21,6 ,19	
	High			4,12,13

Vulnerability level

(green)	No
(orange)	Medium
(red)	High

The numbers 1-23 represents the Key climate variables and climate-related hazards that presented during module 1 description.

8.5.6.4 Module 4: Assess risks

Module 4:

The following risk assessment matrix was used to determine the risk of each individual environmental aspect relevant to the CWMF. The level of risk determined from the matrix identifies the level of control measures required for that environmental aspect.

Table 8-30: Risk Assessment Matrix (example)

Likelihood		Insignificant	Minor	Moderate	Major	Catastrophic
	Rare				Flood	
	Unlikely			Drought		
	Moderate			Heat		
	Likely					
	Almost certain					

Legend:

Risk level
Low
Medium
High
Extreme

Source: Publication: Climate Change and Major Projects, European Commission 2016

The output of the likelihood analysis may be summarised in a qualitative or quantitative estimation of the likelihood for each of the essential climate variables and hazards.

Source: Guide to cost benefit analysis of investment projects 2014-2020

Explanatory notes on the selection of the Severity and Probability for each issue are presented in the following table.

Table 8-31: Risk Matrix Explanation

Probability			Severity		
Rare	Highly unlikely to occur	0-5%	I	Insignificant	No relevant effect on social welfare, even without remedial actions
Unlikely	Unlikely to occur	5-20%	II	Minor	Minor loss of the social welfare generated by the project, minimally affecting the project long run effects. However, remedial or corrective actions needed
Moderate	As likely to occur as not	20-50%	III	Moderate	Social welfare loss generated by the project, mostly financial damage, even in the medium-long run. Remedial actions may correct the problem
Likely	Likely to occur	50-80%	IV	Critical	High social welfare loss generated by the project: the occurrence of the risk causes a loss of the primary functions of the project. Remedial actions, even large in scope, are not enough to avoid serious damage
Almost certain	Very likely to occur	80-95%	V	Catastrophic	Project failure that may result in serious or even total loss of the project functions. Main project effects in the medium-long term do not materialize

Source: Publication: Climate Change and Major Projects, European Commission 2016 And Guide to cost benefit analysis of investment projects 2014-2020

The next table illustrates the Risk Assessment Matrix Results for the CWMF & TSs that will be constructed and operated in Southwest region.
The Risk Assessment will be applied for the key climate variables and climate related hazards that were assessed as High and Medium Vulnerability level according to the vulnerability classification matrix.

Table 8-32: Risk Assessment Matrix Results

		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Rare				2, 21	
	Unlikely			6, 7, 8, 17	4, 12, 13	
	Moderate			1, 11	3	
	Likely			19		
	Almost certain					

Legend:
Risk level
Low
Medium
High
Extreme

8.5.6.5 Module 5 and 6: Identification of adaptation options and appraise adaptation options

Significant risks to the project deriving from the effects of climate change should be managed and reduced to an acceptable level.

In general, adaptation often involves a mix of structural and non-structural options. The former include e.g modifications to the design or specification of physical assets and infrastructure, or the adoption of alternative or improved solutions. The latter includes e.g improved monitoring or emergency response programmes, staff training and skills transfer activities, development of strategic or corporate climate risk assessment frameworks, financial solutions such as insurance against supply chain failure or alternative services. The appraisal of adaptation options can be quantitative or qualitative depending on the availability of information and other factors. In some circumstances it may be in sufficient with a rapid expert assessment. In other circumstances, in particular for options with significant economic impact, it may be relevant to use more comprehensive information, for example on the climate hazard's likelihood distribution and the economic value of the associated (avoided) damages as well as the residual risks. The next step is to integrate the appraised adaption options into the project, at the various development stages, including e.g investment and finance planning, monitoring and response planning, defining roles and responsibilities, organizational arrangements, training, etc.

For each significant risk identified, relevant adaptation measures were considered and integrated into the design of the project and expressed in financial terms where possible, to enhance the resilience of the project:

Regarding temperature changes that can affect the biological process, the biological treatment of both the organic fraction and the green waste stream is foreseen with membrane. The membrane cover possesses unique properties that produce a constant micro-climate in the heap, owned to the material special pore structure.

Regarding rainfall change, extreme rainfall storm and flooding phenomena, in the overall design of the components of the project, protection works have been foreseen. More specifically, flood protection works presented in the general layout include circumferential ditches and culverts. Also the slope of the free surfaces has been considered. Also, for the future CWMF site the geological prospection concluded that the possibility of flooding could be practically eliminated.

Regarding the wild fire, fire fighting network is been foreseen and it shall cover the whole area of the facility. One water tank for fire fighting is envisaged in a building is entirely dug-in, with monolithic Ferro-concrete walls, floor and rooftop slabs. Also the Inside and parallel to the fence, a fire protection zone of 10.00 m width is foreseen for the perimeter of the site. Fire Protection measures have also been foreseen for the TSs.

Regarding ground instability and landslides, the selected site was classified as stable during the geological prospection and during the design all the configurations have been decided having in mind the slopes of the terrain.

As already mentioned adaptation may involve a mix of responses. Besides the above mentioned, that include engineering solutions and technical design options, other flexible/ adaptive measures such as training, capacity building and operations, emergency plan actions have been foreseen and could be implemented during the operation of the facilities.

TABLE OF CONTENTS

LIST OF TABLES

9. FINANCIAL AND ECONOMIC ANALYSIS, RISK ASSESSMENT

9.1. FINANCIAL ANALYSIS

9.1.1. METHODOLOGY OF THE ANALYSIS

The **purpose for requiring CBA** for major projects is **twofold**:

First, it must be shown that the project is desirable from an economic point of view and contributes to the goals of EU regional policy. In order to check this, it is necessary to carry out an economic analysis and look at the effect on economic indices estimated by the CBA. A simple rule is that if the project's economic net present value (ENPV) is positive, then the society is better off with the project because its benefits exceed its costs. Therefore, the project should receive the assistance of EU Funds and be co-financed if needed (which will be proved below, in the Financial Analysis). The fact that a project contributes positively to EU regional policy objectives does not necessarily mean that it has to be co-financed by any Structural Fund.

Second, evidence should be provided that the contribution of the EU Fund is needed for the project to be financially viable. The appropriate level of assistance should be determined on this basis. To check whether a project needs co-financing requires a financial analysis. If the financial net present value of the investment without the contribution of the Funds (FNPV/C) is negative then the project can be co-financed; the EU grant should not exceed the amount of money that makes the project break even, so that no over-financing occurs.

In principle, all impacts should be assessed: financial, economic, social, environmental, etc. The objective of CBA is to identify and monetize all possible impacts in order to determine the project costs and benefits; then the results are aggregated (net benefits) and conclusions are drawn on whether the project is desirable and worth implementing. Costs and benefits should be evaluated on an incremental basis, by considering the difference between the project scenario and an alternative scenario without the project (Business as usual scenario – BAU).

In this paragraph, Financial Analysis carried out according to the principles of the Guide to Cost-Benefit Analysis of Investment Projects, Economic Appraisal tool for Cohesion Policy 2014-2020, European Commission, Directorate-General for Regional and Urban policy, December 2014.

The Guide defines the main purpose of the financial analysis is to use the project cash flow forecasts to calculate suitable net return indicators. The Guide places particular emphasis on two financial indicators: the Financial Net Present Value (FNPV) and the Financial Internal Rate of Return (FRR), respectively in terms of return on the investment cost, FNPV(C) and FRR(C), and return on national capital, FNPV(K) and FRR(K).

The methodology used is discounted cash flow (DCF) analysis. There are **two main features of the DCF method**:

Only cash flows are considered. Thus, non-cash accounting items as depreciation and contingency reserves were not included in the DCF analysis. **However,** due to the fact that a risk analysis also carried out in this study, **10% contingencies**(of each part procured with RED FIDIC) and **5% contingencies**(of each part procured with YELLOW FIDIC) included in the eligible cost. But this cost category is not included for the determination of the funding gap, as they do not constitute cash flows.

The residual value is calculated on the basis of a design life time of 30 years, by computing the net present value of cash flows in the remaining years of the project after the reference period.

As mentioned above, CBA uses the **incremental method**: the project is evaluated on the basis of the differences in the costs and benefits between the scenario with the project and an alternative scenario without the project.

- The scenario "**without the project"** (BAU Scenario) is that without any infrastructure but only the necessary replacements;
- The scenario **"with the project"** takes into consideration the total cost of investment. Operating costs and revenues considered for the entire infrastructure are those of a scenario of efficient operation.

The financial analysis carried out as part of a major project's CBA aiming to:

- Evaluate the financial profitability of the Project and own (national) capital ;
- Determine the appropriate (maximum) contribution from the EU Fund ;
- Check the financial sustainability of the project.

For the sake of the analysis an excel model developed which covers the demands of the guidelines. The purpose of this tool is to facilitate the calculation of the funding gap as well as the financial and economic performance indicators.

9.1.2. CAPEX OVERVIEW

The paragraph describes the total Investments schedule breakdown. The total investment consists of two major parts, the Eligible part and the non-eligible part. The eligible part will be subject of EU co financing with the present will derive from the Funding gap estimation (see below). Non eligible works are not foreseen for the present project.

The Eligible Investment plan includes the following works:

- Mechanical Treatment, includes civil works, plant – machinery and mobile equipment;
- Biological Treatment, includes civil works, plant – machinery and mobile equipment;
- Residual Landfill (WWTP not included), includes civil works, plant – machinery and mobile equipment;
- Waste Water Treatment Plant, includes civil works and plant – machinery;
- Windrow composting (for green waste), includes civil works, plant – machinery and mobile equipment;
- Infrastructure works, includes civil works and plant – machinery;
- Construction of transfer stations, includes civil works plant – machinery and mobile equipment;
- Collection equipment includes collection bins and mobile equipment;
- Technical Assistance -Supervision during implementation& Publicity Measures;
- Public utilities (access roads, connection of power supply network, water supply network etc);
- Land Acquisition.

Contingencies 10% (of each part procured with RED FIDIC) and 5% contingencies(of each part procured with YELLOW FIDIC)also included accordingly for relevant cost categories.

The following table shows the cost breakdown in constant prices:

Table 9-1: Breakdown of Investment Cost, in Euro (constant price 2017)

Initial project cost	**Eligible**				**Non-eligible**			
(in constant EUR)	**2017**	**2018**	**2019**	**2020**	**2017**	**2018**	**2019**	**2020**
Land acquisition								
Acquisition of land of WMC & Transfer Station		830,000				0	0	0
Total	**0**	**830,000**	**0**	**0**		**0**	**0**	**0**
Civil Construction								
Mechanical Treatment		854,694	1,139,592	902,694				
Biological Treatment		646,800	970,200	539,000				
Residual Landfill (WWTP not included)		579,418	744,966	331,096				
Waste Water Treatment Plant		43,155	258,928	129,464				
Infrastucture works		346,908	138,763	208,145				
Windrow Composting (for green waste)		83,460	125,190	69,550				
Transfer Station Struga		306,224	204,149	170,124				
Transfer Station Debar		224,097	67,229	206,667				
Transfer Station Kichevo		276,964	83,089	255,423				
Transfer Station Ohrid		313,709	94,113	289,310				
Collection Equipment	0							
Public Utilities (Access Road)	0			60,000				
Total	**0**	**3,675,429**	**3,826,219**	**3,161,473**	**0**	**0**	**0**	**0**
Plant and machinery								
Mechanical Treatment		516,000	2,290,050	3,736,950				
Biological Treatment		329,600	1,483,200	1,483,200				
Residual Landfill (WWTP not included)		10,257	46,156	46,156				
Waste Water Treatment Plant		20,756	259,450	757,594				
Infrastucture works		74,042	185,104	481,272				
Windrow Composting		25,500	60,750	48,750				
Transfer Station Struga				78,450				
Transfer Station Debar				78,450				
Transfer Station Kichevo				78,450				
Transfer Station Ohrid				78,450				
Collection Equipment	0			1,731,312				
Public Utilities (Access Road)	0							
Total	**0**	**976,155**	**4,324,710**	**8,599,033**	**0**	**0**	**0**	**0**
Mobile equipment								
Mechanical Treatment				357,600				
Biological Treatment				128,000				
Residual Landfill (WWTP not included)				505,000				
Waste Water Treatment Plant								
Infrastucture works								
Windrow Composting				255,000				
Transfer Station Struga				259,130				
Transfer Station Debar				392,249				
Transfer Station Kichevo				415,624				
Transfer Station Ohrid				469,960				
Collection Equipment				2,823,332				
Public Utilities (Access Road)								
Total	**0**	**0**	**0**	**5,605,895**	**0**	**0**	**0**	**0**

Initial project cost	Eligible				Non-eligible			
(in constant EUR)	2017	2018	2019	2020	2017	2018	2019	2020
Contingencies								
Mechanical Treatment	0	68,535	171,482	231,982	0	0	0	0
Biological Treatment	0	48,820	122,670	101,110	0	0	0	0
Residual Landfill (WWTP not included)	0	58,967	79,112	37,725	0	0	0	0
Waste Water Treatment Plant		3,196	25,919	44,353				
Infrastucture works	0	42,095	32,387	68,942	0	0	0	0
Windrow Composting	0	5,448	9,297	5,915	0	0	0	0
Transfer Station Struga	0	30,622	20,415	24,857	0	0	0	0
Transfer Station Debar	0	22,410	6,723	28,512	0	0	0	0
Transfer Station Kichevo	0	27,696	8,309	33,387	0	0	0	0
Transfer Station Ohrid	0	31,371	9,411	36,776				
Collection Equipment	0	0	0	86,566	0	0	0	0
Public Utilities (Access Road)	0	0	0	3,000	0	0	0	0
Total	**0**	**339,160**	**485,725**	**703,125**	**0**	**0**	**0**	**0**
Totals excluding intangibles								
Mechanical Treatment	0	1,439,229	3,601,124	5,229,226	0	0	0	0
Biological Treatment	0	1,025,220	2,576,070	2,251,310	0	0	0	0
Residual Landfill (WWTP not included)	0	648,642	870,233	919,977	0	0	0	0
Waste Water Treatment Plant		67,106	544,296	931,411				
Infrastucture works	0	463,045	356,255	758,358	0	0	0	0
Windrow Composting	0	114,408	195,237	379,215	0	0	0	0
Transfer Station Struga	0	336,846	224,564	532,562	0	0	0	0
Transfer Station Debar	0	246,507	73,952	705,878	0	0	0	0
Transfer Station Kichevo	0	304,661	91,398	782,884	0	0	0	0
Transfer Station Ohrid	0	345,080	103,524	874,496				
Collection Equipment	0	0	0	4,641,210	0	0	0	0
Public Utilities (Access Road)	0	0	0	63,000	0	0	0	0
Total	**0**	**4,990,744**	**8,636,654**	**18,069,526**	**0**	**0**	**0**	**0**
Intangible components								
Technical Assistance - Supervision during implementation & Publicity	0	600,000	950,000	850,000				
Public Utilities (connection of power supply network, water supply network etc)	200,000	100,000	0	0				
Grand total	**200,000**	**6,520,744**	**9,586,654**	**18,919,526**	**0**	**0**	**0**	**0**

During the thirty years analysis period (2017-2046), replacement and reinvestments costs were taken into account. The main parameter for the timing of such investments was the useful life of the assets. The reinvestment cost has been presented as follow:

Table 9-2: Breakdown of Reinvestment Cost, in Euro (constant price 2017)

REINVESTMENT COST - Non Eligible Cost								
(in constant EUR)	**2021-2026**	**2027**	**2028**	**2029-2031**	**2032**	**2033-2038**	**2039**	**2040-2046**
Land acquisition								
Acquisition of land of WMC & Transfer Station	0	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Civil Construction								
Mechanical Treatment	0	0	0	0	0	0	0	0
Biological Treatment	0	0	0	0		0	0	0
Residual Landfill (WWTP not included)	0	653,000	1,253,178	0	0	0	0	0
Waste Water Treatment Plant								
Infrastucture works	0	0	0	0	0	0	0	0
Windrow Composting (for green waste)	0	0	0	0	0	0	0	0
Transfer Station Struga	0	0	0	0	0	0	0	0
Transfer Station Debar	0	0	0	0		0	0	0
Transfer Station Kichevo	0	0	0	0	0	0	0	0
Transfer Station Ohrid								
Collection Equipment	0	0	0	0	0	0	0	0
Public Utilities (Access Road)	0	0	0	0	0	0	0	0
Total	**0**	**653,000**	**1,253,178**	**0**	**0**	**0**	**0**	**0**
Plant and machinery								
Mechanical Treatment	0	0	0	0	2,617,200	0	0	0
Biological Treatment	0	0	0	0	1,318,400	0	0	0
Residual Landfill (WWTP not included)	0	0	0	0	5,128	0	0	0
Waste Water Treatment Plant			400,000	0	51,890			
Infrastucture works	0	0	0	0	296,167	0	0	0
Windrow Composting	0	0	0	0	54,000	0	0	0
Transfer Station Struga	0	0	0	0	31,380	0	0	0
Transfer Station Debar	0	0	0	0	31,380	0	0	0
Transfer Station Kichevo	0	0	0	0	31,380	0	0	0
Transfer Station Ohrid					31,380			
Collection Equipment	0	0	0	0	1,211,918	0	0	0
Public Utilities (Access Road)	0	0	0	0	0	0	0	0
Total	**0**	**0**	**400,000**	**0**	**5,680,224**	**0**	**0**	**0**
Mobile equipment								
Mechanical Treatment	0	0	0	0	357,600	0	0	0
Biological Treatment	0	0	0	0	128,000	0	0	0
Residual Landfill (WWTP not included)	0	0	0	0	505,000	0	0	0
Waste Water Treatment Plant								
Infrastucture works	0	0	0	0	0	0	0	0
Windrow Composting	0	0	0	0	255,000	0	0	0
Transfer Station Struga	0	0	0	0	259,130	0	0	0
Transfer Station Debar	0	0	0	0	392,249	0	0	0
Transfer Station Kichevo	0	0	0	0	415,624	0	0	0

REINVESTMENT COST - Non Eligible Cost								
(in constant EUR)	**2021-2026**	**2027**	**2028**	**2029-2031**	**2032**	**2033-2038**	**2039**	**2040-2046**
Transfer Station Ohrid					469,960			
Collection Equipment	0	812,896	0	0	2,823,332	0	812,896	0
Public Utilities (Access Road)	0	0	0	0	0	0	0	0
Total	**0**	**812,896**	**0**	**0**	**5,605,895**	**0**	**812,896**	**0**
Contingencies					0			
Mechanical Treatment	0	0	0	0	130,860	0	0	0
Biological Treatment	0	0	0	0	65,920	0	0	0
Residual Landfill (WWTP not included)	0	65,300	125,318	0	513	0	0	0
Waste Water Treatment Plant		0	20,000	0	2,595			
Infrastucture works	0	0	0	0	29,617	0	0	0
Windrow Composting	0	0	0	0	2,700	0	0	0
Transfer Station Struga	0	0	0	0	3,138	0	0	0
Transfer Station Debar	0	0	0	0	3,138	0	0	0
Transfer Station Kichevo	0	0	0	0	3,138	0	0	0
Transfer Station Ohrid					3,138			
Collection Equipment	0	0	0	0	60,596	0	0	0
Public Utilities (Access Road)	0	0	0	0	0	0	0	0
Total	**0**	**65,300**	**145,318**	**0**	**305,352**	**0**	**0**	**0**
Totals excluding intangibles								
Mechanical Treatment	0	0	0	0	3,105,660	0	0	0
Biological Treatment	0	0	0	0	1,512,320	0	0	0
Residual Landfill (WWTP not included)	0	718,300	1,378,496	0	510,641	0	0	0
Waste Water Treatment Plant		0	420,000	0	54,485			
Infrastucture works	0	0	0	0	325,784	0	0	0
Windrow Composting	0	0	0	0	311,700	0	0	0
Transfer Station Struga	0	0	0	0	293,648	0	0	0
Transfer Station Debar	0	0	0	0	426,767	0	0	0
Transfer Station Kichevo	0	0	0	0	450,142	0	0	0
Transfer Station Ohrid					504,478			
Collection Equipment	0	812,896	0	0	4,095,846	0	812,896	0
Public Utilities (Access Road)	0	0	0	0	0	0	0	0
Total	**0**	**1,531,196**	**1,798,496**	**0**	**11,591,471**	**0**	**812,896**	**0**
Intangible components								
Technical Assistance - Supervision during implementation & Publicity								
Public Utilities (connection of power supply network, water supply network etc)								
Grand Total	**0**	**1,531,196**	**1,798,496**	**0**	**11,591,471**	**0**	**812,896**	**0**

9.1.3. OPEX OVERVIEW

9.1.3.1. Opex Overview for WITH PROJECT scenario

The operating cost of the project is projected by waste element: collection, transfer and transportation, sorting, biological treatment, infrastructures and disposal. Within each element the cost is split into fixed and variable to allow for better projection and differentiation of growth rates.

The O&M costs were grouped in the following cost centers:

a. Mechanical Treatment of Mixed Municipal Waste and Mechanical Treatment of Recyclables
b. Biological treatment (Anaerobic Digestion &Biostabilization);
c. Landfill for residues (WWTP included);
d. Windrow Composting (for green waste);
e. Infrastructure Works;
f. Transfer stations;
g. Transportation costs direct to WMC and to Transfer Stations;

The O&M cost centers consist of fixed and variable costs. The basic assumptions of that distinguishes the relation between cost category and waste quantities.

In the group of variable costs the **energy** and **fuel** costs that are related to the waste quantities are included. Within the group of fixed costs the maintenance cost, the insurance, monitoring costs and the labor cost are included.
The prices considered standard of 2017 for the whole period of analysis.

The unitary costs per each category are as follow:

Maintenance Cost	:	4% of the Mechanical Treatmentand Biological Treatment investment cost per year, 1.5% of Landfill for residue investment cost per year and 1% for infrastructure;
Monitoring	:	Fixed cost between 5,000 and 25,000 EUROS per year;
Fuel cost	:	0.856€/l;
Energy cost	:	0.140 €/KWh;
Insurance	:	0.7% of the inv. cost;
Administrative cost	:	20% of the labour cost.
Unskilled Labour Cost	:	4,200 € / year;
Skilled Labour Cost	:	6,120 € / year;
Supervisors etc	:	8,160 € / year;

9.1.3.1.1.Mechanical Treatment of Mixed Municipal Waste

The Mechanical Treatment of Mixed Municipal Waste Plant cost center includes the following cost categories per year.

- Labor cost : (15 worker unskilled personnel, 3 driver / handler, 1 engineer / supervisor) 89,520€/year;
- Maintenancecost : 391,903€/year;
- Insurance and Monitoring costs: 93,583€/year;
- Administrative cost : 17,904 Euros / Year.

The average quantity of sorted waste (avg. 41,668 t/ year) was the base of the calculation of the pure variable cost categories such as energy and fuel costs. The cost of energy estimated in average 175,005€/year and the cost of fuel 107,003 €/year.

In summary the table below illustrates the data mentioned above.

Table 9-3: Mechanical Treatment of Mixed Waste–Operating cost basic assumptions

MECHANICAL SORTING PLANT		
LABOUR		
CATEGORY	**No**	**EUR/year**
WORKER UNSKILLED	15	4,200
DRIVER / HANDLER	3	6,120
WORKER SKILLED		6,120
TECHNICIAN		7,200
SUPERVISOR	0	8,160
CHIEF ENGINEER	1	8,160
MAINTENANCE	391,903	Euro/yr
% of investment cost	4.0%	
ENERGY	30	KWh/t @ 0.140 EUR
INSURANCE	68,583	Euro/yr
FUEL	3.0	l/t @ 0,856 EUR
ADMIN. COST	17,904	Euro/yr
% of labour cost	20.0%	
MONITORING	25,000	Euro/yr

Calculation of average annual costs			
Cost category (fixed/variable)			**EUR/yr**
Insurance & Monitoring (fixed)			93,583
Labour (fixed)			89,520
Maintenance (fixed)			391,903
Energy for … t/year sorted waste (variable) = EUR per t	41,668	4.20	175,005
Fuel for … t/year sorted waste (variable) = EUR per t	41,668	2.57	107,003
Administrative cost (fixed)			17,904
Total EUR			**874,918**
Total Euro			874,918
Total EUR/t			**21.00**
Total Euro/t			21.00

9.1.3.1.2.Mechanical Treatment of Recyclables

The Mechanical Treatment of Recyclablescost center includes the following cost categories per year.

- Labor cost : (15workers unskilled personnel, 3 drivers / handlers, 1skilled worker, 1engineer / supervisor) 95,640 Euros/year;
- Insurance and Monitoring costs: 5,000€/year;
- Administrative cost : 19,128€/year

The average quantity of shorted recyclables waste (avg. 13,874 t/ year for the operation period) was the base of the calculation of the pure variable cost categories such as energy and fuel costs. The cost of energy estimated in average 58,271€/ year and the cost of fuel 35,629€ / year.

In summary the table below illustrates the data mentioned above.

Table 9-4: Mechanical Treatment of Recyclables - Operating cost basic assumptions

MECHANICAL SORTING PLANT FOR RECYCLABLE WASTE BIN		
LABOUR		
CATEGORY	**No**	**EUR/year**
WORKER UNSKILLED	15	4,200
DRIVER / HANDLER	3	6,120
WORKER SKILLED	1	6,120
TECHNICIAN	0	7,200
SUPERVISOR		8,160
CHIEF ENGINEER	1	8,160
MAINTENANCE	0	Euro/yr
% of investment cost	4.0%	
ENERGY	30	KWh/t @ 0.140 EUR
INSURANCE	0	Euro/yr
FUEL	3.0	l/t @ 0,856 EUR
ADMIN. COST	19,128	Euro/yr
% of labour cost	20.0%	
MONITORING	5,000	Euro/yr

Calculation of average annual costs			
Cost category (fixed/variable)			**EUR/yr**
Insurance & Monitoring (fixed)			5,000
Labour (fixed)			95,640
Maintenance (fixed)			0
Energy for ... t/year	13,874		
waste (variable)		4.20	58,271
= EUR per t			
Fuel for ... t/year	13,874		
waste (variable)		2.57	35,629
= EUR per t			
Administrative cost (fixed)			19,128
Total EUR			**213,668**
Total Euro			213,668
Total EUR/t			**15.40**
Total Euro/t			15.40

9.1.3.1.3. Biological Treatment (Anaerobic Digestion &BiostabilizationPlant)

The Biological Treatment (Anaerobic Digestion &Biostabilization Plant) cost center includes the following cost categories per year.

- Labor cost : (2 workers unskilled personnel, 4 drivers / handlers, 1 engineer / supervisor) 41,040€/year;
- Maintenancecost : 223,200€ / Year;
- Insurance and Monitoring costs: 54,060€ / Year;
- Administrative cost : 8,208€/ Year.

The average quantity for anaerobic digestion (avg. 23,870 t/ year) and for biostabilisation (avg. 10,806 t/ year) was the base of the calculation of the pure variable cost categories such as energy and fuel costs. The cost of energy estimated in average 167,092€/year and the cost of fuel 2,043€/year for anaerobic digestion.
The cost of energy estimated in average 15,128 €/year and the cost of fuel 9,250 €/year for biostabilisation .

In summary the table below illustrates the data mentioned above.

Table 9-5: Biological Treatment (Anaerobic Digestion &Biostabilization Plant) - Operating cost basic assumptions

BIOLOGICAL TREATMENT		
LABOUR		
CATEGORY	**No**	**EUR/year**
WORKER UNSKILLED	2	4,200
DRIVER / HANDLER	4	6,120
WORKER SKILLED	0	6,120
TECHNICIAN	0	7,200
SUPERVISOR	1	8,160
CHIEF ENGINEER	0	8,160
MAINTENANCE	223,200	Euro/yr
% of investment cost	4.0%	
ENERGY (Anaerobic Digestion stage)	50	KWh/t @ 0.140 EUR
FUEL (Anaerobic Digestion stage)	0.1	l/t @ 0,856 EUR
ENERGY (Biostabilization stage)	10	KWh/t @ 0.0819 EUR
FUEL (Biostabilization stage)	1.0	l/t @ 0,856 EUR
INSURANCE	39,060	Euro/yr
ADMIN. COST	8,208	Euro/yr
% of labour cost	20.0%	
MONITORING	15,000	Euro/yr

Calculation of average annual costs		
Cost category (fixed/variable)		**EUR/yr**
Insurance & Monitoring (fixed)		54,060
Labour (fixed)		41,040
Maintenance (fixed)		223,200
Energy for ... t/year anaerobic digestion waste (variable)	23,870	167,092
= EUR per t	7.00	
Fuel for ... t/year anaerobic digestion waste (variable)	23,870	2,043
= EUR per t	0.09	
Energy for ... t/year biostabilization waste (variable)	10,806	15,128
= EUR per t	1.40	
Fuel for ... t/year biostabilization waste (variable)	10,806	9,250
= EUR per t	0.86	
Administrative cost (fixed)		8,208
Total EUR		**520,022**
Total Euro		520,022
Total EUR/t		**21.79**
Total Euro/t		21.79

9.1.3.1.4Residual Landfiil

The Landfill (residues) cost center includes the following cost categories per year.

- Labor cost : (1 worker unskilled personnel, 3 drivers / handlers)22,560€/year;
- Maintenancecost : 55,986 €/year;
- Monitoring and Aftercare costs: 36,196 Euros / Year;
- Insurance cost : 26,127 Euros / Year;
- Administrative cost : 4,512Euros / Year.

The average quantity of Landfilled waste (avg. 16,436 t/ year for the operation period) was the base of the calculation of the pure variable cost categories such as energy and fuel costs
The cost of energy estimated in average 11,505€/year and the cost of fuel 70,345€/year.

In summary the table below illustrates the data mentioned above.

Table 9-6: Landfill for residues - Operating cost basic assumptions

RESIDUE LANDFILL (WWTP included)		
LABOUR		
CATEGORY	**No**	**EUR/year**
WORKER UNSKILLED	1	4,200
DRIVER / HANDLER	3	6,120
WORKER SKILLED	0	6,120
TECHNICIAN	0	7,200
SUPERVISOR	0	8,160
CHIEF ENGINEER	0	8,160
CHEMICALS	0	0
MAINTENANCE	55,986	Euro/yr
% of investment cost	1.5%	
ENERGY	5	KWh/t @ 0.140 EUR
INSURANCE	26,127	Euro/yr
FUEL	5	l/t @ 0,856 EUR
MONITORING	20,000	Euro/yr
ADMIN. COST	4,512	
% of labour cost	20.0%	Euro/yr
AFTERCARE	70,000	Euro/yr

Calculation of average annual costs		
Cost category (fixed/variable)		**EUR/yr**
Chemicals (fixed)		0
Labour (fixed)		22,560
Maintenance (fixed)		55,986
Energy for … t/year landfilled		
waste (variable)		11,505
= EUR per t	16,436	
Fuel for … t/year landfilled	0.70	
waste (variable)		70,345
= EUR per t	16,436	
Monitoring & Aftercare(fixed)		36,196
Insurance (fixed)		26,127
Administrative cost (fixed)		4,512
Total EUR		**227,231**
Total Euro		227,231
Total EUR/t		**13.83**
Total Euro/t		13.83

9.1.3.1.5Windrow Composting for green waste

The Windrow composting or green waste cost center includes the following cost categories per year.

- Labor cost : (1 worker unskilled personnel, 1 driver / handler) 10,320 Euros/year;
- Maintenancecost : 26,728 Euros / Year;
- Monitoring and Aftercare costs: 5,000Euros / Year;
- Insurance cost : 4,677Euros / Year;
- Administrative cost : 2,064 Euros / Year.

The average quantity of green waste (avg. 3,591 t/ year for the operation period) was the base of the calculation of the pure variable cost categories such as energy and fuel costs
The cost of energy estimated in average 2,514€/ year and the cost of fuel 6,148€ / year.

In summary the table below illustrates the data mentioned above.

Table 9-7: Windrow Composting for green waste- Operating cost basic assumptions

WINDROW COMPOSTING		
LABOUR		
CATEGORY	**No**	**EUR/year**
WORKER UNSKILLED	1	4,200
DRIVER / HANDLER	1	6,120
WORKER SKILLED		6,120
TECHNICIAN		7,200
SUPERVISOR		8,160
CHIEF ENGINEER		8,160
MAINTENANCE	26,728	Euro/yr
% of investment cost	4.0%	
ENERGY	5	KWh/t @ 0.140 EUR
INSURANCE	4,677	Euro/yr
FUEL	2	l/t @ 0,856 EUR
MONITORING	5,000	Euro/yr
ADMIN. COST	2,064	
% of investment cost	20.0%	Euro/yr

Calculation of average annual costs		
Cost category (fixed/variable)		**EUR/yr**
Labour (fixed)		10,320
Maintenance (fixed)		26,728
Energy for ... t/year green waste		
waste (variable)	3,591	2,514
= EUR per t	0.70	
Fuel for ... t/year green waste		
waste (variable)	3,591	6,148
= EUR per t	1.71	
Monitoring & Aftercare(fixed)		5,000
Insurance (fixed)		4,677
Administrative cost (fixed)		2,064
Total EUR		**57,451**
Total Euro		57,451
Total EUR/t		**16.00**
Total Euro/t		16.00

9.1.3.1.5 Infrastructure works

The Infrastructures cost center includes the following cost categories per year.

- Labor cost : (1worker unskilled personnel), 4,200Euros/year;
- Maintenancecost : 14,342 Euros / Year;
- Chemicals cost : 5,000Euros / year;
- Insurance cost : 10,040 Euros / Year;
- Administrative cost : 840 Euros / Year;
- Energy : 11,200 Euros / Year.
- Fuel : 4,280 Euros / Year.

In summary the table below illustrates the data mentioned above.

Table 9-8: Infrastructure works- Operating cost basic assumptions

INFRASTRUCTURE WORKS		
LABOUR		
CATEGORY	**No**	**EUR/year**
WORKER UNSKILLED	1	4,200
DRIVER / HANDLER	0	6,120
WORKER SKILLED	0	6,120
TECHNICIAN	0	7,200
SUPERVISOR	0	8,160
CHIEF ENGINEER	0	8,160
MAINTENANCE	14,342	Euro/yr
% of investment cost	1.0%	
ENERGY	80,000	KWh/y @ 0.140 EUR
INSURANCE	10,040	Euro/yr
FUEL	5,000	l/y @ 0,856 EUR
ADMIN. COST	840	Euro/yr
% of labour cost	20.0%	
Chemicals	5,000	Euro/yr

Calculation of average annual costs		
Cost category (fixed/variable)		
Insurance (fixed)		10,040
Labour (fixed)		4,200
Maintenance (fixed)		14,342
Chemicals (fixed)		5,000
Energy (fixed)	41,668	
= EUR per year		11,200
Fuel (fixed)		
= EUR per year		4,280
Administrative cost (fixed)		840
Total EUR		**49,902**
Total Euro		49,902
Total EUR/t		**1.20**
Total Euro/t		1.20

9.1.3.1.6Transfer stations

The four (4) transfer stations (Struga, Debar, Kichevo and Ohrid) cost center includes the following cost categories per year

- Labor cost: 12 drivers and 9 unskilled workers 138,240 €/year;
- Maintenance and insurance cost : 186,617 € / year;

The quantities of transferred waste on which the calculation of the pure variable cost category of energy and fuel is based, are the average quantities calculated for the whole period of analysis.

- Energy costs (average 2021-2046): 36,000 € / year
- Fuel costs (average 2021-2046): 126,816 € / year

The following table presents the operating cost for the transport of waste from each Transfer Station to Waste Management Center (WMC). The calculations for this operating cost have been presented in chapter 7.

Table 9-9: OPEX per TS (€/t), (average2021-2046)

Transfer Stations	Residual Waste (t/y)	Recyclables (t/y)	Green waste (t/y)	Total Waste (t/y)	Unit Cost (€/t)	Total Cost (€/a)
TS Struga	9,026	3,006	778	12,810	7.72	99,884
TS Debar	5,758	1,917	496	8,172	13.94	113,887
TS Kichevo	10,853	3,614	935	15,402	8.21	126,387
TS Ohrid	15,534	5,172	1,339	22,025	6.69	147,516
			Total	**58,409**	**8.35**	**487,673**

9.1.3.1.7Transportation cost direct to WMC and Transportation cost to Transfer Stations

The following table presents the operating cost for the transport of waste directly to WMC (for municipality ofDebartsa) and transportation cost to transfer stations (for municipalities Ohrid, Struga, Vevchani, CentarZhupa, Debar, Kichevo, Plasnitsa and MakedonskiBrod).

Table 9-10: Transportation cost direct to WMC and Transportation cost to Transfer Stations

Waste categories	Waste quantities that must be transferred	Unit Cost (€/t)	Total Cost (€/y)
Mixed Municipal Waste			
Ohrid	15.534	6,9	107.178
Debarca	496	48,4	23.990
Struga	8.769	7,2	63.328
Vevchani	257	74,6	19.156
CentarZhupa	632	33,5	21.207
Debar	5.126	8,2	41.842
Kichevo	8.714	7,9	68.758
Plasnica	924	26,1	24.086
MakedonskiBrod	1.215	20,1	24.415
Recyclables Waste			
Ohrid	5.172	8,4	43.423
Struga, Vevchani, Debar, Centar Zhupa	4.923	8,7	43.000
Debarca, Kichevo, Plasnica, Makedonski Brod	3.779	12,7	48.118
Green Waste			
Ohrid	1.339	43,3	57.930
Struga, Vevchani, Debar, Centar Zhupa	1.274	59,8	76.212
Debarca, Kichevo, Plasnica, Makedonski Brod	978	63,3	61.876
TOTAL	**59.133**	**12,3**	**724.518**

9.1.3.1.8 Administrative cost

Administration expenses relate to administration, accounting, office running, and other similar expenses, i.e., the expenses that are not directly related to the operation of the Project. The amount of the expenses is according to the LoWM article 123.

9.1.3.1.9 Operating cost for collection

According to the Regional Waste Management Plan, the collection system will use two bins, one for recyclables (dry bin) and one for mixed waste (wet bin). In addition, green waste will be collected separately and will be led for composting.

In order to calculate the operational collection cost in SouthwestRegion, information from the completed questionnaires from the municipalities were taken into account.

The collection cost is estimated about 30% higher compared to current's cost. The increase in cost is due to the upgrading of provided services.

9.1.3.1.10 Total Operating Cost for the WITH PROJECT scenario

The total operating cost for with project scenario, for the period 2021-2046, according to the above data is presented in the table below:

Table 9-11: Total Operating Cost (€/y)- WITH PROJECT scenario, in constant price 2017

Year	Collection Cost (Residual, recyclables, green)	Transfer Stations & Transportation direct to WMC and to Transfer Station	Mechanical Biological Treatment (for mixed waste)	Mechanical Treatment of Recyclables Waste	Infrastructure works	Residual landfill	Windrow Composting for green waste	Other cost (cost for transportation & disposal of RDF)	Administrative Cost	Total
2021	2,346,763	1,208,282	1,383,390	211,960	49,902	225,307	57,293	184,100	65,170	5,732,167
2022	2,380,505	1,209,017	1,385,453	212,335	49,902	225,658	57,328	184,919	65,609	5,770,727
2023	2,415,097	1,209,782	1,387,596	212,726	49,902	226,023	57,364	185,769	66,059	5,810,318
2024	2,450,576	1,210,576	1,389,822	213,133	49,902	226,403	57,402	186,652	66,521	5,850,988
2025	2,486,981	1,211,403	1,392,136	213,558	49,902	226,798	57,441	187,570	66,997	5,892,785
2026	2,522,333	1,212,124	1,394,184	213,914	49,902	227,145	57,474	188,383	67,453	5,932,911
2027	2,558,725	1,212,885	1,396,340	214,291	49,902	227,511	57,508	189,239	67,924	5,974,324
2028	2,596,206	1,213,687	1,398,610	214,690	49,902	227,896	57,545	190,139	68,410	6,017,085
2029	2,634,827	1,214,532	1,400,999	215,113	49,902	228,302	57,584	191,087	68,912	6,061,258
2030	2,674,645	1,215,422	1,403,512	215,561	49,902	228,729	57,626	192,084	69,431	6,106,911
2031	2,697,155	1,215,146	1,402,836	215,371	49,902	228,606	57,608	191,816	69,672	6,128,112
2032	2,720,026	1,214,882	1,402,191	215,188	49,902	228,489	57,591	191,560	75,998	6,155,828
2033	2,743,265	1,214,629	1,401,577	215,012	49,902	228,378	57,575	191,316	76,271	6,177,924

Year	Collection Cost (Residual, recyclables, green)	Transfer Stations & Transportation direct to WMC and to Transfer Station	Mechanical Biological Treatment (for mixed waste)	Mechanical Treatment of Recyclables Waste	Infrastructure works	Residual landfill	Windrow Composting for green waste	Other cost (cost for transportation & disposal of RDF)	Administrative Cost	Total
2034	2,766,875	1,214,388	1,400,993	214,842	49,902	228,271	57,559	191,085	76,549	6,200,463
2035	2,790,860	1,214,157	1,400,439	214,679	49,902	228,170	57,544	190,865	76,833	6,223,449
2036	2,811,866	1,213,729	1,399,341	214,409	49,902	227,975	57,519	190,429	77,065	6,242,234
2037	2,833,200	1,213,312	1,398,274	214,145	49,902	227,785	57,495	190,006	77,301	6,261,421
2038	2,854,868	1,212,907	1,397,237	213,888	49,902	227,601	57,471	189,594	77,543	6,281,013
2039	2,876,872	1,212,513	1,396,230	213,638	49,902	227,422	57,448	189,195	77,790	6,301,011
2040	2,899,216	1,212,130	1,395,253	213,394	49,902	227,248	57,426	188,807	78,042	6,321,418
2041	2,918,893	1,211,579	1,393,816	213,061	49,902	226,995	57,395	188,237	78,248	6,338,126
2042	2,938,874	1,211,041	1,392,410	212,734	49,902	226,748	57,365	187,679	78,459	6,355,212
2043	2,959,163	1,210,514	1,391,034	212,413	49,902	226,506	57,335	187,133	78,675	6,372,675
2044	2,979,760	1,209,998	1,389,689	212,100	49,902	226,269	57,306	186,599	88,363	6,399,987
2045	3,000,670	1,209,494	1,388,373	211,793	49,902	226,037	57,278	186,077	88,615	6,418,239
2046	3,019,349	1,208,857	1,386,693	211,415	49,902	225,743	57,243	185,410	88,825	6,433,436

9.1.3.2. Opex Overview for WITHOUT PROJECT scenario

The "WITHOUT PROJECT" scenario is a theoretical approach of prolonging the existing situation of this non-effective waste management system that already exists. The main assumption for the "WITHOUT PROJECT" scenario is that no investment will take place in order to change the capacity and the nature of the works that exist until now.

The operating cost in the "Without Project" case estimated on the base of weighted average historical cost data, considering that:

- 29Euros per ton is the approximate cost for collection & transportationfor the year 2017with average growth 1%;
- 10Euros per ton is the approximate costfor disposal of residual waste for the period 2021-2046;
- 15Euros per ton for the treatment of recyclablesfor the year 2017 with average growth 1%;
- Administrative cost according the article 123LoWM

The total operating cost for "Without Project" scenario according to the above data is presented in the table below:

Table 9-12: Total Operating Cost (€/y) - WITHOUT PROJECT scenario, in constant price 2017

Year	Collection & transportation Cost (residual & recyclables)	Landfilling of residual waste	Treatment of recyclables	Administrative Cost	Total
2021	1,895,577	594,926	24,561	35,106	2,550,171
2022	1,922,325	597,347	24,908	34,931	2,579,511
2023	1,949,746	599,869	25,263	34,496	2,609,374
2024	1,977,869	602,497	25,628	34,300	2,640,293
2025	2,006,727	605,235	26,002	34,134	2,672,097
2026	2,034,487	607,532	26,361	33,967	2,702,347
2027	2,063,068	609,967	26,732	33,831	2,733,597
2028	2,092,508	612,546	27,113	33,725	2,765,892
2029	2,122,848	615,275	27,506	33,649	2,799,278
2030	2,154,133	618,161	27,911	33,602	2,833,808
2031	2,171,370	616,938	28,135	33,354	2,849,796
2032	2,188,888	615,758	28,362	33,129	2,866,137
2033	2,206,692	614,620	28,593	32,927	2,882,832
2034	2,224,785	613,524	28,827	32,747	2,899,883
2035	2,243,171	612,469	29,065	32,664	2,917,369
2036	2,259,155	610,726	29,272	32,557	2,931,711
2037	2,275,397	609,027	29,483	32,463	2,946,370
2038	2,291,899	607,370	29,697	32,383	2,961,349
2039	2,308,664	605,755	29,914	32,315	2,976,648
2040	2,325,693	604,182	30,134	32,480	2,992,489
2041	2,340,576	602,028	30,327	32,615	3,005,545
2042	2,355,697	599,918	30,523	32,753	3,018,890
2043	2,371,058	597,851	30,722	32,893	3,032,525
2044	2,386,662	595,827	30,924	33,037	3,046,451
2045	2,402,510	593,845	31,130	33,185	3,060,670
2046	2,416,566	591,406	31,312	33,307	3,072,591

9.1.3.3. Incremental Operating Cost

The following table illustrates the forecasted Operating expenses of the system for selected years and **for both** with and without project cases, in order the incremental OPEX to be calculated.

Table 9-13: Incremental Operating Costincl. replacements (€/y), in constant price 2017

Year	Operating cost WITH PROJECT	With Project replacements	Operating cost WITHOUT PROJECT	Without Project replacements	Incremental costs, incl. replacements
2021	5,732,167	0	2,550,171	250.000	2,931,997
2022	5,770,727	0	2,579,511	250.000	2,941,216
2023	5,810,318	0	2,609,374	250.000	2,950,944
2024	5,850,988	0	2,640,293	250.000	2,960,695
2025	5,892,785	0	2,672,097	250.000	2,970,688
2026	5,932,911	0	2,702,347	250.000	2,980,563
2027	5,974,324	1,465,896	2,733,597	250.000	4,456,623
2028	6,017,085	1,653,178	2,765,892	250.000	4,654,372
2029	6,061,258	0	2,799,278	250.000	3,011,980
2030	6,106,911	0	2,833,808	250.000	3,023,103
2031	6,128,112	0	2,849,796	250.000	3,028,316
2032	6,155,828	11,286,119	2,866,137	250.000	14,325,810
2033	6,177,924	0	2,882,832	250.000	3,045,093
2034	6,200,463	0	2,899,883	250.000	3,050,580
2035	6,223,449	0	2,917,369	250.000	3,056,080
2036	6,242,234	0	2,931,711	250.000	3,060,523
2037	6,261,421	0	2,946,370	250.000	3,065,051
2038	6,281,013	0	2,961,349	250.000	3,069,664
2039	6,301,011	812,896	2,976,648	250.000	3,887,259
2040	6,321,418	0	2,992,489	250.000	3,078,929
2041	6,338,126	0	3,005,545	250.000	3,082,581
2042	6,355,212	0	3,018,890	250.000	3,086,321
2043	6,372,675	0	3,032,525	250.000	3,090,150
2044	6,399,987	0	3,046,451	250.000	3,103,535
2045	6,418,239	0	3,060,670	250.000	3,107,569
2046	6,433,436	0	3,072,591	250.000	3,110,845

9.1.4. COST IMPLICATION TO THE CONSUMER, AFFORDABILITY ANALYSIS AND OPERATING REVENUE FORECAST

As for REVENUES, the following operational sources have been predicted which are the “revenues from the proposed tariffs”,the revenues of “recyclables sales” from MBT and from source separated recyclables and the revenues from energy.

9.1.4.1 Revenues from Recyclables, Compost and Energy

The revenues of “**RECYCLABLES SALES**” from MBT took into account the market values of the recyclables as well the cross contaminations of recyclables resulting in lower quality since there are recovered from mixed municipal waste. Thus, the market values of recyclables that they have been used at the following calculations are shown in the following table:

Table 9-14: Market value of recyclables

Sell prices for recyclables and products	Price
Al	600 €/t
Fe	140 €/t
Plastics	50 €/t
Paper/Cardboard	15€/t
Glass	2 €/t

The revenues of “**RECYCLABLES SALES**” from source separated recyclables took into account the average market values of the recyclables. Thus, the market values of recyclables that they have been used at the following calculations are shown in the following table

Table 9-15: Market value of recyclables

Sell prices for recyclables and products	Price
Al	600 €/t
Fe	140 €/t
Plastics	100 €/t
Paper/Cardboard	30 €/t
Glass	2 €/t

The produced electricity from anaerobic digestion will cover a part of the energy needs of the plant. The surplus electricity will be fed to the grid. The energy balance is shown in the table below.

Table 9-16: Energy Balance

Electrical consumption	kWh/year (Average 2021-2046)
Mechanical Separation for residual waste bin	1.250.033
Biological treatment	1.432.218
Landfill for residues	82.179
Infrastucture works	80.000
Mechanical Separation for recyclables waste bin	416.222
Windrow Composting	17.955
Total consumption	3.278.608
E_{el} from Anaerobic Digestion	**4.988.892**
Surplus of E_{el}	**1.710.284**

The price of electricity for the anaerobic digestion is 0.180 €/kWh for 15 years according to the National legislation (Office Gazette no 56 of 17-04-2013) and for the rest years equal to 0.07€/KWh (source: EUROSTA data).

Moreover due to the fact that collection and recycling of packaging waste will be covered by the producers (Producers' responsibility), the collective schemes will be subsidize the cost for the collection and recovery of packaging waste. The revenues from collective schemes is assumed equal to 20€/ t.

9.1.4.2. Revenues from proposed tariffs

9.1.4.2.1. General

In devising the future tariff in the service area, the principles for setting user charges (tariffs) for solid waste management services need to be taken into account, including: polluter pays principle full cost recovery and affordability issues.

Polluter pays principle

Foremost among the principles for setting user charges for solid waste management services is adherence to the polluter pays principle (PPP). According to PPP, the generators of the waste (polluters) should pay the costs of waste collection, transportation and treatment and disposal.Full implementation of the PPP means that the user charges are based on all the MSW management costs. The financial calculations in this feasibility study / CBA assume that PPP is implemented, but in a phase-wise manner in the initial years considering the affordability of households.

Full-cost recovery principle

The principle of full-cost recovery holds that waste tariffs should cover the costs of solid waste management, both the collection, transportation and treatment& disposal of waste. Tariffs should recover the total cost of service, including capital and operating cost and maintenance and financing cost. Full cost recovery means that the operating, maintenance and capital costs (depreciation and debt service) need to be included in the calculation of tariffs.

Affordability

Insofar as possible, solid waste tariffs should be affordable for household customers. The concept of affordability refers to the ability of particular consumer groups to pay for a minimum level of a certain service. Up to now in the country there is no national guideline to determine the affordability threshold concerning waste management**.**

9.1.4.2.2. Levelized Unit Cost (LUC/DPC)

In order to calculate the full cost recovery tariff the LUC has been calculated. The index of Levelized Unit Cost (LUC/DPC) expressed in €/t and calculated by dividing the net present value of the facility's net cost flows over the reference period (including the investment and O&M cost, net of revenues from sale of by-products) by the discounted quantity of waste treated in that same period, using a financial discount rate of 4%. This index is presented in "New Guide to cost – benefit analysis of investment project by European Commission, December 2014".

The following table illustrates the LUC/DPC Cost estimation and the related revenues, for selected years, after imposing of an adequate tariff, as mentioned above.

Table 9-17: LUC/DPC Calculation "With project"

LUC/DPC Calculation With Project	**NPV**	
Discount rate	4.0%	
Investment Cost Total (reinvestments included)	EUR	**41,134,765**
Operating Cost	EUR	**86,442,443**
Revenues	EUR	28,210,099
Total Cost	EUR	99,367,109
Total Waste input into the system	t/year	840,000
LUC, Investment	EUR/t.	49
LUC, O&M	EUR/t.	103
LUC, net O&M	EUR/t.	69
LUC, Total	EUR/t.	118

9.1.4.2.3 Affordability analysis – Tarrifs

The Polluter Pays Principle (PPP) is one of the principles of Community environmental policy and applies throughout the European Union. The simplest way to implement PPP is to introduce **a full cost recovery waste tariff**, which means a tariff high enough to recover the full costs of services provided, including capital and operating costs as well as management and administrative costs of the system. **(i.e. Tariff is equal to LUC)**

However, according to the "Guidance on the methodology for carrying out Cost-Benefit Analysis", *when the affordability of tariffs is considered, stakeholder may artificially cap the level of charges to avoid a disproportionate financing burden for the users, thus ensuring that the service or good is affordable also for the most disadvantaged groups*.

The minimum requirement is that tariffs should at least cover operating and maintenance costs as well as a significant part of the assets' depreciation. An adequate tariff structure should attempt to maximise the project's revenues before public subsidies, while taking affordability into account.

Moreover, according to the "Application of the Polluter Pays Principle (PPP) in Waste Management Projects" of JASPERS Staff Working Papers, August 2011, it has to be considered that where household income levels are generally low or household income is unevenly distributed, residential waste tariffs can be temporarily set below full cost recovery levels.

Taking into account the aforementioned for the present project, the tariffs to the users of the project are proposed to be as follows:

- Commercial users are considered to cover the total Levelized Unit Cost / DPC since the first year.
- Households, will pay prices which in the first years will cover the operating cost. Gradually the price will be increased and about 2044 will cover the Full LUC.

For the residential users is calculated the value of affordability as % of the average annual income.

Table 9-18: Waste tariffs and affordability issues in Southwest region (years 2017-2030)

User fees		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Residential User fees	**EUR/t**	**40**	**44**	**49**	**54**	**59.1**	**60.5**	**62.0**	**63.5**	**65.1**	**66.7**	**68.3**	**70.0**	**71.7**	**73.4**
Commercial User fees	**EUR/t**	**123.8**	**122.8**	**121.8**	**120.8**	**118.3**	**118.3**	**118.3**	**118.3**	**118.3**	**118.3**	**118.3**	**118.3**	**118.3**	**118.3**
Average HH income	EUR/HH /Year	4,427	4,449	4,471	4,494	4,699	4,769	4,841	4,913	4,987	5,062	5,138	5,215	5,293	5,372
Collection,Transportation, Treatment & Disposal		**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Waste per person	tonnes	0.20	0.21	0.21	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.22	0.22
Waste per HH	tonnes	0.78	0.79	0.81	0.84	0.79	0.79	0.80	0.80	0.80	0.81	0.81	0.81	0.82	0.82
Tarrifs per person	EUR/cap	8.12	9.23	10.51	11.83	12.28	12.63	12.99	13.36	13.74	14.14	14.55	14.98	15.41	15.87
Tarrifs per HH	EUR/HH	30.86	35.06	39.92	44.96	46.66	47.99	49.36	50.77	52.22	53.73	55.30	56.91	58.57	60.29
waste tarrif as a % of average HH income	%	0.70%	0.79%	0.89%	1.00%	0.99%	1.01%	1.02%	1.03%	1.05%	1.06%	1.08%	1.09%	1.11%	1.12%

Table 9-19: Waste tariffs and affordability issues in Southwest region (years 2031-2046)

User fees		**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**
Residential User fees for Collection, transportation and treatment - disposal	EUR/t	**75.2**	**77.1**	**79.0**	**80.9**	**82.9**	**84.9**	**87.0**	**89.1**	**91.3**	**93.5**	**95.8**	**98.2**	**100.6**	**118.3**	**118.3**	**118.3**
Commercial User fees	EUR/t	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3	118.3
Average HH income	EUR/HH /Year	*5,453*	*5,535*	*5,618*	*5,702*	*5,787*	*5,874*	*5,962*	*6,052*	*6,143*	*6,235*	*6,328*	*6,423*	*6,520*	*6,617*	*6,717*	*6,817*
Collection,transportation, treatment & disposal		**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**
Waste per person	tonnes	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Waste per HH	tonnes	0.82	0.82	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.84	0.84	0.84	0.84	0.84	0.84
Tarrifs per person	€ p.a.	16.28	16.71	17.15	17.60	18.06	18.53	19.01	19.51	20.02	20.55	21.08	21.63	22.20	26.15	26.19	26.23
Tarrifs per HH	€ per HH	61.86	63.49	65.15	66.86	68.61	70.40	72.25	74.14	76.08	78.08	80.11	82.21	84.36	99.38	99.53	99.68
waste tarrif as a % of average HH income	%	1.13%	1.15%	1.16%	1.17%	1.19%	1.20%	1.21%	1.23%	1.24%	1.25%	1.27%	1.28%	1.29%	1.50%	1.48%	1.46%

Based on the above tables the total charges are set to reach gradually a peak value of 1.5% of the average disposable household income (starting from a current level 0.7%). The foreseen user fees are structured in a way to secure compliance with the polluter – pay principle in the long run.

9.1.4.3. Total revenues WITH PROJECT scenario

The prices assumed constant during the analysis period in the level of 2017. The following table illustrates the Total Revenues after the completion of the project construction and start of operation.

Table 9-20: Revenues of "With project" scenario, prices in EUROS (constant price in 2017)

Year	Revenues - user fees	Revenues - sale of recyclables	Revenues - Savings due to own consumption & sales of energy	Revenues from Collection Schemes	Total Revenues
2021	4,267,616	1,073,872	748,045	177,054	6,266,586
2022	4,149,804	1,078,343	751,392	177,775	6,157,313
2023	4,238,436	1,082,997	754,868	178,525	6,254,826
2024	4,330,183	1,087,842	758,479	179,307	6,355,811
2025	4,425,186	1,092,887	762,232	180,122	6,460,428
2026	4,519,971	1,097,182	765,558	180,806	6,563,516
2027	4,618,318	1,101,726	769,059	181,530	6,670,633
2028	4,720,397	1,106,530	772,744	182,298	6,781,969
2029	4,826,392	1,111,606	776,622	183,110	6,897,729
2030	4,936,497	1,116,966	780,700	183,969	7,018,132
2031	5,016,391	1,114,918	779,616	183,605	7,094,530
2032	5,098,490	1,112,947	778,582	183,254	7,173,274
2033	5,182,851	1,111,051	777,598	182,915	7,254,415
2034	5,269,530	1,109,229	776,663	182,589	7,338,012
2035	5,358,587	1,107,480	775,777	182,275	7,424,120
2036	5,443,577	1,104,485	583,988	181,756	7,313,806
2037	5,530,851	1,101,566	582,684	181,251	7,396,352
2038	5,620,465	1,098,722	581,417	180,758	7,481,362
2039	5,712,476	1,095,953	580,186	180,277	7,568,892
2040	5,806,941	1,093,257	578,992	179,809	7,658,999
2041	5,897,841	1,089,509	577,243	179,168	7,743,760
2042	5,991,122	1,085,838	575,532	178,540	7,831,031
2043	6,086,840	1,082,244	573,858	177,925	7,920,867
2044	6,906,151	1,078,725	572,220	177,322	8,734,419
2045	6,885,756	1,075,280	570,619	176,733	8,708,388
2046	6,860,018	1,071,005	568,578	176,006	8,675,608

9.1.4.4. Revenues WITHOUT PROJECT scenario

As for the present situation related to the "WITHOUT PROJECT" scenario,the followingoperational sources have been predicted which are the "collection revenues" andthe revenues from source separated recyclables. Summarized data, are presented in the following table.

Table 9-21: Revenues for WITHOUT PROJECT scenario prices in EUROS (constant price in 2017)

Year	Revenues - user fees collection	Revenues - sale of subproducts	Revenues Collection Schemes	Total Revenues
2021	3,406,155	89,537	14,957	3,510,649
2022	3,388,217	89,901	15,017	3,493,136
2023	3,344,238	90,281	15,081	3,449,600
2024	3,324,147	90,676	15,147	3,429,970
2025	3,307,097	91,088	15,216	3,413,401
2026	3,290,007	91,434	15,274	3,396,715
2027	3,275,974	91,801	15,335	3,383,110
2028	3,264,939	92,189	15,400	3,372,528
2029	3,256,851	92,599	15,468	3,364,919
2030	3,251,665	93,034	15,541	3,360,240
2031	3,226,995	92,850	15,510	3,335,355
2032	3,204,715	92,672	15,480	3,312,867
2033	3,184,725	92,501	15,452	3,292,678
2034	3,166,932	92,336	15,424	3,274,692
2035	3,158,857	92,177	15,398	3,266,431
2036	3,148,412	91,915	15,354	3,255,681
2037	3,139,335	91,659	15,311	3,246,306
2038	3,131,584	91,410	15,269	3,238,263
2039	3,125,117	91,167	15,229	3,231,513
2040	3,141,887	90,930	15,189	3,248,006
2041	3,155,733	90,606	15,135	3,261,473
2042	3,169,882	90,288	15,082	3,275,252
2043	3,184,336	89,977	15,030	3,289,343
2044	3,199,096	89,673	14,979	3,303,748
2045	3,214,164	89,374	14,929	3,318,468
2046	3,226,819	89,007	14,868	3,330,694

9.1.4.4 Incremental Revenues

The table following present the result of incremental revenues, deriving from the comparison (abstract) between those two scenarios.

Table 9-22: Incremental Revenues prices in EUROS (constant price in 2017)

Year	With Project Revenues	Without Project Revenues	Incremental Revenues
2021	6,266,586	3,510,649	2,755,938
2022	6,157,313	3,493,136	2,664,177
2023	6,254,826	3,449,600	2,805,227
2024	6,355,811	3,429,970	2,925,841
2025	6,460,428	3,413,401	3,047,027
2026	6,563,516	3,396,715	3,166,801
2027	6,670,633	3,383,110	3,287,523
2028	6,781,969	3,372,528	3,409,441
2029	6,897,729	3,364,919	3,532,811
2030	7,018,132	3,360,240	3,657,892
2031	7,094,530	3,335,355	3,759,176
2032	7,173,274	3,312,867	3,860,406
2033	7,254,415	3,292,678	3,961,737
2034	7,338,012	3,274,692	4,063,319
2035	7,424,120	3,266,431	4,157,688
2036	7,313,806	3,255,681	4,058,125
2037	7,396,352	3,246,306	4,150,046
2038	7,481,362	3,238,263	4,243,099
2039	7,568,892	3,231,513	4,337,379
2040	7,658,999	3,248,006	4,410,993
2041	7,743,760	3,261,473	4,482,286
2042	7,831,031	3,275,252	4,555,779
2043	7,920,867	3,289,343	4,631,524
2044	8,734,419	3,303,748	5,430,672
2045	8,708,388	3,318,468	5,389,920
2046	8,675,608	3,330,694	5,344,914

9.1.5. FINANCIAL RETURN ON INVESTMENT AND PERFORMANCE INDICATORS CALCULATION

In this section will estimate the crucial financial performance indicators which prove if the project needs financial contribution from EU Funds.

These indicators are the Financial Net Present Value of the net cash flow of the investment, under financial discount of a rate 4% and the financial rate of Return. The financial discount rate is an interest at which future values are discounted to the present and roughly equals the opportunity cost of capital.

The values will be discounted respectively to 2017 prices. The period of analysis is 30 years which starts from the year 2017 and ends to 2046.

The period 2017 - 2020 is the maturation and construction period of the project. In order to estimate the performance indicators of the investment, the total budget of the project will be considered because all the components of the investments, no matter the financing source, will operate, produce the service, create revenues and costs. Investment costs, reinvestment, residual value, operating costs and revenues will be calculated on incremental base.

Table 9-23: Financial Return of the investment and FRR

FRR/C before EU assistance	**NPV @ 4.0%**
Investment cost (without contingencies)	-30,752,465
Revenues	52,669,213
O&M costs	-51,578,487
Residual value of investments	931,549
PROJECT CASH-FLOW before Community assistance FNPV/C	-28,730,190
FRR/C before Community assistance	-3.7%

The **FNPV/K and FRR/K**before Community assistance is equal to the FNPV/C and FRR/C because assumed that will be used financial sources with zero cost, (EU contribution and National contribution) and no any kind of loans considered.

Before the financial contribution from EU funds, the net present value turns out to negative sign, and of course the FRR/C is lower than the discount rate. That means that the discounted revenues are not sufficient enough to cover the investment cost and the operating costs as well. The indicators above prove that the implementation of the project is not possible if will not be co-financed from other financial sources.

9.1.6. FUNDING GAP CALCULATION

The financial model developed for this project takes into account the EU grant calculation mechanism. The steps followed to determine the EU grant in accordance to the guidelines are presented below:

Step 1*. Find the funding-gap rate (****R****):*

R = Max EE/DIC

Where,

Max EE is the maximum eligible expenditure = DIC-DNR;

DIC is the discounted investment cost;

DNR is the discounted net revenue = discounted revenues – discounted operating costs + discounted residual value.

Step 2.*Find the "decision amount" (**DA**), i.e. "the amount to* which *the co-financing rate for the priority axis applies":*

DA = EC*R

Where,

EC is the eligible cost.

Step 3.*Find the (maximum)* ***EU grant****:*

EU grant = DA*Max CRpa

Where,
Max CRpa is the maximum co-funding rate fixed for the priority axis in the Commission's decision adopting the operational program.

Three basic elements of the process are:
- Calculation of Eligible Cost (EC),
- Discounted Investment Cost (DIC) and
- Discounted Net Revenue (DNR).

The funding gap calculation is illustrated in the following table.

Table 9-24: Funding gap calculation *Prices in Euros*

	Main Elements and Parameters	Value Not discounted	Value Discounted (NPV)
1	Reference period (years)		30
2	Financial discount rate (%), real		4.00%
3	Total investment cost (in current euro, not discounted)	35,226,924	
4	Total **considered** investment cost (in euro, discounted) (*)		30,752,465
5	Residual value (in euro, not discounted)	2,905,177	
6	Residual value (in euro, discounted)		931,549
7	Revenues (in euro, discounted)		52,669,213
8	Operating costs (in euro, discounted)		51,578,487
9	Net revenue (in euro, discounted) = (7) - (8) + (6)		2,022,276
10	Eligible expenditure [Art 55 (2)] (in euro, discounted) = (4) - (9)		28,730,190
11	Funding gap rate (%) = (10) / (4)	93.42%	

(*) Excluding contingencies

9.1.7. FINANCING PLAN FOR THE INVESTMENTS

After the funding gap estimation, on the eligible amount of **35,226,924Euros** applied the estimated grand of EU funding as illustrates the follow table.

Table 9-25: EU Contribution

	EU Community Contribution	Value
1.	Eligible costs (in Euro, not discounted) (Section H.1.12 (C))	35,226,924
2.	Funding gap rate (%) = (E.1.2.11)	93.42%
3.	Decision amount, i.e. the "amount to which the co-financing rate for the priority axis applies" (Article 41(2)) = (1)*(2) (respecting the maximum public contribution according to state aid rules)	32,910,409
4.	Co-financing rate of the priority axis (%)	85.0%
5.	Community contribution (in euro) = (3)*(4)	27,973,848

The EU grant corresponds to the 79.41% (85% * 93.42%) of the investments eligible budget.
The share of National contribution will be Government funds.Taking into account the financial limits per source the financial scheme will be now as following:

Table 9-26: Financing Planprices in EUROS

Source of total investment costs (Euro)								
	Eligible cost			35.226.924	**Ineligible cost**			0
Total investment cost [H.1.12.(A)]	EU assistance [85% of H.2.1-3]	Contribution State budget	Beneficiary Contribution (% of b+c+d)	IFI loan to Beneficiary	IFI loan to Beneficiary	Ineligible other: equity contribution	VAT reclaimed	VAT non reclaimed: own financing
a) = b) through i)	b)	c)	d)		f)	g)	h)	i)
35,226,924	27,973,848	7,253,076	0		0	0	0	0

9.1.8. FINANCIAL RETURN ON NATIONAL CAPITAL AND PERFORMANCE INDICATORS

This paragraph presents calculation of financial performance indicators under the proposed financing scheme. These performance indicators reflect the return potential for the national capital, which is the grant contribution by the Fund.The opportunity cost of the EU grant is equal to zero; therefore, will provide means for financial leverage to the project.

Table 9-27: Financial Return of National Capital

FRR/C after EU assistance	NPV @ 4.0%
PROJECT CASH-FLOW before Community assistance FNPV/C	**-28,730,190**
Community Assistance	24,420,662
PROJECT CASH-FLOW after Community assistance FNPV/C	**-4,309,528**
FRR/C after Community assistance	1.30%

For the reason mentioned in the above paragraph, the **FNPV/K and FRR/Khave the same price** (equal) with the FNPV/C and FRR/C after Community assistance, which represents the return and the financial performances of the National funds.

9.1.9. FINANCIAL SUSTAINABILITY REPORTS

The cash flow statement proved that the operation of the system, under the certain assumptions made, will be sustainable during the analysis period. The sustainability precondition, in order the project to be considered as viable, will be fulfilled. In the following table the net cash flow over the years is positive. The following tables illustrate the Income statement and the cash flow table during the period of analysis.

Table 9-28: Income Statement (Profit – Loss account) (years 2017-2030)

		▼▼Historical data▼▼	►►► Projection ►►►												
SOUTHWEST - Solid Waste Project	Unit	2017	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
INCOME STATEMENT																
Income statement																
Operating revenues - user fees	Th EUR	0	2.632	3.058	3.613	4.279	4.579	4.541	4.731	4.930	5.139	5.354	5.580	5.818	6.067	6.330
Sale of recyclables and compost	Th EUR	0	0	0	0	0	1.152	1.180	1.209	1.239	1.269	1.300	1.331	1.364	1.397	1.432
Other revenues	Th EUR	0	0	0	0	0	993	1.017	1.042	1.068	1.094	1.121	1.149	1.177	1.206	1.237
TOTAL REVENUES	**Th EUR**	**0**	**2.632**	**3.058**	**3.613**	**4.279**	**6.723**	**6.738**	**6.982**	**7.237**	**7.503**	**7.775**	**8.060**	**8.358**	**8.671**	**8.999**
	~~Th EUR~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
Operating costs - Collection Cost (Residual, Recyclables, Green Waste)	Th EUR	0	-1.704	-1.774	-1.878	-1.990	-2.518	-2.605	-2.696	-2.790	-2.888	-2.988	-3.092	-3.200	-3.312	-3.429
Operating costs - Transfer Station Struga	Th EUR	0	0	0	0	0	-107	-109	-111	-114	-116	-118	-121	-123	-126	-129
Operating costs - Transfer Station Debar	Th EUR	0	0	0	0	0	-121	-124	-126	-129	-132	-135	-138	-141	-144	-147
Operating costs - Transfer Station Kichevo	Th EUR	0	0	0	0	0	-136	-139	-142	-145	-148	-151	-154	-157	-160	-163
Operating costs - Transfer Station Ohrid	Th EUR	0	0	0	0	0	-156	-159	-163	-166	-170	-174	-178	-182	-186	-190
Operating costs - Transportation direct to WMC and to transfer stations	Th EUR		0	0	0	0	-776	-792	-808	-825	-841	-858	-876	-893	-912	-930
Operating costs - mechanical sorting	Th EUR	0	0	0	0	0	-931	-951	-972	-993	-1.014	-1.036	-1.058	-1.081	-1.104	-1.128
Operating costs - biological treatment	Th EUR	0	0	0	0	0	-553	-565	-577	-590	-603	-616	-629	-643	-657	-671
Operating costs - infrastructure works	Th EUR	0	0	0	0	0	-54	-55	-56	-57	-58	-59	-60	-62	-63	-64
Operating costs - Residual landfill (WWTP included)	Th EUR	0	-385	-435	-497	-574	-242	-247	-252	-258	-263	-269	-275	-281	-287	-293
Operating costs - Windrow Composting	Th EUR	0	0	0	0	0	-61	-63	-64	-65	-67	-68	-69	-71	-72	-74
Operating costs - Sorting of recyclables	Th EUR	0	0	0	0	0	-227	-232	-237	-243	-248	-253	-259	-265	-270	-276
Other Cost (Gate fee for RDF transportationl)	Th EUR	0	0	0	0	0	-198	-202	-207	-213	-218	-223	-229	-234	-240	-246
Administrative cost	Th EUR		0	0	0	0	-70	-72	-74	-76	-78	-80	-82	-84	-87	-89
TOTAL O&M COSTS	**Th EUR**	**0**	**-2.089**	**-2.209**	**-2.374**	**-2.563**	**-6.150**	**-6.315**	**-6.486**	**-6.662**	**-6.844**	**-7.028**	**-7.219**	**-7.416**	**-7.619**	**-7.830**
EBITDA	**Th EUR**	**0**	**543**	**850**	**1.239**	**1.716**	**573**	**423**	**496**	**575**	**659**	**747**	**841**	**943**	**1.052**	**1.168**
Depreciation	Th EUR	0	0	-8	-272	-668	-1.464	-1.464	-1.464	-1.464	-1.464	-1.464	-1.464	-1.535	-1.616	-1.616
Write-off of bad debts	Th EUR			0	0	0	0	0	0	0	0	0	0	0	0	0
Current portion of investment grants	Th EUR			8	272	668	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464
EBIT	**Th EUR**	**0**	**543**	**850**	**1.239**	**1.716**	**573**	**423**	**496**	**575**	**659**	**747**	**841**	**872**	**899**	**1.016**
Interests	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Foreign exchange correction	Th EUR			0	0	0	0	0	0	0	0	0	0	0	0	0
EBT	**Th EUR**	**0**	**543**	**850**	**1.239**	**1.716**	**573**	**423**	**496**	**575**	**659**	**747**	**841**	**872**	**899**	**1.016**
Income tax	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET INCOME	**Th EUR**	**0**	**543**	**850**	**1.239**	**1.716**	**573**	**423**	**496**	**575**	**659**	**747**	**841**	**872**	**899**	**1.016**
Income tax - Credit for previous years losses	Th EUR				0	0	0	0	0	0	0	0	0	0	0	0
Dividends	Th EUR				0	0	0	0	0	0	0	0	0	0	0	0

Table 9-29: Income Statement (Profit – Loss account)(years 2031-2046)

SOUTHWEST - Solid Waste Project	Unit	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
INCOME STATEMENT																	
Income statement																	
Operating revenues - user fees	Th EUR	6.561	6.801	7.052	7.314	7.586	7.860	8.146	8.444	8.754	9.076	9.403	9.743	10.096	11.684	11.883	12.075
Sale of recyclables and compost	Th EUR	1.458	1.485	1.512	1.540	1.568	1.595	1.622	1.651	1.679	1.709	1.737	1.766	1.795	1.825	1.856	1.885
Other revenues	Th EUR	1.260	1.283	1.307	1.331	1.356	1.106	1.125	1.145	1.165	1.186	1.206	1.226	1.247	1.268	1.290	1.311
TOTAL REVENUES	**Th EUR**	**9.279**	**9.569**	**9.871**	**10.185**	**10.510**	**10.561**	**10.894**	**11.239**	**11.598**	**11.971**	**12.346**	**12.734**	**13.138**	**14.777**	**15.028**	**15.271**
	~~Th EUR~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
Operating costs - Collection Cost (Residual, Recyclables, Green Waste)	Th EUR	-3.527	-3.629	-3.733	-3.840	-3.951	-4.060	-4.173	-4.289	-4.408	-4.532	-4.654	-4.779	-4.908	-5.041	-5.178	-5.315
Operating costs - Transfer Station Struga	Th EUR	-131	-134	-136	-139	-142	-145	-147	-150	-153	-156	-159	-162	-165	-168	-171	-175
Operating costs - Transfer Station Debar	Th EUR	-150	-153	-156	-159	-162	-165	-168	-171	-175	-178	-182	-185	-189	-192	-196	-200
Operating costs - Transfer Station Kichevo	Th EUR	-166	-169	-172	-176	-179	-182	-186	-189	-193	-197	-200	-204	-208	-212	-216	-220
Operating costs - Transfer Station Ohrid	Th EUR	-194	-197	-201	-206	-210	-214	-218	-223	-227	-231	-236	-241	-245	-250	-255	-260
Operating costs - Transportation direct to WMC and to transfer stations	Th EUR	-949	-967	-987	-1.006	-1.026	-1.047	-1.068	-1.089	-1.110	-1.132	-1.155	-1.178	-1.201	-1.225	-1.249	-1.274
Operating costs - mechanical sorting	Th EUR	-1.150	-1.173	-1.196	-1.219	-1.243	-1.267	-1.292	-1.316	-1.342	-1.368	-1.394	-1.420	-1.447	-1.475	-1.503	-1.531
Operating costs - biological treatment	Th EUR	-684	-698	-711	-725	-739	-753	-768	-783	-798	-813	-828	-844	-860	-876	-893	-909
Operating costs - infrastructure works	Th EUR	-65	-67	-68	-69	-71	-72	-73	-75	-76	-78	-80	-81	-83	-84	-86	-88
Operating costs - Residual landfill (WWTP included)	Th EUR	-299	-305	-311	-317	-323	-329	-335	-342	-348	-355	-362	-369	-376	-383	-390	-397
Operating costs - Windrow Composting	Th EUR	-75	-77	-78	-80	-81	-83	-85	-86	-88	-90	-92	-93	-95	-97	-99	-101
Operating costs - Sorting of recyclables	Th EUR	-282	-287	-293	-298	-304	-310	-315	-321	-327	-334	-340	-346	-352	-359	-365	-372
Other Cost (Gate fee for RDF transportationl)	Th EUR	-251	-256	-260	-265	-270	-275	-280	-285	-290	-295	-300	-305	-310	-316	-321	-326
Administrative cost	Th EUR	-91	-101	-104	-106	-109	-111	-114	-116	-119	-122	-125	-128	-130	-149	-153	-156
TOTAL O&M COSTS	**Th EUR**	**-8.015**	**-8.212**	**-8.406**	**-8.606**	**-8.810**	**-9.014**	**-9.222**	**-9.436**	**-9.655**	**-9.880**	**-10.105**	**-10.335**	**-10.570**	**-10.828**	**-11.076**	**-11.324**
EBITDA	**Th EUR**	**1.264**	**1.357**	**1.465**	**1.579**	**1.700**	**1.547**	**1.803**	**1.803**	**1.943**	**2.091**	**2.241**	**2.400**	**2.568**	**3.950**	**3.952**	**3.947**
Depreciation	Th EUR	-1.616	-1.616	-2.219	-2.219	-2.219	-2.219	-2.219	-2.219	-2.219	-2.268	-2.268	-2.268	-2.268	-2.268	-1.320	-804
Write-off of bad debts	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Current portion of investment grants	Th EUR	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	516	0
EBIT	**Th EUR**	**1.112**	**1.205**	**710**	**824**	**945**	**793**	**1.049**	**1.049**	**1.188**	**1.286**	**1.437**	**1.596**	**1.764**	**3.145**	**3.148**	**3.142**
Interests	Th EUR	0	-275	-262	-249	-235	-220	-205	-188	-171	-153	-134	-115	-94	-72	-49	-25
Foreign exchange correction	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EBT	**Th EUR**	**1.112**	**930**	**448**	**575**	**710**	**573**	**844**	**860**	**1.017**	**1.133**	**1.302**	**1.481**	**1.670**	**3.073**	**3.098**	**3.117**
Income tax	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET INCOME	**Th EUR**	**1.112**	**930**	**448**	**575**	**710**	**573**	**844**	**860**	**1.017**	**1.133**	**1.302**	**1.481**	**1.670**	**3.073**	**3.098**	**3.117**
Income tax - Credit for previous years losses	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dividends	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-30: Cash - flow Statement (years 2017-2030)

		listorical dat	►►► Projection ►►►												
SOUTHWEST - Solid Waste Project	**Unit**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
CASH-FLOW STATEMENT															
IFI's loan - Project															
Annual disbursements	*Th EUR*		0	0	0	0	0	0	0	0	0	0	0	0	0
Total disbursements	*Th EUR*		0	0	0	0	0	0	0	0	0	0	0	0	0
Pending disbursements	*Th EUR*		0	0	0	0	0	0	0	0	0	0	0	0	0
Loan amortization	*Th EUR*				0	0	0	0	0	0	0	0	0	0	0
Loan balance	*Th EUR*		0	0	0	0	0	0	0	0	0	0	0	0	0
Interest	*Th EUR*				0	0	0	0	0	0	0	0	0	0	0
Commitment fee	*Th EUR*				0	0	0	0	0	0	0	0	0	0	0
Front-end fee	*Th EUR*				0	0	0	0	0	0	0	0	0	0	0
Cash-flow statement															
EBITDA	***Th EUR***	**543**	**850**	**1,239**	**1,716**	**573**	**423**	**496**	**575**	**659**	**747**	**841**	**943**	**1,052**	**1,168**
Decrease / (Increase) in working capital	*Th EUR*	0	0	-148	-27	-100	-1	-10	-10	-11	-11	-12	-12	-13	-13
FUNDS FROM OPERATIONS	***Th EUR***	**543**	**850**	**1,090**	**1,689**	**473**	**422**	**486**	**564**	**648**	**736**	**830**	**930**	**1,039**	**1,155**
Capital expenditures	*Th EUR*	-200	-6,612	-9,886	-19,901	0	0	0	0	0	0	-1,771	-2,037	0	0
FREE CASH-FLOW	***Th EUR***	**343**	**-5,762**	**-8,796**	**-18,212**	**473**	**422**	**486**	**564**	**648**	**736**	**-942**	**-1,107**	**1,039**	**1,155**
Grants	*Th EUR*	200	6,612	9,886	19,901	0	0	0	0	0	0	0	0	0	0
Equity contributions	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Disbursements IFI loan (project)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Disbursements other loans	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dividend payments	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Income tax payments	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CASH-FLOW BEFORE DEBT SERVICE	***Th EUR***	**543**	**850**	**1,090**	**1,689**	**473**	**422**	**486**	**564**	**648**	**736**	**-942**	**-1,107**	**1,039**	**1,155**
Reimbursement of IFI loan (project)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest payments IFI loan (project)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial fees IFI loan (project)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reimbursement of other loans	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest payments other loans	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reimbursement revolving credit	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SURPLUS / (DEFICIT) FOR THE YEAR	***Th EUR***	**543**	**850**	**1,090**	**1,689**	**473**	**422**	**486**	**564**	**648**	**736**	**-942**	**-1,107**	**1,039**	**1,155**
Drawdowns revolving credit	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest on revolving credit	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET CASH-FLOW	***Th EUR***	**543**	**850**	**1,090**	**1,689**	**473**	**422**	**486**	**564**	**648**	**736**	**-942**	**-1,107**	**1,039**	**1,155**
Cash in hand at the end of the year	*Th EUR*	543	1,392	2,483	4,171	4,644	5,067	5,553	6,117	6,765	7,501	6,560	5,453	6,491	7,646
			OK												

Table 9-31: Cash - flow Statement (years 2031-2046)

SOUTHWEST - Solid Waste Project	Unit	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
CASH-FLOW STATEMENT																	
IFI's loan - Project																	
Annual disbursements	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total disbursements	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pending disbursements	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loan amortization	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loan balance	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commitment fee	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Front-end fee	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash-flow statement																	
EBITDA	***Th EUR***	**1.264**	**1.357**	**1.465**	**1.579**	**1.700**	**1.547**	**1.803**	**1.803**	**1.943**	**2.091**	**2.241**	**2.400**	**2.568**	**3.950**	**3.952**	**3.947**
Decrease / (Increase) in working capital	Th EUR	-12	-12	-12	-13	-13	-2	-14	-14	-15	-15	-15	-16	-17	-67	-10	-10
FUNDS FROM OPERATIONS	***Th EUR***	**1.252**	**1.345**	**1.452**	**1.566**	**1.686**	**1.545**	**1.790**	**1.789**	**1.928**	**2.075**	**2.226**	**2.384**	**2.551**	**3.882**	**3.942**	**3.937**
Capital expenditures	Th EUR	0	-15.056	0	0	0	0	0	0	-1.246	0	0	0	0	0	0	0
FREE CASH-FLOW	***Th EUR***	**1.252**	**-13.711**	**1.452**	**1.566**	**1.686**	**1.545**	**1.790**	**1.789**	**682**	**2.075**	**2.226**	**2.384**	**2.551**	**3.882**	**3.942**	**3.937**
Grants	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Equity contributions	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Disbursements IFI loan (project)	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Disbursements other loans	Th EUR	0	5.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dividend payments	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Income tax payments	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CASH-FLOW BEFORE DEBT SERVICE	***Th EUR***	**1.252**	**-8.211**	**1.452**	**1.566**	**1.686**	**1.545**	**1.790**	**1.789**	**682**	**2.075**	**2.226**	**2.384**	**2.551**	**3.882**	**3.942**	**3.937**
Reimbursement of IFI loan (project)	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest payments IFI loan (project)	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial fees IFI loan (project)	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reimbursement of other loans	Th EUR	0	-255	-268	-281	-295	-310	-325	-342	-359	-377	-395	-415	-436	-458	-481	-505
Interest payments other loans	Th EUR	0	-275	-262	-249	-235	-220	-205	-188	-171	-153	-134	-115	-94	-72	-49	-25
Reimbursement revolving credit	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SURPLUS / (DEFICIT) FOR THE YEAR	***Th EUR***	**1.252**	**-8.740**	**922**	**1.036**	**1.156**	**1.015**	**1.260**	**1.259**	**153**	**1.545**	**1.696**	**1.854**	**2.021**	**3.352**	**3.412**	**3.407**
Drawdowns revolving credit	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest on revolving credit	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET CASH-FLOW	***Th EUR***	**1.252**	**-8.740**	**922**	**1.036**	**1.156**	**1.015**	**1.260**	**1.259**	**153**	**1.545**	**1.696**	**1.854**	**2.021**	**3.352**	**3.412**	**3.407**
Cash in hand at the end of the year	Th EUR	8.899	158	1.081	2.117	3.273	4.289	5.548	6.807	6.960	8.506	10.201	12.055	14.077	17.429	20.841	24.248

Table 9-32: Balance Sheet (years 2017-2030)

		Historical data	►►► Projection ►►►												
SOUTHWEST - Solid Waste Project	Unit	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BALANCE SHEET															
Balance sheet															
Gross fixet assets (existing assets)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
less depreciation (existing assets)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross fixet assets (project assets)	*Th EUR*	200	6,812	16,698	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599
less depreciation (project assets)	*Th EUR*	0	-8	-280	-948	-2,412	-3,876	-5,340	-6,804	-8,268	-9,732	-11,196	-12,660	-14,124	-15,588
Gross fixet assets (other CAPEX)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	1,771	3,809	3,809	3,809
less depreciation (other CAPEX)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	-71	-223	-376
NET FIXED ASSETS	***Th EUR***	**200**	**6,804**	**16,418**	**35,650**	**34,187**	**32,723**	**31,259**	**29,795**	**28,331**	**26,867**	**27,174**	**27,677**	**26,060**	**24,444**
Stocks	*Th EUR*	0	0	297	352	553	554	574	595	617	639	662	687	713	740
Accounts receivable and other current assets	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash in hand	*Th EUR*	543	1,392	2,483	4,171	4,644	5,067	5,553	6,117	6,765	7,501	6,560	5,453	6,491	7,646
CURRENT ASSETS	***Th EUR***	**543**	**1,392**	**2,780**	**4,523**	**5,197**	**5,620**	**6,127**	**6,712**	**7,382**	**8,140**	**7,222**	**6,140**	**7,204**	**8,386**
TOTAL ASSETS	***Th EUR***	**743**	**8,196**	**19,197**	**40,173**	**39,383**	**38,343**	**37,385**	**36,506**	**35,713**	**35,007**	**34,396**	**33,816**	**33,264**	**32,830**
Shareholders' contributions	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained earnings	*Th EUR*	543	1,392	2,631	4,347	4,920	5,343	5,840	6,414	7,074	7,821	8,662	9,534	10,433	11,449
EQUITY	***Th EUR***	**543**	**1,392**	**2,631**	**4,347**	**4,920**	**5,343**	**5,840**	**6,414**	**7,074**	**7,821**	**8,662**	**9,534**	**10,433**	**11,449**
Investment grants	*Th EUR*	200	6,812	16,698	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599
less transfers to income statement	*Th EUR*	0	-8	-280	-948	-2,412	-3,876	-5,340	-6,804	-8,268	-9,732	-11,196	-12,660	-14,124	-15,588
Loans	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bank overdraft	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accounts payable and other current liabilites	*Th EUR*	0	0	148	176	276	277	287	297	308	320	331	343	356	370
Taxes and dividends	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIABILITIES	***Th EUR***	**200**	**6,804**	**16,566**	**35,826**	**34,463**	**32,999**	**31,546**	**30,092**	**28,639**	**27,186**	**25,734**	**24,282**	**22,831**	**21,381**
TOTAL EQUITY AND LIABILITIES	***Th EUR***	**743**	**8,196**	**19,197**	**40,173**	**39,383**	**38,343**	**37,385**	**36,506**	**35,713**	**35,007**	**34,396**	**33,816**	**33,264**	**32,830**
		0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-33: Balance Sheet (years 2031-2046)

SOUTHWEST - Solid Waste Project	Unit	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
BALANCE SHEET																	
Balance sheet																	
Gross fixet assets (existing assets)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
less depreciation (existing assets)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross fixet assets (project assets)	*Th EUR*	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599
less depreciation (project assets)	*Th EUR*	-17,052	-18,516	-19,980	-21,444	-22,908	-24,372	-25,836	-27,300	-28,764	-30,228	-31,691	-33,155	-34,619	-36,083	-36,599	-36,599
Gross fixet assets (other CAPEX)	*Th EUR*	3,809	18,864	18,864	18,864	18,864	18,864	18,864	18,864	20,110	20,110	20,110	20,110	20,110	20,110	20,110	20,110
less depreciation (other CAPEX)	*Th EUR*	-528	-680	-1,435	-2,189	-2,944	-3,699	-4,453	-5,208	-5,962	-6,767	-7,571	-8,375	-9,180	-9,984	-10,789	-11,593
NET FIXED ASSETS	***Th EUR***	**22,828**	**36,267**	**34,049**	**31,830**	**29,612**	**27,393**	**25,175**	**22,956**	**21,983**	**19,715**	**17,446**	**15,178**	**12,910**	**10,641**	**9,321**	**8,517**
Stocks	*Th EUR*	763	787	811	837	864	868	895	924	953	984	1,015	1,047	1,080	1,215	1,235	1,255
Accounts receivable and other current assets	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash in hand	*Th EUR*	8,899	158	1,081	2,117	3,273	4,289	5,548	6,807	6,960	8,506	10,201	12,055	14,077	17,429	20,841	24,248
CURRENT ASSETS	***Th EUR***	**9,661**	**945**	**1,892**	**2,954**	**4,137**	**5,157**	**6,444**	**7,731**	**7,913**	**9,489**	**11,216**	**13,102**	**15,157**	**18,644**	**22,076**	**25,503**
TOTAL ASSETS	***Th EUR***	**32,489**	**37,212**	**35,941**	**34,784**	**33,749**	**32,550**	**31,618**	**30,687**	**29,897**	**29,204**	**28,662**	**28,280**	**28,066**	**29,285**	**31,398**	**34,020**
Shareholders' contributions	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained earnings	*Th EUR*	12,561	13,491	13,938	14,514	15,224	15,797	16,641	17,501	18,518	19,651	20,953	22,434	24,104	27,177	30,275	33,392
EQUITY	***Th EUR***	**12,561**	**13,491**	**13,938**	**14,514**	**15,224**	**15,797**	**16,641**	**17,501**	**18,518**	**19,651**	**20,953**	**22,434**	**24,104**	**27,177**	**30,275**	**33,392**
Investment grants	*Th EUR*	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599	36,599
less transfers to income statement	*Th EUR*	-17,052	-18,516	-19,980	-21,444	-22,908	-24,372	-25,836	-27,300	-28,764	-30,228	-31,691	-33,155	-34,619	-36,083	-36,599	-36,599
Loans	*Th EUR*	0	5,245	4,977	4,696	4,401	4,092	3,766	3,425	3,066	2,690	2,294	1,879	1,443	985	505	0
Bank overdraft	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accounts payable and other current liabilites	*Th EUR*	381	393	406	419	432	434	448	462	477	492	507	523	540	607	618	628
Taxes and dividends	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIABILITIES	***Th EUR***	**19,928**	**23,721**	**22,002**	**20,270**	**18,524**	**16,753**	**14,977**	**13,186**	**11,378**	**9,553**	**7,709**	**5,846**	**3,962**	**2,108**	**1,122**	**628**
TOTAL EQUITY AND LIABILITIES	***Th EUR***	**32,489**	**37,212**	**35,941**	**34,784**	**33,749**	**32,550**	**31,618**	**30,687**	**29,897**	**29,204**	**28,662**	**28,280**	**28,066**	**29,285**	**31,398**	**34,020**
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

9.2. ECONOMIC ANALYSIS

9.2.1. METHODOLOGY OF THE ANALYSIS

According to the EU Regulations for major projects under the regional development component it's obligatory that: "*When submitting a major project to the Commission, the operating structure shall provide (…) an assessment of the overall socio-economic balance of the operation, based on a cost-benefit analysis (…), on the socio-economic situation of the beneficiary country …*"

Contrary to the financial analysis, which was made on behalf of the owner of the infrastructure, the economic analysis is made on behalf of the whole society and appraises the project's contribution to the economic welfare of the region or country. It relies on the fact that observed market prices of inputs and outputs are often distorted and do not mirror their social value (i.e. their social opportunity cost), hence the use of accounting shadow prices. In addition, investment projects often have impacts that have no direct market values (i.e. impacts on the environment). These effects monetized through different valuation techniques depending on the nature of the effect considered.

The key objective of the economic analysis is to prove that the present value of the project's economic benefits exceed the present value of its economic costs, which means that the project has a positive net contribution to society, and is therefore worth being co-financed by EU funds. This is expressed as a positive Economic Net Present Value of the net cash flow, a Benefit / Cost (B/C) ratio higher than 1.0, or a project's economic rate of return (ERR) exceeding the social discount rate (5% in this case). The starting point for calculation of these indicators was the financial cash flows from the financial analysis (paragraph 9.1).

The objective of the analysis is to test the project's contribution to the regional social and economic development by comparing the benefits to the investment cost. On the other hand it is a commonly acceptable fact that to analyze the above mentioned benefits on a quantitative basis is extremely difficult which requires detailed field surveys and thus they are outside the assignment of the study.

The methodological guidelines in the EC CBA Guide have been used during the analysis of the benefits, which are mainly social, environmental health and local economic development. The Guide proposes the following five steps for the economic evaluation of the projects:

The following five methodological steps for the economic evaluation of the project applied:

- conversion of market to accounting prices;
- monetization of non-market impacts;
- inclusion of additional indirect effects;
- discounting of the estimated costs and benefits and,
- calculation of the economic performance indicators (economic net present value, economic rate of return and B/C ratio).

The economic analysis is based on incremental approach, comparing economic cost and benefits (impacts) of the project with the situation without project. It is carried through in constant 2017 prices and uses a social discount rate of 5%. The quantification of economic cost and benefits relies on generally accepted principles. Costs are transformed from financial to economic terms through fiscal and externalities corrections and conversion of distorted market prices to accounting prices. Benefits consist mainly (but not exclusively) of positive externalities arising from the compliance with EU environmental standards (by improving quality of life, sanitary and health conditions, etc.).

As mentioned above, economic analysis assesses whether the project has a positive net contribution to society and thus deserves co-financing by EU funds. A selected project alternative increases economic welfare when its economic and social benefits exceed its costs and that is expressed by the Economic Net Present Value (ENPV). The ENPV is based on the flows of economic benefits and costs. The ***economic benefits*** are the cost savings achieved by the project, ***plus external effects*** such as reductions in emissions to the atmosphere. ***External effects*** are assessed at economic prices, which reflect their value to society. Future benefits and costs are discounted to the present using a social discount rate of 5%. In the economic analysis taxes and other transfers represent no net benefit to society, as they are a cost to one entity and revenue to another.

The economic analysis takes the incremental financial flows as its starting point. It then removes transfers, adds external benefits and subtracts external costs, and finally, if required, it introduces conversion factors to correct perceived price distortions.

As regards transfers, VAT was excluded a priori. Other transfers to be removed from the estimates used in financial analysis are social surcharges on salaries, as well as any penalties for non-compliance with environmental legislation. It is worth noting that the removal of these two types of transfers should not change the ranking of options.

Concerning external effects, the with-project scenario has higher processing and environmental protection costs, which are associated with lower GHG emissions. Also, the with-project scenario has minimal emissions of leachate, as opposed to the without project case. Recycling in the with-project case will result in energy savings.

Regarding price distortions, a standard conversion factor and a shadow wage rate were applied.

9.2.2. ANALYSIS OF THE SOCIOECONOMIC COSTS

Price distortions on means of production

Shadow prices arise when distortions occur in a given market, which lead to the costs of a factor of production being different to the cost that society incurs. Market distortions may be caused by the existence of a monopoly, quotas and price regulation.

Conversion Factors (CF)

For an open economy with international tenders for procuring construction, equipment, materials and services, traded items will normally cover most of the project costs.
No specific conversion is required since market prices are assumed to reflect economic prices.
For non-traded items (such as goods and services that have to be procured domestically), the conversion from financial to economic prices is usually done through conversion factors, if available.
When specific sectoral conversion factors are not available, a Standard Conversion Factor (SCF) is used by default based on the average differences between domestic and international prices, due to trade tariffs and barriers. It can be estimated based on foreign trade statistics using the following formula:

SCF = (M + X)/ ((M + Tm) + (X - Tx))
Where:
M = value of total imports
X = value of total exports

Tm = import taxes
Tx = export taxes

Shadow Wages Distortions

A waste investment project will usually generate employment during the design and build phase, as well as during the operational phase. However, jobs created by the project cannot be counted as a benefit because wages are already counted as part of the costs of the project.
The skilled labor component of the project is considered a scarce resource and therefore is adequately priced on the market in terms of opportunity cost. No specific conversion is required.
On the contrary, in the context of high unemployment, non-skill labor will not be adequately priced by the market from an economic point of view. The correction to reflect the opportunity cost of labor is usually made by multiplying the financial cost of unskilled workers by the, so-called, Shadow Wage Rate Factor (SWRF), which can be calculated as (1-u)*(1-t), where u is the regional unemployment rate and t is the rate of social security payments and relevant taxes included in the labor costs.

This corresponds to a Shadow Wage of:

SW=FW*(1-u)*(1-t),
Where FW being the financial (or market) wage.
In the case of the project and its characteristics, the SCF is estimated as follows:
In this analysis, costs for investment and for O&M are valued differently from their financial values. The cost composition and the conversion of financial costs to economic ones is summarized in table below:

Table 9-34: Breakdown of costs and factors for conversion of financial to economic costs

Break-down of costs (excluding land adquisition)		Construction	Operation	ConvFactor	ConvFactor
Traded goods	%	20%	15%	1.00	1.00
Non-traded goods	%	10%	5%	0.90	0.90
Skilled Labour	%	20%	25%	1.00	1.00
Unskilled Labour	%	35%	40%	1.00	0.48
Transfer payments	%	15%	15%	0.00	0.00
Total (%)		**100%**	**100%**		

The conversion factors applied to the Economic Analysis are:

B1. According to the official statistical data about unemployment rate in the regionwas the recent year about 33.90%.

B2. Taking into account that the average sum for social security payments and relevant taxes are included in the labor costs is about 27% on the gross salary.

The Conversion Factor for non-skilled employment cost is **estimated at 0.48**

C. CF for Non traded goods

The CF for those categories of goods and services is **estimated at 0.90.**

9.2.3. ANALYSIS OF THE SOCIOECONOMIC BENEFITS

The project economic benefits for the current project can be grouped into three main categories: (a) resource cost savings , b) reduction of visual disamenities, odours and direct health risks; and (c) reduction of greenhouse gas emissions.

The different standard values proposed for the quantification of the economic benefits have been taken from the three documents listed below. The specific sections of these documents that were used as a reference are indicated when discussing each one of the specific benefits.

1. Calculation of GHG Emissions in Waste and Waste-to-Energy Projects, Dorothee Teichmann & Christian Schempp, November 2013 (revised version). JASPERS Knowledge Economy and Energy Division, Staff Working Papers
2. Guidelines for Cost Benefit Analysis of Solid Waste projects supported by the Cohesion Fund and the European Regional Development Fund in 2007-2013, Jaspers May 2009
3. Guide to Cost benefit Analysis of investment Projects, 2014-2020
4. Costs for Municipal Waste Management in the EU, prepared by EUNOMIA RESEARCH AND CONSULTING in 2001 for the European Commission, DG Environment.
5. Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste, October 2000 , European Commission, DG Environment.
6. Waste Management Options and Climate Change (ISBN 92-894-1733-1) prepared by AEA Technology in July 2001 for the European Commission, DG Environment.

The specific methodology for the quantification of the economic benefits are according to the Guidelines for Cost Benefit Analysis of Solid Waste projects supported by the Cohesion Fund and the European Regional Development Fund, Jaspers May 2009. The specific assumptions made for the calculation are described below.

a. The resource cost savings are due to
   (i) the recovery of recyclable products, the production of compost and the production of energy. Since some waste will be sorted, thus enabling recycling and reuse, this presents an economic benefit for the entire society, since the basic raw materials (metal, plastic, paper etc) are saved, due to which the project brings positive impacts to society. Moreover due to the production of electricity from anaerobic digestion, electric energy will produced from renewable sources, which consequentially means that less electric energy will be produced through the existing National Standard production process;

   (ii) the reduction of the total amount of waste finally going to final disposal, which extends the economic life of the landfills. The quantification of these benefits have been done based on, avoided investment and operating costs at the landfill site (which have been estimated at a certain standard amount per tonne of waste diverted from the landfill).

   For the purposes of economic analysis of the current project, every tonne of waste that is not going to the landfill for final disposal as a result of the project have been credited with the monetary value of 50€/tonne of waste (source: Guidelines for Cost Benefit Analysis of Solid Waste projects supported by the Cohesion Fund and the European Regional Development Fund in 2007-2013, Jaspers May 2009).

b. The reduction of odours and direct health risks is due to:
   (i) avoided cleaning costs for not having to treat impact of uncontrolled discharges of leachate (which have been estimated at a certain standard amount of 1.50EURO per tonne of waste diverted from the landfill (source: Guidelines for Cost Benefit Analysis of Solid Waste projects supported by the Cohesion Fund and the European Regional Development Fund in 2007-2013, Jaspers May 2009).and

   (ii) disammenities impacts from uncontrolled waste (noise, dust, odours and the presence of vermin) which quantified as 14€/t (source: Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste)

c. Avoided GHG emissions through improved waste management. In order to quantify GHG emissions released and avoided in the waste management system, the system is separated into its individual components, that is facilities for example:
   - Mechanical Treatment
   - Biostabilisation
   - Windrow composting for Green Waste
   - Landfilling

   Specific emission factors taken from the literature are applied to calculate the GHG emissions that are characteristic for the individual processes that take place in these facilities and described **in chapter 8.** The volumes of Greenhouse Gas (GHG) were assessed in the with and without project scenarios utilizing JASPERS Knowledge Economy and Energy Division, Staff Working Papers, Calculation of GHG Emissions in Waste and Waste-to-Energy Projects, Dorothee Teichmann & Christian Schempp, November 2013 (revised version).

Other non-quantifiable benefits of the project that were not considered in the analysis are:

- Elimination of uncontrolled waste deposits improves the aspect of settlements and landscapes by making the area more attractive for living
- Initial educational effect on population regarding environmental awareness. This can be further developed by additional campaigns to all population
- General improvement of the living conditions as a result of significant improvement of the environmental due to the operation of modern waste management facilities
- social and economic development of the area, due to the development of new markets, i.e. the waste management and recycling market

9.2.4. ECONOMIC PERFORMANCE INDICATOR

The incremental economic analysis performed, based in the above mentioned assumptions and calculations. The economic discount rate applied was 5%.
The benefits transferred to social values as well as the costs (construction, O&M). The inflows estimated **1.99**times more than the economic outflows, which means the project produces positive added value to the society. More specific the Net Present Value of the Economic flows is **47,708,597Euros** and the Economic Rate of Return is much higher than the economic discount rate.
Calculation of economic performance indicators under the above mentioned assumptions are presenting below:

Table 9-35: Economic performance indicators

FLOWS - ECONOMIC ANALYSIS	NPV
Total Economic Inflows (Inc.)	**95,769,595**
Resource cost savings	60,054,073
Reduction of visual disamenities, odours and health risk	11,650,482
Reduction of greenhouse gas emissions	24,065,039
Total Economic Outflows (Inc.)	**-48,060,998**
Investments Economic cost	**-19,352,947**
Traded goods	-5,874,449
Non-traded goods	-2,643,503
Skilled Labour	-5,874,449
Unskilled Labour	-4,960,546
O&M economic costs	**-28,708,051**
Traded goods	-6,749,414
Non-traded goods	-2,024,824
Skilled Labour	-11,249,025
Unskilled Labour	-8,684,788
Economic Net Present Value	**47,708,597**
Economic Rate of Return	**20.90%**
B/C ratio	**1.99**

The ENPV/C is positive, which indicates that the project is worthwhile for society.The Economic International Rate of Return (EIRR/C) is defined as the discount rate which results in the ENPV/C = 0.The ERR/C is well above the cut-off rate of 5%, which mirrors the positive ENPV/C and underlines that the project is beneficial for society.

The positive sign of ENPV which leads the ERR in value much higher than the social discount rate (the Economic Rate of Return is defined as the discount rate which results in the ENPV to zero price) and the ratio Benefits to Costs higher than 1 proves that the investment for this project adds to the society welfare and is worthy to be financed from National and European funds.

9.3. RISK ASSESSMENT

9.3.1. METHODOLOGY

As set out in Article 101 (Information necessary for the approval of a major project) ofRegulation (EU)No 1303/2013, a risk assessment must be included in the CBA. This is required to deal with theuncertainty that always permeates investment projects, including the risk that the adverse impacts ofclimate change may have on the project. The recommended steps for assessing the project risks are asfollows:

- sensitivity analysis(identification of critical variables, elimination of deterministicallydependent variables, elasticity analysis, choice of critical variables) ;
- Definition of probability distribution for critical variables ;
- Risk analysis on FNPV/K and on ENPV (Calculation of the distribution of the performance indicator (typically FNPV and ENPV) ;
- Assessment of acceptable levels of risks;
- Recommended actions for prevention of risks.

9.3.2. SENSITIVITY ANALYSIS

Sensitivity analysis enables the identification of the critical variables of the project. Such variables are those whose variations, be their positive or negative, have the largest impact on the project's financial - economic performance. The analysis is carried out by varying one variable at a time and determining the effect of that change on the NPV. As a guiding criterion, the recommendation is to consider critical those variables for which a variation of ±1 % of the value adopted in the base case gives rise to a variation of more than 1 % in the value of the NPV. The tested variables should be deterministically independent and as disaggregated as possible.

A particularly relevant component of the sensitivity analysis is the calculation of the **switching values**. This is the value that the analyzed variable would have to take in order for the NPV of the project to become zero, or more generally, for the outcome of the project to fall below the minimum level of acceptability. The use of switching values in sensitivity analysis allows making some judgements on the risk of the project and the opportunity of undertaking risk-preventing actions.

The following table present the results of these calculations

Table 9-36: Sensitivity analysis (variation of ±1 %)

CATEGORIES OF VARIABLES	CHANGE	FNPV/K	ERR	ENPV	DIFFERENCE ON FNPV/K	DIFFERENCE ON ENPV	DIFFERENCE ON ERR	CRITICAL VARIABLE
BASE	**0.0%**	**-4,309,528**	**20.86%**	**47,708,597**				
Quantity of waste delivered to the plant								
	0.0%	**-4,309,528**	**20.86%**	**47,708,597**				
Quantity of waste delivered to the plant	1.0%	-4,254,130	21.03%	48,340,311	-1.29%	1.32%	0.86%	Yes
	-1.0%	-4,364,927	20.68%	47,076,893	1.29%	-1.32%	-0.86%	
Maintenance Cost								
	0.0%	**-4,309,528**	**20.86%**	**47,708,597**				
Maintenance Cost	1.0%	-4,334,270	20.83%	47,617,527	0.57%	-0.19%	-0.12%	No
	-1.0%	-4,284,788	20.88%	47,799,669	-0.57%	0.19%	0.12%	
Price of Recyclables								
	0.0%	**-4,309,528**	**20.86%**	**47,708,597**				
Price of Recyclables	1.0%	-4,286,222	20.90%	47,850,984	-0.54%	0.30%	0.19%	No
	-1.0%	-4,332,835	20.82%	47,566,218	0.54%	-0.30%	-0.19%	
Price from Collection Schemes								
	0.0%	**-4,309,528**	**20.86%**	**47,708,597**				
Price of recyclables from Collection Schemes	1.0%	-4,305,696	20.86%	47,709,640	-0.09%	0.00%	0.00%	No
	-1.0%	-4,313,362	20.86%	47,707,558	0.09%	0.00%	0.00%	
Tariff								
	0.0%	**-4,309,528**	**20.86%**	**47,708,597**				
Tariff	1.0%	-4,238,162	20.86%	47,708,597	-1.66%	0.00%	0.00%	Yes
	-1.0%	-4,380,895	20.86%	47,708,597	1.66%	0.00%	0.00%	
Price for electricity								
	0.0%	**-4,309,528**	**20.86%**	**47,708,597**				
Price for electricity	1.0%	-4,304,968	20.87%	47,736,162	-0.11%	0.06%	0.05%	No
	-1.0%	-4,314,089	20.85%	47,681,033	0.11%	-0.06%	-0.05%	
Energy cost								
	0.0%	**-4,309,528**	**20.86%**	**47,708,597**				
Energy cost	1.0%	-4,309,261	20.86%	47,730,313	-0.01%	0.05%	0.03%	No
	-1.0%	-4,309,795	20.85%	47,686,887	0.01%	-0.05%	-0.03%	
Fuel cost								
	0.0%	**-4,309,528**	**20.86%**	**47,708,597**				
Fuel cost	1.0%	-4,316,700	20.85%	47,682,224	0.17%	-0.06%	-0.03%	No
	-1.0%	-4,302,357	20.86%	47,734,974	-0.17%	0.06%	0.03%	
Investment Cost								
Investment Cost	**0.0%**	**-4,309,528**	**20.86%**	**47,708,597**				Yes

CATEGORIES OF VARIABLES	CHANGE	FNPV/K	ERR	ENPV	DIFFERENCE ON FNPV/K	DIFFERENCE ON ENPV	DIFFERENCE ON ERR	CRITICAL VARIABLE
	1.0%	-4,385,525	20.64%	47,400,439	1.76%	-1.02%	-1.02%	
	-1.0%	-4,233,531	21.07%	48,016,761	-1.76%	1.0%	1.0%	
Labour Cost								
	0.0%	**-4,309,528**	**20.86%**	**47,708,597**				Yes
Labour Cost	1.0%	-4,331,805	20.83%	47,626,601	0.52%	-0.10%	-0.10%	
	-1.0%	-4,287,252	20.88%	47,790,594	-0.52%	0.10%	0.10%	
Reduction of EU funds								
Reduction of EU funds	**0.0%**	**-4,309,528**	**20.86%**	**47,708,597**				Yes
	-1.0%	-4,553,735	20.86%	47,708,597	5.67%	0.00%	0.00%	
Shadow price of CO2								
	0.0%	**-4,309,528**	**20.86%**	**47,708,597**				No
Shadow price of CO_2	1.0%	-4,309,528	20.9%	47,949,248	0.00%	0.50%	0.29%	
	-1.0%	-4,309,528	20.8%	47,467,947	0.00%	-0.50%	-0.29%	
Shadow price of landfill space								
	0.0%	**-4,309,528**	**20.86%**	**47,708,597**				No
Shadow price of landfill space	1.0%	-4,309,528	20.96%	48,084,419	0.00%	0.79%	0.51%	
	-1.0%	-4,309,528	20.75%	47,332,775	0.00%	-0.79%	-0.49%	

The results of the sensitivity analysis and variables tested are given in the table below:

Table 9-37: Sensitivity analysis - switching values for critical variables

No.	Variable	Switching value	
1	Quantity of waste delivered to the plant	Maximum increase before the FNPV/K equals 0	77.79%
		Maximum decrease before the ENPV equals 0	-75.52%
2	Maintenance Cost	Maximum decrease before the FNPV/K equals 0	Always Negative
		Maximum increase before the ENPV equals 0	Always Possitive
3	Price of Recyclables	Maximum increase before the FNPV/K equals 0	184.91%
		Maximum decrease before the ENPV equals 0	-335.07%
4	Price of recyclables from Collection Schemes	Maximum increase before the FNPV/K equals 0	1124.43%
		Maximum decrease before the ENPV equals 0	Always Possitive
5	Tariff	Maximum increase before the FNPV/K equals 0	85.70%
		Maximum decrease before the ENPV equals 0	Not applicable
6	Price for electricity	Maximum increase before the FNPV/K equals 0	944.95%
		Maximum decrease before the ENPV equals 0	Always possitive
7	Energy cost	Maximum increase before the FNPV/K equals 0	16124.42%
		Maximum decrease before the ENPV equals 0	Always possitive
8	Fuel cost	Maximum decrease before the FNPV/K equals 0	Always Negative
		Maximum increase before the ENPV equals 0	Always Possitive
9	Investment Cost	Maximum decrease before the FNPV/K equals 0	-56.71%
		Maximum increase before the ENPV equals 0	154.82%

No.	Variable	Switching value	
10	Labour Cost	Maximum decrease before the FNPV/K equals 0	-193.46%
		Maximum increase before the ENPV equals 0	581.84%
11	Reduction of EU funds	Maximum increase before the FNPV/K equals 0	Not applicable
		Maximum decrease before the ENPV equals 0	Not applicable
12	Shadow price of CO2	Maximum increase before the FNPV/K equals 0	Not applicable
		Maximum decrease before the ENPV equals 0	-198.25%
13	Shadow price of landfill space	Maximum increase before the FNPV/K equals 0	Not applicable
		Maximum decrease before the ENPV equals 0	-126.94%

9.3.3. RISK ANALYSIS

In order Risk Analysis to be performed, has been used the Monte Carlo simulation method. This simulation analyze a range of variation of the main project parameters (investment cost, revenues, O&M costs, economic benefits, economic cost of the investments and economic cost of the operation and maintenance of the resulting facilities).

For each variable a minimum and maximum value is set (as % to the base case) has been entered as follows.

Table 9-38: Risk analysis - parameters considered in the analysis

	Variable	Range of variation from base case	
		Lower	Upper
1	Project investment cost	-5.00%	30.00%
2	Revenues	-30.00%	5.00%
3	O&M costs	-5.00%	30.00%
4	Economic benefits	-30.00%	5.00%
5	Economic costs (Investment)	-5.00%	30.00%
6	Economic costs (O&M)	-5.00%	30.00%

The number of iterations used for the Monte Carlo Simulation was limited to 25,000.

Table 9-39: Risk analysis - results of the Monte Carlo analysis

	Variable	FNPV/K	ENPV
1	Expected value	-21,010,363	29,712,472
2	Standard deviation	4,665,767	5,925,301

The following figures illustrate the distribution of probabilities as estimated of the Monte Carlo Simulation:

Figure 9-1: Distribution of FNPV/k values

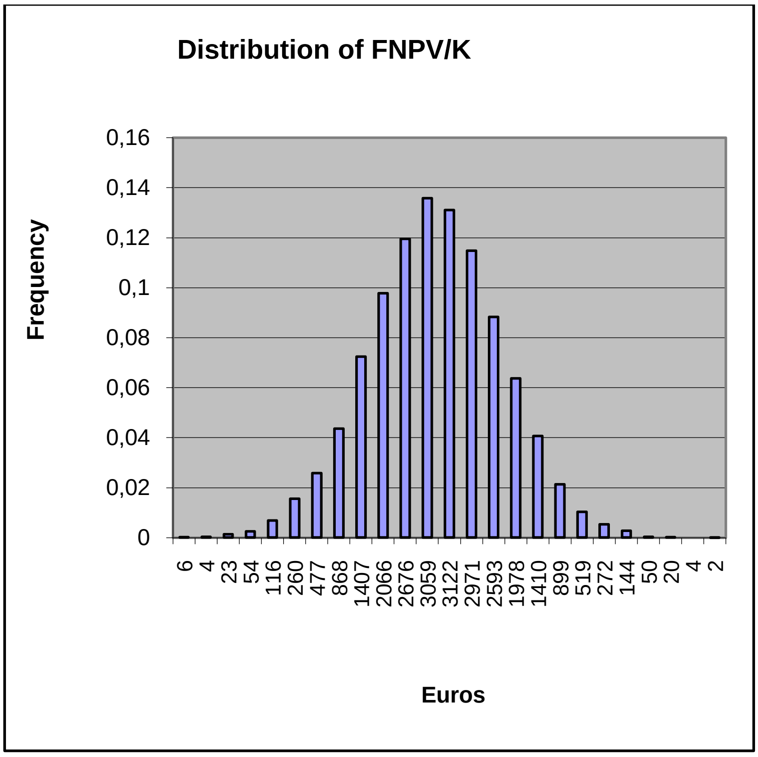
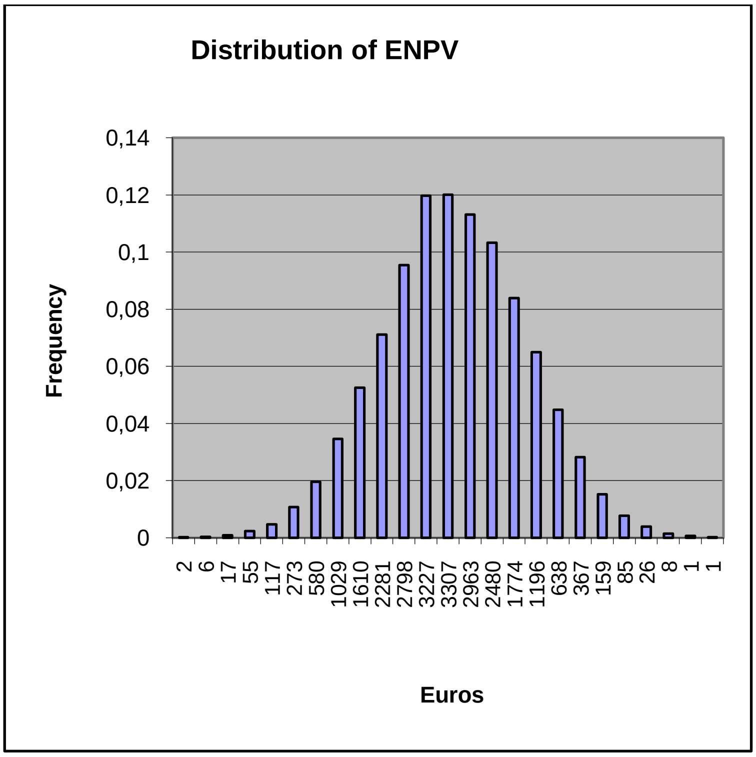


Figure 9-2: Distribution of ENPV values



Based on the above distributionthere is a 95% probability that FNPV/K is between -30,155,266.9 and

-11,865,458, with a 00% probability of FNPV/K >0 and there is a 95% probability that ENPV is between 18,098,888 and 41,326,060.7, with a 100% probability of ENPV >0.

Concluding the results of risk assessment, the project has very high possibility (almost certainty) to be constructed and operated with low risk in financial and economic terms, as are requested by EU co-funding regulations.

9.3.4. QUALITATIVE RISK ANALYSIS

Based on the results of the sensitivity analysis and taking into account uncertainties related to the aspects not directly reflected in CBA calculations, a risk matrix was prepared in order to identify possible risks prevention and mitigation measures.
The level of risk determined from the matrix identifies the level of control measures required for that environmental aspect.

Table 9-40: Risk Assessment Matrix

Probability	Severity: I	II	III	IV	V
A	Low	Low	Low	Low	Moderate
B	Low	Low	Moderate	Moderate	High
C	Low	Moderate	Moderate	High	High
D	Low	Moderate	High	Very High	Very High
E	Moderate	High	Very High	Very High	Very High

Risk level	Colour
Low	green
Moderate	yellow
High	red
Unacceptable	dark red

Source: Guide to cost benefit analysis of investment projects 2014-2020

Explanatory notes on the selection of the Severity and Probability for each issue are presented in the following table.

Table 9-41: Risk Matrix Explanation

Probability			Severity		
A	Very unlikely	0-10%	I	Insignificant	No relevant effect on social welfare, even without remedial actions
B	Unlikely	10-33%	II	Minor	Minor loss of the social welfare generated by the project, minimally affecting the project long run effects. However, remedial or corrective actions needed
C	About as likely as not	33-66%	III	Moderate	Social welfare loss generated by the project, mostly financial damage, even in the medium-long run. Remedial actions may correct the problem
D	Likely	66-90%	IV	Critical	High social welfare loss generated by the project: the occurrence of the risk causes a loss of the primary functions of the project. Remedial actions, even large in scope, are not enough to avoid serious damage
E	Very likely	90-100%	V	Catastrophic	Project failure that may result in serious or even total loss of the project functions. Main project effects in the medium-long term do not materialize

Source: Guide to cost benefit analysis of investment projects 2014-2020

The next table illustrates the Risk Assessment Matrix Results for the Waste Management Centre & TS that will be constructed and operated in Southwest region.

Table 9-42: Risk Assessment Matrix Results

Risk description	Responsible authority	Authority for cooperation	Probability (P)	Severity (S)	Risk level (=P*S)	Risk prevention / mitigation measures	Residual risk after prevention/ mitigation measures
Delays related to the institutional set up of the project	MoEPP	Mayors and PUC	B	IV	Moderate	Ensure that there will be regular cooperation between the Municipalities, PUEs and IWMC at an early stage of project development (at least before the commissioning period of the project) so as to identify and address any issues in a timely manner.	Moderate
	MoEPP	Mayors and PUC				Agreements should be signed promptly between all stakeholders. The agreements will allow sharing the responsibilities between the involved parties.	
	Mayors	MoEPP				Establishment of the Regional WM boards	
	Mayors	MoEPP				Establishment of RWM Centers	
	Mayors and municipal councils	MoEPP				Centers should have sufficient staff, capacity.	
	Mayors and municipal councilsor any other possible					The level of tariff should have been agreed and the municipalities	

Risk description	Responsible authority	Authority for cooperation	Probability (P)	Severity (S)	Risk level (=P*S)	Risk prevention / mitigation measures	Residual risk after prevention/ mitigation measures
	involved entity					should verify their contribution by including these expenses in its future budget or any other possible involved entity should act accordingly	
	MoEPP	Mayors and PUCs				Ensure that there will be regular cooperation between the Municipalities and PUEs concerning the trans -municipal cooperation for the collection and transportation of recyclables and green waste.	
Lack of funds	MoEPP		B	IV	Moderate	The project promoter ensures that there will be regular cooperation with the managing authority in order to find funds and donors for the implementation of the project.	Moderate

Risk description	Probability (P)	Severity (S)	Risk level (=P*S)	Risk prevention / mitigation measures	Residual risk after prevention/mitigation measures
Demand risks					
Waste generation lower than predicted	B	III	Moderate	• Demand analysis is carried out based on waste measurements and conservative assumptions on waste generation in the project area which are comparable with assumptions made in other regions in the country. • Currently, waste generation per capita in the Beneficiary Country is quite lower than EU average.	LOW
Waste flow control/delivery insufficient	B	III	Moderate	• PUEs participating in the project control the waste flow within their collection zones in order to ensure sufficient delivery to the plant. • The operating hours of mechanical unit can be extended or reduced in case of seasonal fluctuations in waste input.	LOW
Design risks					
Inadequate surveys and investigation	A	III	Low	• Necessary surveys (topography, geological, hydrogeological, geotechnical etc) are undertaken during design. • The local conditions of the site have been considered during the elaboration of design.	Low
Choice of unsuitable technology	A	III	Low	• Option analysis has been carried out and the best-available technology has been selected. • Technology has many references in similar EU plants.	Low
Inadequate design cost estimates	B	III	Moderate	• Investment cost estimates are comparable to cost experienced with similar projects implemented in the EU in the last years. • Consultations with equipment manufacturers were carried out to cross – check estimates with current market conditions. • Prices at local market have been considered • Investment cost contains an element of contingency to meet the first tranche of overrun (if any).	Low

Risk description	Probability (P)	Severity (S)	Risk level (=P*S)	Risk prevention / mitigation measures	Residual risk after prevention/mitigation measures
Land acquisition risks					
Procedural delays	C	II	Moderate	It can be obtained after communication of Project Team, Beneficiaries and competent authorities.	Low
Land cost higher than predicted	B	I	Low	For the purchase of private parts of land, an amount is foreseen in the investment cost	Low
Administrative and procurement risks					
Procedual delays	C	III	Moderate	• Prepared detailed tendering documentation by experienced designers. • Introduce time contingencies in project planning by taking into account possible procurement delays (i.e. management of claims by competitors).	Low
Building or other permits	B	II	Low	• EIA documentation has been submitted and the procedure for EIA permit is ongoing. The revision of Detailed Design for Building Permit for RED FIDIC part of works is under preparation within the project. • All other permits required for the construction and operation of the project will be acquired by the Contractor.	Low
Utility approvals	B	II	Low	• The Beneficiary will ensure close cooperation with the local authorities at the stage of design in order to obtain all necessary approvals (power supply, water supply etc.).	Low
Construction risks					
Project cost overruns and delays in construction	B	II	Low	• Investment cost estimates are comparable to cost experienced with similar projects implemented in the EU in the last years. • Investment cost contains an element of contingency to meet the first tranche of overrun (if any). • Publication of contract notices in the needed extend will be made so as to ensure wider competition. • Close monitoring of cost relative to budget should be undertaken (at least quarterly) to allow	Low

Risk description	Probability (P)	Severity (S)	Risk level (=P*S)	Risk prevention / mitigation measures	Residual risk after prevention/mitigation measures
				management and mitigation of any over-runs should such occur. • Possibilities for delays in construction will be minimized through well balanced tender dossier. • Delays in construction due to unforeseeable reasons affect only the time of achievement of targets.	
Contractor related (bankruptcy)	A	II	Low	• Requirements concerning financial capacity of the candidates will be included in the tender documents. • Bank guarantees will be required.	Low
Lack of resources	C	III	Moderate	• The sound maturation of the project and its self-sustainability are strengthening the possibility to ensure financing. • Besides the possibility of EU funds , attractive resources may be attracted.	Low
Operational risks					
Waste composition other than predicted or having unexpectedly large variations	B	II	LOW	• Waste sampling and analysis sets have been carried out. • The results of the waste analysis are comparable to existing studies and surveys. • Changes in separation at source rates of recyclables and other waste fractions have been based on conservative assumptions observed also in other countries. • The selected technology and the designed facilities have flexibility against waste composition changes.	Low
Maintenance and repair costs higher than predicted, accumulation of technical breakdowns	A	II	Low	• Maintenance and repair cost is a small percentage of the operation cost • Operating cost estimates compare well with costs experienced with similar projects in operation. • Operational shutdowns for maintenance has been foreseen in the design stage	Low
Process outputs fail to meet quality targets	B	II	Low	• Selection of best available technology for mechanical treatment and biological treatment, aiming to achieve the targets. • Moreover in the TD it will be	Low

Risk description	Probability (P)	Severity (S)	Risk level (=P*S)	Risk prevention / mitigation measures	Residual risk after prevention/mitigation measures
				included Eligibility Criteria for tenderers and Performance Guarantee Forms for processes, in order to safeguard quality requirements.	
Failure to meet limits of emissions produced by the facility (to air and/or water)	A	II	Low	• All necessary measures for the environmental protection have been considered in the EIA. • Selection of proven, best-available technologies for wastewater treatment facilities and air pollution mitigation measures according the latest Best Available Techniques (BAT) Reference Document for Waste Treatment, 2015 and regulatory documents. • Moreover in the TD it will be included Performance Guarantee Forms for pollution control equipment, in order to safeguard quality requirements. • In the operation manual effective retrieving measures will be defined. • Training programs will be provided to the personnel	Low
Financial risks					
Tariff increases slower than predicted	B	III	Moderate	• Provisions for regular price adjustments for inflation will exist. • Institutional arrangements are foreseen in the legislation for securing adequate tariff changes • Tarrifs are not allowed to exceed the affordability threshold	Low
Tariff collection lower than predicted	B	III	Moderate	• Institutional arrangements are foreseen in the legislation for securing adequate tariff collection • Tariffs are not allowed to exceed the affordability threshold	Moderate
Regulatory risks					

Risk description	Probability (P)	Severity (S)	Risk level (=P*S)	Risk prevention / mitigation measures	Residual risk after prevention/mitigation measures
Changes of environmental requirements, economic and regulatory instruments (i.e. introduction of landfill taxes, bans on landfilling)	B	II	Low	• The EIA permit which is now under consultation has been elaborated taking into account all environmental acquis in force. • The design of the new facilities have adopted state of art environmental conditions • Since the Beneficiary country is a Pre Accession Country, no new Regulations are expected than the already transposed of EU legislation while any new regulation have reasonable transition stipulations.	Low
Other risks					
Public opposition	C	II	Moderate	• The location for TS have been proposed by the Municipalities. • The location for CWMF have been selected through a comparative analysis among several alternative locations • Ad hoc report for site selection has been presented with not strong oppositions • During EIA consultation all needed clarifications will be provided.	Low

Table of Contents

List of Tables

10. PROCUREMENT AND IMPLEMENTATION

10.1 PROCUREMENT STRATEGY

10.1.1 Intruduction

This chapter presents the options for the implementation of the works, supply and services contracts, which were identified in the Feasibility Study. The proposed strategy shall take into consideration the most representative elements of good practice and shall remain flexible enough to answer the national and international evolution. The strategy identifies the key elements, which must be observed in the procurement activity.

10.1.1 Definitions

A Project Implementation Plan is the program that defines the long, medium and short term activities that will take place in a specific period in order for an investment project to be implemented. The procurement plan describes the timing, budget and type of the procurement activities that will take place in order to fulfil the requirement of the project implementation plan.

The project Implementation Plan and the Procurement Plan are required when the decision for financing is reached, funding sources have been identified and to purchase works, equipment or services has been made. Procurement planning is used as an opportunity to evaluate/review the entire procurement process so that sound judgements and decision making will facilitate the success of the overall project.

The overall objective of a Procurement Plan is to document and inform project stakeholders about how the procurements will be planned, executed, and managed throughout the life of the project. This Procurement Plan should outline the specific actions necessary to execute the approved acquisition strategy. The Procurement Plan documents the approach to be taken for items such as the actual acquisition, contracting, and fiscal, legal, personnel considerations, etc. The Procurement Plan should also address any policy, process, regulatory, etc. necessary to comply with any other requirements related to the specific acquisition.
For the purposes of this document, the following basic terms and expressions have the following meanings:

- **Action for the maturation of the project**: relates specifically to the activities before tenders start.
- **Implementation Plan for the tendering:** covers the sequenced steps for implementing the specific measures identified as priority investments for financing under EU Funds, comprising a timeline and a detailed programme from completion of the tender documents through to final approval and payment of contractors for works contracts and the final Supervision report.
- **Procurement Plan**: relates specifically to the procurement cycle from preparation of Tender Documents for all defined project objectives and the associated works and supervision contracts, advertising of tenders for those contracts in the Official Journal of the EU (or elsewhere as appropriate), submission and evaluation of offers, awarding of contracts, mobilisation of contractors and execution of the works through to completion including hand-over of the works.
  It is assumed that the implementation will start at year 2018. However, due to the fact that, due to the uncertainty of financing, the commencement year it is not safely known yet, for the procurement plan the first year of implementation, will be defined as year "n".

10.1.2 List of activities for the maturation of the project

Action for the maturation of the project relates specifically to the activities before tenders start:

- Regular cooperation with the managing authority in order to find funds and donors for the implementation of the project;
- Establishment of the Inter-municipal waste management enterprise (IWME);
- Establishment of the Regional WM boards
- Establishment of RWM Centres
- Agreements should be signed promptly between all stakeholders (Municipalities, PUEs, IWME, Regional Centre etc.). The agreements will allow sharing the responsibilities between the involved parties; Clarifying the roles and responsibilities, so that overlapping and duplication of efforts shall be avoided;
- The level of tariff should have been agreed and the municipalities should verify their contribution by including these expenses in its future budget or any other possible involved ;
- Regular cooperation between the Municipalities and PUEs concerning the trans -municipal cooperation for the collection and transportation of recyclables and green waste;
- Increasing the efficiency of the public personnel, via training and capacity building;

If the above list of priorities is not accomplished before the tendering phase, it has to be completed prior to the commissioning stage, the latest.

10.1.3 EU and Macedonian legislation on public procurement

The procurement for the solid waste sector projects must be made according to the requirements imposed by the relevant national legislation and the EU Directives in force. In December 2011 the Commission proposed the revision of Directives 2004/17/EC (procurement in the water, energy, transport and postal services sectors) and 2004/18/EC (public works, supply and service contracts), as well as the adoption of a directive on concession contracts. The directives were voted by the European Parliament on 15 January 2014 and adopted by the Council on 11 February 2014. Therefore, the procurement shall be made according to the following:

- Directive 2014/25/EU on procurement by entities operating in the water, energy, transport and postal services sectors (repealing Directive 2004/17/EC)
- Directive 2014/24/EU on public procurement (repealing Directive 2004/18/EC)
- Regulation (EU) No 1336/2013amending Directives 2004/17/EC, 2004/18/EC and 2009/81/EC of the European Parliament and of the Council in respect of the application thresholds for the procedures for the awards of contract
- Law on Public Procurement (Official Gazette of the Republic of Macedonia no. 136/07)

The principles at the base of the public procurement contract awarding are:

- Non-discrimination
- Equal treatment
- Mutual acknowledgement
- Transparency
- Proportionality
- The efficient use of EU and National funds
- Taking responsibility

10.1.4 Principal procurement options and procedures

The basic principle governing the award of contracts is competitive tendering. The purposeistwofold:

- To ensure the transparency of operations
- To obtain the desired quality of services, supplies or works at the best possible price.

The different types of public procurement procedures regulated by the Republic of Macedonia include:

(a) '**Open procedures'** means those procedures whereby any interested economic operator may submit a tender.

(b) '**Restricted procedures'** means those procedures in which any economic operator may request to participate and whereby only those economic operators invited by the contracting authority may submit a tender.

(c) '**Competitive dialogue'** is a procedure in which any economic operator may request to participate and whereby the contracting authority conducts a dialogue with the candidates admitted to that procedure, with the aim of developing one or more suitable alternatives capable of meeting its requirements, and on the basis of which the candidates chosen are invited to tender.

(d) '**Negotiated procedures'** means those procedures whereby the contracting authorities consult the economic operators of their choice and negotiate the terms of contract with one or more of these.

10.2 TENDERING STRATEGY

10.2.1 Tender Process

Contracting authorities who wish to commence a procurement have an obligation to publish a prior information notice and a procurement notice in the Official Journal of the European Union. In the case of open procedures, the minimum time limitsare set in the Directive. In particular, the stages for the Tender Process are as follows:

- Preparation of Tender Dossier with Employer Requirements/ Technical Specifications (Use of FIDIC Yellow Book is recommended)
- Notices and publication in Official Journal of the EU and any other media
- Provisionof tender documents and clarifications to the interested parties
- Evaluation of Offers based on Award criteria
- Contract award
- Contract signing

The award of the procurement should be based on objective criteria. Two award criteria are applicable, "the lowest price" and "the most economically advantageous tender" criteria.

At present, the following thresholds apply in the case of public procurements for the estimated value excluding VAT (http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=8624&lang =en&title=Changes-to-public-procurement-thresholds):

- **5.225.000 EURO** for public works procurements
- **135.000 EURO**, for public supply and service procurements awarded by contracting authorities which are listed as central government authorities
- **209.000 EURO**, for public supply and service procurements awarded by contracting authorities other than those listed in Annex IV of the Directive (not the present case)

Where contracts are subdivided in lots, the value of each lot shall be taken into account when calculating the overall threshold. They are divided between those for services (i.e. technical assistance, studies, provision of know-how and training), supplies (i.e., equipment and materials) and works (i.e. infrastructure and other engineering works). For the contracts that will be financed by national or local funds, national procurement rules will be applied. Note that projects must not be split artificially to circumvent the procurement thresholds.

Depending on the eventual financing institution of the tendering (eg. EU, national funds, IFIs etc) the procurement rules that will be followed should be adjusted accordingly.

Beside the aforementioned in case that a PPP procedure will be chosen, the tendering strategy may be customised (e.g. through competitive dialogue etc).

10.2.2 Criteria for Grouping of Tenders

In order to define the criteria to group the tenders it should be considered the type of investments. In general, the investment can be grouped into three main categories:

- Facilities undergoing construction works (Central Waste Management Facilities, Transfer Stations)
- Services (Technical assistance - supervision of the work contracts, etc)

- Supplies (Central Waste Management Facilities' mobile equipment, bins, trucks)

The number or type of contracts to be awarded for each of the above categories shall be established according to the following criteria:

- the type of construction works and services to be procured
- number and location of construction works to be procured
- the timeframe for the completion of the works and services
- the value of the works or services to be procured
- expertise/ know-how available on the local market
- management capacity of the Contracting Authority

10.2.3 Works Contracts

The procurement strategy shall present types of works contracts, which can be implemented, depending on the complexity of the works. The types define the standard contract terms, which shall be applied for the implementation of the project. The available contractual arrangement may be one of the following:

- **Build (Constructions - CONS):** For this type of contract, the Contractor constructs the works in accordance with a design provided by the Employer (which includes the Specification and Drawings) and the Engineer's instructions. Under CONS, design is the responsibility of the Employer. The Specification must therefore clearly state, and should also specify the appropriate criteria with which these parts shall comply. Funding for the procurement comes from combinations of European Union grant funding, contributions from central and local authorities. The International Federation of Consulting Engineers ("FIDIC") published a contract for CONS projects (known as the "**RED Book**"). The TenderDocumentscomprise:
  (a) Volume I containing Instructions, the Letter of Tender,
  (b) Volume II containing the Bill of Quantities and Schedules;
  (c) Volume III containing the Conditions of Contract,
  (d) Volume IV containing the technical description, and specifications and the Drawings.
- **Design and Build (D&B):** For this type of contract, the Contractor provides both the design and construction of the facility to specified performance requirements. The Contractor provides plant, and designs and executes the other works, all in accordance with the Contract which includes his Proposal and the Employer's Requirements. Under D&B design is the responsibility of the Contractor. Similarly to CONS, the public sector pays for the project's construction and can apply for EU co-financing in the same way as in a CONS project.FIDIC published a contract for DB projects (known as the "**Yellow Book**"). The TenderDocumentscomprise:
  (a) Volume I containing Instructions, the Letter of Tender,
  (b) Volume II containing the Schedules;
  (c) Volume III containing the Conditions of Contract,
  (d) Volume IV containing the Employer's Requirements.

The above are the two dominant types of contracts, however there are some other possible types: Design, Build and Operate (DBO) and Design, Build, Finance and Operate (DBFO).

- **Design, Buildand Operate(DBO):**In a DBO project, a tendering authority contracts with a private sector company (or consortium) to design, build and then - differently from a D&B contract - operate an infrastructure for a designated period of time. The private sector is therefore focused not only on the construction of the asset, but also on ensuring its efficient operation for anextended period. Similarly to a D&B, the public sector pays for the project's construction and can apply for EU co-financing in the same way as in a D&B project. However, whereas in a D&B contract the contracting authority takes over operation of the asset and pays the costs associated directly from its budget, in a DBO the concessionaire operates the project and receives periodic payments - usually monthly - from the contracting authority for doing so. Typically the level of these payments is established at the outset of the project, which calculates the amount the operator will need to receive in order to cover operating and lifecycle maintenance costs, manage risk and generate a profit.FIDIC published in September 2008 a draft contract for DBO projects (known as the "**Golden Book**"). The Tender Documents comprise:

(a) Volume I containing Instructions, theLetter of Tender,
(b) Volume II containing the Schedules;
(c) Volume III containing the Conditions ofContract,
(d) Volume IV containing the Employer's Requirements.

- **Design, Build, Finance and Operate (DBFO):** DBFO is a type of Public Private Partnership (PPP). In PPP the private sector designs, builds, operates and finances afacility for a defined period, afterwhich the facility reverts to thepublic sector.
  The facility is owned by the privatesector for the contract period and itrecovers costs through local authorities. In this type of contracts, the concessionaire will bring a financing structure, negotiated with equityinvestors and commercial lenders, as part of his tender. The rationale for using a PPP arrangement instead of conventionalpublic procurement rests on the proposition thatoptimal risk sharing with the private partner delivers better"value for money" for the public sector. In a PPP procurement the public and private sectors collaborate to deliver public infrastructure projects which typically have the following:
  (a) a long-term contract between a public contracting authority and a private sector company based on the procurement of services
  (b) the transfer of certain project risks to the private sector with regard to designing, building, operating and/or financing the project
  (c) focus on the specification of project outputs
  (d) Payments to the private sector which reflect the services delivered
  (e) The PPP Company may be paid either by the Authority or by a combinationof Authority and users through user charges

Regardless of the procedure used, the Contracting Authority must ensure that all the basic principles are respected (including eligibility, exclusion and selection criteria).

10.2.4 Supply and Service Contracts

Similarly, Supply and Service Contracts can be tendered using either the Open, Restricted or Competitively Negotiated procedure.

The service contract is envisaged to provide support to the Final Beneficiary and the PIU in the implementation stage. During this phase, the Beneficiary through the Project Implementation Unit (PIU) with the Consultant Supervisors, will manage and supervise the contracts by working closely with the contractors to ensure that contract requirements are met. The purpose is to ensure that the contractors, as well as the works or equipment delivered comply with the contract requirements.

10.3 PROCUREMENT PLAN

It is assumed that the implementation will start at year 2018. However, due to the fact that, due to the uncertainty of financing, the commencement year it is not safely known yet, for the procurement plan the first year of implementation, will be defined as year "n".

Four different contracts is recommended that should be implemented as follows:

10.3.1 Works Contracts

1.1. Works contract 1.1,International open tender: **:** “Construction of Waste Treatment and Disposal Facilities for Southwest Region” according to “Red Book” type of Contract, with special conditions from “Yellow Book” will be included for the technological process of the plant,(i.e. Mechanical & Biological Treatment, Waste Water Treatment Plant, etc). The contract will not be divided to Lots.

No. 1.1 Works contract	
SUBJECT	**Construction of Waste Treatment and Disposal Facilities for Southwest Region**
Budget without VAT	**24,017,307€** without contingencies &VAT
Procedure	International open tender procedure “Build – Red Book” type of Contract”
Award	09/n
Construction Completion	11/(n+2)
Test Run	1 month 12/(n+2)
Trial Operational Period	01/(n+3)-03/(n+3)
Defects and Notification Period (DNP) (12 months)	04/(n+3)–03/(n+4)

The award criterion of the Tender will be defined at a later stage.

1.2. Works contract 1.2,International open tender: “Closure, rehabilitation and aftercare of non-compliant landfills and dumpsites in Southwest Region”

No. 1.2 Works contract	
SUBJECT	**Closure, rehabilitation and aftercare of non-compliant landfills and dumpsites in Southwest Region**
Budget without VAT	**9,635,864€** without contingencies &VAT (*)
Procedure	International open tender procedure “YELLOW Book” type of Contract”
Award	04/(n+3)
Construction Completion	03/(n+4)
Defects and Notification Period (DNP) (12 months)	04/(n+4)– 03/(n+5)

(*) Source: Detailed Design of Closure, rehabilitation and aftercare of non-compliant landfills and dumpsites in Southwest Region

10.1.2 Supply Contracts

Based on the "*Need assessments, market analyses with costs estimations and Technical Specifications (TSs) for supply of equipment for waste collection and transferring of waste Southwest Region*" report, it has been decided to group the equipment to three categories – Lots, namely:

1) **LOT 1:**Bins and containers for temporary storage of waste (including bins for home-composting)
2) **LOT 2:** Trucks for collection of waste
3) **LOT 3:** Equipment for transfer stations

2. Supply contract, International open tender: The tender will be divided in lots as follow:

Supply contract: Supply of equipment for waste collection and transferring of waste for Southwest Region	
LOT 1 **Budget** without VAT	Bins and containers for temporary storage of waste (including bins for home-composting) **1,731,312€** without VAT
LOT 2 **Budget** without VAT	Trucks for collection of waste **2,823,332€** without VAT
LOT 3 **Budget** without VAT	Equipment for transfer stations **1,536,963€** without VAT
Procedure	International open tender procedure
Award	02/(n+2)
Construction Completion	06/(n+2)

10.1.3 Service Contracts

3.1. Services contract 1,International open tender: Technical Assistance - Supervision during implementation & Public Awareness services.

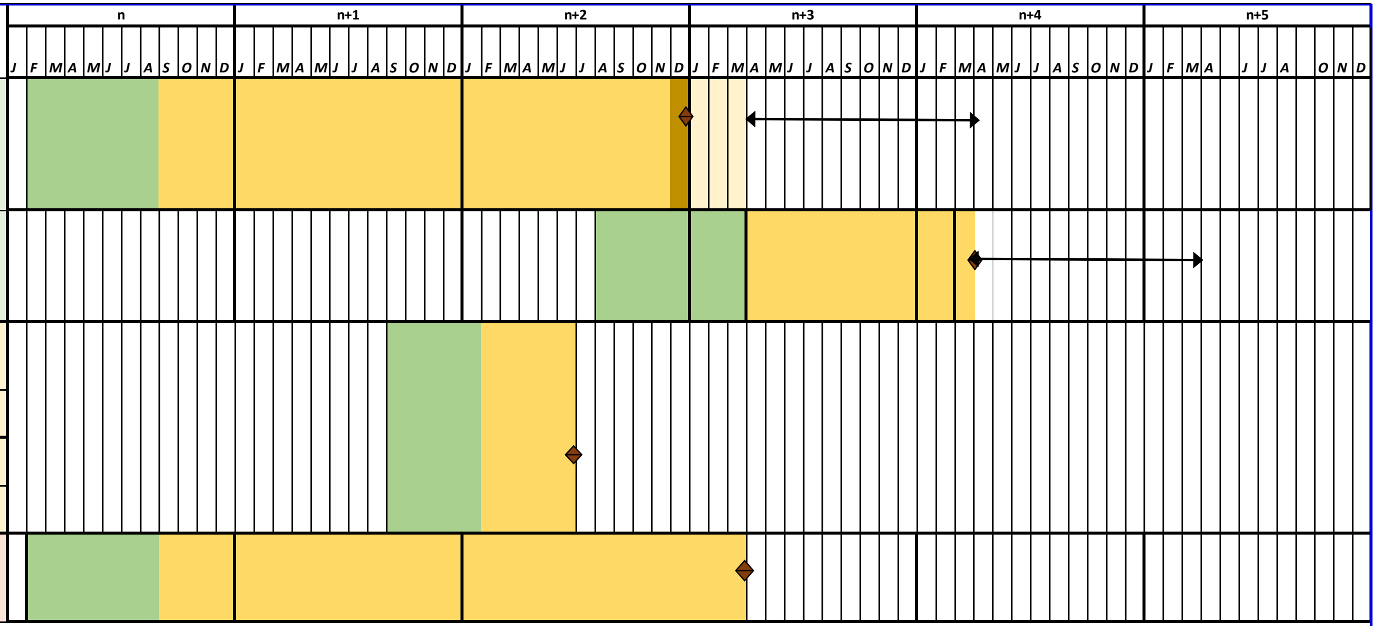
No.1 Service contract	
SUBJECT	**Technical Assistance - Supervision during implementation& Public Awareness services**
Budget without VAT	**2,400,000 €**without VAT
Procedure	International open tender procedure
Award	09/n
Completion	03/(n+3)

10.4 IMPLEMENTATION PLAN

The following table illustrates the estimated timetable for the execution of the proposed works and services.

Table 10-1: Project implementation timetable

		SUBJECT
WORKS	1.1	Construction of Waste Treatment and Disposal Facilities for Southwest Region
WORKS	1.2	Closure, Rehabilitation and Aftercare of Non- Compliant Landfills and Dumpsites in Southwest Region
SUPPLIES	2.1	Supply of equipment for waste collection and transferring of waste for Southwest Region
SUPPLIES	Lot 1	Bins for temporary storage of waste
SUPPLIES	Lot 2	Trucks for collection of waste
SUPPLIES	Lot 3	Equipment for transfer stations
SERVICE	3.1	Technical Assistance - Supervision during implementation & Public Awareness service



TENDERING
EXECUTION
TEST RUN
COMPLETION
TRIAL OPERATION PERIOD
DNP