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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

Vardar Region

(10/11/2017)

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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 ExistingWaste 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 tariffs 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 for CWMF Transfer Stations and regional waste management scenarios.
- *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 (Rosoman Municipality, R1 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.

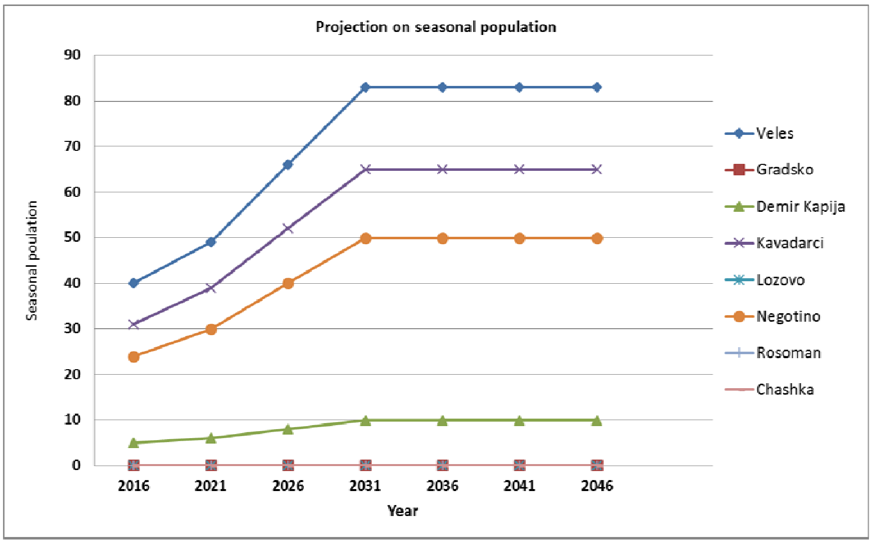
1.3 SOCIO-ECONOMIC CONTEXT OF THE PROJECT

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**
Vardar Region (without Sveti Nikole)	136,038	135,182	135,224	135,365	135,107	134,287	132,786	130,712	128,194

- 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 Vardar Region. GPD per capita in Vardar Region for years 2012 and 2013 is higher 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 tariffs. This paragraph includes calculations regarding the current tariffs for waste management.
- Future economic development.. 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	**13.75%**
Other Biodegradable waste	**36.81%**
Paper	**9.34%**
Cardboard	**5.02%**
Glass	**3.49%**
Ferrous metal packaging and other	**0.84%**
Aluminum (non-ferrous) metal packaging and other	**0.46%**
Composite Materials	**2.00%**
Other Plastic packaging waste	**1.56%**
Plastic bags	**6.08%**
PET Bottles	**2.13%**
Other plastic/Hard plastic	**0.80%**
Textile	**2.77%**
Leather	**1.30%**
Diapers	**6.27%**
Wood	**0.80%**
Construction and demolition material	**3.22%**
WEEE	**0.25%**
Medical Waste	**0.12%**
Other special waste streams (Elastic-tyres, etc)	**0.39%**
Fine elements <10mm	**2.59%**
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	135,224	128,194
Seasonal Population	100	208
Quantity of produced Municipal Waste (t)	37,853	40,960
Waste production Rate for permanent population (kg/ca/year)	280	319
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

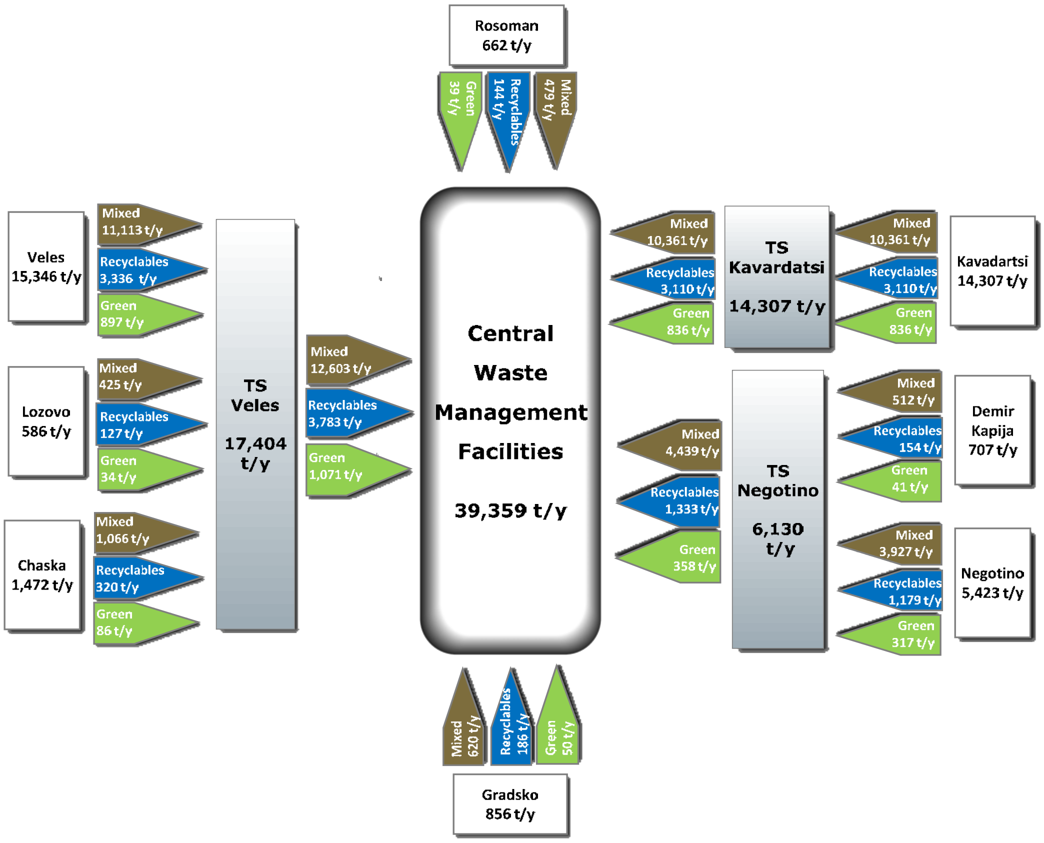
The main contents of chapter 6 (Option analysis) are the following:

- 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 TSs. 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 Vardar region are described.

TS	Served Municipalities
Veles TS	Veles, Lozovo, Chashka
Kavadartsi TS	Kavadartsi
Negotino TS	Negotino, Demir Kapija

- 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) – three (3) TSs: at Veles, Kavadartsi and Negotino, direct transportation for the municipalities of Gradsko and Rosoman.

  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 three (3) TS (in Veles, Kavadartsi, and Negotino).



- 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 3c was presented.
- Additionally, After the selection of the appropriate waste management system in Vardar 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 3c
- The Chapter concludes 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 (€)	3,360,746
Total Investment Cost of Infrastructures (€)	1,658,602

- **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 (€)	5,550,182
Total Investment Cost of Biological Treatment (€)	1,982,500
Total Investment Cost of windrow composting for green waste (€)	622,500

- 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 (€)	21,451,416
Total investment cost for collection bins (€)	1,013,301
Total investment cost for collection trucks/TSs (€)	2,109,356
Total operational cost for collection trucks/TSs (€/y)	808,918

- 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 R1 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 R1 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))	14,471
Total with project scenario net GHG emissions (t Co_2(eq))	-3,609
Total incremental GHG emissions (t Co_2(eq))	-18,079

- 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 Recyclables
  - Biological treatment;
  - 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.
- State Aid Issues. This paragraph defines the state aid and the regulations that apply. It describes the Altmark criteria and the provisions in tender documents that need to be fulfilled.
- 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.

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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 and 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 studies, 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 Vardar 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 Vardar 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.

<u>Brief description of the region</u>

The Vardar Region is located in the central and south part of the Republic of Macedonia and borders with Greece. Internally, it borders the Pelagonija, Skopje, Eastern, Southwestern and Southeastern regions. Vardar Region is divided into nine (9) municipalities: (1) Veles, (2) Gradsko, (3) Demir Kapija, (4) Kavadarci, (5) Lozovo, (6) Negotino, (7) Rosoman, (8) Chashka, (9) Sveti Nikole.

The current population of the Vardar Region is 154,535 citizens according to the last population census in 2002. The population density is 37.9 citizens/km^2. The Vardar region has an area of ~3,995 km^2 with an urban population of 106,711 and a rural population of 47,824. According to population estimates (on 30.06.2015) from the State Statistical Office, the overall population of Vardar Region has slightly decreased (153,094 inhabitants). Although Sveti Nikole Municipality administratively is part of the

Vardar region, it is included in the documentation for RWMP in East Region and was not included in the present study.

The Vardar region is a mountainous region and covers part of the central and south part of Republic of Macedonia. It spreads along the Vardar River and Ovchepole Basin. It covers 16.2% of the total area land of the Republic of Macedonia. The abundance of water resources - rivers and artificial lakes, the favorable Mediterranean climate that penetrates along the Vardar River valley and the geomorphological configuration of the terrain are the main preconditions for this region to be renowned for its production of fruit and geographically specific grape vines. As a result, this region has the largest number of wine cellars and grape processing facilities in Macedonia. Another important industry is the manufacture and processing of ferronickel.

In Vardar region there are one (1) Strict Nature Reserve, eleven (11) Natural Monuments and three (3) areas with important characteristics.

2.2 CURRENT WASTE MANAGEMENT SYSTEM

In the following paragraphs the existing situation regarding the waste management in Vardar 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 at municipal level. 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) in Vardar Region

#	Municipality	Public Utility Enterprises (PUE)	Duties	Coverage	Employees	Transportation equipment
1	Chashka	PUE Topolka Caska	Collection, transportation	52%	8	1 compaction vehicle, 1 open truck, 2 tractors
2	Demir Kapija	PUE Bosava	Collection, transportation	100%	8	1 compaction vehicle, 1 tractor
3	Gradsko	PUE Klepa	Collection, transportation	80%	6	1 compaction vehicle
4	Kavadartsi	PUE Kavadartsi	transportation	98%	95	6 compaction vehicles
5	Lozovo	PUE Lozovo		95%	10	-
6	Negotino	PUE Komunalec	Collection, transportation	94%	29	6 compaction vehicles

#	Municipality	Public Utility Enterprises (PUE)	Duties	Coverage	Employees	Transportation equipment
7	Rosoman	PUE Rosoman		67	7	-
8	Veles	PUE Derven	Collection, transportation	97%	7	6 compaction vehicles

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		Chashka	Demir Kapija	Gradsko	Kavadartsi	Lozovo	Negotino	Rosoman	Veles
5 m^3	metal				20				23
	plastic								
	others								
	frequency	2			2-3				2-7
1.1 m^3	metal	45	20		200	5	89		151
	plastic		10		20	20	2		
	others								
	frequency	2			2-7				2-7
240 lt	metal							204	
	plastic							226	
	others								
	frequency	2							
120 lt	metal				4,000			136	
	plastic	80	515	1,100		95		54	980
	others							30	
	frequency	2		1	2-3				2-7
Collection Company		PUE Lozovo						PUE Rosoman	PUE Derven

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

Current Collection Equipment for Recyclable Waste									
Household premises		Chashka	Demir Kapija	Gradsko	Kavadartsi	Lozovo	Negotino	Rosoman	Veles
1.1 m^3	Glass								
	Paper/Cardboard		8		10				
	Plastic		8	3	10		25		
	Metals								
	Combined								
240 lt	Glass								
	Paper/Cardboard								
	Plastic								
	Metals								
	Combined								

Current Collection Equipment for Recyclable Waste									
Household premises		Chashka	Demir Kapija	Gradsko	Kavadartsi	Lozovo	Negotino	Rosoman	Veles
120 lt	Glass								
	Paper/Cardboard								
	Plastic								
	Metals								
	Combined								200

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
Veles	Compaction vehicle	27	13	0
	Compaction vehicle	8	22	
	Compaction vehicle	8	22	
	Compaction vehicle	4	20	
	Compaction vehicle	4	20	
	Compaction vehicle	16	26	
Gradsko	Compaction vehicle	8	4	1
Demir Kapija	Compaction vehicle	8	4	1
Kavadartsi	Compaction vehicle	5	2	5
	Compaction vehicle	8	4	
	Compaction vehicle	5	3	
	Compaction vehicle	5	2	
	Compaction vehicle	12	5	
	Compaction vehicle	16	25	
Lozovo	Compaction vehicle	12	6 (on old tractor)	-
	Skip truck		13	
	Skip truck		35	
Negotino	Compaction vehicle	24	19	1
	Compaction vehicle	12	36	
	Compaction vehicle	5.5	44	
	Compaction vehicle	8	12	
	Compaction vehicle	8	4	
	Compaction vehicle	2	26	
Rosoman	Compaction vehicle	1	-	-
Chashka	Compaction vehicle	7	7	1
	Open truck	5	13	
Total vehicles in Vardar region: 26				
Total number of new vehicles in Vardar 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 was collected with desk top research using official sources of data. The aforementioned data were analytically presented at the 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 Vardar Region are nine (9), eight of them active, and one closed in the last 20 years. The identified dumpsites in the region are 28. Specifically for Vardar region, it should be noted that the new regional landfill of Vardar will be constructed in a site which is in the vicinity of a non compliant landfill (RALL003). The description of the location where the CWMFs will be constructed will be made in a following chapter.

Out of 37 landfills and dumpsites, 2 (5%) are evaluated as high risk and 35 (95%) as medium risk sites out of which 29 sites can be reclaimed with waste removal (cleaning), 6 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 the problems encountered in Solid Waste Management Service in Vardar Region are presented as they were identified through the relevant sections of the filled questionnaires.

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

Problems Encountered in solid Waste Management Service in Vardar Region	Municipalities answered %	No problem %	Not so serious %	Serious %	Very serious %
Inadequate service coverage	87,5	72	14	14	
Lack of service quality	87,5	57	29	14	
Lack of financial resources	87,5		14	57	29
Lack of trained personnel	87,5	29	14	57	
Lack of vehicles	87,5		43		57
Lack of collection equipment	87,5		57	14	29
Old vehicle equipment	75		83	17	
Difficulty to find spare parts	87,5	29	57	14	
Lack of capability to maintain/repair vehicle	87,5	57	14	14	14
No standardization of vehicle equipment	87,5	72	14	14	
No proper institutional set-up for solid waste	87,5	57	14	29	
Lack of legislation	75	50	33	17	
Lack of planning	87,5	43	43	14	

Rapid urbanization outstripping service capacity	87,5	57	29		14
Lack of separate collection of recyclables	87,5	14	14	43	29
Lack of separate collection of biowaste	87,5		29	29	42
Poor response to waste minimization	75		50	33	17
Lack of control of hazardous waste	75	17	66	17	
Others					

The key problems that the municipalities face are evident from the results, and they mainly regard the lack of transportation equipment, the lack of separate collection of waste streams and waste minimization in general and the lack of planning.

2.2.5 Overview of Existing/ Current waste streams and waste production

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 Veles Municipality and covers 38% of the overall waste production in Vardar Region and is closely followed by Kavadartsi Municipality (35%). The purely rural municipalities i.e. Gradsko, Lozovo, Rosoman and Chashka have generally lower waste production than the urban areas resulting in small participation in regional waste production. The average annual waste production per inhabitant of the Vardar Region is 280 kg/ca/yr.

An overview of the main calculations for annually produced quantities of municipal waste in Vardar Region with the contribution of municipal waste derived from seasonal population is given at the table below:

Table 2-6: Overview of generated waste data in the municipalities of Vardar Region

Municipalities *(Vardar 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)**
Veles	**54,729**	**263**	**14,415**		
Veles urban	*43,491*	*274*	*11,924*	**17**	**264**
Veles rural	*11,238*	*222*	*2,491*		
Gradsko	**3,559**	**275**	**978**		
Gradsko urban	*0*	*0*	*0*	**0**	**275**
Gradsko rural	*3,559*	*275*	*978*		
Demir Kapija	**4,084**	**197**	**803**		
Demir Kapija urban	*0*	*0*	*0*	**2**	**197**
Demir Kapija rural	*4,084*	*197*	*803*		
Kavadarci	**38,938**	**342**	**13,322**		
Kavadarci urban	*32,866*	*353*	*11,591*	**14**	**342**
Kavadarci rural	*6,072*	*285*	*1,731*		
Lozovo	**2,592**	**258**	**669**		
Lozovo urban	*0*	*0*	*0*	**0**	**258**
Lozovo rural	*2,592*	*258*	*669*		
Negotino	**19,361**	**268**	**5,187**		
Negotino urban	*13,413*	*285*	3,818	**11**	**268**
Negotino rural	*5,948*	*230*	1,369		
Rosoman	**4,057**	**186**	**755**		
Rosoman urban	*0*	*0*	*0*	**0**	**186**
Rosoman rural	*4,057*	*186*	*755*		
Chashka	**7,903**	**213**	**1,680**	**0**	**213**

Municipalities *(Vardar 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)
Chashka urban	*0*	*0*	*0*		
Chashka rural	*7,903*	*213*	*1,680*		
TOTAL	**135,224**	**280**	**37,809**	**44**	**280**

2.2.6 Current status on recycling

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 municipality of Negotino, in which bin equipment (bins) for recyclable waste was given.
There no private or PPP (Public-Private) administrative companies for waste management or treatment in the Vardar region.

2.2.7 Existing waste management system costs

Costs of waste management system are divided into:

- Collection costs - consisting 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 paragraph presents the cost for waste management system for municipalities of the region (data derived from questionnaires). 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.

Table 2-7: Costs (MKD) and Unit cost (MKD/t) for Collection

Municipality	Costs for collection, MKD		Collection unit cost (MKD/t)	
	2014	2015	2014	2015
Chashka	1,679,152	2,095,277	1,922	2,398
Demir Kapija	-	2,119,103	-	2,633
Gradsko	1,579,371	1,550,300	2,019	1,982
Kavadarci	13,873,852	13,653,436	1,060	1,043
Lozovo	2,390,050	1,958,311	3,758	3,080
Negotino	6,564,429	9,089,567	1,953	1,856
Rosoman	1,518,00	1,532,400	2,984	3,012
Veles	-	-	-	-

Table 2-8: Costs (MKD) and Unit cost (MKD/t) for Disposal

Municipality	Costs for Disposal, MKD		Disposal unit cost (MKD/t)	
	2014	2015	2014	2015
Chashka	409,905	509,,850	469	584
Demir Kapija	-	-	-	-
Gradsko	-	-	-	-
Kavadarci	23,561,078	28,363,799	1,801	2,168
Lozovo	4,468,495	4,485,132	7,027	7,053
Negotino	-	-	-	-
Rosoman	473,776	392,800	931	772
Veles	-	-	-	-

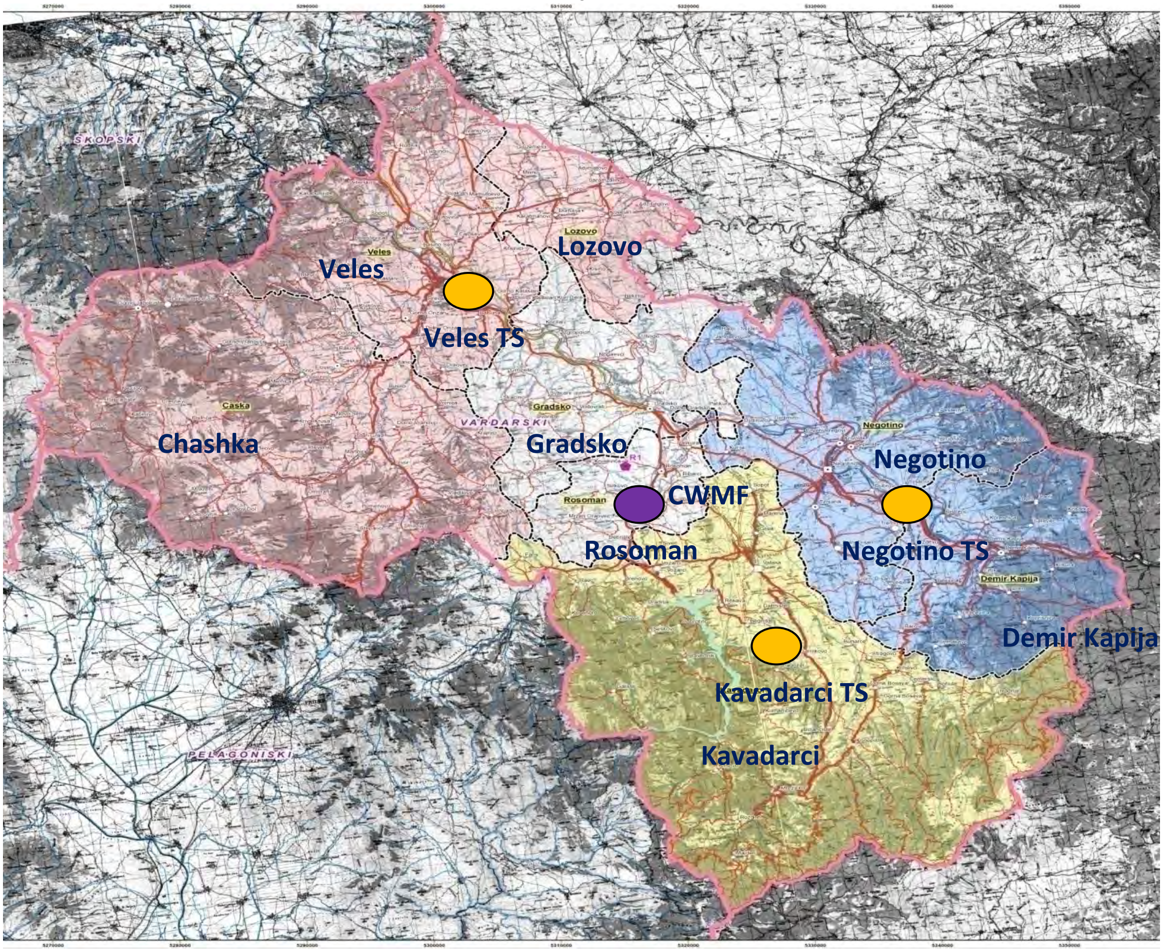
2.3 PROJECT DESCRIPTION

The Central Waste Management Facilities (CWMFs) in Vardar region are going to be located in site R1, which administratively belongs to the municipality of Rosoman. The selection methodology for the selection of the most appropriate location for placing the Central Waste Management Facilities in Vardar 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) Veles, (ii) Kavadartsi and (iii) Negotino, serving the municipalities of (i) Veles, Lozovo and Chashka, (ii) Kavadartsi and (iii) Negotino, Demir Kapija, respectively.
The municipalities of Gradsko and Rosoman will transfer their waste directly to 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



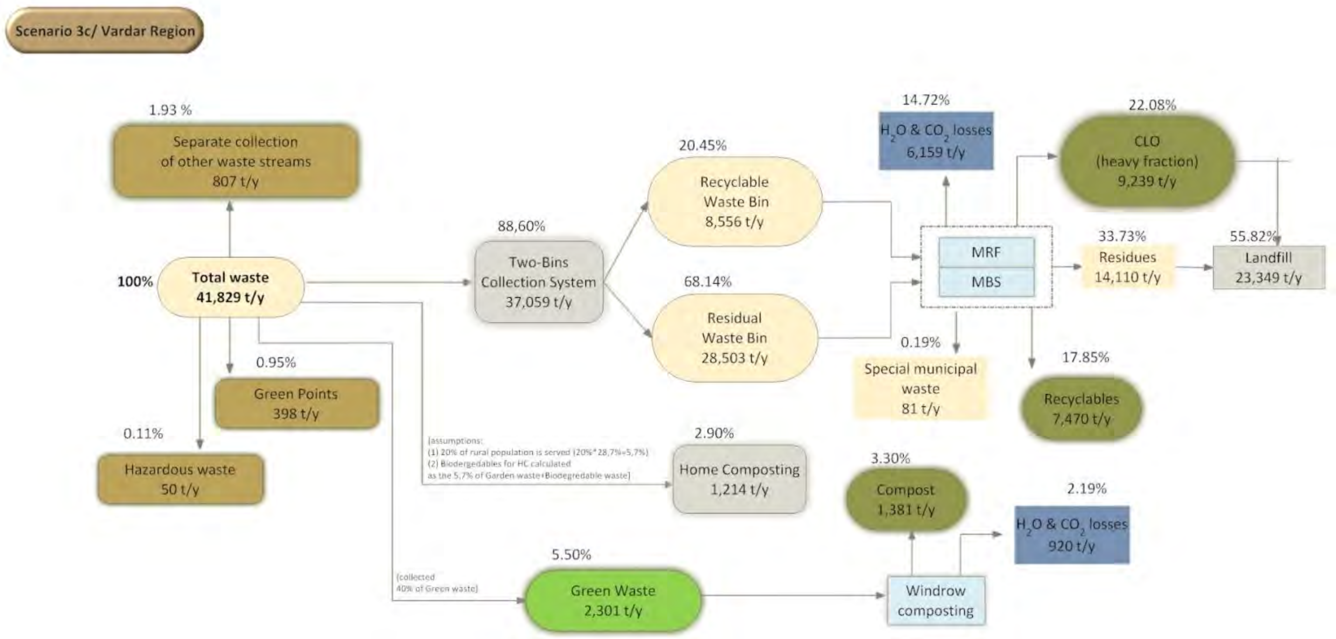
During the elaboration of the Regional Waste Management Plan for Vardar region, four waste management scenarios (including sub-scenarios) have been defined and examined. For all the aforementioned scenarios, flow diagrams have been created, the targets according to the Law on the management of packaging 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 Vardar region is Scenario 3c. 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 led to windrow composting process for the production of high quality compost.
- Recyclable waste bin which will be led to a Material Recovery Facility (MRF) for the recovery of recyclables (glass, paper, plastic, metals)
- Residual waste bin which will be led to a biological stabilization plant (MBS)
- Landfill which will accept residues from MRF/MBS and CLO

The next figure illustrates the total waste management system which proposed:

Figure 2-2: Selected Waste Management System in Vardar region

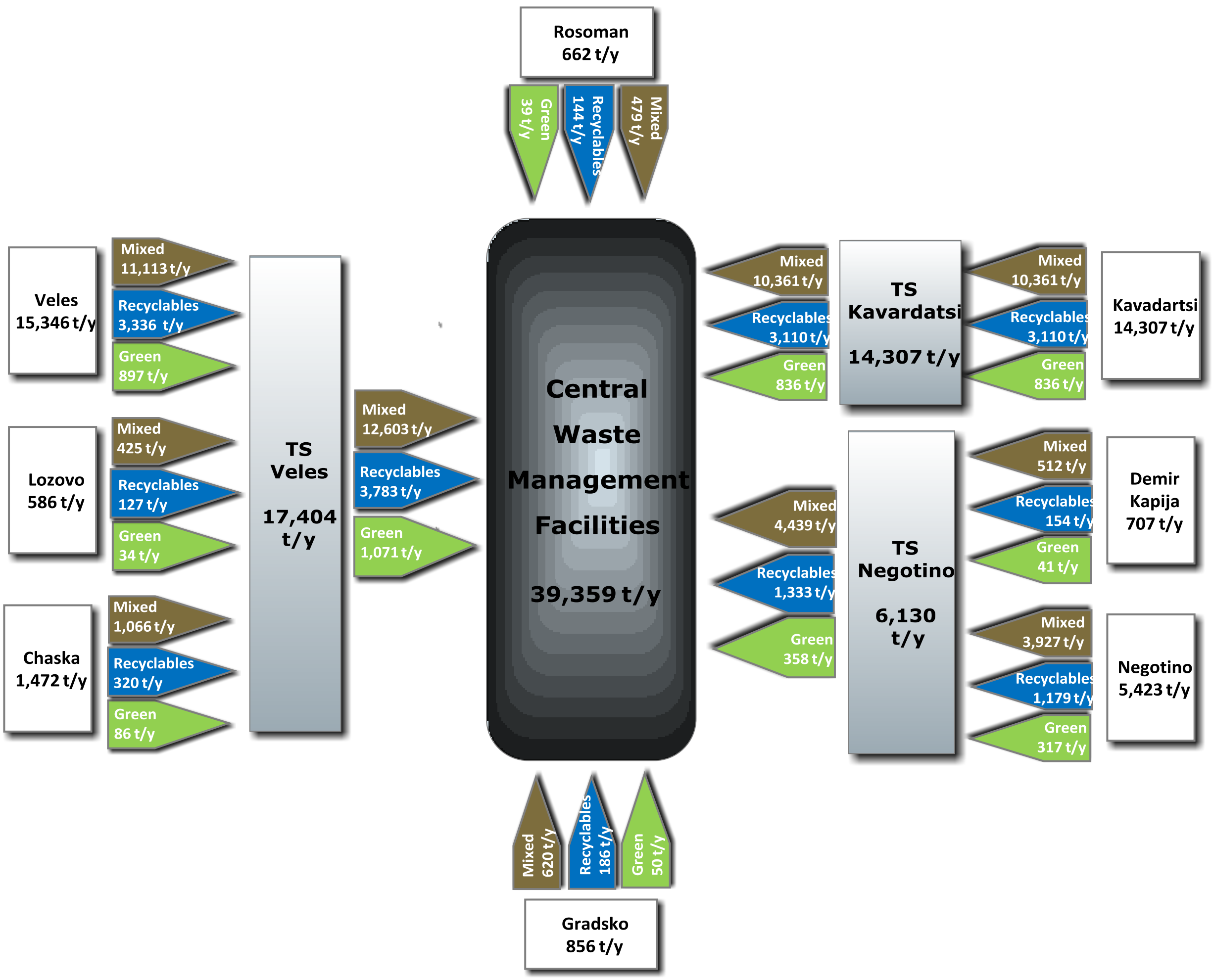


Scenario 3c	
Collection	Two Bins Collection System (Recyclable Waste Bin and Residual Waste Bin) Green Points Separate Collection of Green waste
Treatment of Recyclable Waste Bin	MRF
Treatment of Residual Waste Bin	MBS
Treatment of Green Waste	Aerobic composting
Treatment at the Source	Home Composting
Products	Compost Recyclables
Landfill	Residues from MRF Facility and Biostabilization Process

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 alternative scenarios were examined in relation to the minimum requirements. 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 3c, 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 Vardar 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 national possibilities for compost like output / compost

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 intention 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 2-9: 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 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

[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)

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 Vardar Region (data from Census of Agriculture 2007), where compost could be utilized.

Table 2-10: 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*	33,313.39
Utilized agricultural land, arable land and gardens and kitchen gardens, ha	18,163.53
Utilized agricultural land, meadows, ha	1,189.63
Utilized agricultural land, pastures, ha	2,429.05
Utilized agricultural land, orchards-total, ha	1,153.81
Utilized agricultural land, vineyards-total, ha	10,367.76
Utilized agricultural land, nurseries and osier for basket-weaving etc., ha	9,62
Other land, total, ha	201
Other land, of that unutilized agricultural land, ha	2,970
Other land, of that wooded area, ha	728

*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 2-11: 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 $\leq$ 10 mg O2 / g dry mater by 31 December 2019
  - AT4 $\leq$ 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)

2.4.2 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

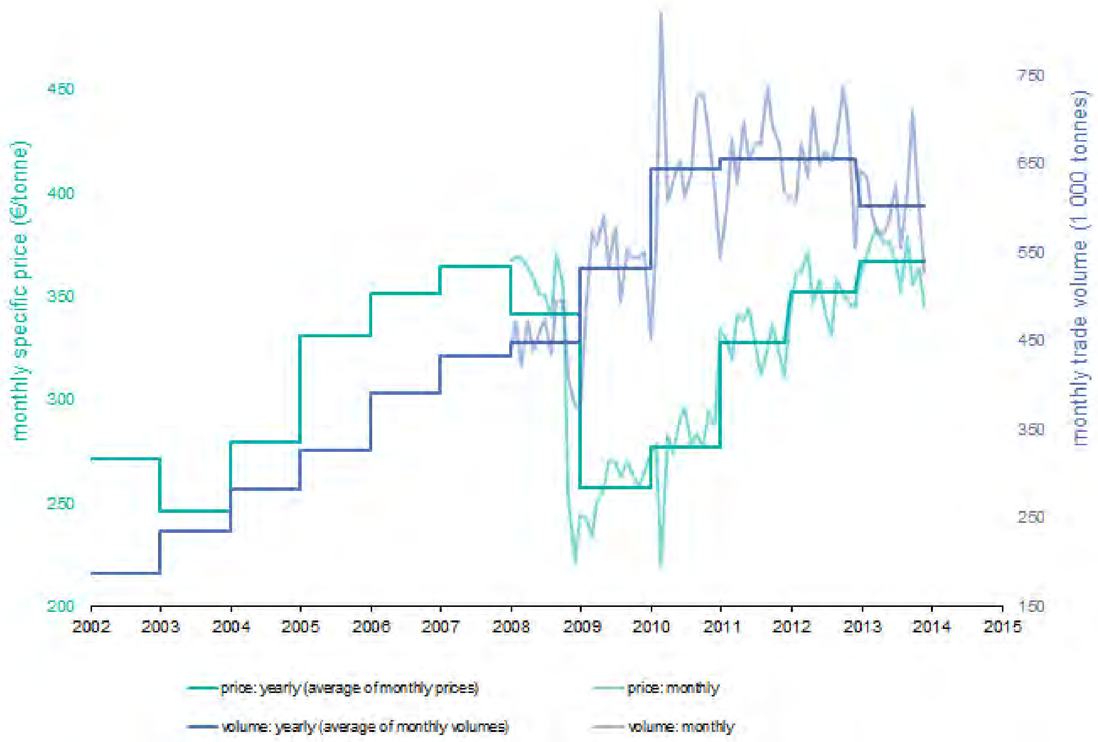
The conditions exist for an increased use of secondary raw materials in the manufacture of new packaging due to the good quality and sufficient quantities available.

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 (€/t)

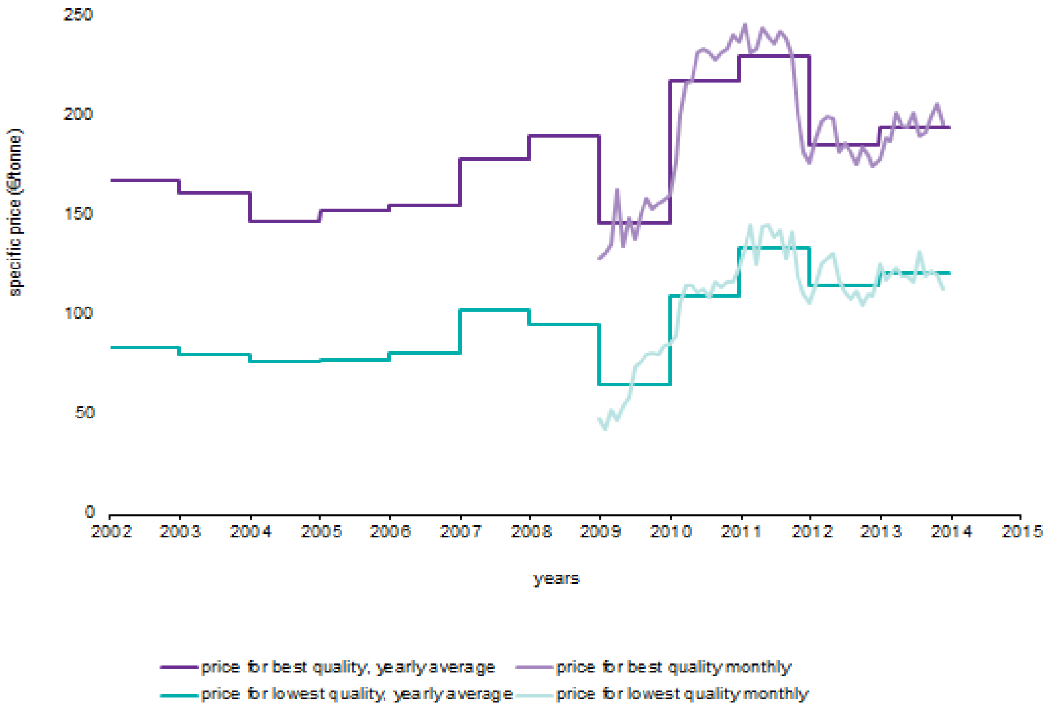


(Source:http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Price_indicator_and_trade_volume_for_plastic_waste_in_EU-28_till_December2013_update3.PNG)

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.

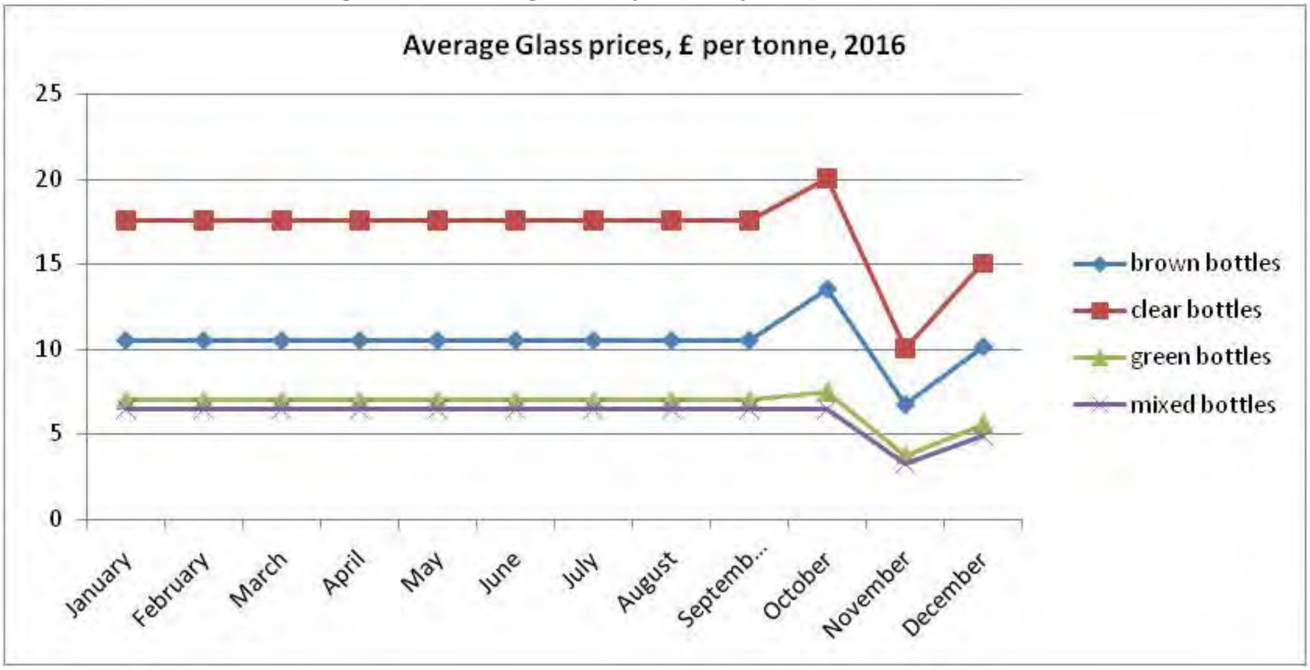
Local Authorities cannot guarantee this. Setting up public private partnerships, or making contracts with private companies can help local authorities achieve 100% waste collection. However municipalities may need assistance to ensure appropriate contracts are established and are supported by legislation.

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.

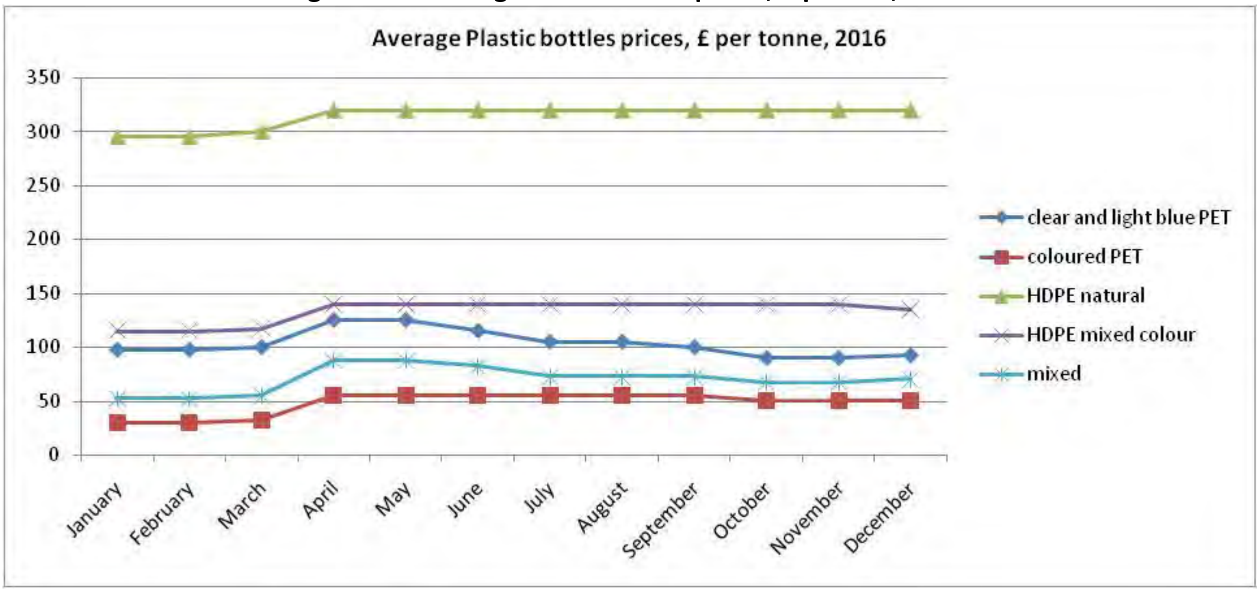
Table 2-12: Mixed and Clear Glass prices, £ per ton, 2016-2015

	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.

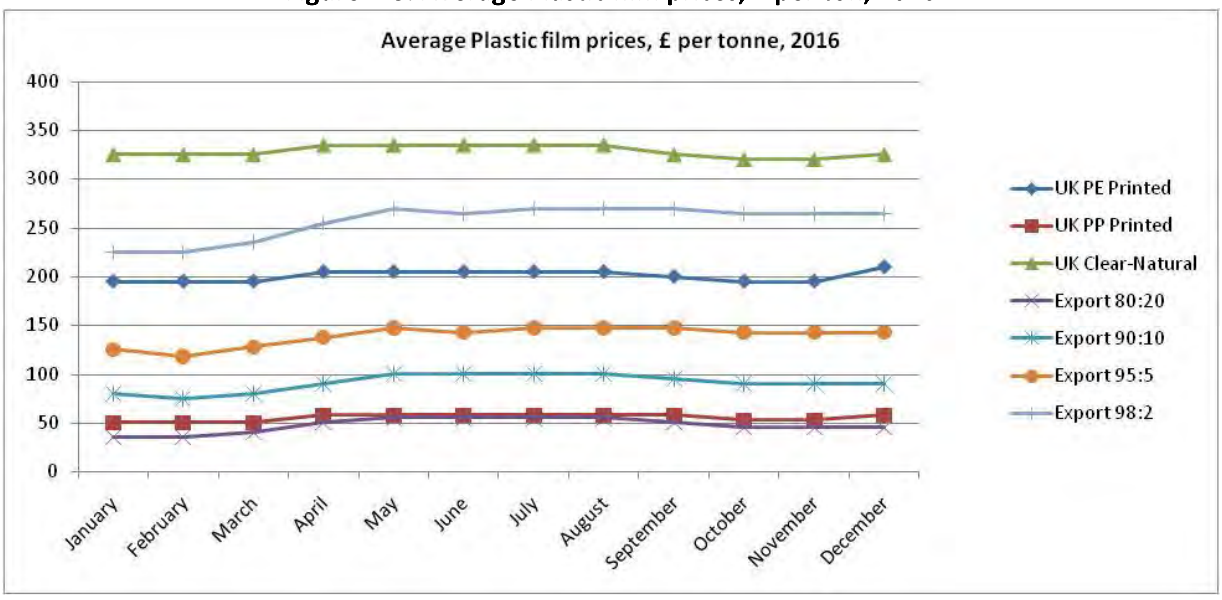
Figure 2-7: Average Plastic bottle prices, £ per ton, 2016



(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.

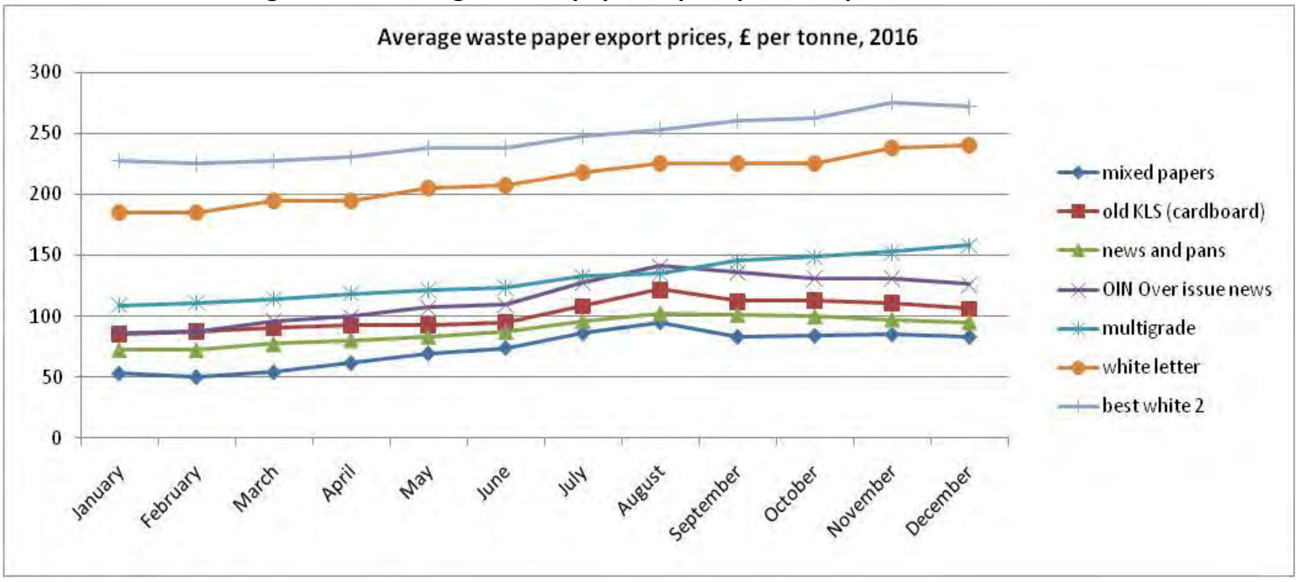
Table 2-13: Plastic bottles and PP-PE printed prices, £ per ton, 2016-2015

	2016						2015					
MONTH	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.

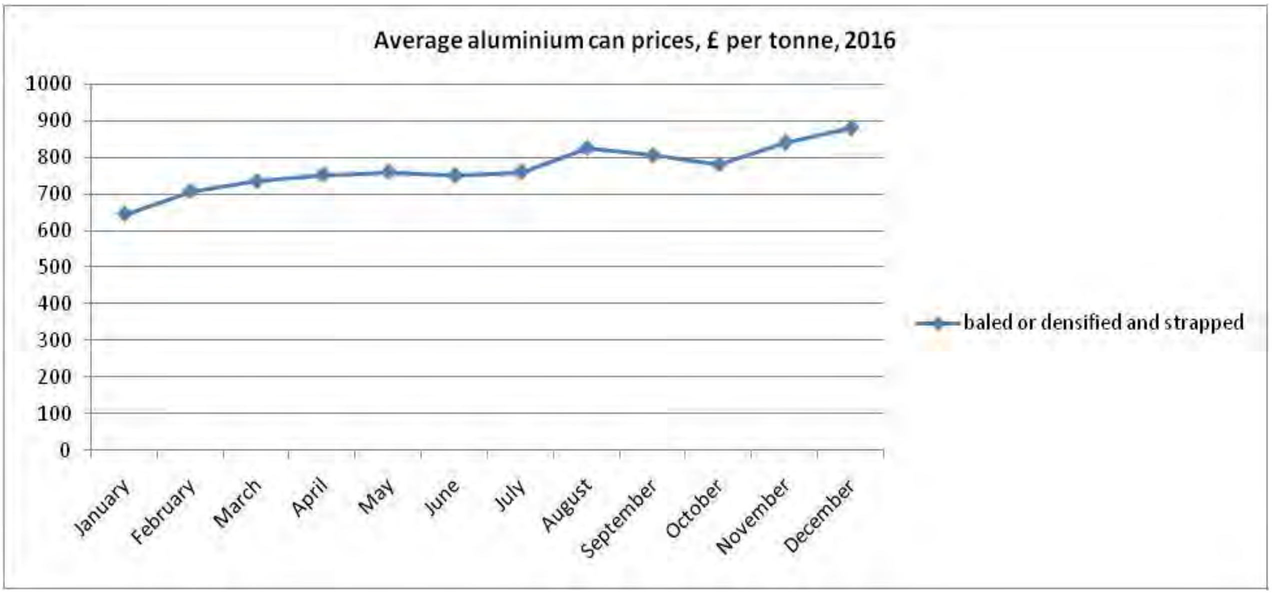
Table 2-14: Mixed paper and cardboard prices, £ per ton, 2016-2015

	2016				2015			
MONTH	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 ton, 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 2-15: Aluminium 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**

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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 Vardar region had 154,535 inhabitants. According to population estimates (on 30.06.2015) from the State Statistical Office, the overall population of Vardar Region has slightly decreased (153,094 inhabitants), while the overall population of the country has slightly increased. Data regarding population per municipality are given below, comparing years 2002 and 2015.

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

	Population 2002	Estimated population 2015
Veles	55,082	54,668
Gradsko	3,760	3,573
Demir Kapija	4,545	4,100
Kavadartsi	38,767	38,882
Lozovo	2,858	2,602
Negotino	19,212	19,352
Rosoman	4,141	4,072
Chashka	7,673	7,933
Total (without Sveti Nikole)	136,038	135,182

(*)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 %
Veles	79.4	20.6
Gradsko	-	100
Demir Kapija	-	100
Kavadartsi	84.3	15.7
Lozovo	-	100
Negotino	69.1	30.9
Rosoman	-	100
Chashka	-	100
Total	66.2	33.8

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%

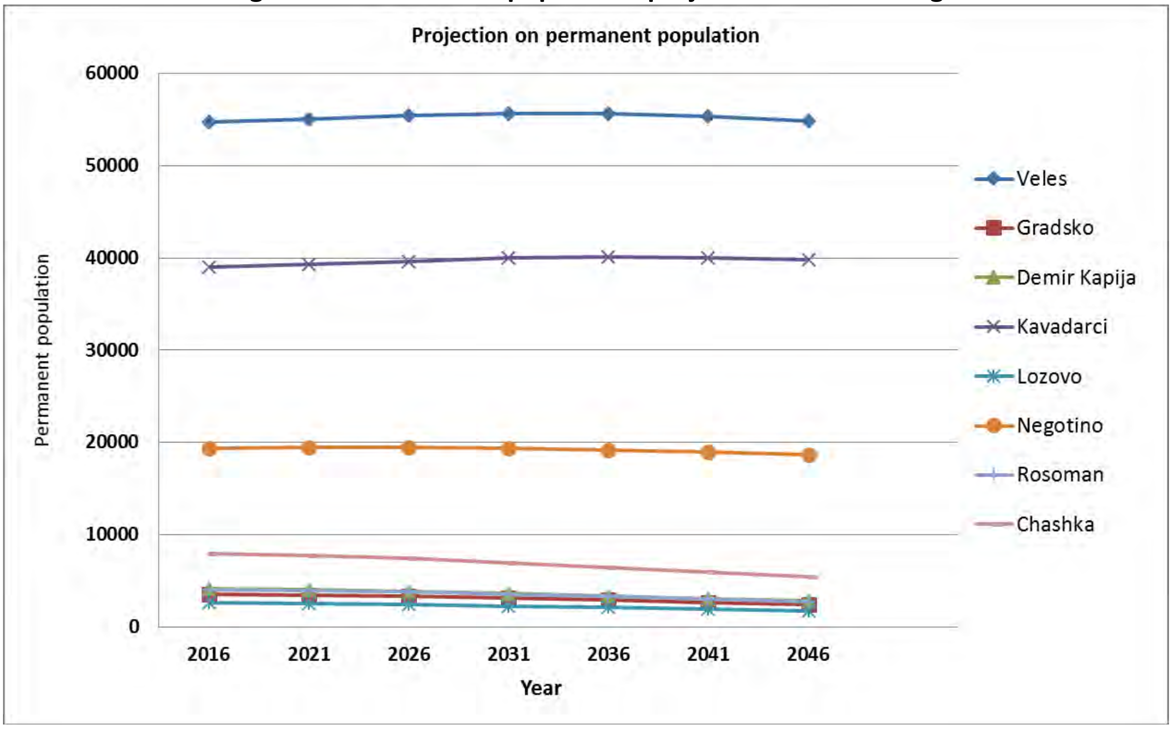
Source: United Nations, Department of Economic and Social Affairs, Population Division (http://esa.un.org/unpd/wup/DataQuery/)

The following figure presents the forecast for the permanent population in each Municipality.

Table 3-4:Permanent population projection in Vardar region (2016 -2046)

Municipality	2016	2021	2026	2031	2036	2041	2046
Veles	54,729	55,045	55,374	55,608	55,579	55,270	54,730
Gradsko	3,559	3,478	3,328	3,120	2,889	2,660	2,435
Demir Kapija	4,084	3,991	3,819	3,580	3,315	3,052	2,794
Kavadartsi	38,938	39,231	39,582	39,900	40,036	39,958	39,703
Lozovo	2,592	2,533	2,423	2,272	2,104	1,937	1,773
Negotino	19,361	19,402	19,399	19,326	19,156	18,900	18,577
Rosoman	4,057	3,964	3,793	3,555	3,293	3,031	2,775
Chashka	7,903	7,722	7,389	6,926	6,414	5,905	5,406
Total	**135,224**	**135,365**	**135,107**	**134,287**	**132,786**	**130,712**	**128,194**

Figure 3-1: Permanent population projection in Vardar 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 Vardar Region for the year 2015 is presented at the following table.

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

Municipality	Number of Nights spent 2015
Veles	13,928
Gradsko	0
Demir Kapija	1,612
Kavadartsi	10,963
Lozovo	0
Negotino	8,443
Rosoman	0
Chashka	0
Total	**34,946**

In order to calculate the forecasting of the seasonal population, the indicators from the 'National Tourism Strategy in Macedonia 2009-2013' study (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 Vardar Region

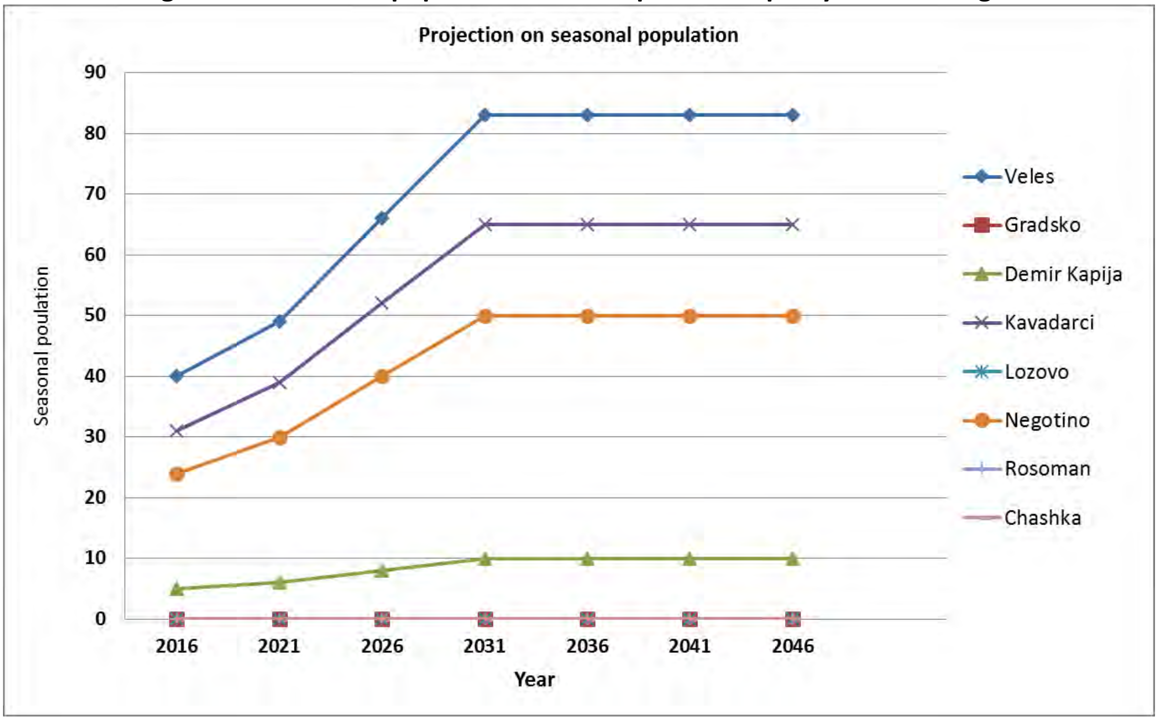
Municipality/tourists overnights	2016	2021	2026	2031	2036	2041	2046
Veles	14,541	18,035	24,040	30,253	30,253	30,253	30,253
Gradsko	0	0	0	0	0	0	0
Demir Kapija	1,683	2,087	2,782	3,501	3,501	3,501	3,501
Kavadartsi	11,446	14,196	18,922	23,813	23,813	23,813	23,813
Lozovo	0	0	0	0	0	0	0
Negotino	8,815	10,933	14,573	18,339	18,339	18,339	18,339
Rosoman	0	0	0	0	0	0	0
Chashka	0	0	0	0	0	0	0
Total	**36,484**	**45,252**	**60,316**	**75,906**	**75,906**	**75,906**	**75,906**

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

Table 3-7: Equivalent seasonal population projection in Vardar Region

Municipality	2016	2021	2026	2031	2036	2041	2046
Veles	40	49	66	83	83	83	83
Gradsko	0	0	0	0	0	0	0
Demir Kapija	5	6	8	10	10	10	10
Kavadartsi	31	39	52	65	65	65	65
Lozovo	0	0	0	0	0	0	0
Negotino	24	30	40	50	50	50	50
Rosoman	0	0	0	0	0	0	0
Chashka	0	0	0	0	0	0	0
Total	**100**	**124**	**165**	**208**	**208**	**208**	**208**

Figure 3-2: Seasonal population forecast per municipality - Vardar Region



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, Vardar region (Census 2002 & estimation 2016)

	Total number of individual households (census 2002)	Total number of members of households (census 2002)	Average size of household	Total number of individual households (estimation 2016)
Veles	16,959	55,108	3.2	17,103
Gradsko	1,137	3,760	3.3	1,079
Demir Kapija	1,387	4,197	3.0	1,361
Kavadartsi	12,026	38,741	3.2	12,168
Lozovo	899	2,858	3.2	810
Negotino	5,898	19,199	3.3	5,867
Rosoman	1,284	4,141	3.2	1,268
Chashka	2,185	7,673	3.5	2,258
Total	41,775	135,677	3.2	41,914
Source: State Statistical Office				

Table 3-9: Household revenues MKD/HH

Household revenues/ Covered Households	MKD/HH 2014	MKD/HH 2015
Chashka	1,401	2,294
Demir Kapija	1,030	1,419
Gradsko	1,207	1,669
Kavadartsi	1,404	1,319
Lozovo	1,271	1,180
Negotino	1,204	1,236
Rosoman	2,326	2,350
Veles	1,277	1,309

3.4 Gross Domestic Product (GDP)

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

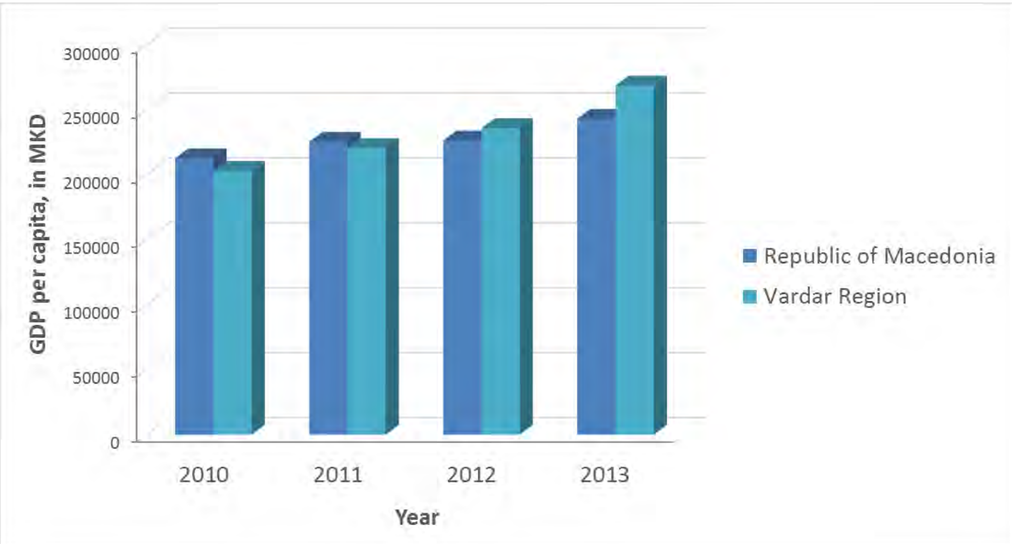
Table 3-10: GDP per Capita, 2010-2013

Year	Republic of Macedonia	Vardar Region	
2010	212,795	203,102	95.4%
2011	225,493	220,590	97.8%
2012	226,440	236,025	104.2%
2013	243,161	268,819	110.6%

Source: State statistical office of the Republic of Macedonia

According to the data in the above table GDP per capita in Vardar Region for years 2012 and 2013 is higher than the average GDP per capita in the Republic of Macedonia.

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



The GDP in million dinars for Republic of Macedonia and Vardar Region is presenting in the following table.

Table 3-11: Gross Domestic Product, in million denars

Year	Republic of Macedonia	Vardar Region	
2010	437,296	31,249	7.1%
2011	464,187	33,932	7.3%
2012	466,703	36,287	7.8%
2013	501,891	41,260	8.2%

Source: State statistical office of the Republic of Macedonia

Figure 3-4: Gross domestic product in million denarsfor the Republic of Macedonia and Vardar region

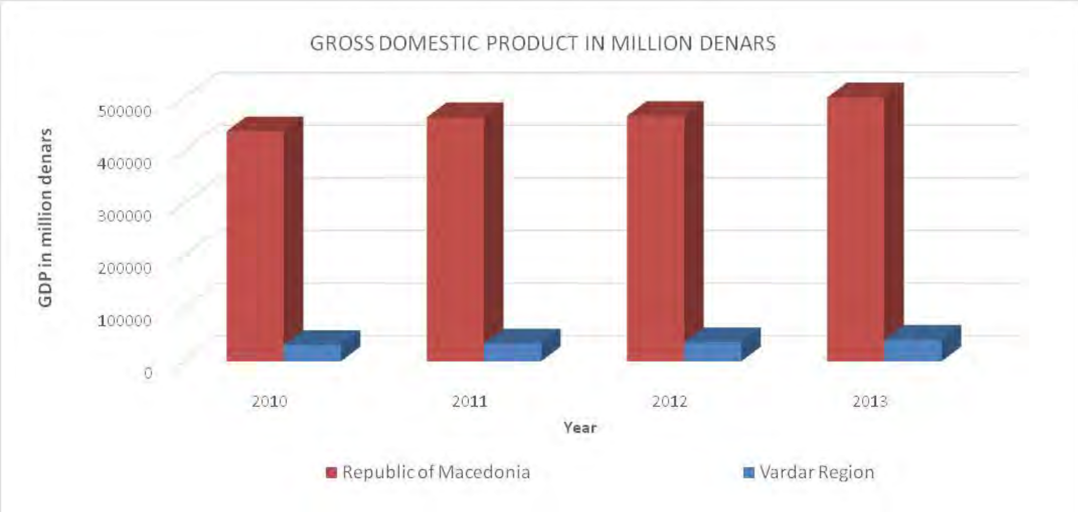


Table 3-12: Gross value added, by Sector of activity, by year, in million MKD, (% of total for the year)

	Republic of Macedonia			Vardar region		
	2011	2012	2013	2011	2012	2013
Total	399,376	403,684	436,706	29,194	31,370	35,901
Agriculture, forestry and fishing	43,405	42,493	50,327	4,379	5,234	7,132
Mining, manufacturing, electricity, gas and water supply, sewerage, waste management, remediation activities	76,013	71,689	75,397	7,328	7,173	8,556
Construction	24,215	26,695	35,725	1,730	2,015	2,364
Wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage; accommodation and food service activities	79,423	78,150	92,403	6,932	7,980	9,010
Information and communication	15,942	16,167	16,177	132	124	129
Financial and insurance activities	11,327	13,542	13,863	134	178	168
Real estate activities	56,665	59,862	60,259	3,380	3,611	3,538
Professional, scientific and technical activities; administrative and support a service activities	14,371	14,852	16,058	440	568	644
Public administration and defence; compulsory social security; education; human health and social work activities	66,496	69,317	64,277	4,216	3,946	3,924
RSTU Arts, entertainment and recreation, repair of household good and other services	11,518	10,917	12,221	522	451	436

Source: State statistical office of the Republic of Macedonia

Available income by income decile

According to data from the State Statistical Office, the average household size for Vardar region is 3.2 persons per household, lower than the country average 3.6 persons per household. The average household size varies from 3 in Demir Kapija to 3.5 persons per household in Chashka.

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
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	100.0	-	-	-	-	-	-

Source: State statistical office of the Republic of Macedonia

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

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

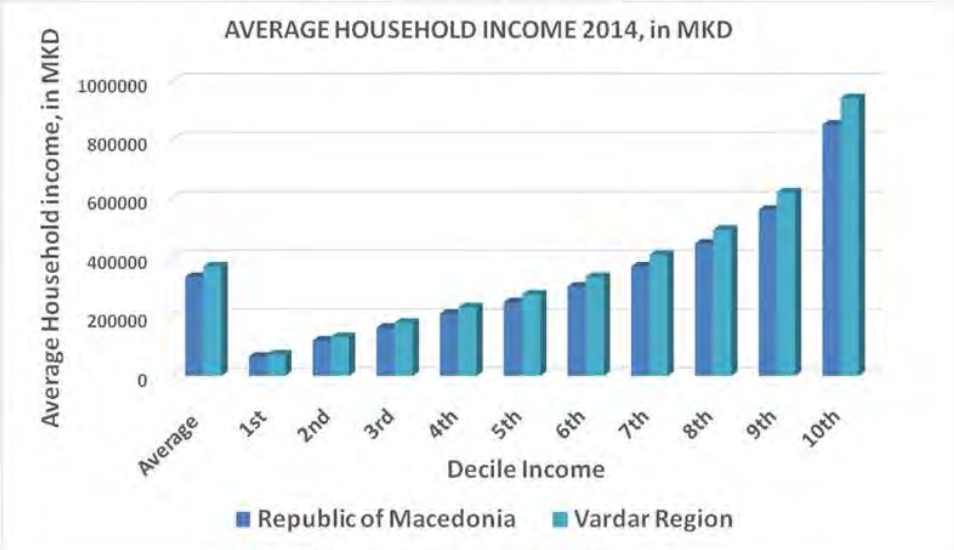
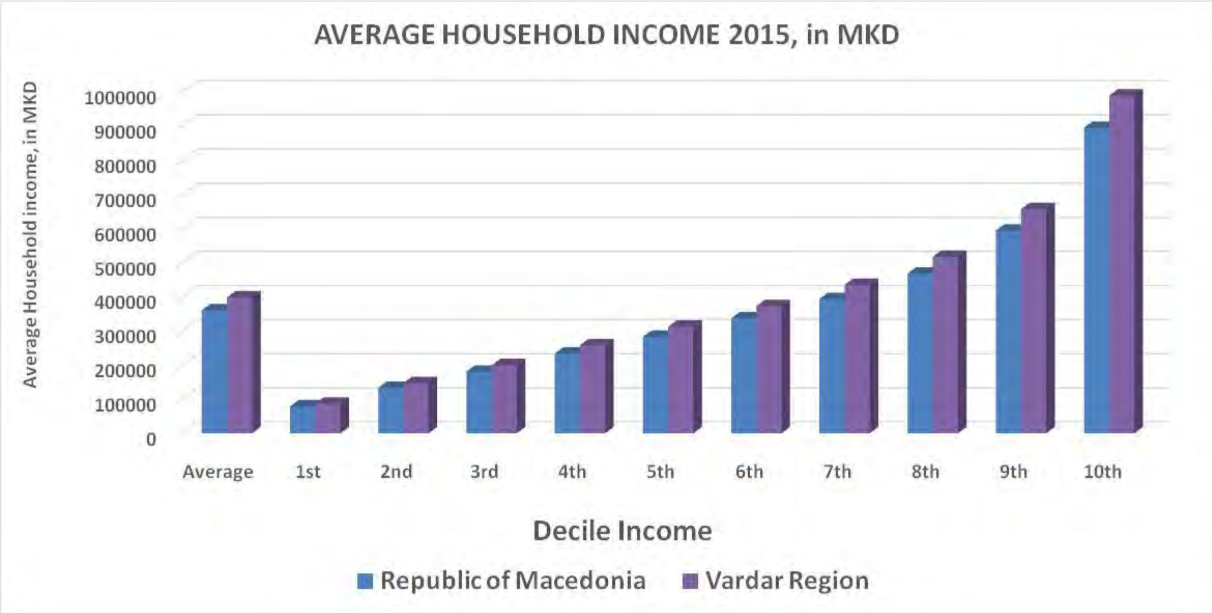


Table 3-14: Total available assets on average, per household for 2015, MKD

		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	467,888	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
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	-	-	-

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



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 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-

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

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 a % 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 Vardar region

Municipality	Household users, (MKD/t)		Commercial users, (MKD/t)	
	2014	2015	2014	2015
Chashka	2,092	3,426	1,637	1,425
Demir Kapija	1,937	2,667	20,167	29,390
Gradsko	1,480	2,047	4,757	8,221
Kavadarci	1,601	1,504	11,452	11,233
Lozovo	1,710	1,586	18,465	12,704
Negotino	1,510	1,551	9,057	9,304
Rosoman	4,339	4,383	21,331	25,017
Veles	2,226	2,282	4,949	4,944

The following table present 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
Chashka	1,401	2,294
Demir Kapija	1,030	1,419
Gradsko	1,207	1,669
Kavadarci	1,404	1,319
Lozovo	1,271	1,180
Negotino	1,204	1,236
Rosoman	2,326	2,350
Veles	1,277	1,309

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

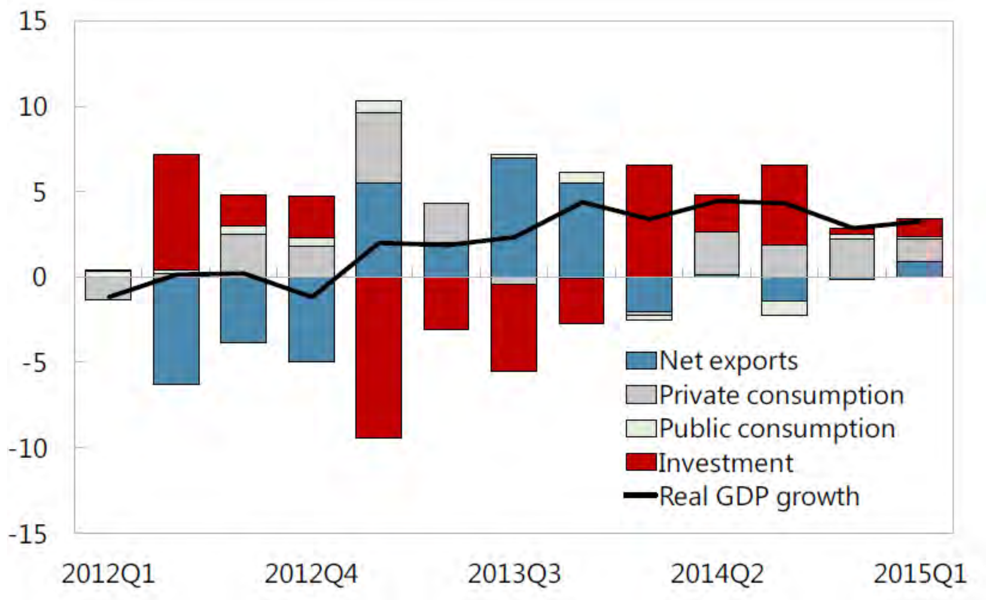
Table 3-20: Tariffs as a % of the average household income in Vardar region for the years 2014 and 2015

Municipality	Tariffs as a % of the average household income	
	2014	2015
Chashka	0.38%	0.58%
Demir Kapija	0.28%	0.36%
Gradsko	0.32%	0.42%
Kavadarci	0.38%	0.33%
Lozovo	0.34%	0.30%
Negotino	0.32%	0.31%
Rosoman	0.63%	0.59%
Veles	0.34%	0.33%

3.6. Future economic development

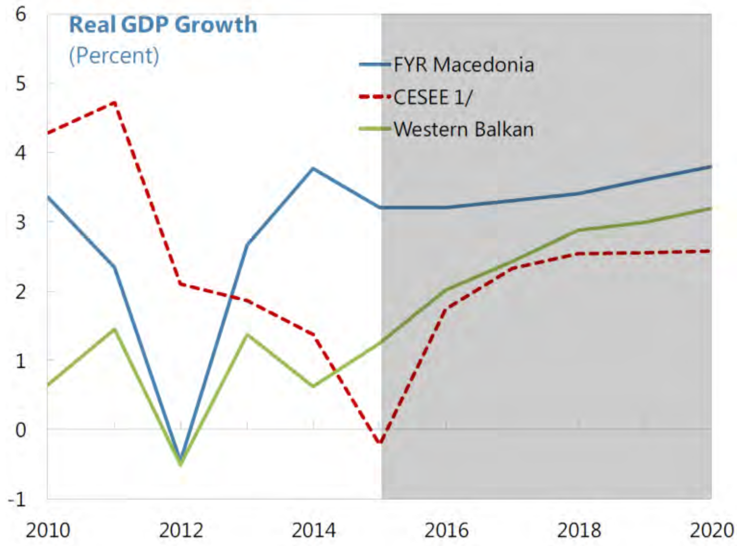
Real GDP growth accelerated in 2014 to 3.8% and strong growth continued in 2015Q1. Double-digit growth in investment, and strong private consumption supported by credit growth and improved labour market conditions, boosted output. Favourable developments in exports, domestic demand and credit continued 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.

Figure3-7: Republic of Macedonia: Contribution to Real GDP Growth (Percent)



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

Figure3-8: 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.

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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 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/analyzed 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: Vardar Region/Qualitative analysis

Sorting equipment

The equipment needed for the properly conduct of 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, 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.

Waste category	Examples
Other plastic/Hard plastic	"Plastic toys, rulers, pencils, toilet lids, toothbrushes, plastic boxes, cleaning supplies, Flower pots etc.
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 Vardar Region was performed in different sampling areas in the periods of June 2016 and October 2016 in the following municipalities: Veles, Chaska, Demir Kapija, Kavadartsi, Negotino.

For the municipalities that no measurements took place, assumptions concerning their composition analysis have been made, based on their geomorphological and population characteristics. No measurements took place in the Municipalities of Gradsko, Lozovo and Rosoman. All three aforementioned municipalities were considered to have similar geomorphological and population characteristics with the Municipality of Demir Kapija regarding the urban II and the rural zone. For that reason, data measurements of the waste morphological composition of Demir Kapija 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 Vardar region.

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

Waste category	Veles	Gradsko	Demir Kapija	Kavadarci	Lozovo	Negotino	Rosoman	Chashka
Garden Waste	11.38%	12.56%	12.48%	17.23%	12.81%	12.75%	12.37%	17.69%
Other Biodegradable waste	37.49%	29.55%	30.68%	37.44%	25.72%	40.55%	32.41%	32.16%
Paper	8.85%	9.74%	9.91%	8.41%	9.18%	11.51%	10.16%	11.18%
Cardboard	6.08%	6.98%	6.95%	3.13%	7.07%	3.30%	6.92%	7.62%
Glass	4.29%	5.63%	5.35%	2.14%	6.60%	2.72%	4.91%	2.92%
Ferrous metal packaging and other	0.87%	0.62%	0.62%	0.88%	0.63%	0.84%	0.62%	0.95%
Aluminum (non-ferrous) metal packaging and other	0.42%	1.03%	1.05%	0.30%	0.94%	0.44%	1.09%	0.42%
Composite Materials	2.41%	1.20%	1.26%	2.06%	1.03%	1.89%	1.33%	0.66%
Other Plastic packaging waste	1.77%	2.04%	2.24%	1.29%	1.36%	1.20%	2.55%	1.37%
Plastic bags	4.69%	5.76%	5.73%	8.19%	5.86%	6.82%	5.68%	4.11%
PET Bottles	1.74%	2.60%	2.60%	2.33%	2.61%	2.08%	2.60%	3.19%
Other plastic/Hard plastic	0.93%	1.45%	1.45%	0.50%	1.43%	0.60%	1.46%	0.66%
Textile	2.37%	4.32%	4.09%	2.57%	5.11%	2.02%	3.74%	5.63%
Leather	1.70%	1.53%	1.47%	0.54%	1.72%	1.77%	1.38%	0.77%
Diapers	5.98%	5.87%	6.16%	6.29%	4.91%	7.11%	6.59%	6.57%
Wood	1.40%	0.29%	0.25%	0.52%	0.41%	0.42%	0.20%	0.00%
Construction and demolition material	4.84%	3.35%	2.81%	2.88%	5.18%	0.68%	1.98%	0.00%
WEEE	0.20%	0.67%	0.60%	0.20%	0.93%	0.07%	0.48%	0.63%
Medical Waste	0.05%	0.02%	0.02%	0.27%	0.01%	0.12%	0.02%	0.12%
Other special waste streams (Elastic-tyres etc.)	0.30%	0.30%	0.35%	0.30%	0.11%	0.59%	0.44%	0.98%
Fine elements <10mm	2.25%	4.48%	3.92%	2.53%	6.40%	2.51%	3.05%	2.38%
TOTAL	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

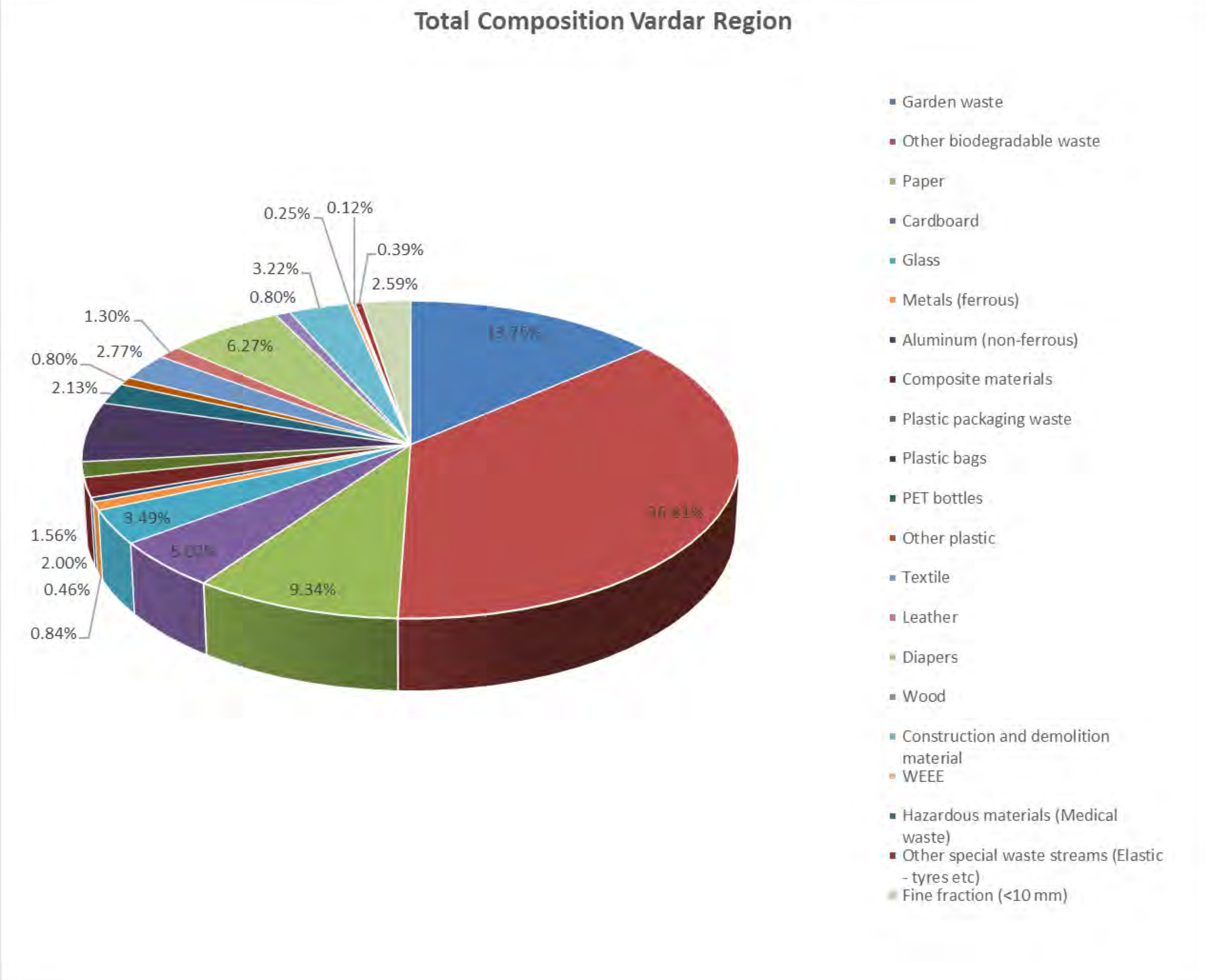
Overall data of waste composition at regional level

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 Vardar Region.

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

Waste category	Average Mass share
Garden Waste	**13.75%**
Other Biodegradable waste	**36.81%**
Paper	**9.34%**
Cardboard	**5.02%**
Glass	**3.49%**
Ferrous metal packaging and other	**0.84%**
Aluminum (non-ferrous) metal packaging and other	**0.46%**
Composite Materials	**2.00%**
Other Plastic packaging waste	**1.56%**
Plastic bags	**6.08%**
PET Bottles	**2.13%**
Other plastic/Hard plastic	**0.80%**
Textile	**2.77%**
Leather	**1.30%**
Diapers	**6.27%**
Wood	**0.80%**
Construction and demolition material	**3.22%**
WEEE	**0.25%**
Medical Waste	**0.12%**
Other special waste streams (Elastic-tyres, etc)	**0.39%**
Fine elements <10mm	**2.59%**
TOTAL	**100.00%**

Figure 4-2: Weighted average waste composition for Vardar 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

Methodology

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 mass of fully-laden trucks was weighed using a weighbridge of a utility company or other business entities in the territory of the local self-government unit where the procedure is performed.

The municipal waste quantities were weighed during a period of one week (from 9th till 15th of May 2016). 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 has been estimated taking into consideration the assumption that an average tourist in Europe generates approximately 1.2 kg of waste per bednight (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 waste (household and commercial) for each municipality has been estimated taking into consideration data deriving from Municipalities.

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

Veles Municipality

The actual quantity measurement took place in Veles Municipality from 9 – 15 May2016 – data is summarized in the following table.

Table 4-5:Waste weighting (in t) in Veles Municipality for the period 9 – 15 May 2016

	Date of measurements (Municipal waste, t)							
Vehicle type	**9/5/16**	**10/5/16**	**11/5/16**	**12/5/16**	**13/5/16**	**14/5/16**	**15/5/16**	**Total**
Press container	15.3	26.1	29.1	25.2	22.3	7.1	26.2	**151.3**
Skip loader track	21.7	23.3	6.7	13.5	8.6	6.2	0	**79.9**
Tractor	8.6	5.9	7.3	6.26	4.0	0	7.4	**39.3**
Total	**45.6**	**55.3**	**43.1**	**44.8**	**34.9**	**13.3**	**33.6**	**270.5**

During the period of measurements 270.5 t of waste were collected and the annual waste collected has been calculated to 14,065t, including the permanent and seasonal population. The following table presents the calculation of the waste generation rate (kg/ca/year).

Table 4-6: Waste Generation Rate (kg/ca/year) for Veles Municipality

Permanent population of Veles Municipality (2016)	**54,729**
Urban population	43,491
Rural population	11,238
Collection coverage for house premises %(Source questionnaires)	
Urban population	100%
Rural population	82%
Weighted collection coverage for house premises %	**96.3%**
Collection coverage for commercial premises % ***(Source questionnaires)***	**100%**
Generated Waste from Seasonal Population (t)	
Total annual generation from tourists, 2016(t/y)	**17**
Number of tourists overnight, 2016	14,541

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

Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**14,048**
Collected waste derived from house premises (t) 68% of the total collected waste *(source questionnaires)*	9,553
Collected waste derived from industrial premises (t) 32% of the total collected waste *(source questionnaires)*	4,495

Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**14,415**
Produced waste derived from house premises (t)	9,919
Produced waste derived from industrial premises (t)	4,495
Waste Generation Rate (kg/ca/year)	**263**

Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**14,415**
Generated municipal waste (t) (urban areas)	11,924
Generated municipal waste (t) (rural areas)	2,491
Waste Generation Rate (kg/ca/year) for urban areas	274
Waste Generation Rate (kg/ca/year) for rural areas	222
Waste Generation Rate (kg/ca/year)	**263**

Gradsko municipality

The actual quantity measurement took place in Gradsko Municipality from 9 – 14 May2016 – data is summarized in the following table.

Table 4-7: Waste weighting (in t) in Municipality of Gradsko for the period 9 – 14 May 2016

	Date of measurements (Municipal waste, t)						
Vehicle type	**9/5/16**	**10/5/16**	**11/5/16**	**12/5/16**	**13/5/16**	**14/5/16**	**Total**
Press container	4,0	2,3	2,0	2,8	2,4	1,5	**15,0**
Total	**4,0**	**2,3**	**2,0**	**2,8**	**2,4**	**1,5**	**15,0**

During the period of measurements 15.0 t of waste were collected and the annual waste collected has been calculated to 782 t. The following table presents the calculation of the waste generation rate (kg/ca/year).

Table 4-8: Waste Generation Rate (kg/ca/year) for Gradsko Municipality

Permanent population of Gradsko Municipality (2016)	**3,559**
Urban population	0
Rural population	3,559
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)***	**80%**

Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**782**
Collected waste derived from house premises (t) 90% of the total collected waste *(source questionnaires)*	704
Collected waste derived from industrial premises (t) 10% of the total collected waste *(source questionnaires)*	78

Generated municipal waste (t)	
Total Generated municipal waste (t)	**978**
Produced waste derived from house premises (t)	880
Produced waste derived from industrial premises (t)	98
Waste Generation Rate (kg/ca/year)	**275**

Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**978**
Generated municipal waste (t) (urban areas)	0
Generated municipal waste (t) (rural areas)	978
Waste Generation Rate (kg/ca/year) for urban areas	0
Waste Generation Rate (kg/ca/year) for rural areas	275
Waste Generation Rate (kg/ca/year)	**275**

Demir Kapija Municipality

The actual quantity measurement took place in Demir Kapija Municipality from 9-15 May2016 – data is summarized in the following table.

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

	Date of measurements (Municipal waste, t)							
Vehicle type	**9/5/16**	**10/5/16**	**11/5/16**	**12/5/16**	**13/5/16**	**14/5/16**	**15/5/16**	**Total**
Press container		3.7	3.4	2.7	3.5	0.9	0.7	**14.9**
Tractor	0.6	0	0	0	0	0	0	**0.6**
Total	**0.6**	**3.7**	**3.4**	**2.7**	**3.5**	**0.9**	**0.7**	**15.5**

During the period of measurements 15.5 t of waste were collected and the annual waste collected has been calculated to 805 t, including the permanent and seasonal population. The following table presents the calculation of the waste generation rate (kg/ca/year).

Table 4-10: Waste Generation Rate (kg/ca/year) for Demir Kapija Municipality

Permanent population of Demir Kapija Municipality (2016)	**4,084**
Urban population	0
Rural population	4,084
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%**

Generated Waste from Seasonal Population (t)	
Total annual generation for tourists, 2016(t/y)	**2**
Number of tourists overnight, 2016	1,683
"Waste Generation for tourists (kg/night)"	1.2

Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**803**
Collected waste derived from house premises (t) 90% of the total collected waste *(source questionnaires)*	723
Collected waste derived from industrial premises (t) 10% of the total collected waste *(source questionnaires)*	80

Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**803**
Produced waste derived from house premises (t)	723
Produced waste derived from industrial premises (t)	80
Waste Generation Rate (kg/ca/year)	**197**

Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**803**
Generated municipal waste (t) (urban areas)	0
Generated municipal waste (t) (rural areas)	803
Waste Generation Rate (kg/ca/year) for urban areas	0
Waste Generation Rate (kg/ca/year) for rural areas	197
Waste Generation Rate (kg/ca/year)	**197**

Kavadarci municipality

The actual quantity measurement took place in Kavadarci Municipality from 9 – 15 May 2016 – data is summarized in the following table.

Table 4-11: Waste weighting (in t) in Kavadarci Municipality for the period 9 – 15 May 2016

	Date of measurements (Municipal waste. kg)							
Vehicle type	**9/5/16**	**10/5/16**	**11/5/16**	**12/5/16**	**13/5/16**	**14/5/16**	**15/5/16**	**Total**
Press container	35.9	38.8	10.7	21.8	16.3	19.6	5.6	**148.8**
Skip loader track	1.2	0	0	0	0	0	0	**1.2**
Tractor	5.2	2.3	5.8	1.3	0.5	0	0	**15.2**

	Date of measurements (Municipal waste. kg)							
Open truck	8.8	14.4	6.1	12.4	10.6	6.4	0	**58.8**
Waste collection truck	0	8.3	5.2	5.8	8.3	0	0	**27.6**
Total	**51.1**	**63.9**	**27.9**	**41.4**	**35.7**	**26.0**	**5.6**	**251.6**

During the period of measurements 251.6 t of waste were collected and the annual waste collected has been calculated to 13,085 t, including the permanent and seasonal population. The following table presents the calculation of the waste generation rate (kg/ca/year).

Table 4-12: Waste Generation Rate (kg/ca/year) for Kavadarci Municipality

Permanent population of Kavadarci Municipality (2016)	**38,938**
Urban population	32,866
Rural population	6,072
Collection coverage for house premises %(Source questionnaires)	
Urban population	100%
Rural population	85%
Weighted collection coverage for house premises %	**97.7%**
Collection coverage for commercial premises % ***(Source questionnaires)***	**100%**
Generated Waste from Seasonal Population (t)	
Total annual generation for tourists, 2016(t/y)	**14**
Number of tourists overnight, 2016	11,446
"Waste Generation for tourists (kg/night)"	1.2
Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**13,072**
Collected waste derived from house premises (t) 80% of the total collected waste *(source questionnaires)*	10,457
Collected waste derived from industrial premises (t) 20% of the total collected waste *(source questionnaires)*	2,614
Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**13,322**
Produced waste derived from house premises (t)	10,708
Produced waste derived from industrial premises (t)	2,614
Waste Generation Rate (kg/ca/year)	**342**
Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**13,322**
Generated municipal waste (t) (urban areas)	11,591
Generated municipal waste (t) (rural areas)	1,731
Waste Generation Rate (kg/ca/year) for urban areas	353
Waste Generation Rate (kg/ca/year) for rural areas	285
Waste Generation Rate (kg/ca/year)	**342**

Lozovo municipality

The actual quantity measurement took place in Makedonska Kamenica Municipality from 10 – 12 May2016 – data is summarized in the following table.

Table 4-13: Waste weighting (in t) in Lozovo Municipality for the period 10 – 12 May 2016

	Date of measurements (Municipal waste. t)			
Vehicle type	**10/5/16**	**11/5/16**	**12/5/16**	**Total**
Tractor	4.1	4.0	4.1	**12.2**
Total	**4.4**	**4.0**	**4.1**	**12.2**

During the period of measurements 12.2 t of waste were collected and the annual waste collected has been calculated to 636 t. The following table presents the calculation of the waste generation rate (kg/ca/year).

Table 4-14: Waste Generation Rate (kg/ca/year) for Lozovo Municipality

Permanent population of Lozovo Municipality (2016)	**2,592**
Urban population	0
Rural population	2,592
Collection coverage for house premises %(Source questionnaires)	
Urban population	-
Rural population	95%
Weighted collection coverage for house premises %	**95%**
Collection coverage for commercial premises % *(Source questionnaires)*	**95%**
Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**636**
Collected waste derived from house premises (t) 90% of the total collected waste *(source questionnaires)*	572
Collected waste derived from industrial premises (t) 10% of the total collected waste *(source questionnaires)*	64
Generated municipal waste (t)	
Total Generated municipal waste (t)	**669**
Produced waste derived from house premises (t)	602
Produced waste derived from industrial premises (t)	67
Waste Generation Rate (kg/ca/year)	**258**
Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**669**
Generated municipal waste (t) (urban areas)	0
Generated municipal waste (t) (rural areas)	669
Waste Generation Rate (kg/ca/year) for urban areas	0
Waste Generation Rate (kg/ca/year) for rural areas	258
Waste Generation Rate (kg/ca/year)	**258**

Negotino Municipality

The actual quantity measurement took place in Negotino Municipality from 9 – 13and 16 May 2016 – data is summarized in the following table.

Table 4-15: Waste weighting (in t) in Negotino Municipality for the period 9 – 13 May 2016

	Date of measurements (Municipal waste, t)					
Vehicle type	**9/5/2016**	**10/5/16**	**11/5/16**	**12/5/16**	**13/5/16**	**Total**
Press container	11,8	6,7	6,6	7,8	8,5	**41,5**
Open truck	2,1	1,0	1,2	1,1	1,4	**6,8**
Truck without press	6,2	5,3	14,1	6,7	4,2	**36,5**
Tractor	1,7	2,2	2,0	1,6	1,8	**9,3**
Total	**21,8**	**15,3**	**23,9**	**17,2**	**15,9**	**94,2**

During the period of measurements 94.2 t of waste were collected and the annual waste collected has been calculated to 4,898 t, including the permanent and seasonal population. The following table presents the calculation of the waste generation rate (kg/ca/year).

Table 4-16: Waste Generation Rate (kg/ca/year) for Negotino Municipality

Permanent population of Negotino Municipality (2016)	**19,361**
Urban population	13,413
Rural population	5,948
Collection coverage for house premises %(Source questionnaires)	
Urban population	100%
Rural population	85%
Weighted collection coverage for house premises %	**95.4%**
Collection coverage for commercial premises % *(Source questionnaires)*	**85%**
Generated Waste from Seasonal Population (t)	
Total annual generation for tourists, 2016(t/y)	**11**
Number of tourists overnight, 2016	8,815
"Waste Generation for tourists (kg/night)"	1.2
Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**4,888**
Collected waste derived from house premises (t) 90% of the total collected waste *(source questionnaires)*	4,399
Collected waste derived from industrial premises (t) 10% of the total collected waste *(source questionnaires)*	489
Generated municipal waste from permanent population (t)	
Total Generated municipal waste (t)	**5,187**
Produced waste derived from house premises (t)	4,612
Produced waste derived from industrial premises (t)	575
Waste Generation Rate (kg/ca/year)	**268**

Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**5,187**
Generated municipal waste (t) (urban areas)	3,818
Generated municipal waste (t) (rural areas)	1,369
Waste Generation Rate (kg/ca/year) for urban areas	285
Waste Generation Rate (kg/ca/year) for rural areas	230
Waste Generation Rate (kg/ca/year)	**268**

Rosoman Municipality

The actual quantity measurement took place in the period from 9-14of May 2016 – data is summarized in the following table.

Table 4-17: Waste weighting (in t) in Rosoman Municipality for the period 9 – 14May 2016

	Date of measurements (Municipal waste. t)					
Vehicle type	**9/5/16**	**10/5/16**	**11/5/16**	**13/5/16**	**14/5/16**	**Total**
Tractor	2.2	2.1	2.1	1.2	2.2	**9.8**
Total	**2.2**	**2.1**	**2.1**	**1.2**	**2.2**	**9.8**

During the period of measurements 9.8 t of waste were collected and the annual waste collected has been calculated to 509 t. The following table presents the calculation of the waste generation rate (kg/ca/year).

Table 4-18: Waste Generation Rate (kg/ca/year) for Rosoman Municipality

Permanent population of Rosoman Municipality (2016)	**4,057**
Urban population	0
Rural population	4,057
Collection coverage for house premises %(Source questionnaires)	
Urban population	-
Rural population	65%
Weighted collection coverage for house premises %	**65%**
Collection coverage for commercial premises % ***(Source questionnaires)***	**100%**

Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**509**
Collected waste derived from house premises (t) 90% of the total collected waste *(source questionnaires)*	458
Collected waste derived from industrial premises (t) 10% of the total collected waste *(source questionnaires)*	51

Generated municipal waste (t)	
Total Generated municipal waste (t)	**755**
Produced waste derived from house premises (t)	704
Produced waste derived from industrial premises (t)	51

Waste Generation Rate (kg/ca/year)	**186**

Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**755**
Generated municipal waste (t) (urban areas)	0
Generated municipal waste (t) (rural areas)	755
Waste Generation Rate (kg/ca/year) for urban areas	0
Waste Generation Rate (kg/ca/year) for rural areas	186
Waste Generation Rate (kg/ca/year)	**186**

Chashka Municipality

The actual quantity measurement took place in Chashka Municipality from 9 – 13 May 2016 – data is summarized in the following table.

Table 4-19: Waste weighting (in t) in Chashka Municipality for the period 9-13 May 2016

	Date of measurements (Municipal waste, t)					
Vehicle type	**9/5/16**	**10/5/16**	**11/5/16**	**12/5/16**	**13/5/16**	**Total**
Truck with press	3.2	4.0	3.3	3.1	3.2	**16.8**
Total	**3.2**	**4.0**	**3.3**	**3.1**	**3.2**	**16.8**

During the period of measurements 16.8 t of waste were collected and the annual waste collected has been calculated to 874 t. The following table presents the calculation of the waste generation rate (kg/ca/year).

Table 4-20: Waste Generation Rate (kg/ca/year) for Chaska Municipality

Permanent population of Chashka Municipality (2016)	**7,903**
Urban population	0
Rural population	7,903
Collection coverage for house premises %(Source questionnaires)	
Urban population	-
Rural population	52%
Weighted collection coverage for house premises %	**52%**
Collection coverage for commercial premises % ***(Source questionnaires)***	**52%**

Collected municipal waste (t)	
Total collected municipal waste (permanent population) (t)	**874**
Collected waste derived from house premises (t) 90% of the total collected waste *(source questionnaires)*	786
Collected waste derived from industrial premises (t) 10% of the total collected waste *(source questionnaires)*	87

Generated municipal waste (t)	
Total Generated municipal waste (t)	**1,680**
Produced waste derived from house premises (t)	1,512
Produced waste derived from industrial premises (t)	168

Waste Generation Rate (kg/ca/year)	**213**

Division of waste generation rate for urban and rural population	
Total Generated municipal waste (t)	**1,680**
Generated municipal waste (t) (urban areas)	0
Generated municipal waste (t) (rural areas)	1,680
Waste Generation Rate (kg/ca/year) for urban areas	0
Waste Generation Rate (kg/ca/year) for rural areas	213
Waste Generation Rate (kg/ca/year)	**213**

Overall data at regional level

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

Table 4-21: Measured waste quantities (in t) in the municipalities of Vardar Region, 9 – 15 May 2016

	MON	TUE	WED	THR	FRI	SAT	SUN	TOTAL
Veles	45,6	55,3	43,1	44,8	34,9	13,3	33,6	**270,5**
Gradsko	4,0	2,3	2,0	2,8	2,4	1,6	0,0	**15,0**
Demir Kapija	0,6	3,7	3,4	2,7	3,5	0,9	0,7	**15,5**
Kavadarci	51,1	63,9	27,9	41,3	35,8	26,0	5,6	**251,6**
Lozovo	0,0	4,1	4,0	4,1	0,0	0,0	0,0	**12,2**
Negotino	21,8	15,3	23,9	17,3	15,9	0,0	0,0	**94,2**
Rosoman	2,2	2,1	2,2	0,0	1,2	2,2	0,00	**9,8**
Cashka	3,2	4,0	3,3	3,1	3,2	0,0	0,0	**16,8**
TOTAL	**128,6**	**150,6**	**109,6**	**116,1**	**96,9**	**43,9**	**39,9**	**685,7**

During the period of measurements 686 t of waste were collected and the annual waste collected has been calculated to 35,652 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 Vardar Region without the contribution of municipal waste derived from seasonal population.

Table 4-22: Overview of produced and waste data for permanent population in the municipalities of Vardar Region

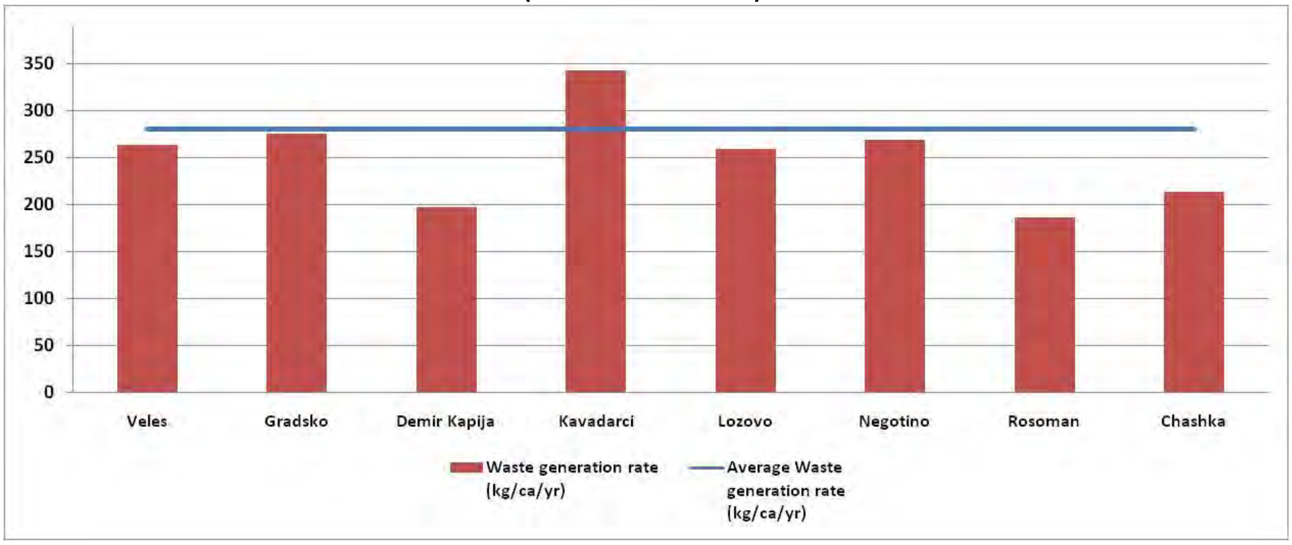
Vardar Region *(without Sveti Nicole Municipality)*	Weekly measurements for permanent population (t) (1)	Permanent Population 2016 (2)	Annual waste collection (t) (3)=(1)*52	Annual waste production (t) (4)	Annual waste production (kg) (5)	Collection coverage % (6)=(3)/(4)	Waste generation rate (kg/ca/yr) (7)=(5)/(2)	Participation in regional waste production (%) (8)
Veles	270.15	54,729	14,048	14,415	14,414,512	97%	263	38%
Gradsko	15.04	3,559	782	978	977,600	80%	275	3%
Demir Kapija	15.44	4,084	803	803	802,984	100%	197	2%
Kavadarci	251.38	38,938	13,072	13,322	13,322,307	98%	342	35%
Lozovo	12.23	2,592	636	669	669,377	95%	258	2%
Negotino	94.00	19,361	4,888	5,187	5,186,837	94%	268	14%
Rosoman	9.78	4,057	509	755	755,273	67%	186	2%
Chashka	16.80	7,903	874	1,680	1,680,000	52%	213	4%
TOTAL	**684.82**	**135,224**	**35,611**	**37,809**	**37,808,890**	**94%**	**280**	**100%**

The following table presents an overview of main calculations for annual produced quantities of municipal waste in Vardar Region with the contribution of municipal waste derived from seasonal population.

Table 4-23: Overview of waste data for permanent and seasonal population in the municipalities of Vardar Region

Municipalities (Vardar Region)	Permanent Population 2016	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)	Collection coverage %	Weighted Waste generation (kg/ca/y)
Veles	54,729	14,541	40	1.2	263	14,415	17	14,432	97%	264
Gradsko	3,559	0	0	1.2	275	978	0	978	80%	275
Demir Kapija	4,084	1,683	5	1.2	197	803	2	805	100%	197
Kavadarci	38,938	11,446	31	1.2	342	13,322	14	13,336	98%	342
Lozovo	2,592	0	0	1.2	258	669	0	669	95%	258
Negotino	19,361	8,815	24	1.2	268	5,187	11	5,197	94%	268
Rosoman	4,057	0	0	1.2	186	755	0	755	67%	186
Chashka	7,903	0	0	1.2	213	1,680	0	1,680	52%	213
TOTAL	**135,223**	**36,485**	**100**		**280**	**37,809**	**44**	**37,853**		**280**

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

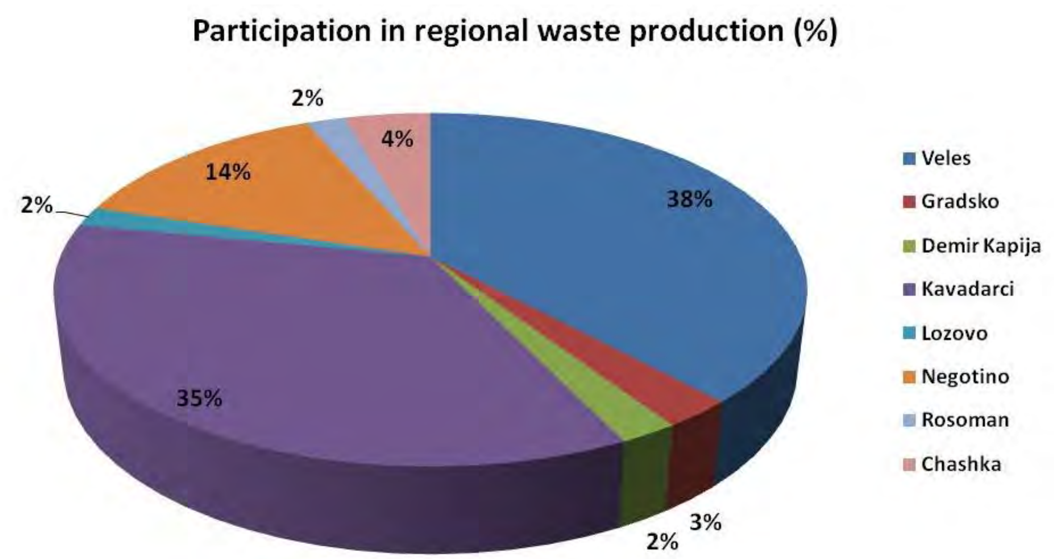


The average daily waste production per capita of the Vardar Region is 280kg/capita/yr.

As shown in the diagram above, waste generation rate in the Kavadarci municipality is substantially different from the rest of the region, which has a rate of less than 280(kg/ca/y).

The data which presented in the FS concerning Kavadarci Municipality have been derived from the specific survey and have been checked also with the data which presented on Waste Management Plan of Kavadarci Municipality (2015-2020). The figures concerning the produced waste are similar so the waste generation rate for this specific municipality can be considered representative taking into consideration also that in this Municipality a Factory for electronic equipment is operating which employees approx. 5000 workers.

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



As shown in the figure 4-4, the most populated Municipality of the region is Veles Municipality and covers the 38% of the overall waste production in Vardar Region and is followed by Kavadarci

Municipality (35%). The pure rural municipalities i.e. Gradsko, Demir Kapija, Lozovo, Rosoman and Chashka have generally lower waste production than the urban areas resulting in small participation in regional waste production.

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 Vardar 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 Vardar 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 4-24: 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 and the results are presented in the following table and diagram. More specifically, Waste Generation rate for each municipality of Vardar Region was estimated for 30 years (2016-2046) and is presented per 5 years, for both urban and rural population.

Table 4-25: Waste Generation rate for permanent population, Scenario 2

WGR for Permanent Population (kg/ca/year) per year per Municipality in Vardar Region	2016	2021	2026	2031	2036	2041	2046
Veles	263	288	292	295	295	296	297
Urban	274	300	303	305	305	305	305
rural	222	242	245	247	247	247	247
Gradsko	275	300	303	306	306	306	306
Urban	-	-	-	-	-	-	-
rural	275	300	303	306	306	306	306
Demir Kapija	197	215	217	219	219	219	219
Urban	-	-	-	-	-	-	-
rural	197	215	217	219	219	219	219
Kavadarci	342	374	379	382	383	384	385
Urban	353	385	389	392	392	392	392
rural	285	312	315	317	317	317	317
Lozovo	258	282	285	287	287	287	287
Urban	-	-	-	-	-	-	-
rural	258	282	285	287	287	287	287
Negotino	268	293	297	300	301	302	303
Urban	285	311	314	317	317	317	317
rural	230	251	254	256	256	256	256
Rosoman	186	203	206	207	207	207	207
Urban	-	-	-	-	-	-	-
rural	186	203	206	207	207	207	207
Chashka	213	232	235	237	237	237	237
Urban	-	-	-	-	-	-	-
rural	213	232	235	237	237	237	237
Weighted Average WGR for Permanent Population (kg/ca/year) of Vardar Region	280	306	310	314	316	317	319

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

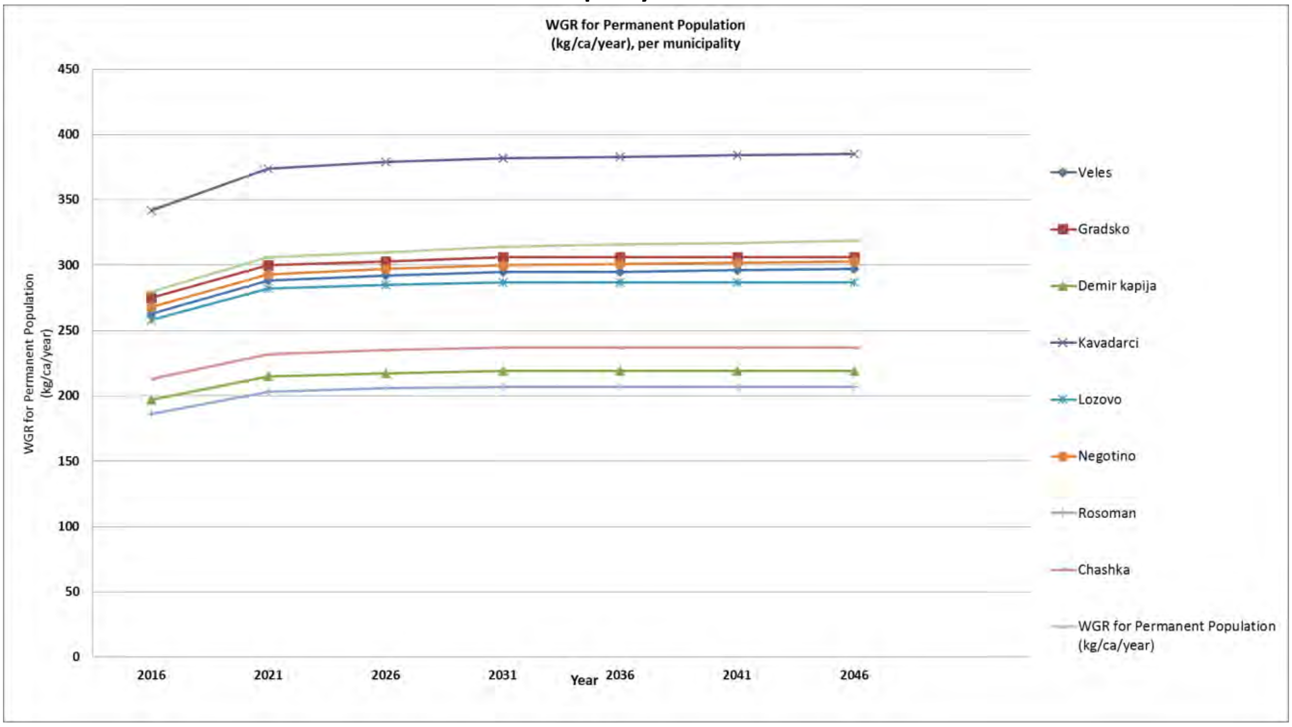


Table 4-26: Total Produced Waste from Permanent Population for the municipalities of Vardar region (t) for Scenario 2

Year	2016	2021	2026	2031	2036	2041	2046
Veles	14,415	15,864	16,149	16,387	16,421	16,369	16,246
Gradsko	978	1,044	1,009	953	883	813	744
Demir Kapija	803	858	829	783	725	668	611
Kavadarci	13,322	14,685	14,986	15,257	15,340	15,339	15,267
Lozovo	669	715	691	653	605	556	510
Negotino	5,187	5,690	5,761	5,804	5,774	5,716	5,637
Rosoman	755	807	779	737	682	628	575
Chashka	1,680	1,794	1,734	1,638	1,517	1,397	1,279
Total Produced Waste from Permanent Population in Vardar Region	37,809	41,456	41,938	42,213	41,947	41,485	40,869

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 Vardar 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 Vardar region.

Table 4-27: Total Produced Waste from Seasonal Population for the municipalities of Vardar region (t) for Scenario 2

Year	2016	2021	2026	2031	2036	2041	2046
Veles	17	22	29	36	36	36	36
Gradsko	0	0	0	0	0	0	0
Demir Kapija	2	3	3	4	4	4	4
Kavadarci	14	17	23	29	29	29	29
Lozovo	0	0	0	0	0	0	0
Negotino	11	13	17	22	22	22	22
Rosoman	0	0	0	0	0	0	0
Chashka	0	0	0	0	0	0	0
Total Produced Waste from Seasonal Population in Vardar Region	44	54	72	91	91	91	91

Total future generated waste for the permanent and seasonal population

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 4-28: Forecast of Waste Production for the municipalities of Vardar region (t) for Scenario 2

Year	2016	2021	2026	2031	2036	2041	2046
Veles	14,432	15,886	16,178	16,424	16,457	16,405	16,282
Gradsko	978	1,044	1,009	953	883	813	744
Demir Kapija	805	860	832	787	729	672	615
Kavadarci	13,336	14,702	15,009	15,286	15,368	15,367	15,296
Lozovo	669	715	691	653	605	556	510
Negotino	5,197	5,703	5,778	5,826	5,796	5,738	5,659
Rosoman	755	807	779	737	682	628	575
Chashka	1,680	1,794	1,734	1,638	1,517	1,397	1,279
Total Produced Waste (t) in Vardar Region	**37,853**	**41,510**	**42,010**	**42,304**	**42,038**	**41,577**	**40,960**

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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 behaviour. 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

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

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

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 labelled.[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 harmonise 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-of-life vehicles and to increase re-use, recycling and recovery of end-of-life

[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

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 POLITICAL 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
- Installations for incineration of animal carcases
- Installations for managing mining 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)

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;
- **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;

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

- **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

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

Strategy. 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 Vardar 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 Vardar 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 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 no more than one WMC in each region. For construction of integral waste management system, regions should adopt required physical plans. Some of the sites, where the future WMC is going to be counstructed in each region, are in private ownership, while others are in the ownership of the country or a combination of private and public ownership.

Planned waste management system is compatible with Waste Management Strategy of the beneficiary country such as 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". • 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.

Grants from other international donors
A variety of bilateral development cooperation organizations provide grants to middle income countries preparing for accession to the EU such as 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 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 favourable 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.

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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 acceptable 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 production of emissions to air, water and land.

Integrated Waste Management System (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.

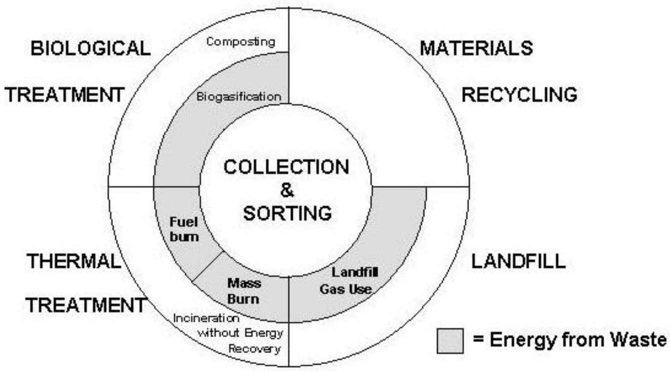


Figure 6-1: The Elements of Integrated Solid Waste Management system

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 land filling. Together 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 IWM 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 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 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. These data have been analyzed in the Assessment report of the current project.
- Step 2: Calculation 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 be remain and will be transferred in future CWMF for further treatment through Transfer Stations.
- 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 Vardar 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 in 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 treated. 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

In line 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, three (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:

[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

- 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.
- 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 the non-compliant municipal landfills and dumpsites
- 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

[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

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:

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 need 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

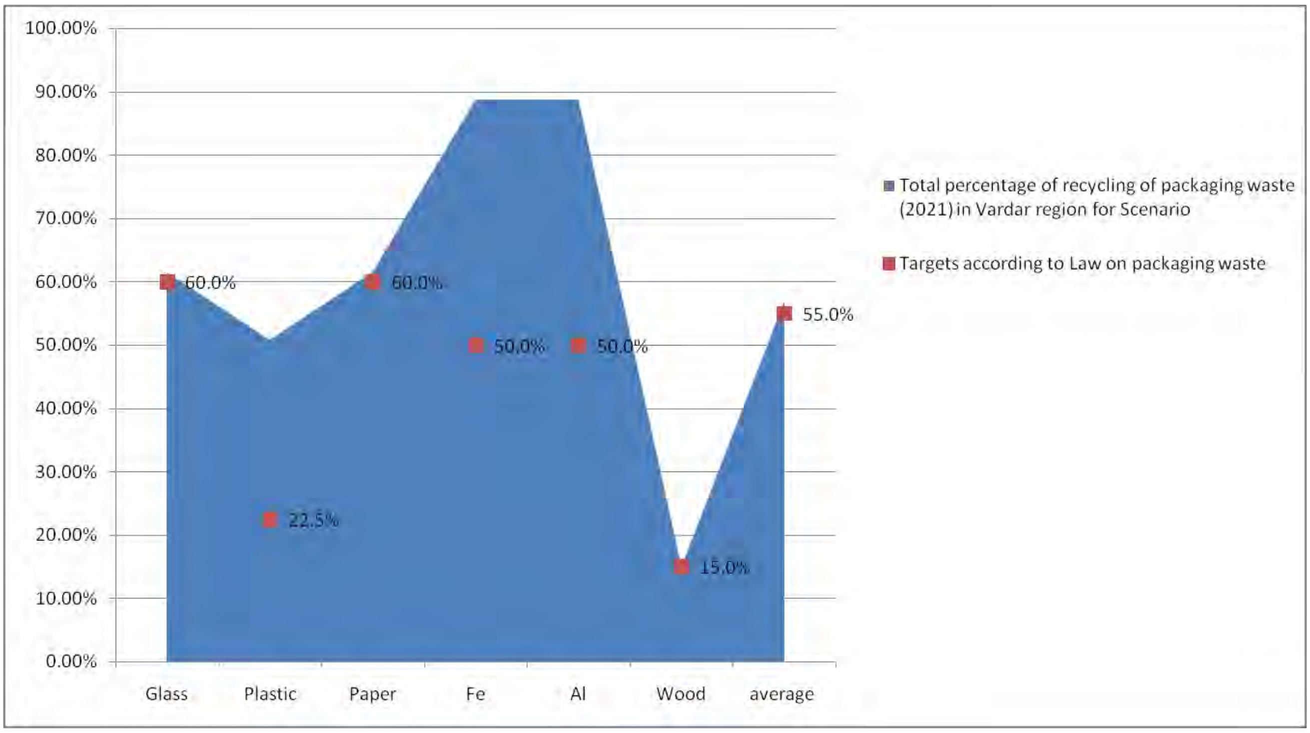
3. by 31st December 2026 the reduction must be 65%, that is a maximum allowable mass of 106,750 t BMW

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

- *15,386 t* by 31st December 2016
- *10,258 t* by 31st December 2019
- *7,180 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



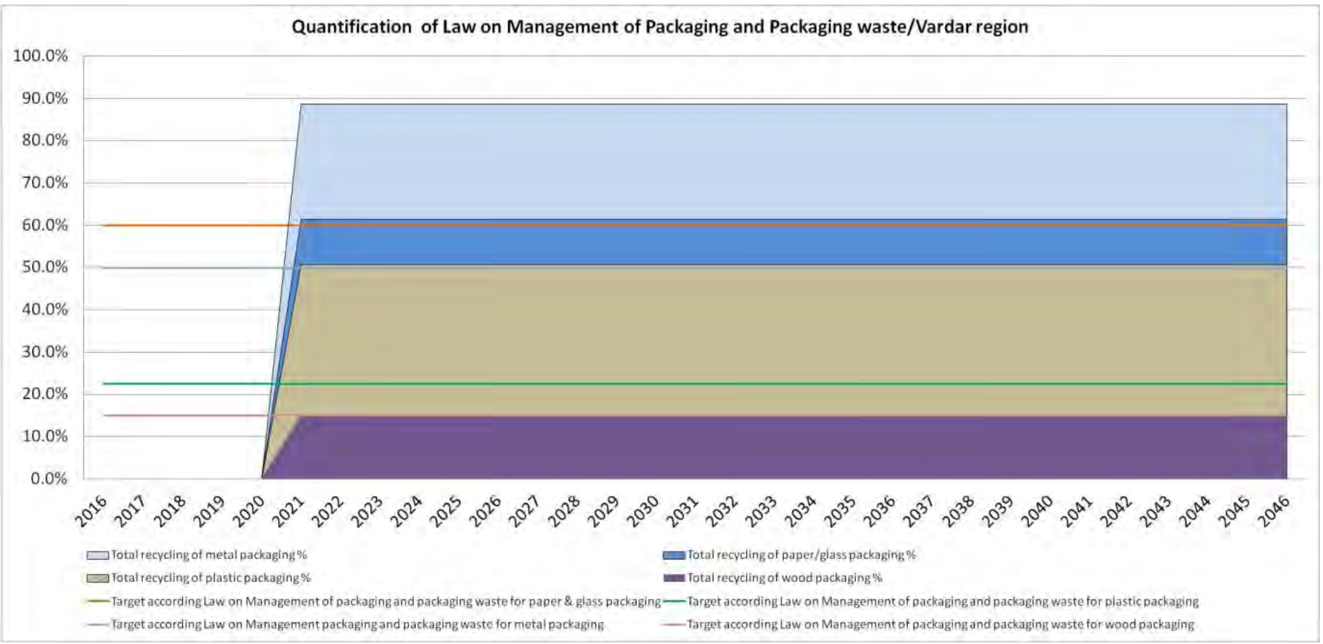
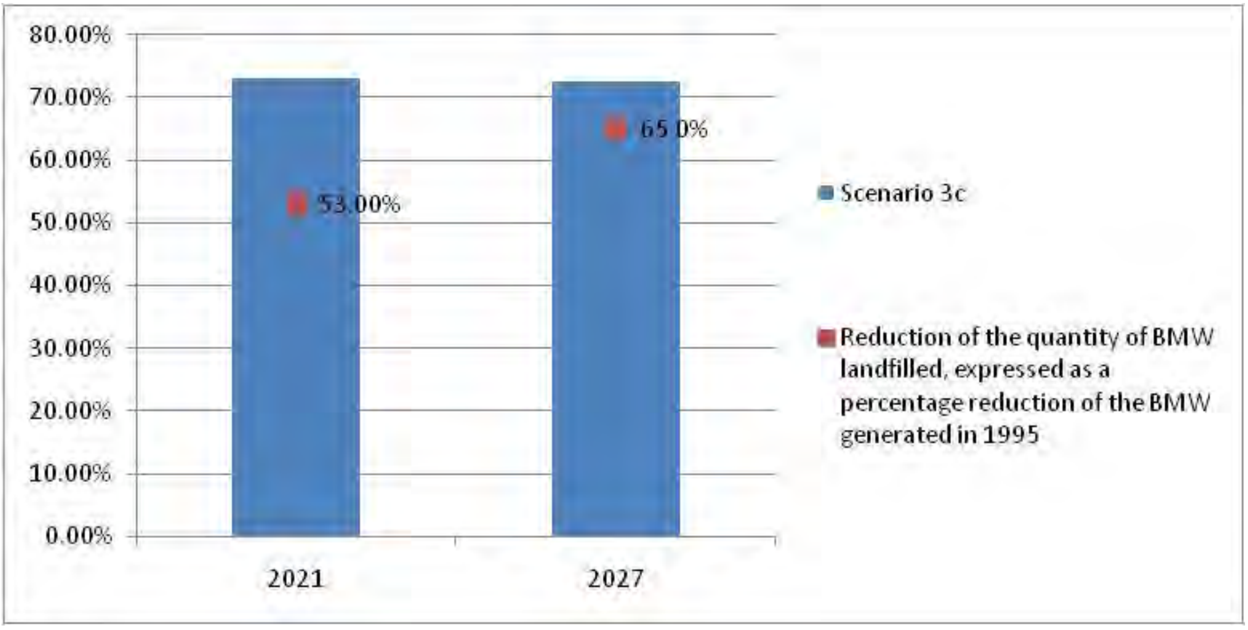


Table 6-1:Quantification of Law on Management of Packaging and Packaging waste

YEAR	Total Packaging Waste Produced in Vardar 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	8,809		4,845	
2017	8,953		4,924	
2018	9,095		5,002	
2019	9,369		5,153	
2020	9,636		5,300	
2021	9,660	5,504	5,313	57%
2022	9,684	5,517	5,326	57%
2023	9,708	5,531	5,339	57%
2024	9,733	5,545	5,353	57%
2025	9,758	5,560	5,367	57%
2026	9,776	5,570	5,377	57%
2027	9,795	5,581	5,387	57%
2028	9,815	5,592	5,398	57%
2029	9,835	5,604	5,409	57%
2030	9,856	5,616	5,421	57%
2031	9,845	5,609	5,415	57%
2032	9,833	5,603	5,408	57%
2033	9,823	5,597	5,403	57%
2034	9,813	5,591	5,397	57%
2035	9,804	5,586	5,392	57%
2036	9,783	5,574	5,380	57%
2037	9,762	5,562	5,369	57%
2038	9,742	5,551	5,358	57%
2039	9,723	5,540	5,348	57%
2040	9,704	5,529	5,337	57%
2041	9,675	5,513	5,321	57%
2042	9,647	5,497	5,306	57%
2043	9,620	5,481	5,291	57%
2044	9,593	5,465	5,276	57%
2045	9,566	5,450	5,261	57%
2046	9,532	5,431	5,242	57%

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



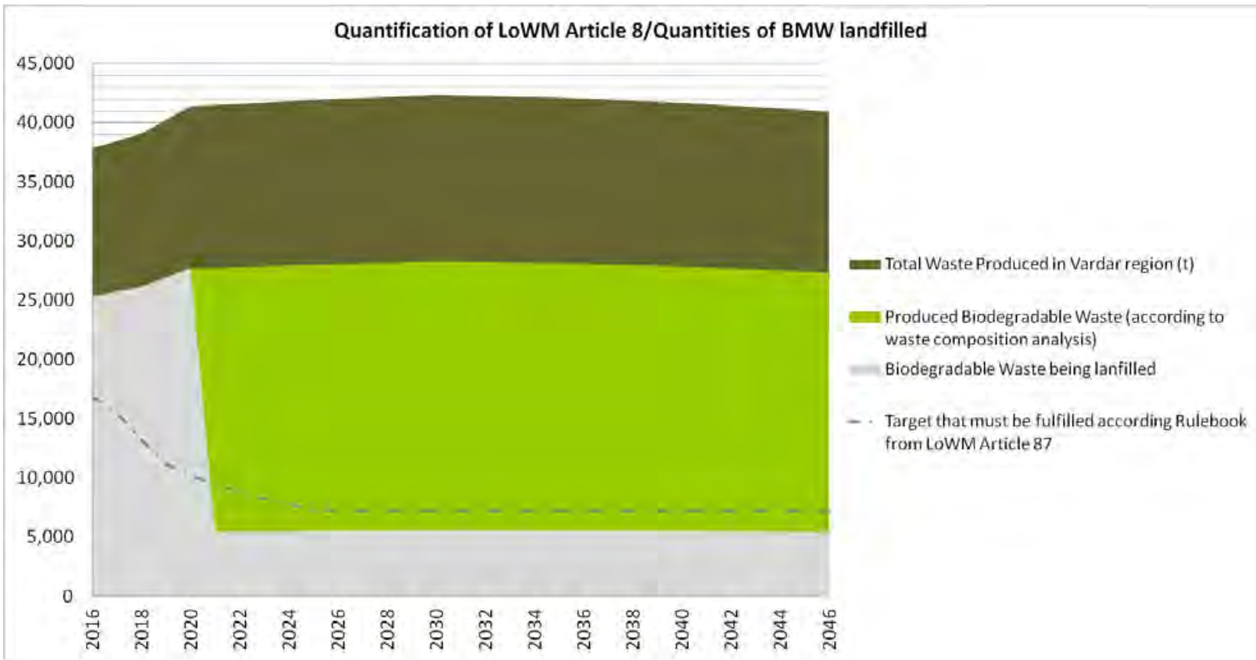


Table 6-2: Quantification of LoWM Article 8 regarding biodegradable municipal waste landfilled for selected scenario

YEAR	Total Waste Produced in Vardar region (t)	Produced Biodegradable Municipal Waste (according to waste composition analysis) (t)	Target that must be fulfilled according to the LoWM article 8 (t)	Biodegradable Municipal Waste being landfilled (t)
2016	37,853	25,332	16,875	25,332
2017	38,472	25,746	15,551	25,746
2018	39,083	26,155	13,235	26,155
2019	40,261	26,943	11,250	26,943
2020	41,409	27,712	10,257	27,712
2021	41,510	27,779	9,595	5,062
2022	41,613	27,848	8,934	5,076
2023	41,717	27,918	8,272	5,091
2024	41,823	27,989	7,941	5,105
2025	41,931	28,061	7,279	5,120
2026	42,010	28,114	7,279	5,132
2027	42,092	28,169	7,279	5,144
2028	42,177	28,226	7,279	5,156
2029	42,264	28,284	7,279	5,169
2030	42,354	28,344	7,279	5,182
2031	42,304	28,310	7,279	5,179
2032	42,256	28,279	7,279	5,175
2033	42,211	28,248	7,279	5,172
2034	42,169	28,220	7,279	5,169
2035	42,129	28,193	7,279	5,167
2036	42,038	28,133	7,279	5,158
2037	41,950	28,074	7,279	5,149
2038	41,864	28,016	7,279	5,141
2039	41,781	27,961	7,279	5,133
2040	41,700	27,907	7,279	5,125
2041	41,577	27,824	7,279	5,112
2042	41,455	27,743	7,279	5,099
2043	41,337	27,663	7,279	5,087
2044	41,221	27,586	7,279	5,075
2045	41,108	27,510	7,279	5,063
2046	40,960	27,411	7,279	5,047

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

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

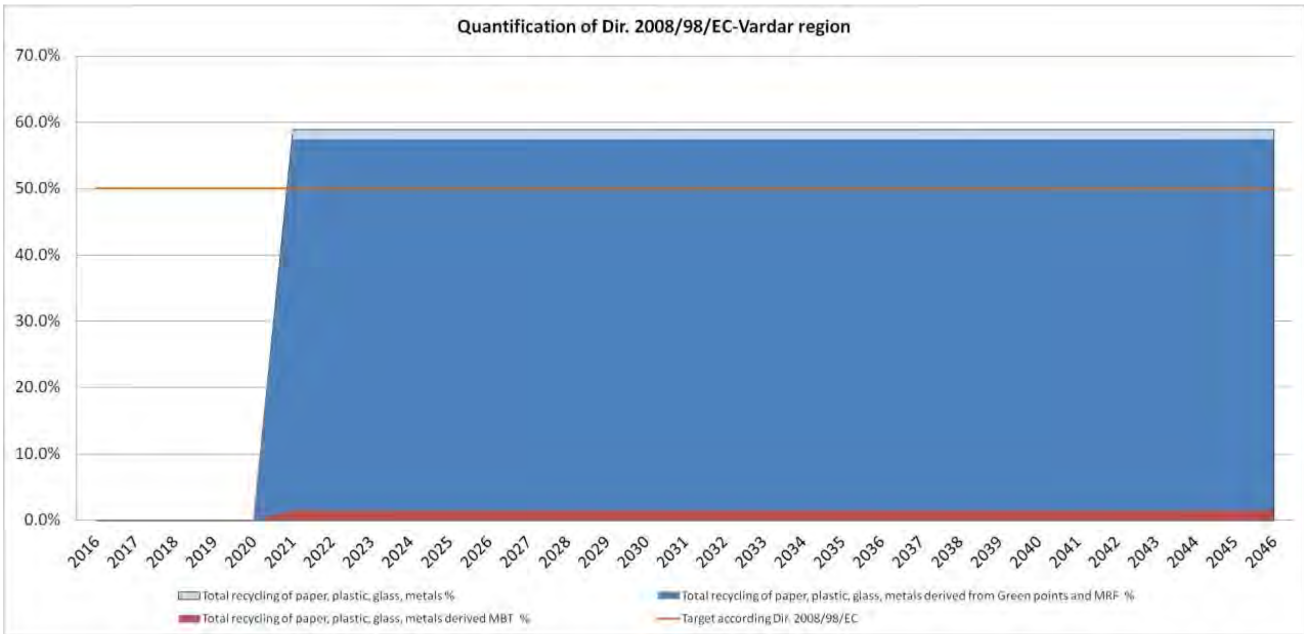


Table 6-3: Quantification of LoWM Article 8 regarding biodegradable municipal waste landfilled for selected scenario

	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	12,013	0	0	0	0.0%	0.0%	0.0%	50%
2017	12,210	0	0	0	0.0%	0.0%	0.0%	50%
2018	12,404	0	0	0	0.0%	0.0%	0.0%	50%
2019	12,778	0	0	0	0.0%	0.0%	0.0%	50%
2020	13,142	0	0	0	0.0%	0.0%	0.0%	50%
2021	13,174	7,767	7,571	196	59.0%	57.5%	1.5%	50%
2022	13,207	7,787	7,590	197	59.0%	57.5%	1.5%	50%
2023	13,240	7,806	7,609	197	59.0%	57.5%	1.5%	50%
2024	13,273	7,826	7,629	197	59.0%	57.5%	1.5%	50%
2025	13,308	7,846	7,648	198	59.0%	57.5%	1.5%	50%
2026	13,333	7,861	7,663	198	59.0%	57.5%	1.5%	50%
2027	13,359	7,876	7,678	199	59.0%	57.5%	1.5%	50%
2028	13,386	7,892	7,693	199	59.0%	57.5%	1.5%	50%
2029	13,413	7,908	7,709	200	59.0%	57.5%	1.5%	50%
2030	13,442	7,925	7,725	200	59.0%	57.5%	1.5%	50%
2031	13,426	7,916	7,716	200	59.0%	57.5%	1.5%	50%
2032	13,411	7,907	7,707	200	59.0%	57.5%	1.5%	50%
2033	13,397	7,899	7,699	199	59.0%	57.5%	1.5%	50%
2034	13,383	7,891	7,691	199	59.0%	57.5%	1.5%	50%
2035	13,370	7,883	7,684	199	59.0%	57.5%	1.5%	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
2036	13,342	7,866	7,668	199	59.0%	57.5%	1.5%	50%
2037	13,314	7,850	7,652	198	59.0%	57.5%	1.5%	50%
2038	13,286	7,834	7,636	198	59.0%	57.5%	1.5%	50%
2039	13,260	7,818	7,621	197	59.0%	57.5%	1.5%	50%
2040	13,234	7,803	7,606	197	59.0%	57.5%	1.5%	50%
2041	13,195	7,780	7,583	196	59.0%	57.5%	1.5%	50%
2042	13,157	7,757	7,561	196	59.0%	57.5%	1.5%	50%
2043	13,119	7,735	7,540	195	59.0%	57.5%	1.5%	50%
2044	13,082	7,713	7,519	195	59.0%	57.5%	1.5%	50%
2045	13,046	7,692	7,498	194	59.0%	57.5%	1.5%	50%
2046	12,999	7,664	7,471	193	59.0%	57.5%	1.5%	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, the supply of collection bins and trucks and the construction of TSs.
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 Vardar 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, e.g. 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

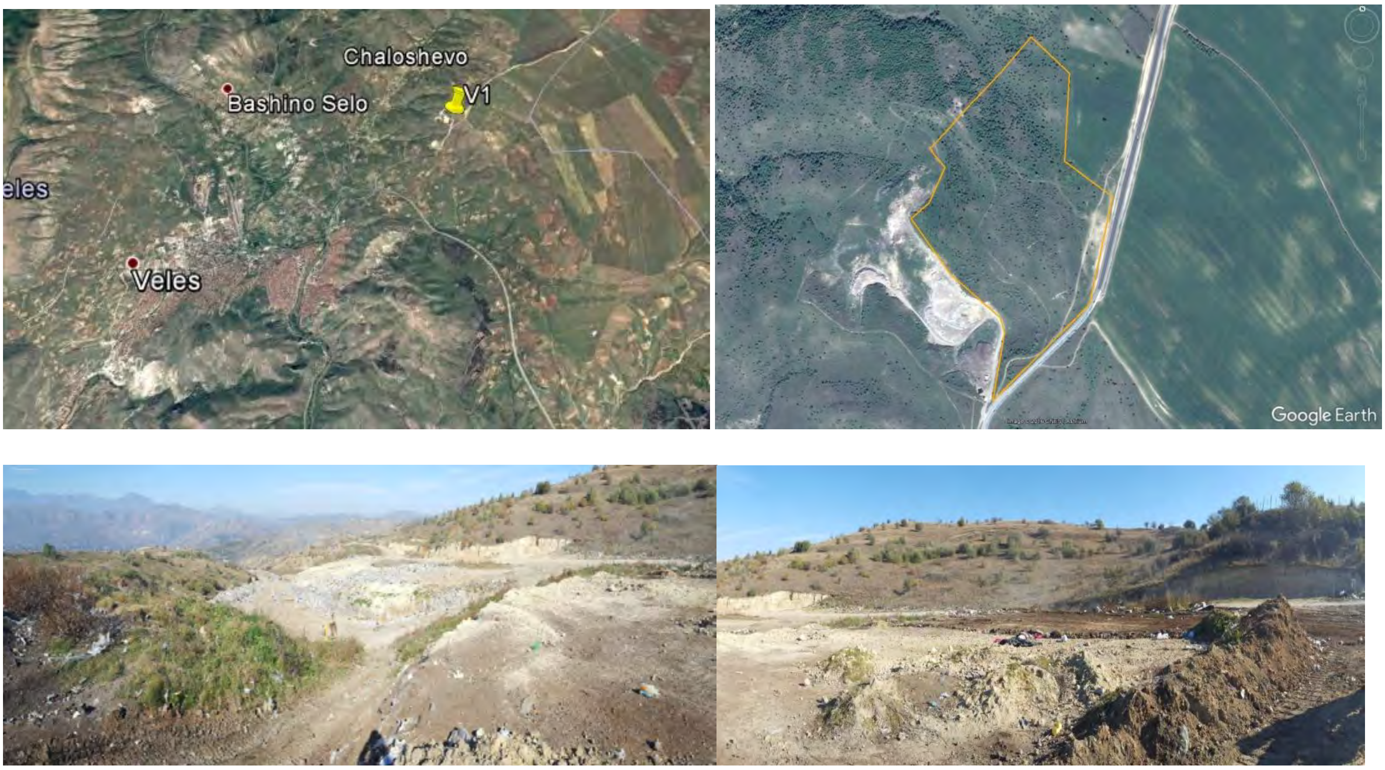
Based on all the above mentioned about exclusion and selection criteria, a "Significant / Protected Areas Map" for Vardar Region was prepared, indicating the areas not included in exclusion areas. Within those areas, after site visits and taking under consideration the proposals of the local authorities,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

- Alternative site Bunare Dere Landfill Veles (V1) – Veles Municipality
- Alternative site Rosoman Existing Landfill (R1) – Rosoman Municipality
- Alternative site Kavadartsi Existing Landfill (KA1) –Kavadartsi Municipality
- Alternative sites: Ulantsi 1 (U1), Ulantsi 2 (U2), Ulantsi 3 (U3) – Gradsko Municipality
- Alternative sites: Negotino 1 industry (N1), Negotino 2 (N2), Negotino 3 (N3), Negotino 4 (N4), Negotino 5 (N5) and Krivolak (KR1) – Negotino Municipality

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

Alternative site Bunare Dere Landfill Veles (V1) – Veles Municipality	
Geographical site location	• The site is situated northeast of Veles settlement at approximately 3.5 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the V1 proposed site is: 1.5 km southeast of Chaloshevo and 3.5 km east of Bashino Selo.
Access road	• The access to the site takes place through the regional road R-1312 which connects the Veles settlement with Lozovo and Shtip settlements. Regional road R-1312 is connecting with the national road E75 close to Veles settlement.
Spatial characteristics	• The optical isolation of the site is in a medium level from the closest settlements and low level from the access regional road R-1312. • At the limits of the proposed site to the south, anon-compliant municipal landfill site exists. • There is no archaeological site under a distance of 3km
Environmental characteristics	• The site is located in the emerald protected area "Ovche pole" with code MK0000035. • The wider area is agricultural land with pastures and non-irrigated arable land 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). • According to the hydrogeological map of the Republic of Macedonia (1: 200,000) these areas fall into waterless terrains. • There are no significant tectonic structures with the site area. • Surface rocks are no coherent or poorly coherent sediments with high thickness, without appearance of dominant structures of crimping. • There are no hydrant points within or near the site. Vardar River flows 3 km south west of the site. • The town of Veles is the main recipient, located around 4 km from the site. • Alluvium of Vardar River is the most permeable zone around the landfill (about 4.5 km). • About 500 meters south of the site, an old borrow pit of Pliocene clay is available.
Technical and Operational characteristic	• The altitude of the site range from 344 to 388 meters (mean average 372 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 includes both private and state land. • 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 regional road R1312 which connects the settlement of Veles with the settlements of Lozovo and Shtip. • 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 28km.
Conclusion	No further evaluation. The site is located in the emerald protected area "Ovche pole" with code MK0000035.

Figure 6-5: Geographical location, utilization area and site photos of the alternative site Veles 1 (V1)



Alternative site Rosoman Existing Landfill (R1) – Rosoman Municipality	
Geographical site location	• The site is situated west of Rosoman settlement and northeast of Sirkovo settlement at approximately 3 km direct distance. • Regarding the approx. direct distance from the nearby settlements, the V1 site is: 4 km southeast of Dolno Chichevo settlement (belongs to Gradsko municipality).
Access road	• The access to the site takes place from the regional road A1 which has access to the settlement of Rosoman. Following the regional road which connects the settlement of Rosoman with Sirkovo settlement, at the first cross road follow the right direction for approx. 1.5km long and then turn right crossing a small drain pipe. After the culvert follow a paved accessible road for approx. 200m.
Spatial characteristics	• The optical isolation of the site is in a medium level from the closest settlement (Rosoman) and in low level from the main access road. • At the limits of the proposed site, a non-compliant municipal landfill site currently exists. • The wider area is agricultural land, with complex cultivation patterns, according to Corine land cover 2012. Also there is an irrigation network around the site. • There is no archaeological site under a distance of 3km
Environmental characteristics	• There are no protected areas nearby the site in a distance under 3km. • The wider area is agricultural land, with complex cultivation patterns, according to Corine land cover 2012. Also there is an irrigation network around the site. • The soil of the site is characterized as pathogenous due to the existence of a landfill.
Geological – Hydrogeological characteristics	• The site is built of none permeable clays and clay sands with (all none permeable rocks with sub capillary porosity). • According to the hydrogeological map of the Republic of Macedonia (1: 200,000) these areas fall into waterless terrains. • There are no significant tectonic structures within site area. • Surface rocks are unbound or weakly bound sediments with high thickness, without appearance of dominant structures of crimping. • There are no hydrant points within or near the site. An open irrigation channel exists in 200m below the site. • The main recipient in the area is Rosoman, located at about 2.5 km from the site considered. • Terraces and alluvial sediments of the Crna River are the most permeable zones around the site, at approx. 2km. • At about 4 km from the site considered borrow pits for diluvial materials could be formed.
Technical and Operational characteristic	• The altitude of the site range from 234 to 267 meters (mean average 254 m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 21 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, most of the site belongs to a public ownership. • 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 easily takes place through an existing regional road which connects Rosoman and Sirkovo settlements. • For the final access to the site, approx. 200m of road needs to be improved with asphalt pavement and also redesigning of the culvert. • Closing and rehabilitation of the existing landfill in the site • The site could be connected to the public utility networks through the nearby settlement in a distance of approx. 3km.
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 27km.
Conclusion	***Further evaluation.*** The site R1 in Municipality of Rosoman has the following advantages: ✓ It is not located in, or near protected areas ✓ It has plenty of space to implement the central waste management facilities. ✓ The geological – hydrogeological conditions are suitable

Figure 6-6: Geographical location, utilization area and site photos of the alternative site Rosoman 1 (R1)

Alternative site Kavadartsi Existing Landfill (KA1) –Kavadartsi Municipality	
Geographical site location	• The site is situated west of Kavadartsi settlement at approximately 2.5 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the KA1 proposed site is: 3.5 km north of the settlement of Reshava, 3.5 km northeast of Brushani settlement, and 5km east of Vozartsi settlement.
Access road	• The access to the site takes place through the local road network of Kavadartsi following the regional road (R-1103) which connects the settlement of Kavadartsi with Vozartsi settlement and at the first cross road turn left to the south. After 700m of paved accessible road and then 500m of not accessible unpaved road the final access to the site could be achieved.
Spatial characteristics	• The optical isolation of the site is in a good level and it cannot be seen from the closest settlement (Kavadartsi). Also there is a medium to low optical isolation level from the closest regional road R-1103. The site limits are in vicinity with an existing non-compliant municipal landfill. • There is no archaeological site under a distance of 3km
Environmental characteristics	• There are no protected areas under a distance of 3km. The closest emerald protected area is "Raechkaklisura" (MK0000028) in the west in a distance of approx. 7.5km. • The wider area is characterized as agricultural land, mixed of pastures and vineyards, according to Corine land cover 2012.
Geological – Hydrogeological characteristics	• The site is built of none permeable clays and clay sands (weakly coherent clays) with sub capillary porosity. • According to the hydrogeological map of the Republic of Macedonia (1: 200,000) these areas fall into waterless terrains. • There are no significant tectonic structures with the site area. • The eastern part of the site considered is almost vertical slope built of poorly coherent clays. The slope is man-made (borrow pit for the existing landfill). • There are no hydrant points within or near the site. River Crna is about 7 km and Tikves Lake about 5 km from the site under consideration. • The settlement of Kavadartsi is the main recipient, located around 2.5 km from the site. • The site is at the hilltop and therefore has no catchment area, excluding man made steep slopes on the east). • Borrow pit can be formed within the site considered (good quality clay).
Technical and Operational characteristic	• The altitude of the site ranges from 316m to390m (mean 352m). • 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, most of the site belongs to a private ownership. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The final access is easy and an existing regional road is connecting with the site. The distance from the regional road to the site is approx.700m of paved accessible road and then approx. 500 m of unpaved not accessible road. There is a need of improvement with asphalt pavement and also widen the road where it is necessary. • Diversion works in order to avoid access through Kavadartsi settlement • 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 25km.
Conclusion	***No further evaluation.*** The site KA1 in Municipality of Kavadartsi, has the following advantages and disadvantages: ○ It is not located in a protected area, and the closest under 3km is a designated area with code 81085 "Kalnica" in the east in a distance of approx. 2.5km ○ The geological – hydrogeological conditions are suitable ○ The site has very low social acceptance, which is a very critical parameter for the selection of a site

Figure 6-7: Geographical location, utilization area and site photos of the alternative site Kavadartsi 1 (KA1)

Alternative site Ulantsi 1 (U1) – Gradsko Municipality	
Geographical site location	• The site is situated east of Ulantsi settlement at approximately 0.5 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the U1 proposed site is: 1 km north Gradsko, 4 km southeast of Vinichani, and 6km north of Palikura.
Access road	• The access to the site takes place through the local road network of Gradsko settlement crossing the bridge which connects Gradsko with Ulantsi settlement. The final access is achieved, through Ulantsi, directing to the east across unpaved road for approx. 0.5km. • The national road E75 and the regional road R1102 are very close to the settlement of Gradsko.
Spatial characteristics	• The optical isolation of the site is in a low level from the closest settlement of Ulantsi. • There is no archaeological site under a distance of 3km. The closest archaeological site is "Archaeological site Stobi" characterized as a Point of Interest with code 132 in the southeast of the site in a distance of approx. 4km
Environmental characteristics	• There are no protected areas nearby the site in a distance under a distance of 3km. The closest protected area is the Emerald site "Klisurana Bregalnica" (MK0000031) in the north in a distance of approx. 6km. • The wider area is characterized as agricultural land with complex cultivation patterns and 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 claystone, marlstone and sandstone (all none permeable rocks with a very slight fissure porosity). • There are no significant tectonic structures with the site area. Rocks on the surface have only rare cracks, tight and not filled. • There are no hydrant points within or near the site. River Vardar flows about 100 m south of the site. • The Vardar River and therefore settlement of Negotino and several settlements along the river Vardar are the main recipients (mostly rural). • The site catchment area is morphologically diverse but dominated with low hills and shallow valleys, with an average angle of slope of 20 degrees). • Sediments of Pliocene clays are found at a distance of 5 km from the site considered (the other side of the river Vardar near Gradsko).
Technical and Operational characteristic	• The altitude of the site ranges from 136 to 181 meters (mean average 158m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 14.4 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, most of the site belongs to a private ownership. • 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 road which connects Ulantsi settlement with Gradsko settlement. Between the two settlements there is a bridge in order to cross Vardar River. The final access to the proposed site is achieved through Ulantsi directing to the east going across unpaved road for approx. 0.5km. • Demand for infrastructure works both for the improvement of the bridge and the unpaved road. The small bridge is highly unlikely to accept the required traffic road from and to the proposed site area. • There is also the need for additional works in order to divert the waste transportation traffic from Ulantsi settlement. • The site could be connected to the public utility networks through the nearby settlement of Ulantsi in a distance of approx. 0.5km, and regarding power network, connection could be achieved with the power lines crossing through site U2.
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 30km.
Conclusion	***No further evaluation.*** The site U1 in Municipality of Gradsko, has the following advantages and disadvantages: o It is not located in, or near protected areas o It has not enough space to implement the central waste management facilities. o It is located by Vardar River and because of that, for the final access to the site the demand for infrastructure works is very high. In the wider area of Gradsko Municipality two more sites are identified: sites U2 and U3, which have the same characteristics, and the description of them is given in the next paragraphs. The site U3 is considered as prevailing and it is chosen for further evaluation.

Figure 6-8: Geographical location, utilization area and site photos of the alternative site Ulantsi 1 (U1)

Alternative site Ulantsi 2 (U2) – Gradsko Municipality	
Geographical site location	• The site is situated east of Ulantsi settlement at approximately 1 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the U2 proposed site is: 1 km north Gradsko, 5 km southeast of Vinichani, and 6km north of Palikura.
Access road	• The access to the site takes place through the local road network of Gradsko settlement crossing the bridge which connects Gradsko with Ulantsi settlement. The final access to the proposed site is achieved through Ulantsi directing to the east through an unpaved road for approx. 1km. • The national road E75 and the regional road R-1102 are very close to the settlement of Gradsko.
Spatial characteristics	• The closest settlements to the site are Gradsko and Ulantsi settlements in a distance of approx. 1km. • The optical isolation of the site is in a low level from the closest settlements. • There is no archaeological site under a distance of 3km. The closest archaeological site is "Archaeological site Stobi" characterized as a Point of Interest with code 132 in the southeast of the site in a distance of approx. 3.5km.
Environmental characteristics	• There are no protected areas nearby the site in a distance under a distance of 3km. The closest protected area is the Emerald site "Klisurana Bregalnica" (MK0000031) in the north in a distance of approx. 6km. • The wider area is characterized as agricultural land with mix of complex cultivation patterns, land principally occupied by agriculture with significant areas of natural vegetation and non irrigated arable land, according to Corine land cover 2012.
Geological – Hydrogeological characteristics	• The site is built of none permeable claystone, marlstone and sandstone (all none permeable rocks with a very slight fissure porosity). • There are no significant tectonic structures with the site area. Rocks on the surface have only rare cracks, tight and not filled. • There are no hydrant points within or near the site. River Vardar flows about 400 m south of the site. • The Vardar River and therefore settlement of Negotino and several settlements along the river Varda, are the main recipients (mostly rural). • The site catchment area is morphologically diverse but dominated with low hills and shallow valleys, with an average angle of slope of 30 - 40 degrees. • Sediments of Pliocene clays are found at a distance of 5 km from the site considered (the other side of the river Vardar near Gradsko).
Technical and Operational characteristic	• The altitude of the site ranges from 134 to 172 meters (mean average 152m). • The total expansion of the area that could be used according to the morphological characteristics is approximately 14.6 ha, so there is available space to implement the Central waste management facilities. • Regarding the property ownership of the site, most of the site belongs to a private ownership. • 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 the local road which connects Ulantsi settlement with Gradsko settlement. Between the two settlements there is a bridge in order to cross Vardar river. The final access is achieved through Ulantsi, directing to the east across unpaved road for approx. 1km. • There is a need for infrastructure works both for the improvement of the bridge and the redesigning of unpaved road. The small bridge is highly unlikely to accept the required traffic road from and to the proposed site area. • There is also the need for additional works in order to divert the waste transportation traffic from Ulantsi settlement. • The site could be connected to the public utility networks through the nearby settlement of Ulantsi in a distance of approx. 0.5km, and regarding power network, connection could be achieved with the power lines crossing through the site.
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 28km.
Conclusion	***No further evaluation.*** The site U2 in Municipality of Gradsko, has the following advantages and disadvantages: ○ It is not located in, or near protected areas ○ It has not enough space to implement the central waste management facilities. ○ It is located by Vardar River and because of that, for the final access to the site the demand for infrastructure works is very high. In the wider area of Gradsko Municipality two more sites are identified: sites U1 and U3, which have the same characteristics. The site U3 is considered as prevailing and it is chosen for further evaluation.

Figure 6-9: Geographical location, utilization area and site photos of the alternative site Ulantsi 2 (U2)

Alternative site Ulantsi 3 (U3) – Gradsko Municipality	
Geographical site location	• The site is situated east of Ulantsi settlement at approximately 1.5 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the U3 proposed site is: 1 km northeast of Gradsko, 5.5 km southeast of Vinichani, and 5 km north of Palikura settlement.
Access road	• The access to the site takes place through the local road network of Gradsko settlement crossing the bridge which connects Gradsko with Ulantsi settlement. The final access to the proposed site is achieved through Ulantsi directing to the east across unpaved and rough terrain road for approx. 2km. • The national road E75 and the regional road R-1102 are very close to the settlement of Gradsko.
Spatial characteristics	• The closest settlements to the site are Gradsko and Ulantsi settlements in a distance of approx. 1km. • The optical isolation of the site is in a low level from the closest settlements. • There is no archaeological site under a distance of 3km. The closest archaeological site is "Archaeological site Stobi" characterized as a Point of Interest with code 132 in the southeast of the site in a distance of approx. 3km.
Environmental characteristics	• There are no protected areas nearby the site in a distance under a distance of 3km. The closest protected area is the Emerald site "Klisurana Bregalnica" (MK0000031) in the north in a distance of approx. 6.5km. • According to Corine Land Cover 2012, the area characterized as natural grassland. The wider area is characterized as land principally occupied agriculture with significant areas of natural vegetation and as non irrigated arable land and with complex cultivation patterns.
Geological – Hydrogeological characteristics	• The site is built of none permeable claystone, marlstone and sandstone (all none permeable rocks with a very slight fissure porosity). • There are no significant tectonic structures with the site area. Rocks on the surface have only rare cracks, tight and not filled. • There are no hydrant points within or near the site. River Vardar flows about 700 m southwest of the site. • The Vardar River and therefore settlement of Negotino and several settlements along the river Vardar, are the main recipients (mostly rural). Main usage is irrigation and recreation. The site is around 17 km upstream for the recipients. • The site catchment area is surrounded with low hills east, north and south. The slopes are relatively steep ranging from 30 to 40 degrees. • Sediments of Pliocene clays are found at a distance of 5 km from the site considered (the other side of the river Vardar near the Gradsko settlement).
Technical and Operational characteristic	• The altitude of the site ranges from 138 to 180 (mean 156m). • 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, most of the site belongs to a private ownership. • 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 local road which connects Ulantsi settlement with Gradsko settlement. Between the two settlements there is a bridge in order to cross Vardar river. The final access is achieved through Ulantsi directing to the east going across unpaved road for approx. 2km. • There is a need for infrastructure works both for the redesigning of the bridge and the improvement of the unpaved rough terrain of the road with asphalt pavement. The small bridge is highly unlikely to accept the required traffic road from and to the proposed site area. • Connection to the public utility networks through the nearby settlement, and regarding power network, connection could be done with the power lines crossing through site U2.
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 28km.
Conclusion	***Further evaluation.*** The site U3 in Municipality of Gradsko, has the following advantages and disadvantages: ○ It is not located in, or near protected areas ○ It has not enough space to implement the central waste management facilities. ○ It is located by Vardar River and because of that, for the final access to the site the demand for infrastructure works is very high. In the wider area of Gradsko Municipality two more sites are identified: sites U1 and U2, which have the same characteristics. The site U3 is considered as prevailing and it is chosen for further evaluation.

Figure 6-10: Geographical location, utilization area and site photos of the alternative site Ulantsi 3 (U3)

Alternative site Negotino 1 (N1) – Negotino Municipality	
Geographical site location	• The site is situated northwest of Negotino settlement at approximately 2.9 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the N1 proposed site is: 2.5 km Southwest of Crveni Bregovi, 3.4 km West - Southwest of Krivolak, 4.2 km East of Pepelishte, 5.8 km North-Northwest of Timjanik, 5.6 km west of Kurija.
Access road	• The access to the site takes place either through R-1102 regional road, or the national road (E-75 – 4 lanes) and it can easily be accessed from Negotino junction traveling to northwest. • The national road E75 is very close to the site N1.
Spatial characteristics	• The closest settlement to the site is Crveni Bregovi settlement in a distance of approx. 2.5km. • The site is placed on a remote area without any optical contact from settlements or any other activities. The site is only visible from the "Sportski Aerodrom of Negotino", as well as the regional road R1102 and the national road (E-75- 4 lanes). • There is no archaeological site under a distance of 3km.
Environmental characteristics	• The Emerald site "OrlovoBrdo" (MK0000011) is in the northwest of the site, at a distance of approximately 3 km. The boundaries of this protected area coincide with the designated area with same name "OrlovoBrdo" (196505). • According to Corine Land Cover 2012, the site is situated in a non-irrigated arable land and natural grasslands.
Geological – Hydrogeological characteristics	• The site is situated within diluvial sediments of small thickness, made by clays crushed stones, gravels and sands with good water permeability and with expressed porosity. • As per the Hydrogeological map of the Republic of Macedonia (1: 200,000) flysch sediments fall into waterless terrains. • There are no hydrant points within or near the site. River Vardar flows 2 km on the east. There are no wells for groundwater pumping within or near the site considered. • There are no significant tectonic structures with the site area. • The Vardar River and therefore town of Negotino is the main recipients. Main usage is irrigation and recreation. • The site catchment area is located within lowlands without hills or other morphological forms with the presence of slopes. • Negotino area includes several clay pits (some of them there illegal) and the nearest is about 1.5 km from the proposed site.
Technical and Operational characteristic	• The altitude of the site ranges from 180 to 189 meters (mean average 185 m). • The proposed site is at a flat area slightly to the north of the regional road R-1102. • The total expansion of the area that could be used according to the morphological characteristics is approximately 15.4 ha, so there is enough area for the sitting of central waste management facilities of Vardar region. • Regarding the property ownership of the site, the site is characterized as fully state owned. • 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 proposed site is through an unpaved accessible road that is also access road to the "Sportski Aerodrom of Negotino", which needs improvement works (<500m). • There is a need for infrastructure works both for the redesigning of the bridge and the improvement of the unpaved rough terrain of the road with asphalt pavement. The small bridge is highly unlikely to accept the required traffic road from and to the proposed site area. • The site could be connected to the public utility networks either through the nearby settlements or the national road E-75or the regional road R-1102.
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 29km.
Conclusion	***No further Evaluation***. The site N1 in Municipality of Negotino, has the following advantages and disadvantages: ○ It is not located in, or near protected areas ○ It has enough area to implement the central waste management facilities. ○ It has visual contact of the regional road ○ It is located near "Sportski Aerodrom of Negotino"

Figure 6-11: Geographical location, utilization area and site photos of the alternative site Negotino1 (N1)

Alternative site Negotino 2 (N2) – Negotino Municipality	
Geographical site location	• The site is situated northwest of Negotino settlement at approximately 3.7 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the N2 proposed site is: 1.5 km Northwest of Dubrovo, 3.3 km West-southwest of Vojshantsi, 4.4 km Northwest of Tremnik. 6 km North-Northeast of DolniDisan, 4 km East-Northeast of Timjanik, 4.6 km South of Pepelishte, 5.5 south of Krivolak.
Access road	• The access to the site takes place easily through the regional road R-2137 that connects Vojshantsi with Negotino, crossing Vardar river • The proposed site is also in the proximity of national road (E75 -4 lanes) and can be also accessed through the Negotino junction.
Spatial characteristics	• Although Vojshantsi settlement is the nearest to the proposed site regarding the straight line distance (approximately 3.3 km) the actual road distance is longer and the access is across the Vardar river, thus Negotino is the closest settlement to the proposed location (approximately 3.7 km). • The site is situated in the vicinity of the Dubrovo farm (approximately 1.5 km. • The site is placed on a remote area without any optical contact from settlements or any other activities. Regarding the regional road R-2137, there is a low optical isolation level. • There is no archaeological site under a distance of 3km.
Environmental characteristics	• There are no protected areas nearby the proposed site, at a distance of approximately 3 km. • The closest protected areas to the site is Emerald site “OrlovoBrdo” (MK0000011) in the north in a distance of approx. 5.5 km. The boundaries of this protected area coincide with the designated area with same name “OrlovoBrdo” (196505). • According to Corine Land Cover 2012, in the wider area of the site there is agricultural land, with complex cultivation patterns and non irrigated arable land.
Geological – Hydrogeological characteristics	• The site is situated within diluvia sediments of small thickness, made by clays crushed stones, gravels and sands with good water permeability and with expressed porosity . • The site is located far from any active seismic structures. • There are no hydrant points within or near the site. River Vardar flows at about 1 km east of the site. There are no wells for groundwater pumping within or near the site considered. • In his largest part the site is located within flat lowlands, without big hills or other morphological forms with the presence of slopes. • Closest recipients are rural (Dubrovo settlement) located about 1.3 km from the site. River Vardar flows at about 0.6 km east of the settlement. Main usage is irrigation and recreation. • The wider area of the location is wavelike creased without dominant slopes so the catchment area size is insignificant. • About 2 km west of the location (near the road) a hill built of clay sediments is available for borrow pit construction.
Technical and Operational characteristic	• The altitude of the site ranges from 112 to 141 meters (mean average 127 m). • The proposed site is situated at a flat area slightly to the north of the regional road R-2137 to Negotino. • The total expansion of the area that could be used according to the morphological characteristics is approximately 17 ha, so there is enough area for the sitting of central waste management facilities of Vardar region. • Regarding the property ownership of the site, the site is characterized as fully state owned. • According to the geological characteristics, there is availability of soil material for the daily soil cover.
Demands for infrastructure works	• The site can be accessed easily through regional road R-2137. • The site could be connected to the public utility networks through the regional road R-2137.
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 30km.
Conclusion	***No further Evaluation.*** The site N2 in Municipality of Negotino, has the following advantages and disadvantages: ○ It is not located in, or near protected areas ○ It has space to implement the central waste management facilities. ○ It has an easy access ○ It has visual contact of the regional road ○ The site is located in a private area ○ Even though the site area characterized as state owned, has been conceded with a private contract. This contract is about to expire but the existing ownership status make impossible the acquirement of the site.

Figure 6-12: Geographical location, utilization area and site photos of the alternative site Negotino 2 (N2)

Alternative site Negotino 3 (N3) – Negotino Municipality	
Geographical site location	• The site is situated east –northeast of Negotino settlement at approximately 6.4 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the N3 proposed site is situated approx.: 4.7 km South-west of Peshternitsa, 2.6 km Southwest of Brusnik, 7.3 km west of Kalanjevo, 6.4 km Northwest of Lipa, 3.3 km North-Northeast of Vojshantsi, 7.7 km North of Tremnik, 5 km Northeast of Dubrovo, 9.1 km southwest of Timjanik, 4.5 km east of Pepelishte and 5.4 km southeast of Krivolak.
Access road	• The access to the site takes place from Vojshantsi through an unpaved not accessible road (approximately 3.6 km road distance) and from Brusnik through an unpaved not accessible road (approximately 2.5 km road distance). • Vojshantsi settlement is connected with regional road R-2137 to the regional and national road grid, crossing the Vardar river through a paved bridge (2 lanes that needs improvement works.
Spatial characteristics	• Brusnik is the closest settlement to the proposed location (approximately 2.6 km). • The site is placed on a remote area without any optical contact from settlements or any other activities. The site is only visible from the rural road. • There is no archaeological site under a distance of 3km.
Environmental characteristics	• There are no protected areas nearby the proposed site, at a distance of approximately 3 km. • The closest protected area to the site is the Emerald site "OrlovoBrdo" (MK0000011) in the northwest of the site, at a distance of approx 3.8 km. The boundaries of this protected area coincide with the designated area with same name "OrlovoBrdo" (196505). • According to Corine Land Cover 2012, the site is situated in a non-irrigated arable land with a part of transitional wood land –shrub.
Geological – Hydrogeological characteristics	• The site is situated within diluvia sediments of small thickness, made by clays crushed stones, gravels and sands with good water permeability and with expressed porosity. • The site is located within Eocene sediments built of sandstone and claystone accounted as impermeable. There are no significant tectonic structures with the site area. Rocks on the surface have only rare cracks, tight and not filled. • There are no hydrant points within or near the site. River Vardar flows at about 4.5 km south of the site. There are no wells for groundwater pumping within or near the site considered. • From north and south location is limited by low hills structures with not very steep slopesmade of tightly bound, not petrified rock masses is found. • Closest recipients are rural (Vojshanci settlement) located about 3.5 km from the site. River Vardar flows at about 1 km south of the settlement. Main usage is irrigation and recreation. • Large masses of green Pliocene clays located east from the site, can be used for borrow pits.
Technical and Operational characteristic	• The altitude of the site ranges from 217 to 265 meters (mean average 242 m). • The proposed site is situated at a generally flat area slightly to the north of the unpaved not accessible road connecting Vojsanci with Brusnik. The ground is sloping down towards southeast. • The total expansion of the area that could be used according to the morphological characteristics is approximately 15.6 ha, so there is enough area for the sitting of central waste management facilities of Vardar region. • Regarding the property ownership of the site, the site is characterized as fully state owned. • 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 through the unpaved not accessible road connecting the settlements Vojsanci and Brusnik, so there is a need for road construction works for approximately 3.6 km. • The bridge that crosses Vardar river also needs improvement works. • There is also the need of deviation of the waste transportation route from the Vojsanci settlement. • The site could be connected to the public utility networks through the nearby settlements.
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 38km.
Conclusion	***No further Evaluation.*** The site N3 in Municipality of Negotino, has the following advantages: ○ It is not located in, or near protected areas ○ It has space to implement the central waste management facilities In the wider area of the proposed site two more sites are identified: sites N4 and N5, which have in general same characteristics and the description of them is given in the next paragraphs. The site N5 is considered as prevailing and it is chosen for further evaluation.

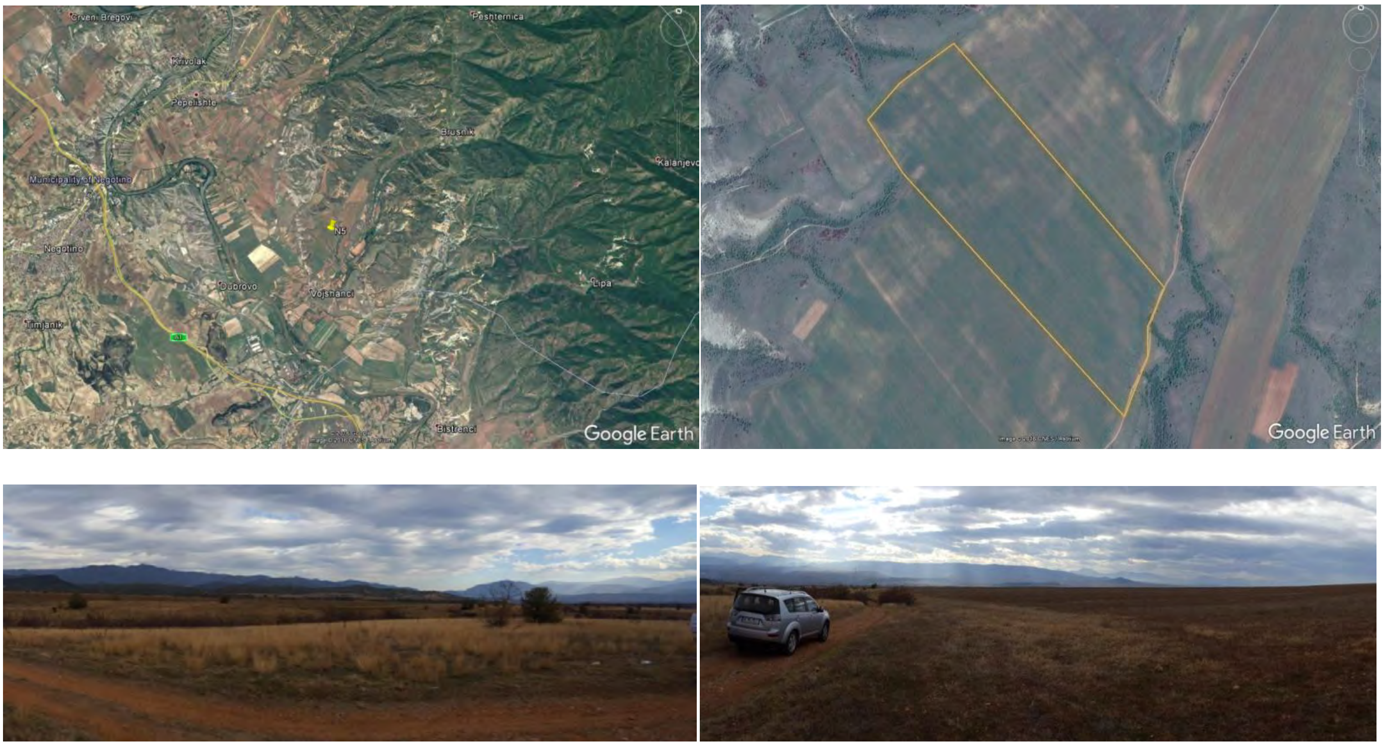
Figure 6-13: Geographical location, utilization area and site photos of the alternative site Negotino 3 (N3)

<table>
<tr><th colspan="2">Alternative site Negotino 4 (N4) – Negotino Municipality</th></tr>
<tr><td>Geographical site location</td><td>The site is situated east of Negotino settlement at approximately 5.8 km direct distance.
Regarding the approximate direct distance from the nearby settlements, the N3 proposed site is situated approx.: 6.1 km South-Southwest of Peshternitsa, 3.6 km Southwest of Brusnik, 8 km Waste-Southwest of Kalanjevo, 6.6 km west of Lipa, 2 km North-Northeast of Vojshantsi, 6.4 km North of Tremnik, 3.9 km Northeast of Dubrovo, 8 km Northeast of Timjanik, 4.4 km Southeast of Pepelishte, 5.4 km Southeast of Krivolak.</td></tr>
<tr><td>Access road</td><td>The access to the site takes place from Vojshantsi through an unpaved not accessible road (approximately 2.5 km road distance).
Vojshantsi settlement is connected with regional road R-2137 to the regional and national road grid, crossing the Vardar river through a paved bridge (2 lanes that needs improvement works).</td></tr>
<tr><td>Spatial characteristics</td><td>Brusnik is the closest settlement to the proposed location (approximately 2km).
The site is placed on a remote area without any optical contact from settlements or any other activities. The site is only visible from the rural road.
There is no archaeological site under a distance of 3km.</td></tr>
<tr><td>Environmental characteristics</td><td>There are no protected areas nearby the proposed site, at a distance of approximately 3 km.
The closest protected area to the site is the Emerald site "OrlovoBrdo" (MK0000011) in the northwest of the site, at a distance of approx 4 km. The boundaries of this protected area coincide with the designated area with same name "OrlovoBrdo" (196505).
According to Corine Land Cover 2012, the site is situated in non-irrigated arable land with a small part of transitional woodland –shrub.</td></tr>
<tr><td>Geological – Hydrogeological characteristics</td><td>Site considered is situated within Pliocene sediments of small thickness, made by clays, gravel and sand. The Pliocene sediments are considered as semi permeable. There are no significant tectonic structures with 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 Vardar flows at about 3 km south of the site. There are no wells for groundwater pumping within or near the site considered.
In his largest part the site is located within flat lowlands. Along the east boundary of the site a long and shallow gorge with relatively mild slopes made of tightly bound, not petrified rock masses is found.
Closest recipients are rural (Vojshanci settlement) located about 2 km from the site. River Vardar flows at about 1 km south of the settlement. Main usage is irrigation and recreation.
The wider area of the location is wavelike creased with dominant slopes located in the eastern part of the site. The slopes have not very steep sides (greater than 30 degrees).
As the site is located within Pliocene clay, the borrow pit can be formed within the site.</td></tr>
<tr><td>Technical and Operational characteristic</td><td>The altitude of the site ranges 202 to 229 meters (mean average 216 m).
The proposed site is at a flat area slightly off the unpaved not accessible connecting Vojsanci with Brusnik.
The total expansion of the area that could be used according to the morphological characteristics is approximately 15.6 ha, so there is enough area for the sitting of central waste management facilities of Vardar region.
Regarding the property ownership of the site, the site is characterized as fully state owned.
According to the geological characteristics, there is availability of soil material for the daily soil cover.</td></tr>
<tr><td>Demands for infrastructure works</td><td>The final access to the site can be through the unpaved not accessible road connecting the settlements Vojsanci and Brusnik, so there is a need for road construction works for approximately 2.5 km.
The bridge that crosses Vardar river also needs improvement works.
There is also the need of deviation of the waste transportation route from the Vojsanci settlement.
The site could be connected to the public utility networks through the nearby settlements.</td></tr>
<tr><td>Transportation costs – Distance from waste production center of the region</td><td>Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 36km.</td></tr>
<tr><td>Conclusion</td><td>No further Evaluation.
The site N4 in Municipality of Negotino, has the following advantages:
It is not located in, or near protected areas
It has space to implement the central waste management facilities
In the wider area of the proposed site two more sites are identified: sites N3 and N5, which have in general same characteristics. The site N5 is considered as prevailing and it is chosen for further evaluation.</td></tr>
</table>

Figure 6-14: Geographical location, utilization area and site photos of the alternative site Negotino 4 (N4)

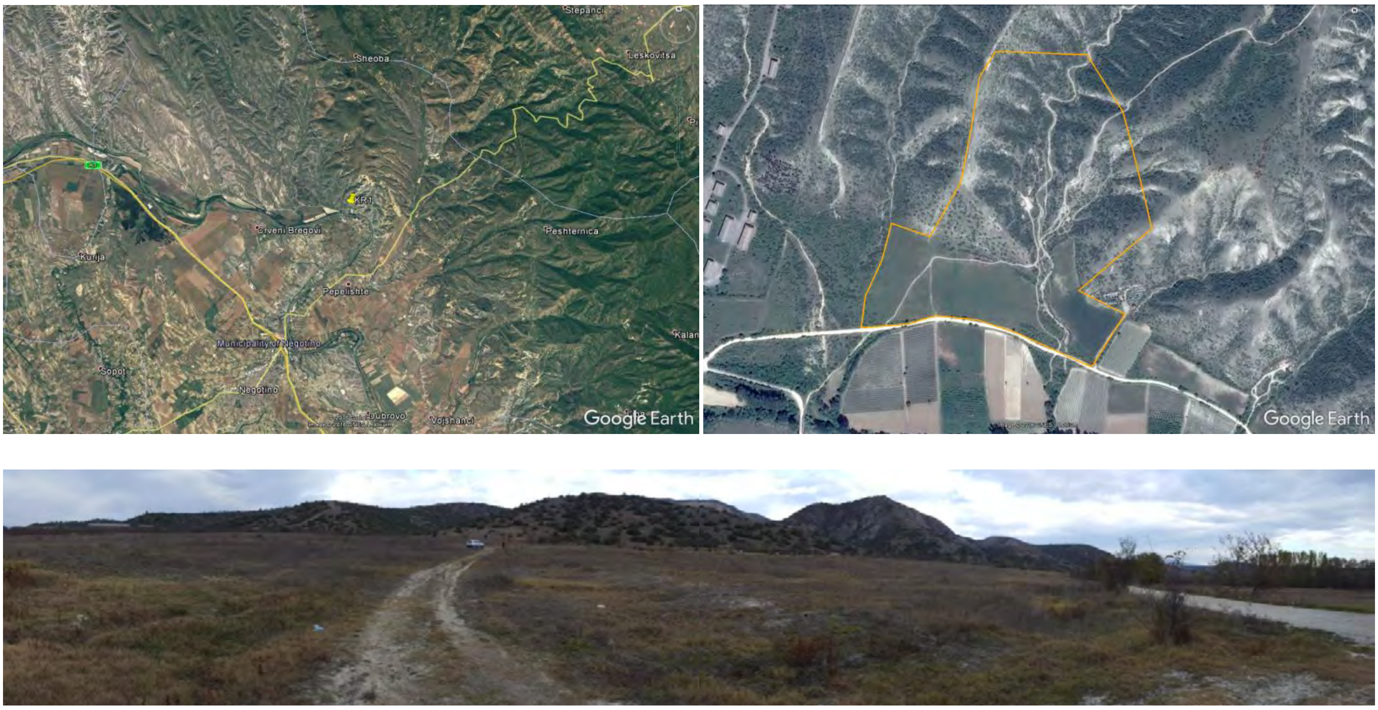
<table>
<tr><th colspan="2">Alternative site Negotino 5 (N5) – Negotino Municipality</th></tr>
<tr><td>Geographical site location</td><td>The site is situated east –northeast of Negotino settlement at approximately 5.4 km direct distance.
Regarding the approximate direct distance from the nearby settlements, the N3 proposed site is situated approx.: 7 km South- Southwest of Peshternitsa, 4.5 km Southwest of Brusnik, 8.7 km West- Southwest of Kalanjevo, 6.9 km west of Lipa, 1.4 km North of Vojshantsi, 5.6 km North of Tremnik, 2.5 km Northeast of Dubrovo, 7.2 km Northeast of Timjanik, 4.5 km Southeast of Pepelishte, 5.4 km southeast of Krivolak.</td></tr>
<tr><td>Access road</td><td>The final access to the site is from Vojshantsi through an unpaved not accessible road (approx. 1.5 km road distance).
Vojshantsi settlement is connected with regional road R-2137 to the regional and national road grid, crossing the Vardar river through a paved bridge (2 lanes that needs improvement works).</td></tr>
<tr><td>Spatial characteristics</td><td>Vojshantsi is the closest settlement to the proposed location (approximately 1.4 km).
The site is placed on a remote area without any optical contact from settlements or any other activities. The site is only visible from the rural road.
There is no archaeological site under a distance of 3km.</td></tr>
<tr><td>Environmental characteristics</td><td>There are no protected areas nearby the proposed site, at a distance of approximately 3 km.
The closest protected area to the site is the Emerald site "Orlovo Brdo" (MK0000011) is in the northwest of the site, at a distance of approximately 4.3 km. The boundaries of this protected area coincide with the designated area with same name "Orlovo Brdo" (196505).
According to Corine Land Cover 2012, the site is situated in non-irrigated arable and the wider area also includes a small part of complex cultivation patterns.</td></tr>
<tr><td>Geological – Hydrogeological characteristics</td><td>Site considered is situated within Pliocene sediments of small thickness, made by clays, gravel and sand. The Pliocene sediments are considered as semi-permeable.
As per the Hydrogeological map of the Republic of Macedonia (1: 200 000) flysch sediments fall into waterless terrains.
There are no significant tectonic structures with 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 Vardar flows at about 3 km south of the site. There are no wells for groundwater pumping within or near the site considered.
In his largest part the site is located within flat lowlands where morphological forms with the presence of slopes are found.
Closest recipients are rural (Vojshanci settlement) located about 1.7 km from the site. River Vardar flows at about 1 km south of the settlement. Vardar River alluvium (at about 1.8 km) is the most permeable zone around the site considered.
The wider area of the location is wave like creased with dominant slopes located in the western part of the site. The slopes have very steep sides (greater than 50 degrees).
As the site is located within Pliocene clay, the borrow pit can be formed within the site.</td></tr>
<tr><td>Technical and Operational characteristic</td><td>The altitude of the site ranges from 178 to 197 meters (mean average 190 m).
The proposed site is at a flat area slightly to the north –northeast of the unpaved not accessible road connecting Vojsanci with Brusnik settlements. The ground is sloping down towards south (southwest to northwest).
The total expansion of the area that can be utilized according to the morphological characteristics is approximately 18.3 ha, so there is enough area for the sitting of central waste management facilities of Vardar region.
Regarding the property ownership of the site, the site is characterized as fully state owned.
According to the geological characteristics, there is availability of soil material for the daily soil cover.</td></tr>
<tr><td>Demands for infrastructure works</td><td>The final access to the site can be through the unpaved not accessible road connecting the settlements Vojsanci and Brusnik, so there is a need for road construction works for approximately 1 km.
The bridge that crosses Vardar river also needs improvement works.
The site could be connected to the public utility networks through the nearby settlements.</td></tr>
<tr><td>Transportation costs – Distance from waste production center of the region</td><td>Taking into consideration the produced waste from each municipality for 2016, the estimation of weighted distance to this site has been calculated to 35km.</td></tr>
<tr><td>Conclusion</td><td>Further Evaluation.
The site N5 in Municipality of Negotino, has the following advantages:
It is not located in, or near protected areas,
It has plenty of space to implement the central waste management facilities, etc
In the wider area of the proposed site two more sites are identified: sites N3 and N4, which have in general same characteristics. The site N5 is considered as prevailing and it is chosen for further evaluation.</td></tr>
</table>

Figure 6-15: Geographical location, utilization area and site photos of the alternative site Negotino 5 (N5)



Alternative site Krivolak (KR1) – Negotino Municipality	
Geographical site location	• The site is situated north–northeast of Negotino settlement at approx. 5.2 km direct distance. • Regarding the approximate direct distance from the nearby settlements, the KR1 proposed site is: 2.3 km North of Krivolak, 2.3 km Northeast of Crveni Bregovi, 2.9 km North-Northwest of Pepelishte, 7.5 km West-Southwest of Peshternitsa, 7.9 km Northwest of Brusnik and 8.4 km North-Northwest of Vojshantsi.
Access road	• The access to the site takes place from Krivolak settlement through a local road that crosses Vardar river through a small paved bridge. • Krivolak settlement is connected to the main road grid through R-2137 regional road (2 lanes).
Spatial characteristics	• Krivolak and CrveniBregovi are closest settlements to the proposed location (approximately 2.3 km). • The site is situated in the vicinity of military installations and within the limits of the protected area OrlovoBrdo. • The site is placed on a remote area without any optical contact from settlements or any other activities. The site is only visible from the local road. • There is no archaeological site under a distance of 3km.
Environmental characteristics	• The proposed site is situated within the limits of the Emerald site "OrlovoBrdo" (MK0000011). The boundaries of this protected area coincide with the designated area with same name "OrlovoBrdo" (196505). • According to Corine Land Cover 2012, the site is situated in a non-irrigated arable land with alteration of transitional woodland shrub and natural grasslands, and near Vardar river banks.
Geological – Hydrogeological characteristics	• The site is built of none permeable claystone, marlstone and sandstone (all none permeable rocks with a very slight fissure porosity). • As per the Hydrogeological map of the Republic of Macedonia (1: 200,000) flysch sediments fall into waterless terrains. • There are no hydrant points within or near the site. River Vardar flows about 200 m south of the site. There are no wells for groundwater pumping within or near the site considered. • There are no significant tectonic structures with the site area. Rocks on the surface have only rare cracks, tight and not filled. • The Vardar River and therefore settlement of Negotino and several settlements along the river Vardar, are the main recipients (mostly rural). Main usage is irrigation and recreation. • The site catchment area is morphologically diverse but dominated with low hills and shallow valleys, with an average angle of slope of 40 degrees. • Near Pepeliste settlement, in a distance of 2.5 km from the site, there are Pliocene structures which can be used for excavation of plastic clay.
Technical and Operational characteristic	• The altitude of the site ranges from 123 to 180 meters (mean average 145m). • The proposed site is at a flat area slightly to the north of the local road. • The total expansion of the area that could be used according to the morphological characteristics is approximately 12.7ha, so there is enough area for the sitting of central waste management facilities of Vardar region. • Regarding the property ownership of the site, most of the site belongs to a private ownership. • 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 proposed site is through an unpaved accessible road that needs improvement works (<500m). • The bridge crossing Vardar river also needs improvement works. • The site could be connected to the public utility networks through the nearby settlements.
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 39km.
Conclusion	***No further Evaluation.*** The site KR1 in Municipality of Negotino, has the following disadvantages: ○ there is not enough space to implement the central waste management facilities ○ the site KR1 is located within the limits of the Emerald site "OrlovoBrdo" (MK0000011).

Figure 6-16: Geographical location, utilization area and site photos of the alternative site Krivolak 1 (KR1)



<u>Selection of the appropriate site</u>

Based on the conclusions of those descriptions, 3 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.The three alternative potential sites in the area of Vardar Region were selected finally for evaluation from the multi-criteria analysis procedure were:

- Site R1
- Site U3
- Site N5

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

Step 1: Determine exclusion criteria for the examination of alternative potential sites;
Step 2: Choose, classify and calibrate the evaluation criteria;
Step 3: Estimate the criteria weight factors;
Step 4: Set alternative potential sites;
Step 5: Grade alternative potential sites – Determine indifference and preference thresholds;
Step 6: Use a multi-criteria software tool;
Step 7: 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 seismic 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 three potential sites took place. The following table presents the grading results for the three potential landfill sites obtained for the first criteria category's individual criteria. The same was done for the individual criteria of the other four categories.

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
R1	10	10	1	10	7	10	7	5	10	5	8	7	5
U3	10	8	7	10	4	10	7	10	9	3	4	5	5
N5	7	8	7	10	10	10	8	4	8	4	4	10	10

Table 6-6: Multi criteria matrix for Environmental group

Site/Criterion	B1a	B1b	B2	B3a	B3b	B4a	B4b
R1	10	3	2	10	10	8	5
U3	8	6	1	3	5	7	3
N5	8	6	6	3	1	8	5

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

Site/Criterion	C1	C2a	C2b	C3	C4	C5a	C5b	C5c	C5d	C6a	C6b
R1	6	10	1	10	10	10	10	10	10	5	9
U3	4	7	5	10	5	10	10	6	5	5	5
N5	4	9	5	10	10	10	10	10	10	5	7

Table 6-8:Multi criteria matrix for Operational group

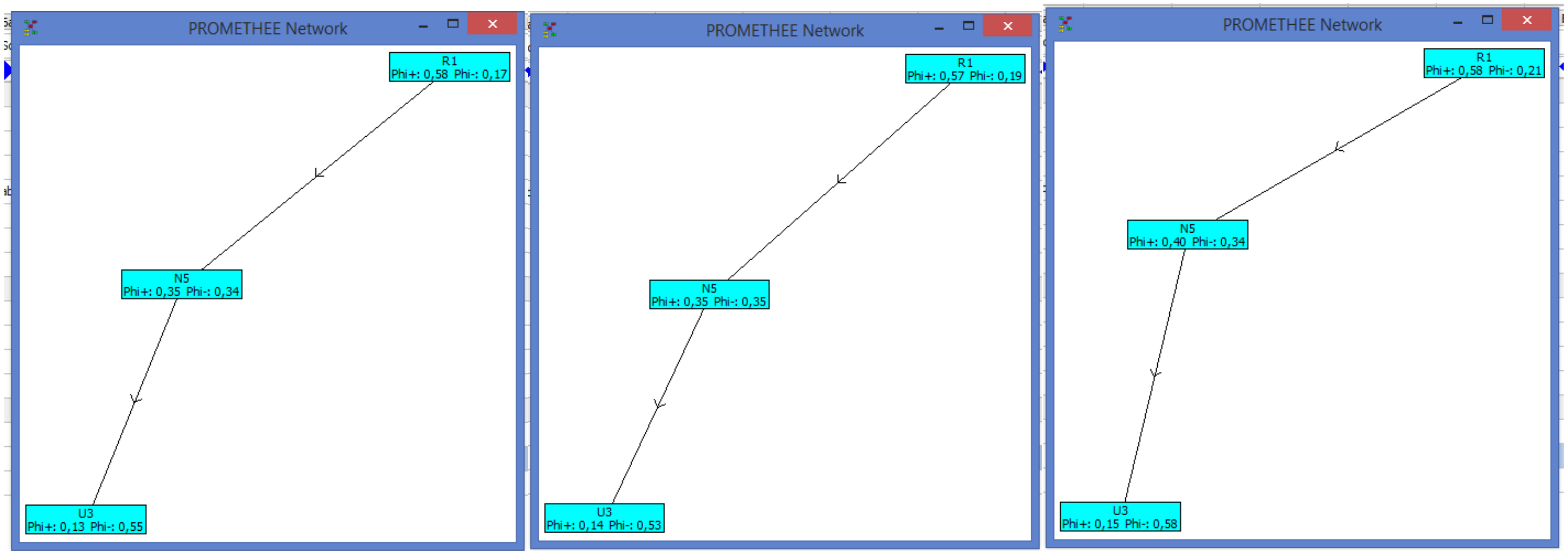
Site/Criterion	D1a	D1b	D2	D3
R1	8	5	10	5
U3	10	5	7	5
N5	10	5	9	5

Table 6-9: Multi criteria matrix for financial group

Site/Criterion	E1	E2	E3	E4
R1	7	10	3	5
U3	4	7	7	5
N5	8	8	5	4

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 figure shows 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 R1 located in Rosoman municipality was ranked as the best potential site for the construction and operation of a central waste management facility in Vardar Region. The following table summarises 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	R1→U3→N5	R1→U3→N5	R1→U3→N5
	B: Environmental	R1→N5→U3	R1→N5→U3	R1→N5→U3
	C: Land-planning	R1→N5→U3	R1→N5→U3	R1→N5→U3
	D: Operational	R1→N5→U3	R1→N5→U3	R1→N5→U3
	E: Financial	R1→N5→U3	R1→N5→U3	R1→N5→U3

6.3.2 Option analysis for location of Transfer Stations - Methodology

The selection of the appropriate location for the construction of Transfer Stations (TSs)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 Vardar region the project team applied the following steps:

- The maximum possible number of TSs 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.

Selected sites' description

The municipalities in which Transfer Stations will be constructed are the municipalities of (i) Veles, (ii) Kavadartsi and (iii) Negotino. 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
Veles TS	Veles, Lozovo, Chashka
Kavadartsi TS	Kavadartsi
Negotino TS	Negotino, Demir Kapija

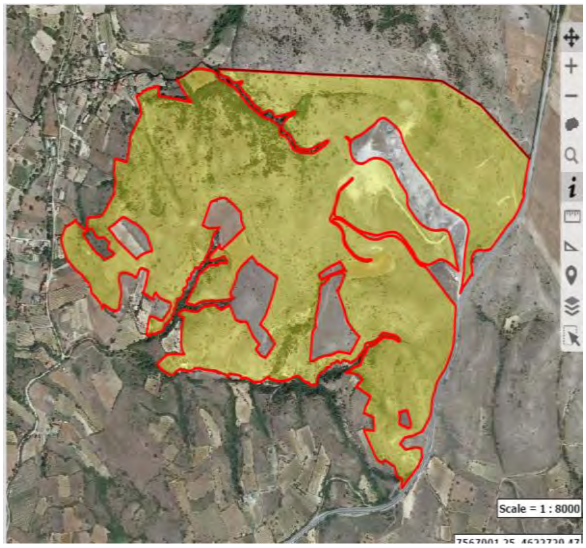
The municipalities of Gradsko and Rosoman will transfer their waste directly to Central Waste Management Facilities.

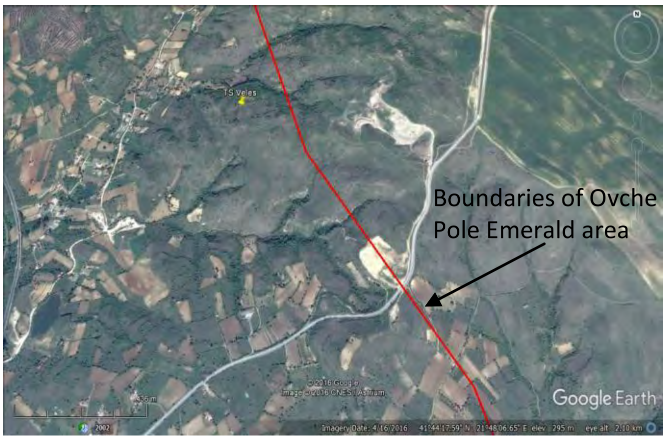
Veles TS

- The site which was proposed by Veles Municipality is located N-NE of Veles settlement in a direct distance of approx. 3 km.
- The total surface of the proposed site is 79 ha and the area that will be used for the construction of the TS is 2.2 ha.
- The nearest settlement is Chalosevo settlement in a direct distance of approx. 300 m.
- The site partially belongs to the Emerald area Ovche Pole (MK0000035). The part of the site within Emerald area was abstracted.
- The access to the site is from the national road R1312 that connects Lozovo settlement with Veles settlement to the point that intersects with the access route to Bunar Dere landfill. A new road of approx 700 m should be constructed for access in the specific area.
- The site is public owned.

The following figures illustrate the plot area of the proposed site, the boundaries of the Emerald area Ovche Pole and the national road R1312 which connects the settlements of Lozovo and Veles.

Figure 6-18: Plot are of the proposed site, boundaries of Emerald area and national access road R1312/Veles TS



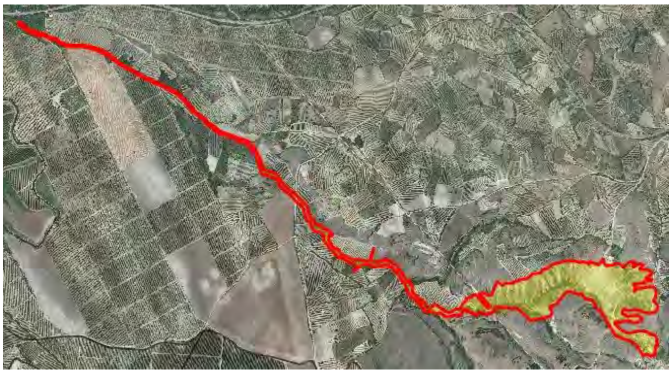


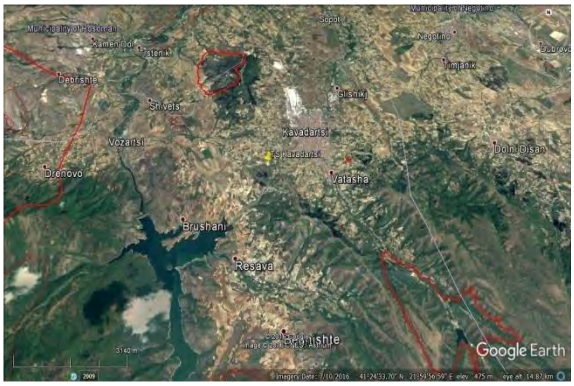
Kavadartsi TS

- The site which was proposed from Kavadartsi Municipality is located S-SW of Kavadartsi settlement in a direct distance of approx. 1 km.
- The total surface of the proposed site is 15 ha and the area that will be used for the construction of the TS is 2.8 ha.
- The proposed site is located in an existing non compliant municipal landfill (RALL 008).
- The closest Emerald site is Raec site (MK0000028) in a direct distance of approx 7 km west of proposed site. In a direct distance of approx. 3 km E of proposed site a monument of nature '*Kalnica*' is located, in a direct distance of approx 4 km N-NW the strict Nature Reserve Ljubash is located and in a direct distance of approx 5.4 km S-SE the Nature Park Lake Moklishko is located.
- The nearest settlement is Kavadartsi settlement.
- The access to the site is through Kavadartsi settlement. 700 m of the existing road should be improved.
- The site is public owned.

The following figures illustrate the plot area of the proposed site, the boundaries of Emerald and protected areas and the access road for the specific site.

Figure 6-19: Plot area of the proposed site, boundaries of Emerald and protected area and access road/Kavadartsi TS



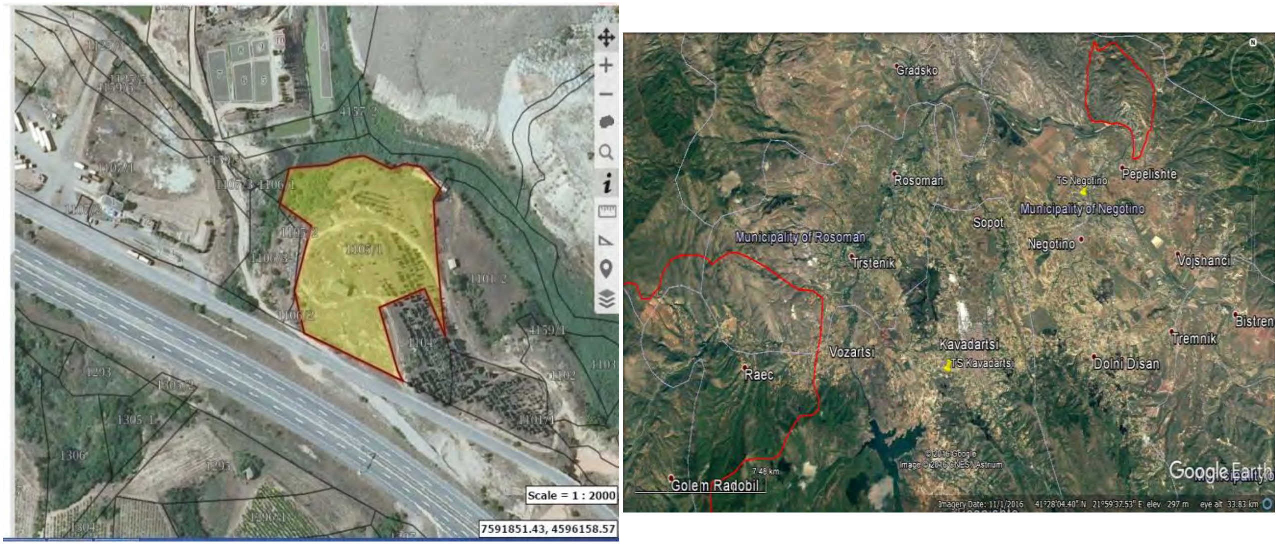


Negotino TS

- The site which was proposed by Negotino Municipality is located N of Negotino settlement in a direct distance of approx. 1 km.
- The total surface of the proposed site is 1,15 ha and the whole area will be used for the construction of the TS.
- The closest Emerald site is Orlovo Brdo site (MK0000011) in a direct distance of approx 4.2 km N-NE of proposed site. In a direct distance of approx. 17 km W-SW of proposed site the Emerald site Raec (MK0000028) is located.
- The nearest settlement is Negotino settlement.
- The access to the site is through national road R1102 which connects Negotino settlement with Gradsko settlement.
- The site is public owned.

The following figures illustrate the plot area of the proposed site, the boundaries of Emerald and protected areas and the access road for the specific site.

Figure 6-20: Plot area of the proposed site, boundaries of Emerald and protected area and access road/Negotino 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 traveling 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 bins, 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 R1 site (Rosoman Municipality), either directly with waste collection vehicles or through transfer stations, are equal to **39,359 t/y,** after removal of hazardous municipal waste, waste collected in Green Points, waste used in home composting actions, and other waste streams(i.e. WEEE, construction and demolition waste, etc.).

The quantity of waste per municipality of Vardar region that will be transferred for the appropriate treatment and disposal is presenting in the following table.

Table 6-12: Waste quantities per municipality that will be transferred to CWMF in R1 site (aver. 2021-2046)

Municipalities	Quantity (t/y)	Participation %
Veles	15,346	39.0%
Lozovo	586	1.5%
Chashka	1,472	3.7%
Kavadartsi	14,307	36.4%
Negotino	5,423	13.8%
Demir Kapija	707	1.8%
Gradsko	856	2.2%
Rosoman	662	1.7%
TOTAL	**39,359**	**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 eight (8) municipalities in Vardar 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 Vardar Region.

As it is already mentioned 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 quantities to be transferred to the CWMFat Rosoman, either directly with waste collection vehicles, or through transfer stations, are equal to 39,359t/y (2021-2046 average waste quantity). The waste quantities to be transferred via TS vary depending on the number of TSs, 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.

The following tables present 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 2021-2046)

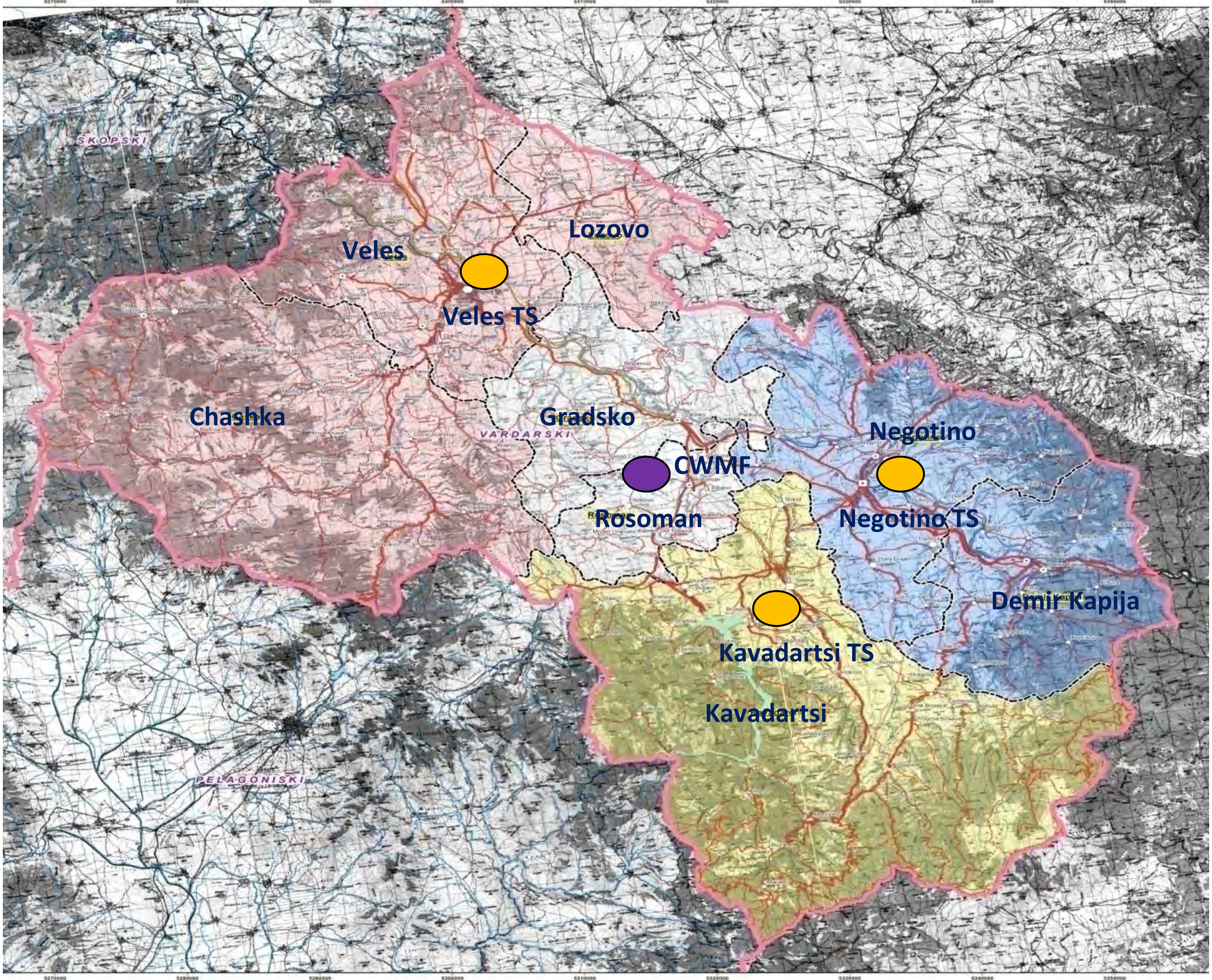
Potential TS	TS to CWMF (roundtrip, km)	Served municipalities	Residual waste stream (t/y)	Recyclable waste stream (t/y)	Green waste stream (t/y)	Total Quantities (t/y)
Veles	72	Veles	11,113	3,336	897	15,346
		Lozovo	425	127	34	586
		Chaska	1,066	320	86	1,472
		Sub-total	***12,603***	***3,783***	***1,017***	***17,404***
Kavadarci	32	Kavadarci	10,361	3,110	836	14,307
		Sub-total	***10,361***	***3,110***	***836***	***14,307***
Negotino	50	Negotino	3,927	1,179	317	5,423
		Demir Kapija	512	154	41	707
		Sub-total	***4,439***	***1,333***	***358***	***6,130***
Total quantity transported through TSs						**37,842**

Table 6-14: Capacities of municipalities that will transfer their waste directly to CWMF (average quantities 2021-2046)

Direct transportation toCWMF-Municipalities	(roundtrip, km)	Residual waste stream (t/y)	Recyclable waste stream (t/y)	Green waste stream (t/y)	Total Quantities (t/y)
Gradsko	20	620	186	50	856
Rosoman	6	479	144	38	661
		1,099	***330***	***89***	***1,517***
Total quantity transported directly					**1,517**

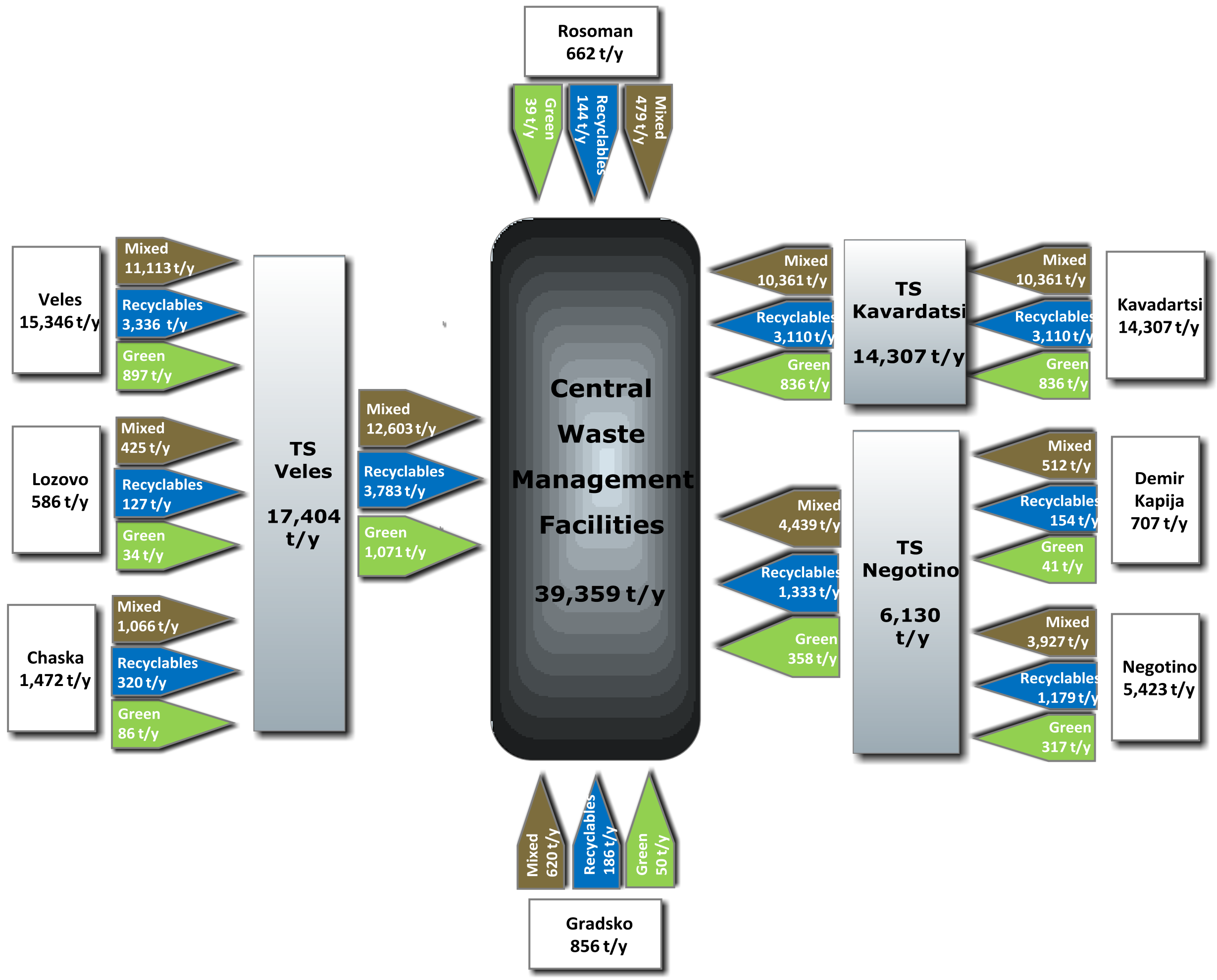
The following map illustrates the locations, in a municipality level, and the municipalities which will be served for each proposed TS. Also municipalities that transport their waste directly to CWMF are presented.

Figure 6-21: Locations of potential Transfer Stations and CWMF and respective served 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 6-22: Overall transportation system in Vardar 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 generally designed in two main operating floors. During the operation the waste is dumped directly from collection vehicles (which located on the top floor), through a hopper, into an open-top trailer which located on the lower floor. The trailers positioned on scale so that dumping 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 dump 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 leveled 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 which 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 (usually less than 20,000 t/y), 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 less than 20,000 t/y (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 6-23: Option Wheeled press containers and relevant trucks for wheeled press containers

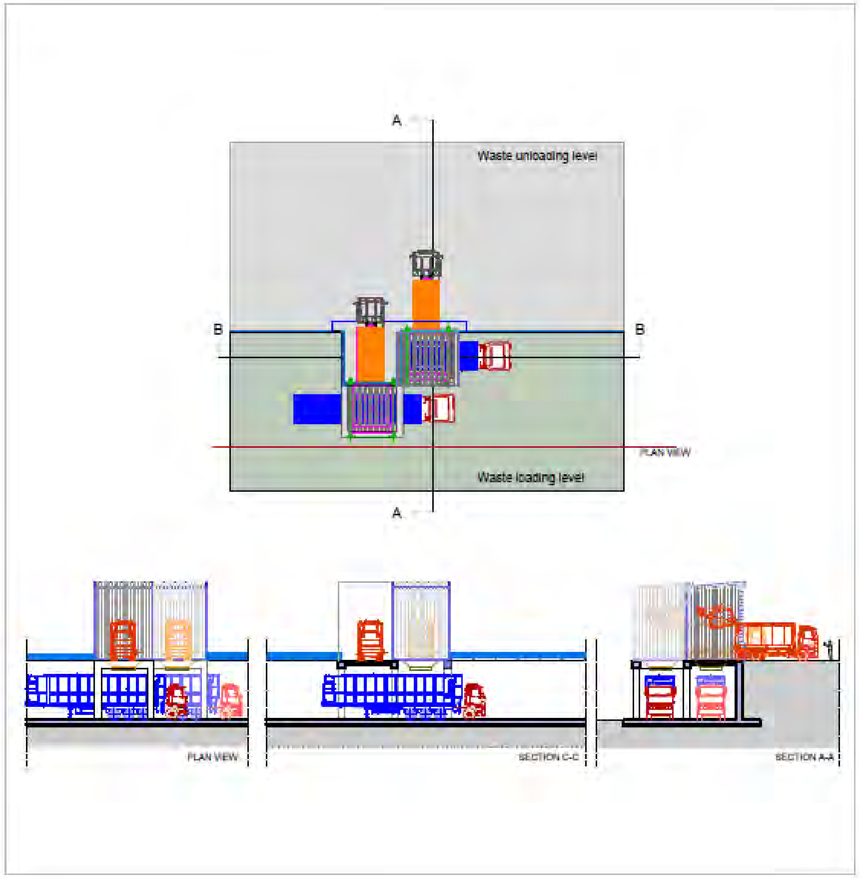
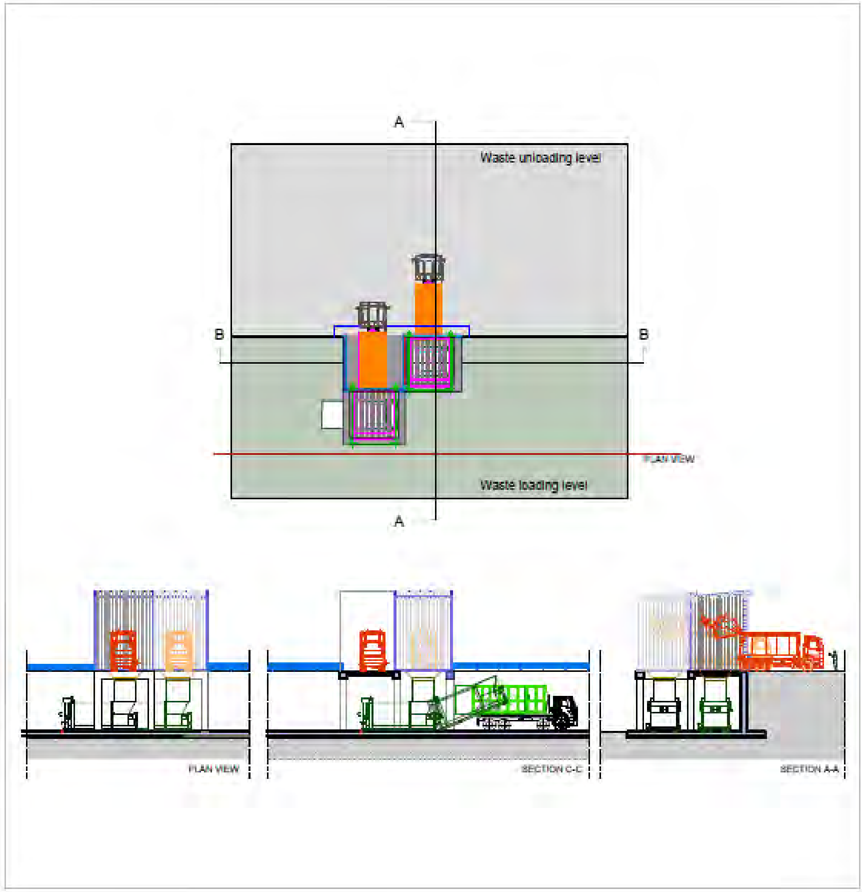
Wheeled press containers/Truck for wheeled press containers	Press containers/Truck with hook lift for press containers
	

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

Alternative options for transportation equipment	Option 1	Option 2
Wheeled press containers 55 m^3 for mixed waste	V	
Press containers 24 m^3 for mixed waste		V
Press containers 24 m^3 for recyclable waste	V	V
Containers 24 m^3 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 Vardar region. Analytical calculations are presenting in relevant Annex of the present study.

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

Investment cost for transportation equipment €/Vardar Region	Option 1	Option 2
Veles TS	527,455	414,074
Kavadartsi TS	527,455	257,580
Negotino TS	527,455	234,205

<u>Option 2</u> (press containers for mixed and recyclable waste and open containers for green waste/truck with hook lift) selected for all the proposed TSs in Vardar 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 Vardar region

	Veles TS	Kavadartsi TS	Negotino TS
Total Investment cost of TS €/y	1,178,591	918,324	857,314
Total operational cost of TS €/y	145,988	87,800	78,416

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

	Veles TS	Kavadartsi TS	Negotino TS
Unit cost for build own and operate TS facility (incl. also transportation cost to CWMF) (€/t)	12.14	9.51	20.12

6.4.3.2 Calculation of trucking cost

The average cost of direct or transfer hauling in €/km 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.

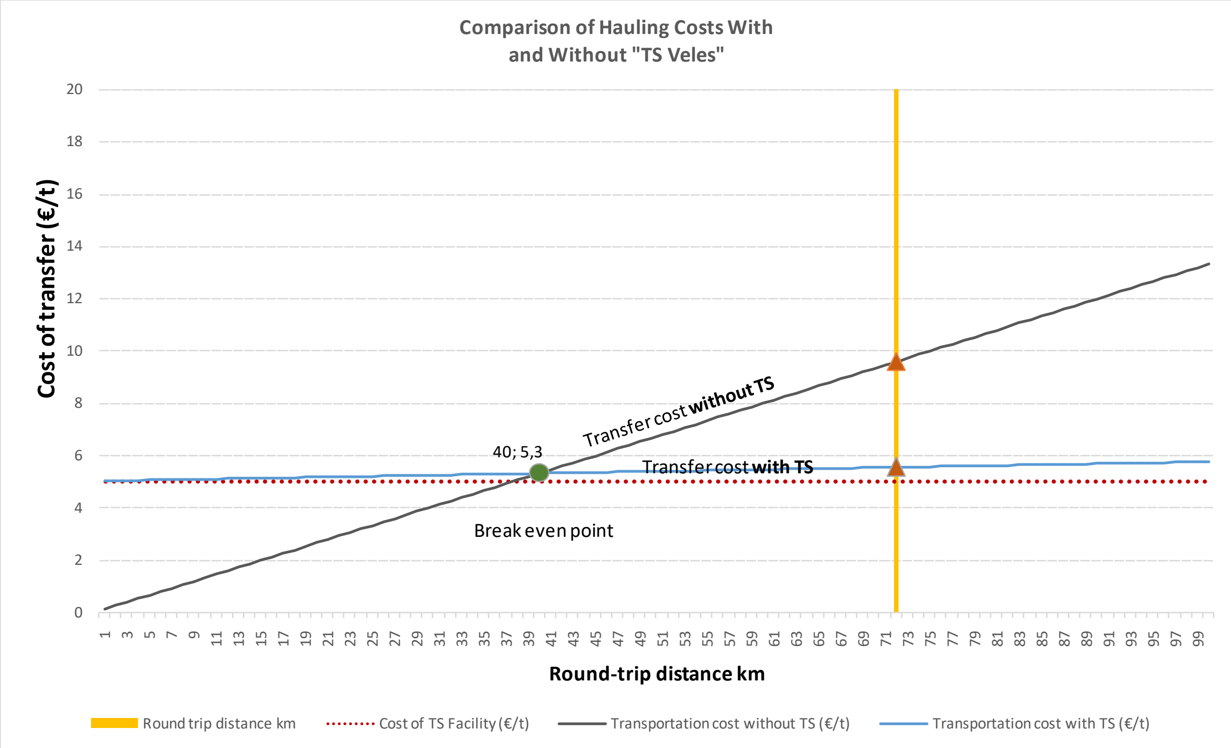
Table 6-19: Average cost of direct or transferring hauling (Investment and operational cost)

	Veles, Lozovo, Chashka	Kavadartsi	Negotino, Demir Kapija
Cost for transportation equipment through TSs (€/t)	7.15 (for average round-trip 72 km)	4.65 (for average round-trip 32 km)	9.19 (for average round-trip 50 km)
Cost for transportation equipment through small trucks without TSs (€/t)	33.90 (for average round-trip 75 km)	21.10 (for average round-trip 32 km)	41.40 (for average round-trip 56 km)

6.4.3.3 Break even points determination

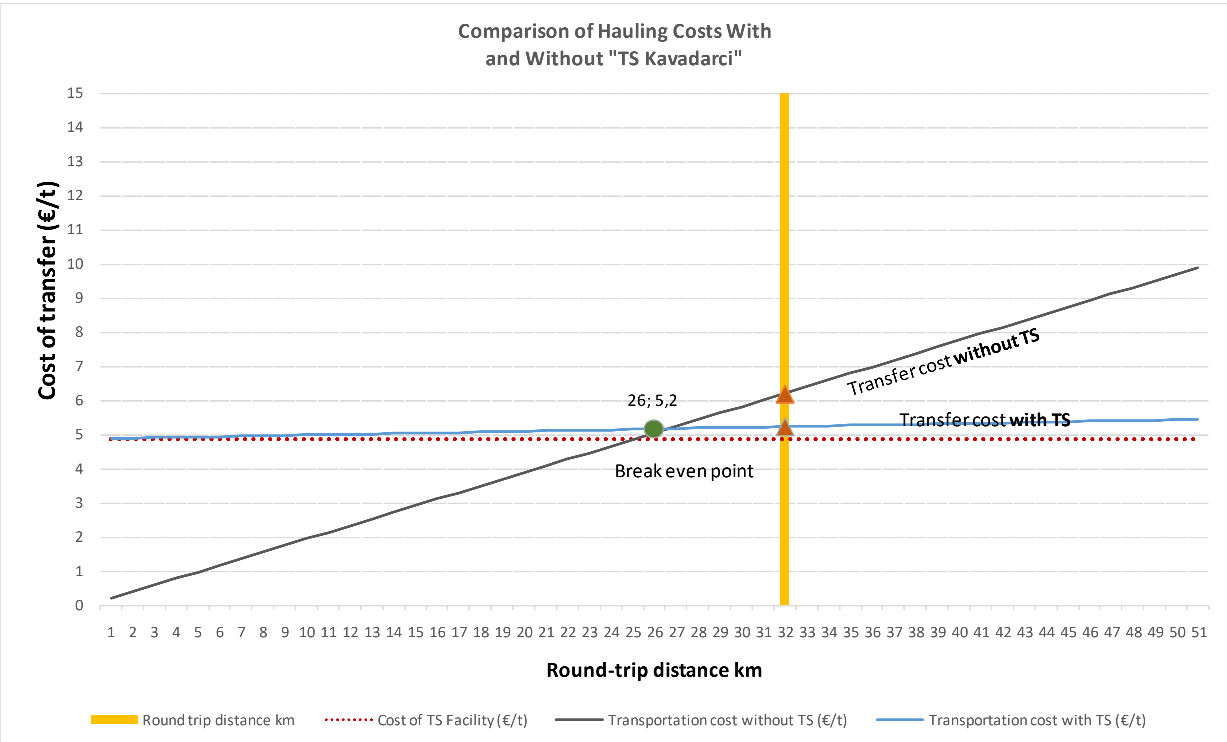
The following figures demonstrate a representative "cost versus kilometres" relationship between direct hauling waste to disposal facilities in collection vehicles versus hauling in larger vehicles for each proposed Transfer station in Vardar Region.

TS in Veles municipality (served municipalities: Veles, Lozovo, Chashka)



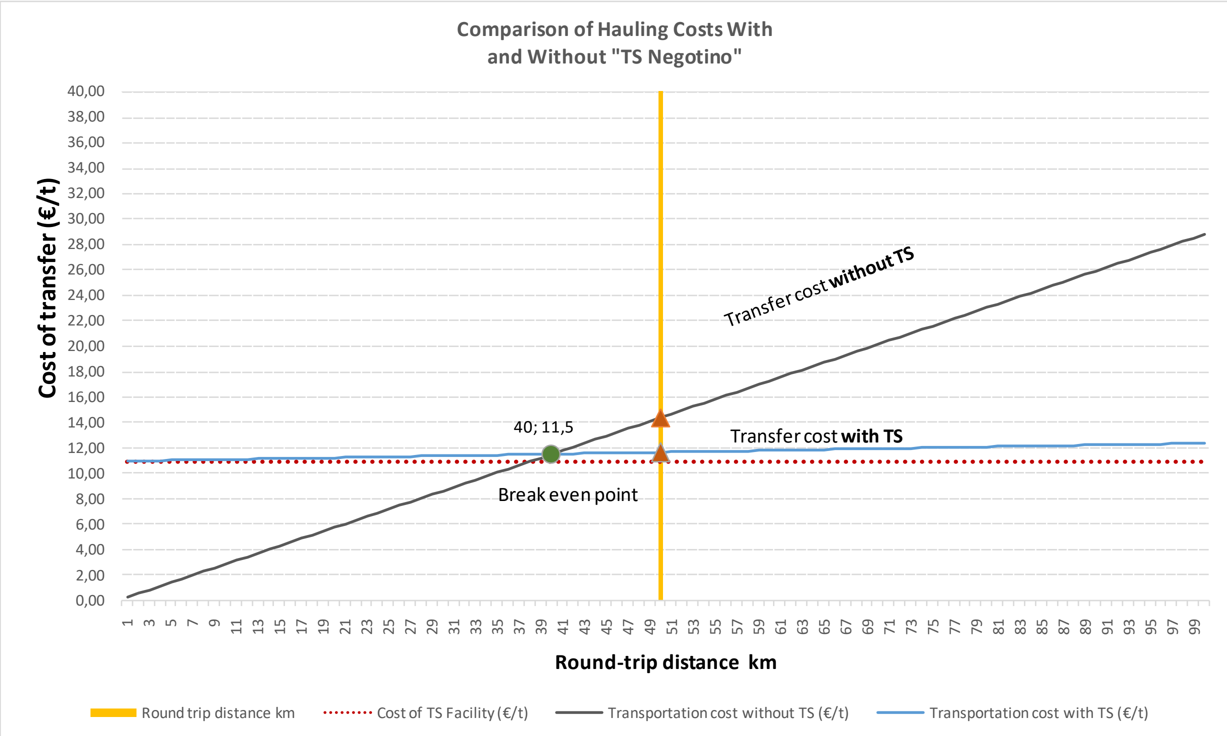
The comparison shows a break-even distance of 40 km (round-trip), which means that is cost effective to construct this specific TS when the round-trip distance exceeds 40 km. The round-trip distance from TS location in Veles municipality to CWMF is approx. 72 km so Veles TS is cost-effective and proposed to be constructed.

TS in Kavadartsi municipality (served municipalities: Kavadartsi)



The comparison shows a break-even distance of about 26 km (round-trip), which means that is cost effective to construct this specific TS when the round-trip distance exceeds 26 km. The round-trip distance from TS location in Kavadartsi municipality to CWMF is approx. 32 km so Kavadartsi TS is cost-effective and proposed to be constructed.

TS in Negotino municipality (Served municipalities: Negotino, Demir Kapija)



The comparison shows a break-even distance of about 40 km (round-trip), which means that is cost effective to construct this specific TS when the round-trip distance exceeds 40 km. The round-trip distance from TS location in Negotino municipality to CWMF is approx. 50 km so Negotino TS is cost-effective and proposed to be constructed.

6.4.4 Analysis of alternative scenarios for waste transportation in Vardar region

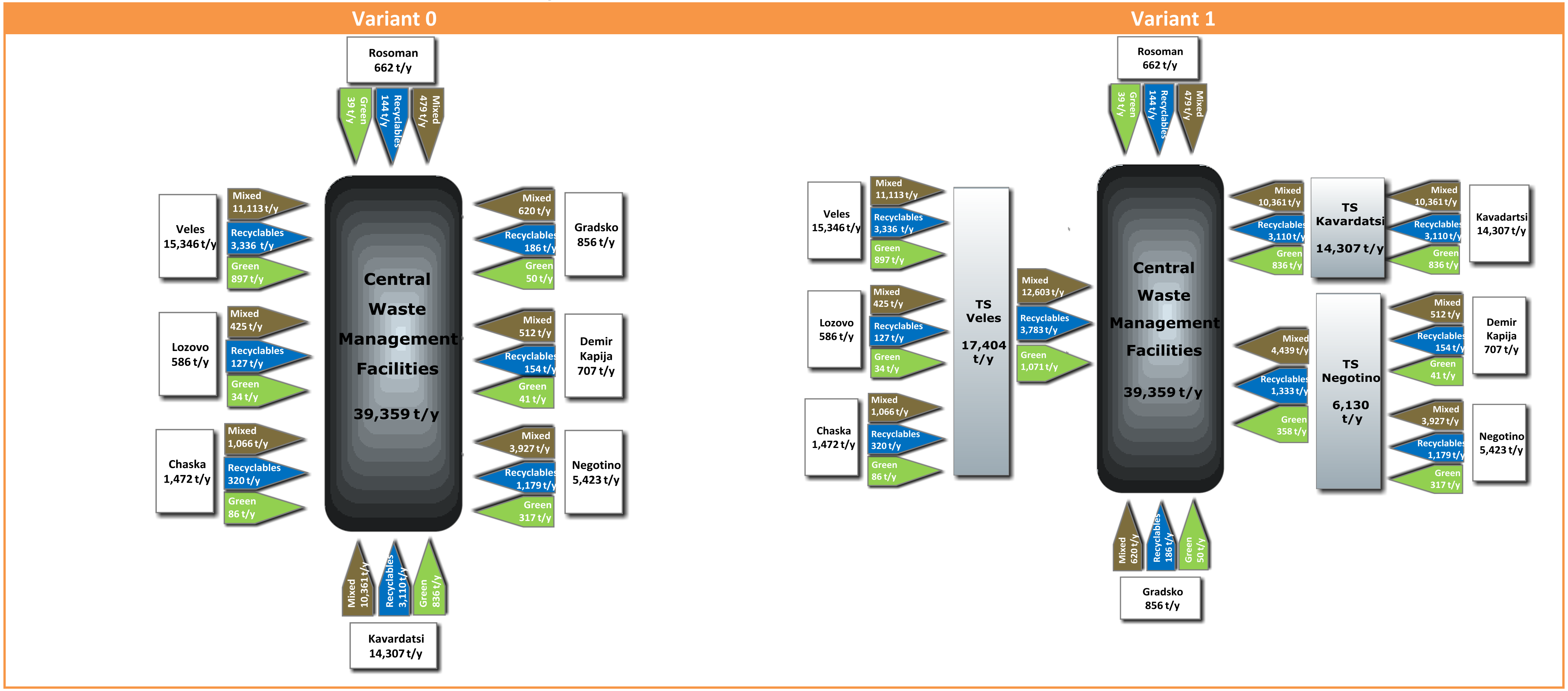
6.4.4.1 Description of options

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 scenario" (no TSs, direct transportation to landfill with collection trucks) with the "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 CWMF
- Do-something (Variant 1) – three (3) TSs: at Veles, Kavadartsi and Negotino, direct transportation for the municipalities of Gradsko and Rosoman.

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

Figure 6-24: 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

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 between the municipalities that will be served by the same Transfer station (i.e. Veles, Lozovo and Chashka municipalities is the first group of municipalities that can share the same trucks and Demir Kapija and Negotino is the second group of municipalities that can share the same trucks for the collection and transportation of recyclable waste). Concerning Kavadarci municipality which is the only municipality that will be served from Kavadarci TS, this can share the trucks with the municipalities of Gradsko and Rosoman.
- 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 these calculations per waste fraction.

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

Trucks for Residual waste	Veles	Gradsko	Demir Kapija	Kavadartsi	Lozovo	Negotino	Rosoman	Chashka	Total
Total CAPEX (€)	580,640	0	0	232,256	116,128	232,256	116,128	116,128	**1,393,536**

Trucks for Recyclable waste	Veles, Lozovo, Chashka	Gradsko, Rosoman, Kavadarci	Demir Kapija, Negotino	Total
Total CAPEX (€)	348,384	232,256	116,128	**696,768**

Trucks for Green waste	Veles, Lozovo, Chashka	Gradsko, Rosoman, Kavadarci	Demir Kapija, Negotino	Total
Total CAPEX (€)	322,376	241,782	161,188	**725,346**

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 (€)

	Veles TS	Kavadartsi TS	Negotino TS
Total investment cost €	1,178,591	918,324	857,314

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	Veles	Gradsko	Demir Kapija	Kavadartsi	Lozovo	Negotino	Rosoman	Chashka	Total
Total CAPEX (€)	348,384	0	0	116,128	116,128	116,128	116,128	0	**812,896**

Trucks for Recyclable waste	Veles, Lozovo, Chashka	Gradsko, Rosoman, Kavadarci	Demir Kapija, Negotino	Total
Total CAPEX (€)	232,256	232,256	116,128	**580,640**

Trucks for Green waste	Veles, Lozovo, Chashka	Gradsko, Rosoman, Kavadarci	Demir Kapija, Negotino	Total
Total CAPEX (€)	161,188	161,188	80,594	**402,970**

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 (€)	2,815,650	1,796,506

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	Veles	Gradsko	Demir Kapija	Kavadartsi	Lozovo	Negotino	Rosoman	Chashka	Total
Total OPEX (€/y)	170,119	25,329	27,691	111,958	26,094	89,365	23,349	60,404	**534,310**

Trucks for Recyclable waste	Veles, Lozovo, Chashka	Gradsko, Rosoman, Kavadarci	Demir Kapija, Negotino	Total
Total CAPEX (€/y)	98,342	55,746	29,473	**183,560**
Trucks for Green waste	**Veles, Lozovo, Chashka**	**Gradsko, Rosoman, Kavadarci**	**Demir Kapija, Negotino**	**Total**
Total CAPEX (€/y)	109,546	71,827	48,073	**229,446**

Calculations for Variant 1

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

Table 6-25: Total OPEX per TS (€/y)

	Veles TS	KavadartsiTS	Negotino TS
Total OPEX €/y	145,988	87,800	78,416

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 the CWMF) is presented in the following tables.

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

Trucks for Residual waste	Veles	Gradsko	Demir Kapija	Kavadartsi	Lozovo	Negotino	Rosoman	Chashka	Total
Total OPEX (€/y)	77,506	25,328	21,862	63,754	21,087	21,483	23,349	26,064	**280,433**

Trucks for Recyclable waste	Veles, Lozovo, Chashka	Gradsko, Rosoman, Kavadarci	Demir Kapija, Negotino	Total
Total OPEX (€/y)	49,728	42,470	21,242	**113,441**

Trucks for Green waste	Veles, Lozovo, Chashka	Gradsko, Rosoman, Kavadarci	Demir Kapija, Negotino	Total
Total OPEX (€/y)	44,865	38,564	19,412	**102,841**

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 for necessary collection trucks for Variant 0 and Variant 1 (€/y)

	Variant 0	Variant 1
Total OPEX (€/y)	947,317	496,714

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 was 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 Vardar region

Variants	LUC (€/t)
Variant 0 (Business as Usual, no TSs will be constructed/The waste will be transported through collection trucks in CWMF)	**32.0**
Variant 1 (Do something scenario, 3 TSs will constructed and will serve the municipalities of Veles, Lozovo, Chashka, Kavadarci, Negotino & Demir Kapija, while the municipalities of Gradsko and Rosoman will transport the waste directly to CWMF)	**28.1**

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 CWMFsite 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 the waste quantities, the optimal option is to have three (3) TSs (in Veles, Kavadartsi, and Negotino settlements).

6.5 Option analysis for regional waste management

6.5.1 Introduction

During the elaboration of the Regional Waste Management Plan for Vardar 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 fulfil 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) 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 include separate collection of garden waste and sorting at source of recyclables or packaging waste based on each examined scenario. Finally the proposed scenarios including a collection system with the use of either 1 bin, 2 bins and 3 bins. Obviously, based on the collection system, the proposed treatment facilities (including home composting), 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 (MRF + Aerobic Composting)	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 Vardar Region.

Table 6-30: Quantification of targets for all scenarios in Vardar 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	55.19 %	Glass 60,16%	78.61 %	78.26%
		Plastic 47,92%		
		Paper 60,29%		
		Fe 90,49%		
		Al 90,49%		
		Wood 15,00%		
1b	55.19 %	Glass 60,16%	95.96%	95.90%
		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	65,56%	Glass 79,83%	51.99%	67.40%
		Plastic 55,99%		
		Paper 74,89%		
		Fe 68,93%		
		Al 68,93%		
		Wood 15,00%		
3a	68.92%	Glass 68.26%	75.32%	74.93%

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 68.56% Paper 70.96% Fe 88.76% Al 88.76% Wood 15.00 %		
3b	68.92%	Glass 68.26% Plastic 68.56% Paper 70.96% Fe 88.76% Al 88.76% Wood 15.00 %	91.20%	91.06%
3c	56.98%	Glass 61.54% Plastic 50.82% Paper 61.54% Fe 88.76% Al 88.76% Wood 15.00 %	73.10%	72.66%
4	55.34%	Glass 61.54% Plastic 50.82% Paper 61.54% Fe 52.47% Al 52.47% Wood 15.00 %	14.25%	64.83%

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 Vardar Region

Examined Scenarios	Total Investment Cost (million €)	Total Operational Cost (million €)	Revenues (million €)	Levelized Unit Cost (LUC) (€/t)
Scenario 1a	15.8	2.1	0.2	83.60
Scenario 2	14.6	2.3	0.3	84.76
Scenario 3a	16.7	2.6	0.7	87.13
Scenario 3c	17.3	2.3	0.6	82.99
Scenario 4	14.9	2.6	0.6	85.07

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.

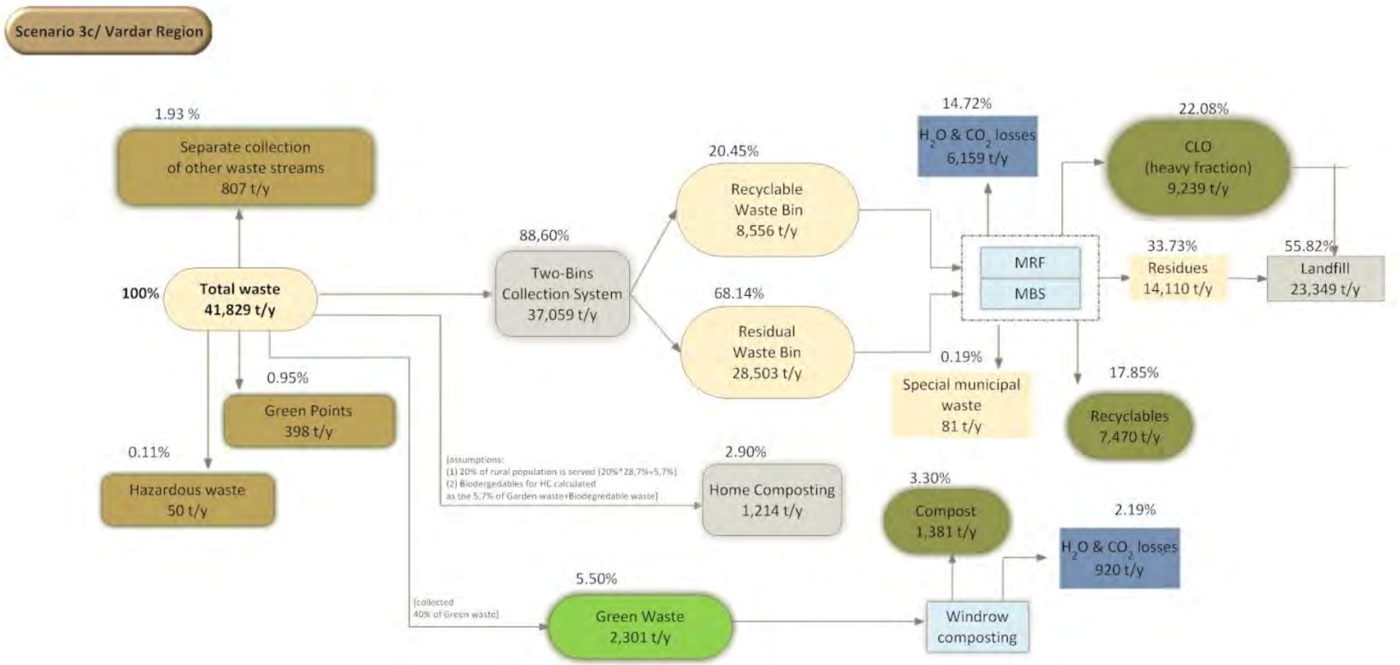
Each alternative scenario has been rated according each alternative criterion. All the criteria are benefit criteria, i.e. the higher the score, the better the performance is.

The selected scenario concerning Waste Management System for Vardar region, is Scenario 3c. 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 biological stabilization plant (MBS)
- Landfill which will accept residues from MRF/MBS and CLO

The next figure illustrates the total waste management system that can be applied:

Figure 6-25: Waste Management System in Vardar region



Scenario 3c	
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	MBS
Treatment of Green Waste	Aerobic composting
Treatment at the Source	Home Composting
Products	Compost Recyclables
Landfill	Residues from MRF Facility and Biostabilization Process

6.5.2 Project justification against scenarios Business as Usual and Do minimum

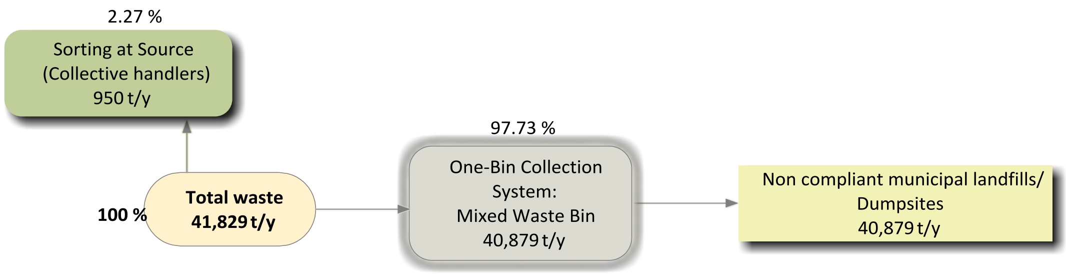
After the selection of the appropriate waste management system in Vardar region (Scenario 3) the alternatives which will be examined in this paragraph are:

- 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 3c

Option 1-Business as Usual

The following diagram presents the "Business as Usual option" for Vardar region.

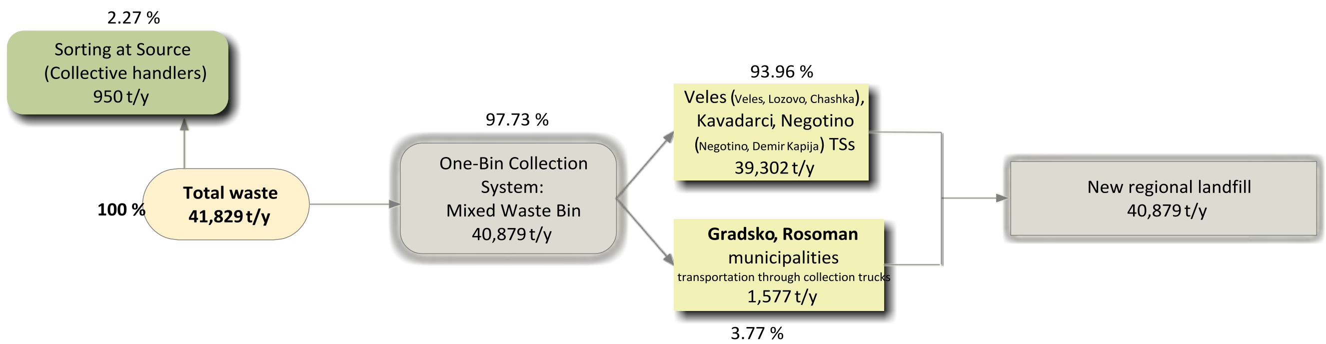
Figure 6-26: Business as Usual option



Option 2-Do minimum

The following diagram presents the "Do minimum option" for Vardar region.

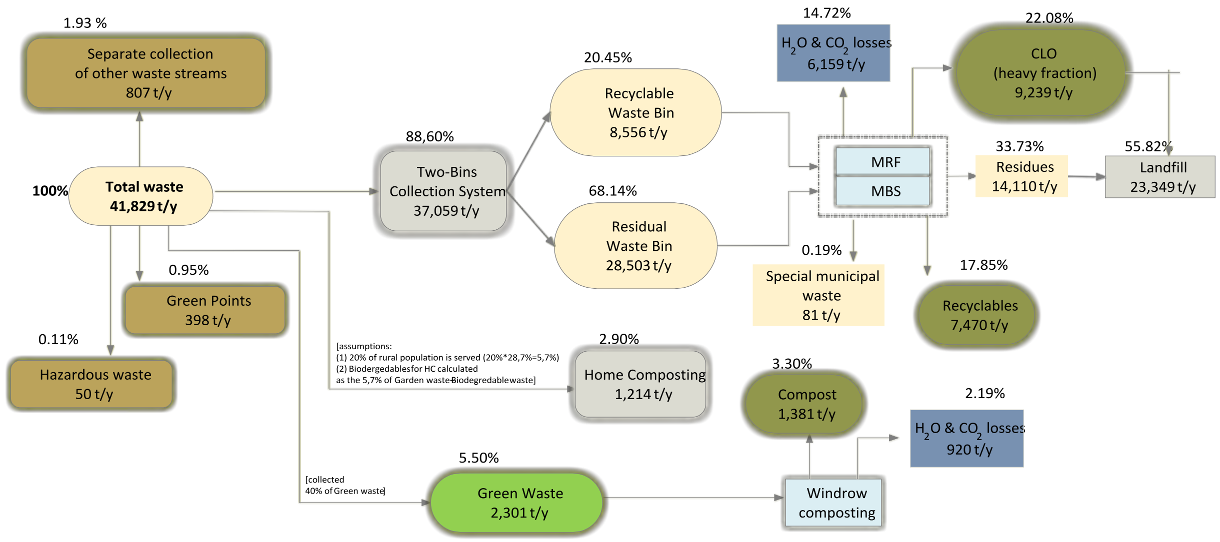
Figure 6-27: Option Do minimum



Option 3-Do something

The following diagram presents the "Do something option" for Vardar region.

Figure 6-28: Do something option/Selected scenario 3c



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)	1,625,650	965,650	3,122,657
Transfer stations (Veles, Kavadarci, Negotino)	0	2,039,000	2,954,229
Composting plant	0	0	622,500
MBT/MRF	0	0	7,532,682
Landfill (A phase)	0	4,886,975	3,360,746
Total	**1,625,650**	**7,891,625**	**17,592,814**

More analytical calculations concerning option 3 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 regions

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	9.8 %	Glass 10.1%	0%	0%
		Plastic 6.3%		
		Paper 13.9%		
		Fe 10.9%		
		Al 10.9%		
		Wood 0%		
Do minimum	9.8 %	Glass 10.1%	0%	0%
		Plastic 6.3%		
		Paper 13.9%		
		Fe 10.9%		
		Al 10.9%		
		Wood 0%		
Do something (Scenario 3c)	56.98 %	Glass 61.5%	73%	73%
		Plastic 50.8%		
		Paper 61.5%		
		Fe 88.8%		
		Al 88.8%		
		Glass 61.5%		

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.

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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 biological stabilization plant (MBS)
- 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 collectionsystem of the proposed scenario (Sc 3c) for Vardar Region.

The information for existing bins was taken from the waste questionnaires and was presented in the Assessment Report of the region and in the following tables.

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 Par. 2.2.2) 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 m^3 bins.
- The density of mixed/residual waste assumed to be 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 density of recyclable waste assumed to be120 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.

Table 7-1: Collection bins for mixed waste per municipality

Scenario 3c									
Residual Waste bin (1.1 m^3 Collection Bins)									
	Veles	**Gradsko**	**Demir Kapija**	**Kavadartsi**	**Lozovo**	**Negotino**	**Rosoman**	**Chashka**	**Total**
Average Waste Generation 2021-2046, t	16,308	910	752	15,204	623	5,763	703	1,564	**41,829**
Quantities to Mixed/Residual Waste Bin									
Waste in Mixed Waste Bin (t)	11,113	620	512	10,361	425	3,927	479	1,066	**28,503**
Waste in Mixed Waste Bin (kg/d)	30,447	1,699	1,403	28,387	1,163	10,760	1,313	2,919	**78,091**
Daily collection (m^3/day) Density 180 kg/m^3	169.15	9.44	7.79	157.71	6.46	59.78	7.29	16.22	**433.84**
Waste Containers									
Average weekly volume (m^3)	1,184	66	55	1,104	45	418	51	114	**3,037**
Collection frequency/week	4	2	2	3	2	2	2	2	
Needed bin volume (m^3)	296	33	27	368	23	209	26	57	**1,038**
No. of 1.1 m^3 bins with 85% bin factor	317	35	29	394	24	224	27	61	**1,111**
No. of 1.1 m^3 bins with irregularity coefficient x1.2	380	42	35	472	29	269	33	73	**1,333**
No of weighted 1.1m^3 bins in place	362	120	86	747	35	91	115	54	**1,610**
No. of 1.1 m^3 bins needed to be purchased	199			99	12	224		46	**580**

Table 7-2: Collection bins for recyclables per municipality

Recyclable waste bin (1.1 m^3 Collection Bins)									
	Veles	**Gradsko**	**Demir Kapija**	**Kavadartsi**	**Lozovo**	**Negotino**	**Rosoman**	**Chashka**	**Total**
Average Waste Generation 2021-2046, t	16,308	910	752	15,204	623	5,763	703	1,564	**41,829**
Quantities to Recyclable Waste Bin									
Waste in Recyclable Waste Bin (t)	3,336	186	154	3,110	127	1,179	144	320	**8,556**
Waste in Recyclable Waste Bin (kg/d)	9,139	510	421	8,520	349	3,230	394	877	**23,440**
Daily collection (m^3/day) Density 120 kg/m^3	76.16	4.25	3.51	71.00	2.91	26.91	3.28	7.31	**195**
Waste Containers									
Average weekly volume (m^3)	533	30	25	497	20	188	23	51	**1,367**
Collection frequency/week	2	2	2	2	2	2	2	2	
Needed bin volume (m^3)	267	15	12	249	10	94	11	26	**684**
No. of 1.1 m^3 bins with 85% bin factor	285	16	13	266	11	101	12	27	**731**
No. of 1.1 m^3 bins with irregularity coefficient x1.2	342	19	16	319	13	121	15	33	**877**
No of weighted 1.1m^3 bins in place	22	3	16	20	0	25	0	0	**86**
No. of 1.1 m^3 bins needed to be purchased	331	18	8	309	13	108	15	33	**835**

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%*28.7%=5.7%, 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 home composting process is 2,405.

Table 7-3: Home composting bins

No of HH in Vardar Region	**41,914**
Average No of HH in rural areas	**12,023**
No of Bins for 20% of HH	**2,405**

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 theimplementation of the Feasibility Study of Vardar 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 Vardar Region" Report, more detailed calculations were made. The results of these calculations are given in the following tables. These data have been taken into consideration for the implementation of Cost Benefit Analysis:

Table 7-4: Results of calculations for waste bins in Vardar Region

Municipality	Number of 1.1 m^3 bins (commerce & industry)	Number of 1.1 m^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
Veles	104	578	740	151	980	531	-
Gradsko	0	42	377	18	400	34	-
Demir Kapija	0	43	325	0	515	43	-
Kavadartsi	112	514	315	160	7,000	466	0
Lozovo	0	29	292	20	48	9	244
Negotino	34	228	239	46	0	217	239
Rosoman	0	34	414	0	0	34	414
Chaska	0	76	758	20	100	56	658
TOTAL –Vardar Region	**250**	**1,544**	**3,460**	**415**	**9,043**	**1,390**	**1,555**

Municipality	Number of 1.1 m^3bins(commerce & industry)	Number of 1.1 m^3bins (households)	Bins in place	Bins to be purchased
Veles	93	541	0	634
Gradsko	0	55	2	53
Demir Kapija	0	38	0	38
Kavadartsi	101	469	10	560
Lozovo	0	34	0	34
Negotino	30	213	13	231
Rosoman	0	39	0	39
Chaska	0	82	0	82
TOTAL – Vardar Region	**224**	**1,471**	**25**	**1,671**

Municipality	Number of persons per household	Number of households	Home composting bins to be purchased
Veles	3.2	2,951	603
Gradsko	3.3	906	187
Demir Kapija	3.0	1,147	235
Kavadartsi	3.2	1,594	337

Municipality	Number of persons per household	Number of households	Home composting bins to be purchased
Lozovo	3.2	681	141
Negotino	3.3	1,515	309
Rosoman	3.2	1,065	219
Chaska	3.5	1,897	398
TOTAL –Vardar Region	**3.2**	**11,756**	**2,429**

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 Par. 2.2.2) 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 14m^3 for both mixed and recyclable waste.
- The truck capacity will be 6m^3 for green waste.
- The average waste density in truckfor mixed waste was considered 0.45 t/m^3.
- The average waste density in truck for recyclable waste was considered 0.30 t/m^3.
- The average waste density in truck for green waste was considered 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 three hours.
- 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 for the transportation in TSs and/or in CWMF 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 (m³)	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
Veles (Transportation to TS Veles)	14	6.7	3.4	6.7	3	0	3
Gradsko (Direct transportation to CWMF)	8	0.6	3.7	0.6	1	1	0
Demir Kapija (Transportation to Negotino TS)	8	0.5	4.3	0.5	1	1	0
Kavadartsi (Transportation to Kavadarci TS)	14	6.2	3.2	6.2	3	2	1

Mixed Municipal Waste							
Lozovo (Transportation to TS Veles)	14	0.3	3.6	0.3	1	0	1
Negotino (Transportation to Negotino TS)	14	2.4	3.2	2.4	1	0	1
Rosoman (Direct transportation to CWMF)	14	0.3	3.2	0.3	1	0	1
Chashka (Transportation to TS Veles)	7	1.3	4.3	1.3	1	1	0
Totalnumber of extra trucks required for mixed municipal waste for Vardar region							7

Recyclable Waste							
	Capacity of trucks (m³)	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
Veles, Lozovo, Chashka (Transportation to TS Veles)	14	3.4	12.3	3.4	2	0	2
Gradsko, Rosoman, Kavadarci (Direct transportation to CWMF and/or transportation to TS)	14	3.1	11.1	3.1	2	0	2
Demir Kapija, Negotino (Transportation to Negotino TS)	14	1.2	8	1.2	1	0	1
Totalnumber of extra trucks required for recyclable waste for Vardar region							5

Green Waste							
	Capacity of trucks (m³)	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
Veles, Lozovo, Chashka (Transportation to TS Veles)	6	5.8	9.3	5.8	2	0	2
Gradsko, Rosoman, Kavadarci (Direct transportation to CWMF and/or to TS)	6	5.8	8.1	5.8	2	0	2
Demir Kapija, Negotino (Transportation to Negotino TS)	6	2.3	6	2.3	1	0	1
Totalnumber of extra trucks required forgreen waste for Vardar region							5

The above tables, include calculations made during the implementation of the Feasibility Study of Vardar 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 Vardar 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 Vardar Region

Mixed Municipal Waste		
	Capacity of trucks(m^3)	Number of extra trucks required
Veles (Transportation to TS Veles)	14	4
Gradsko (Direct transportation to CWMF)	14	0
Demir Kapija (Transportation to Negotino TS)	14	0
Kavadartsi (Transportation to Kavadarci TS)	14	1
Lozovo (Transportation to TS Veles)	14	1
Negotino (Transportation to Negotino TS)	14	1
Rosoman (Direct transportation to CWMF)	14	1
Chashka (Transportation to TS Veles)	14	0
Totalnumber of extra trucks required for mixed waste for Vardar region		8

Recyclable Waste		
	Capacity of trucks(m^3)	Number of extra trucks required
Veles, Lozovo, Chashka (Transportation to TS Veles)	14	2
Gradsko, Rosoman, Kavadarci (Direct transportation to CWMF and/or transportation to TS)	14	3
Demir Kapija, Negotino (Transportation to Negotino TS)	14	1
Totalnumber of extra trucks required for recyclable waste for Vardar region		6

Green Waste		
	Capacity of trucks(m^3)	Number of extra trucks required
Veles, Lozovo, Chashka (Transportation to TS Veles)	6	2
Gradsko, Rosoman, Kavadarci (Direct transportation to CWMF and/or transportation to TS)	6	3
Demir Kapija, Negotino (Transportation to Negotino TS)	6	1
Totalnumber of extra trucks required for green waste for Vardar region		6

7.1.2.1 The TS sites and their characteristics

Regarding the municipalities that will not 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 Vardar Region are three:

- Veles TS
- Kavadartsi TS
- Negotino TS

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 three TS 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
- Water supply and sewage networks
- 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 needspace 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 (loadingarea 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 internalroads. 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 stripe12 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 assistancearea

Parking area

The vehicles of theemployees 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.

Water tank
To supply the water booster set with water, a dedicated 15m^3 water tank will be provided. The tank will be made of HDPE.

Water piping network
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.

Sewage system
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.

Sewage tank & other elements:
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 (m2)

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

$$Q = A \times V \text{ } (m^3/s)$$
$$V = (1/n) \times R^{2/3} \times S^{1/2}$$

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:

<u>Press containers</u>

Hydraulic steel press containers of $24m^3$ 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.

<u>Skid Steer Loader</u>

There will be a skid steer loader available in each TS, for various tasks, mainly for assisting the loading of green waste.

<u>Bulky waste container</u>

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	Veles	Kavadartsi	Negotino
Fence	x	x	x
Entrance gate	x	x	x
Plateau and roads	x	x	x
Administration building	$60m^2$	$60m^2$	$60m^2$
Water supply	x	x	x
Sewerage system	x	x	x
Electrical installations (lighting, electricity, phone)	x	x	x

Cost Category	Veles	Kavadartsi	Negotino
Hopper	2	2	2
Landscaping	x	x	x

The following Table presents the required equipment for the TSs.

Table 7-8: Required number of equipment per TS

Equipment	Veles	Kavadartsi	Negotino
Weighbridge	1	1	1
Press containers 24 m^3 (for mixed waste)	4	3	2
Press containers 24 m^3 (for recyclable waste)	2	2	2
Containers 24 m^3 (for green waste)	1	1	1
Skid Steer Loader	1	1	1
Truck with hook lift	2	1	1
Skip (for bulky waste)	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^3in 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*		
	Veles TS	**Kavadartsi TS**	**Negotino TS**
1. Operations manager	1*		
2. Weighbridge operator	1	1	1
3. General tasks workers	1	1	1
4. Hook- lift truck drivers	4	2	2

* Regarding the Operations Manager position, it will be covered by one (1) person who will have under his responsibility the Operation of all three Transfer Stations in Vardar 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 Veles TS

Figure7-2: General layout of Kavadartsi TS

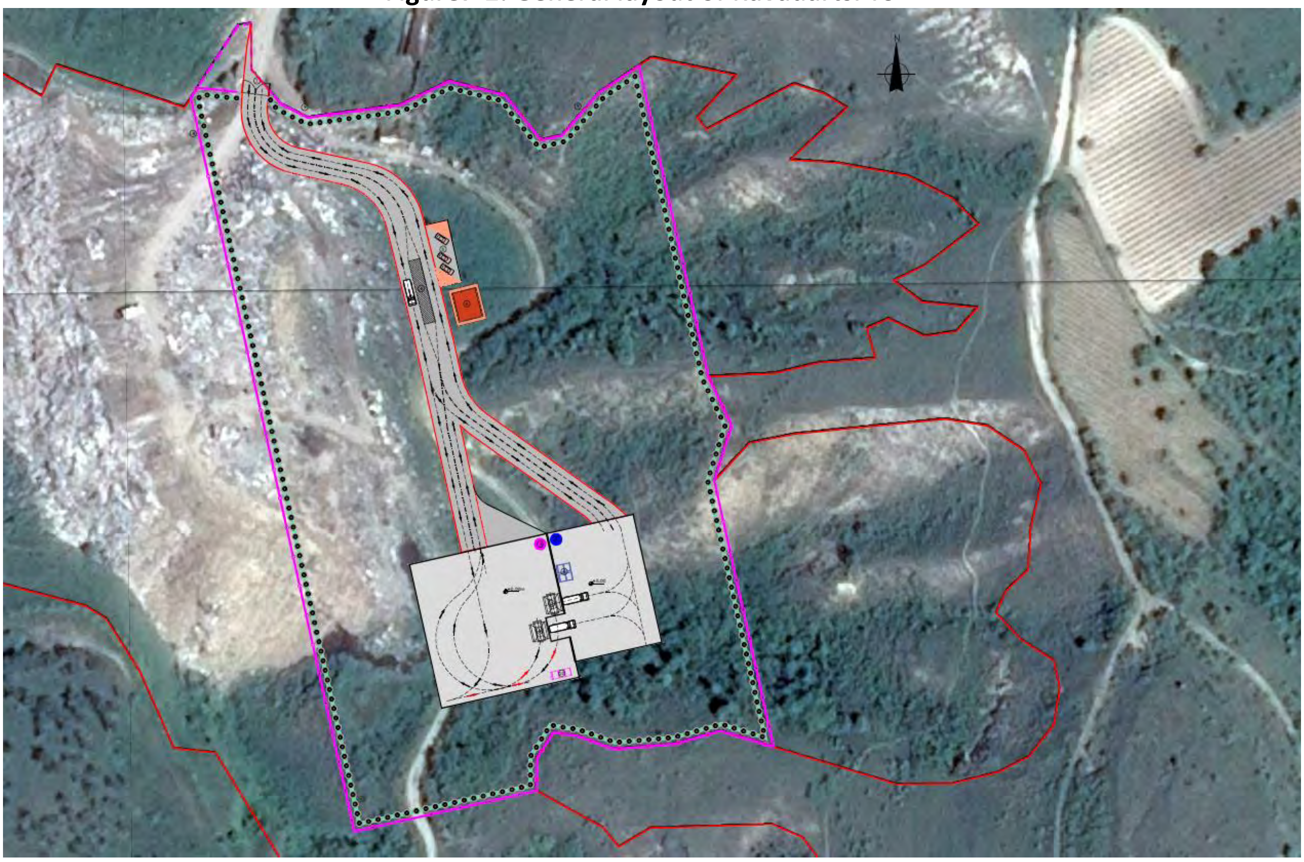


Figure7-3: General layout of Negotino TS

Figure 7-4: Legend of the General layout of the TSs

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

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 Vardar region, are given in the following paragraphs.

7.1.3.2 Waste Disposal Facilities (WDFs) in Vardar Region

As approved by the TOR in total 8 municipalities are included in Vardar Region; Veles, Kavadartsi, Negotino, Demir Kapija, Rosoman, Gradsko, Chaska and Lozovo. All of them manage at least one non-compliant 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 waste are disposed.
- Capping is performed fully or partiallyon all landfills. Light fractions of waste were dispersed by wind to significant distances from the landfills polluting large surrounding areas.
- 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 municipal landfill sites in Vardar Region

Landfill ID	Municipality	Settlement	Coordinates	
			X	Y
RALL001	Veles	Veles	41°42' 26"	21°45' 24"
RALL002	Veles	Veles	41°44' 27.5"	21°48' 19.5"
RALL003	Rosoman	Rosoman	41°31' 33"	21°55' 6.8"
RALL004	Gradsko	Gradsko	41°34' 16.6"	21°55' 23.3"
RALL005	Negotino	Dubrovo	41°28' 30.56"	22°07' 38.34"
RALL006	Demir Kapija	Demir Kapija	41°24' 52.32"	22°12' 38.11"
RALL007	Chashka	Chashka	49°39' 31.6"	21°40' 19.6"
RALL008	Kavadartsi	Melci	41°28' 30.56"	22°07' 38.34"

*Note: The new regional landfill will be constructed in a site which includes the RALL003 non compliant landfill.

Only Negotino has reported recently closed (in last 20 years) non-compliant MSW landfill, which was taken into consideration in order to include it in future remediation/closure plans as the cost associated with such activities could be significant.

Table 7-11: Closed non – compliant landfills in Vardar Region

Landfill ID	Municipality	Settlement	Coordinates	
			X	Y
RALLC001	Negotino	Dubrovo	41°28’ 37.99”	22°08’ 16.51”

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, excluding Veles. 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 (sludge’s) they can pose great risks to surrounding environment. In total 28 dumpsites were identified in the Vardar Region.

Table 7-12: Dump sites in Vardar Region

Dumpsite ID	Municipality	Settlement	Coordinates	
			Latitude	Longitude
RAIL001	Negotino	Timjanik	41°27’ 41.57”	22°4’ 58.88”
RAIL002	Negotino	Dolni Disan	41°26’ 16.33”	22°5’ 42.91”
RAIL003	Negotino	Negotino	41°29’ 32.26”	22°6’ 23.24”
RAIL004	Negotino	Negotino	41°29’ 5149”	22°5’ 51.15”
RAIL005	Negotino	v.Kurija	41°31’ 43.38”	22°0’ 50.20”
RAIL006	Negotino	Krivolak	41°32’ 24.24”	22°7’ 30.9”
RAIL007	Negotino	v. Pepelishte	41°30’ 20.85”	22°7’ 36.2”
RAIL008	Gradsko	Kochilari	41°39’ 53.4”	21°51’ 50.7”
RAIL009	Gradsko	Ulanci	41°35’ 9.5”	21°56’ 33.3”
RAIL010	Gradsko	Vodovrati	41°34’ 58.99” 41°35’ 0.9”	21°52’ 43.35” 21°52’ 49.6”
RAIL011	Gradsko	Dolno Chichevo	41°34’ 28.9”	21°54’ 58.4”
RAIL012	Rosoman	Rosoman	41°30’ 59.9”	21°57’ 7.4”
RAIL013	Rosoman	Rosoman	41°31’ 35.22”	21°56’ 48.54”
RAIL014	Rosoman	Sirkovo	41°30’ 9.96”	21°53’ 43.06”
RAIL015	Rosoman	Kamen Dol	41°28’ 41.11”	21°53’ 39.58”
RAIL016	Rosoman	Debrishte	41°27’ 31.13”	21°52’ 49.59”
RAIL017	Rosoman	Trstenik	41°28’ 3171”	21°55’ 23.71”
RAIL018	Rosoman	Trstenik	41°28’ 25.57”	21°55’ 1.14”
RAIL019	Rosoman	Manastirec	41°29’ 19.10”	21°56’ 7.87”
RAIL020	Rosoman	Ribarci	41°30’ 19.49”	21°57’ 36.62”
RAIL021	Rosoman	Palikura	41°32’ 14.13”	21°58’ 26.56”
RAIL022	Negotino	Tremnik	41°27’ 11.59”	22°09’ 36.0”
RAIL023	Demir Kapija	Bistrenec	41°26’ 41.77”	22°12’ 23.96”
RAIL024	Demir Kapija	Chiflik	41°22’ 50.41”	22°13’ 30.93”
RAIL025	Demir Kapija	v. Dren	41°22’ 29.50”	22°14’ 03.52”
RAIL026	Kavadartsi	Kavadarci	41°25’ 58.7”	21°58’ 42.9”
RAIL027	Kavadartsi	Vozarci	41°25’ 25.3”	21°56’ 03.6”
RAIL028	Kavadartsi	Drenovo	41°25’ 19,14”	21°53’38,4”

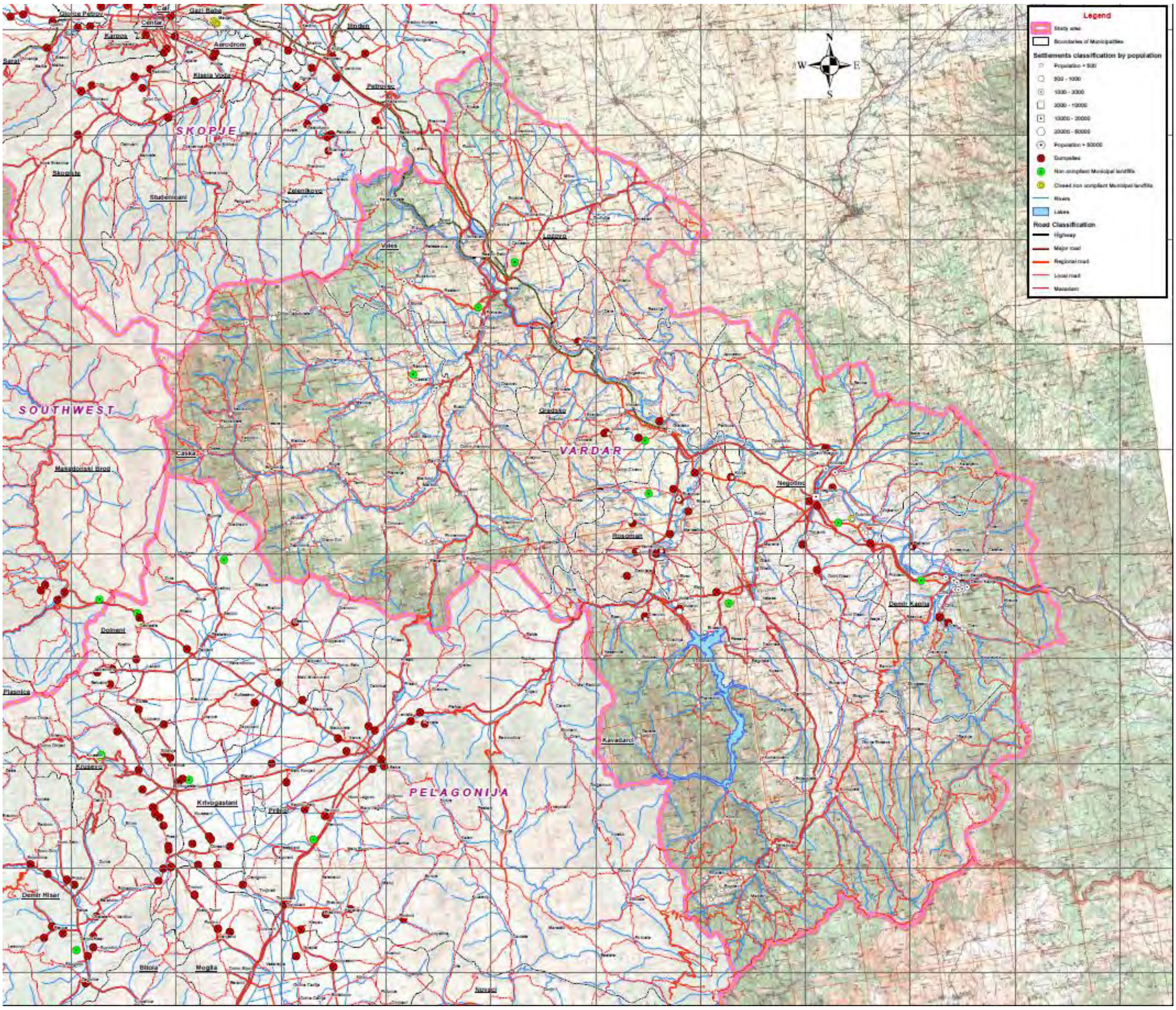


Figure7-5:Location of WDFs

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 Veles

According to data from Municipality of Veles officials, two non-compliant MSW landfills were identified within municipality territory, and both were visited on 05 May 2016 and screened according to RSS protocols.

Figure7-6:Location of WDFs in Veles

Figure7-7:Satellite image of the location of WDFs in Veles

There are no dumpsites located within municipality territory. General data summary of all WDF's identified in Veles Municipality is given below.

Table 7-13: WDFs data in Veles Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume [m^3]
1	RALL 001	Veles	41°42' 26"	21°45' 24"	1 375	25	30	34 375
2	RALL 002	Veles	41°44' 27.5"	21°48' 19.5"	80 000	35	90	2 800 000

Municipality of Negotino

According to data from Municipality of Negotino officials, one non-compliant MSW landfill and 8 dumpsites were identified within municipality territory. In addition, officials reported one non-compliant municipal landfill closed in last 20 years. All WDF's identified were visited on 09 May 2016 and screened according to RSS protocols.

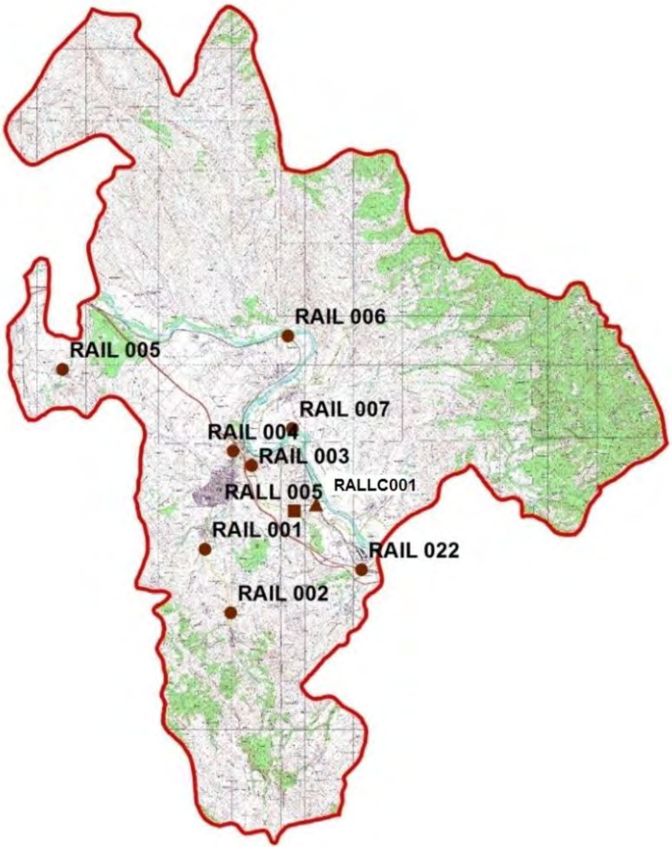


Figure7-8:Location of WDFs in Negotino Municipality

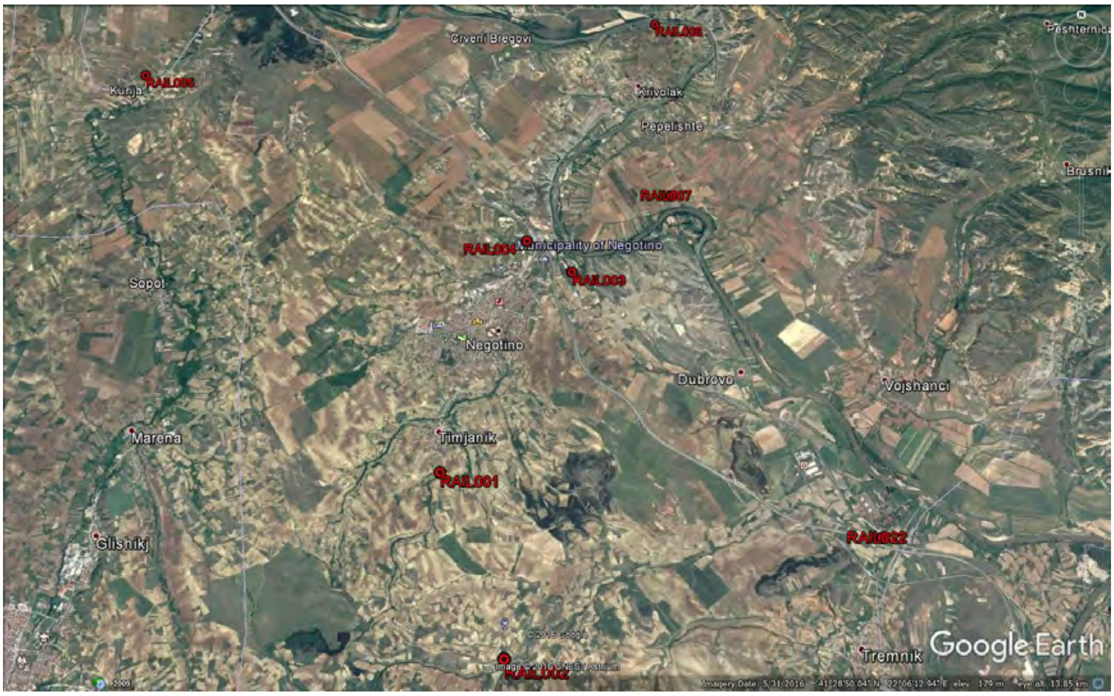


Figure 7-9: Satellite image of the location of WDFs (dumpsites) in Negotino

Figure 7-10: Satellite image of the location of WDFs (non – compliant) in Negotino

General summary of all WDF’s identified within Negotino Municipality is given below.

Table 7-14: WDFs data in Negotino Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume [m^3]
1	RALL005	Dubrovo	41°28’ 30.56”	22°07’ 38.34”	100 000	3	5	300 000
2	RALLC001	Dubrovo (C)	41°28’37.99”	22°08’16.51”	21 600	4	6	86 400
3	RAIL001	Timjanik	41°27’ 41.57”	22°4’ 58.88”	100	2.5	5	250
4	RAIL002	Dolni Disan	41°26’ 16.33”	22°5’ 42.91”	50	1.5	2	75
5	RAIL003	Negotino	41°29’ 32.26”	22°6’ 23.24”	70	1.5	3	100
6	RAIL004	Negotino	41°29’ 51.49”	22°5’ 51.15”	100	3	8	300
7	RAIL005	Kurija	41°31’ 43.38”	22°0’ 50.20”	20	1.5	3	30
8	RAIL006	Krivolak	41°32’ 24.24”	22°7’ 30.9”	150	2	3	350
9	RAIL007	Pepelishte	41°30’ 20.85”	22°7’ 36.2”	250	2	2	250
10	RAIL022	Tremnik	41°27’ 11.59”	22°09’36.0”	100	0.5	1	50

Municipality of Kavadartsi

According to data from Municipality of Kavadartsi officials, one non-compliant MSW landfill and total 3 dumpsites were identified within municipality territory. All dumpsites identified were visited on May 13, 2016 and screened according to RSS protocols.

Figure 7-11: Location of municipal landfill and dumpsites in Municipality of Kavadartsi

Figure 7-12: Satellite image of the location of WDFs (non-compliant) in Kavadartsi

Figure 7-13: Satellite image of the location of WDFs (dumpsites) in Kavadartsi

General summary for all WDF's identified within Kavadartsi Municipality is given below.

Table 7-15: WDFs data in Kavadarci Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume [m^3]
1	RALL008	Melci	41°28' 30.56"	22°07' 38.34"	20 000	30	40	600 000
2	RAIL026	Kavadartsi	41°25' 58.7"	21°58' 42.9"	350	2.5	5	875
3	RAIL027	Vozarci	41°25' 25.3"	21°56' 03.6"	90	4	5	360
4	RAIL028	Drenovo	41°25' 19.14"	21°53'38.4"	3 000	0.5	2	1 500

Municipality of Demir Kapija

The Municipality of Demir Kapija officials have reported one non-compliant MSW landfill and 3 dumpsites within their territory. All WDF's identified were visited at May, 09, 2016 and screened according to RSS protocols.

Figure 7-14: Location of WDF's in Demir Kapija

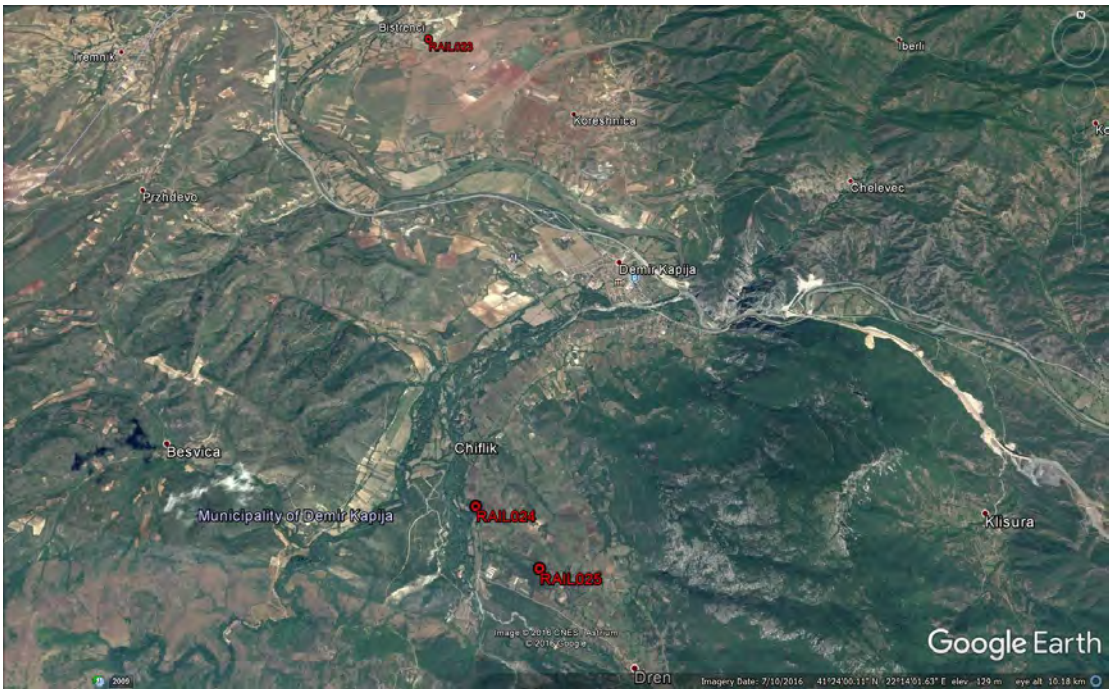


Figure 7-15: Satellite image of the location of WDFs (dumpsites) in Demir Kapija

Figure 7-16: Satellite image of the location of WDFs (non - compliant) in Demir Kapija

Data summary for WDF’s identified within Demir Kapija Municipality is given below.

Table 7-16: WDFs data for Demira Kapija Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume[m^3]
1	RAIL 023	Bistrenci	41°26’ 41.77”	22°12’ 23.96”	200	0.2	1	40
2	RAIL 024	Chiflik	41°22’ 50.41”	22°13’ 30.93”	40	0.5	0.7	20
3	RAIL 025	Dren	41°22’ 29.50”	22°14’ 03.52”	70	0.3	0.5	20

<u>Municipality of Gradsko</u>

The Municipality of Gradsko officials has reported one non-compliant MSW landfill and 4 dumpsites within their territory. All WDF’s identified were visited in period from 05 to 07 of May 2016 and screened according to RSS protocols.

Figure 7-17: Location of WDF's in Gradsko

Figure 7-18: Satellite image of the location of WDFs (non – compliant) in Gradsko

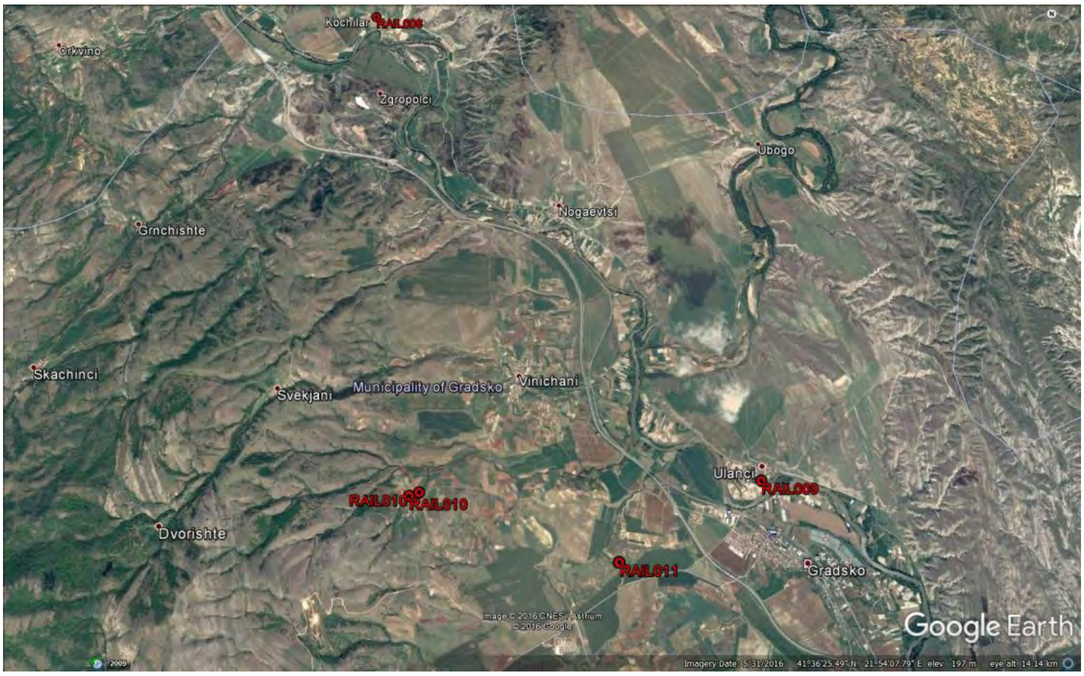


Figure 7-19: Satellite image of the location of WDFs (dumpsites) in Gradsko

<u>Municipality of Chashka</u>

According to data from Municipality of Chashka officials, one non-compliant municipal landfill and dumpsites were identified within municipality territory. Municipal landfill was visited on 09 May 2016 and screened according to RSS protocols.

Figure 7-20: Location of WDF's in Chashka

Figure 7-21: Satellite image of the location of WDFs in Chashka

Data summary for WDF's identified within Chashka territory is given below.

Table 7-17: WDFs data for Chaska Municipality

No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume [m^3]
1	RALL 007	Chaska	49°39' 31.6"	21°40' 19.6"	900	7.3	9	6570

Municipality of Rosoman

According to data from Municipality of Rosoman officials, one non-compliant MSW landfill and total 10 dumpsites were identified within municipality territory. All dumpsites identified were visited from 05 to 07 of May, 2016, and screened according to RSS protocols.

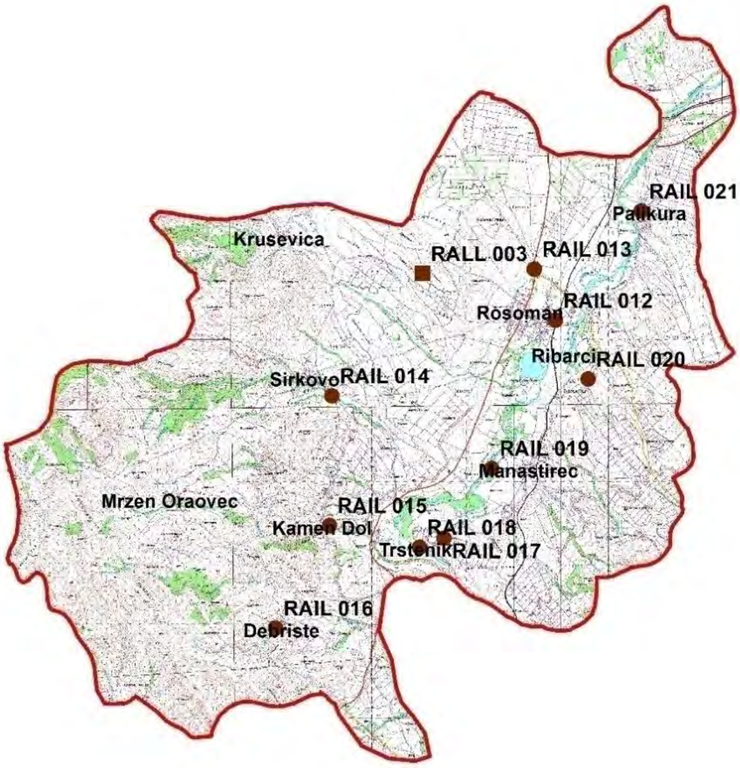


Figure 7-22: Location of WDFs in Rosoman

Figure 7-23: Satellite image of the location of WDFs (non – compliant) in Rosoman

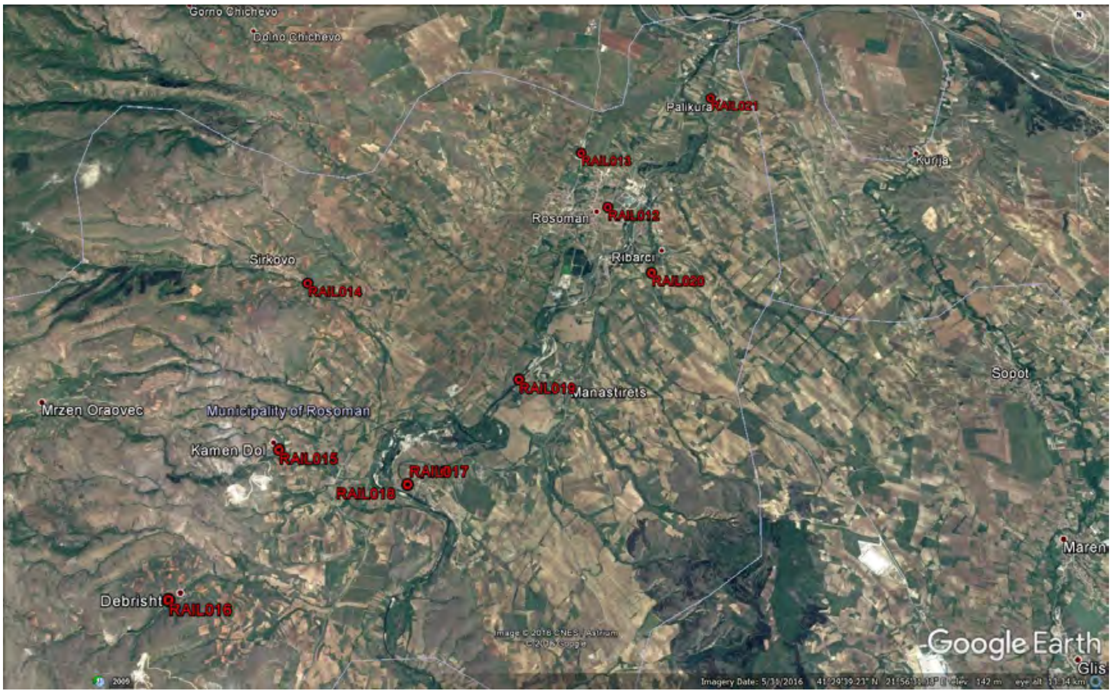


Figure 7-24: Satellite image of the location of WDFs (dumpsites) in Rosoman

Summary of data collected for all WDF within Rosoman territory is given below.

Table 7-18: WDFs data for Rosoman Municipality

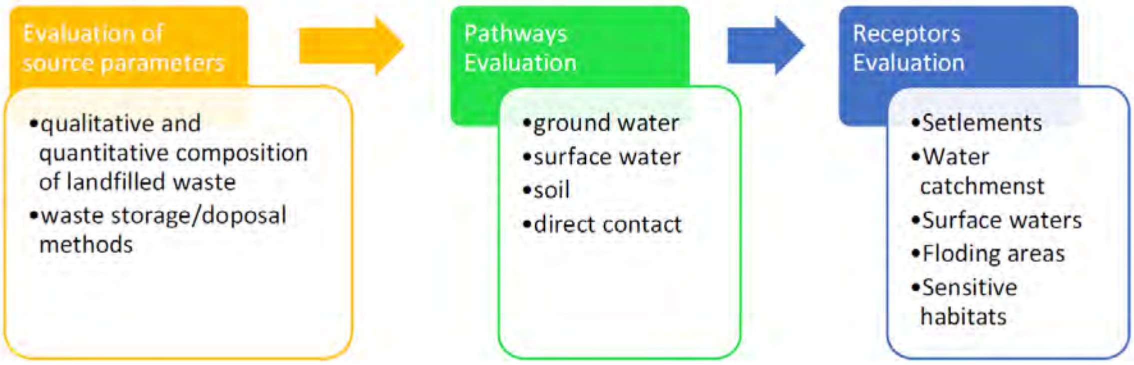
No	ID	Settlement	X	Y	Area [m^2]	Avg. Thikness [m]	Max. Thikness [m]	Volume [m^3]
1	RALL 003	Rosoman	41°31' 33"	21°55' 6.8"	13600	2	3	27200
2	RAIL 012	Rosoman	41°30' 59.9"	21°57' 7.4"	50	1	1.5	50
3	RAIL 013	Rosoman	41°31' 35.22"	21°56'48.54"	50	2	3	100
4	RAIL 014	Sirkovo	41°30' 9.96"	21°53' 43.06"	80	1.2	2	100
5	RAIL 015	Kamen Dol	41°28' 4.,11"	21°53' 39.58"	200	1.5	2	300
6	RAIL 016	Debrishte	41°27' 31.13"	21°52' 49.59"	20	3	5	60
7	RAIL 017	Trstenik	41°28' 31.71"	21°55' 23.71"	400	1	1.5	400
8	RAIL 018	Trstenik	41°28' 25.57"	21°55' 1.14"	60	0.5	1	30
9	RAIL 019	Manastirec	41°29' 19.10"	21°56' 787"	100	0.3	0.5	30
10	RAIL 020	Ribarci	41°30' 19.49"	21°57' 36.62"	300	0.5	2	150
11	RAIL 021	Palikura	41°32' 14.13"	21°58' 26.56"	50	2	3	100

<u>Municipality of Lozovo</u>

Waste collection and disposal in Lozovo Municipality is organized by PUE Derven and waste is disposed at Bunar Dere non-compliant MSW landfill in Veles. No other waste disposal facilities were reported in Lozovo.

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 7-19: 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 Vardar 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 7-11 and 7-12.

Table 7-20: Non – compliant MSW landfills (included closed) categorization

No	Region	Municipality	Settlement	Landfill No.	Risk category	Priority Group	Time Frame
1	Vardar	Veles	Veles	RALL001	**II**	**II**	Long
2		Veles	Veles	RALL002	**II**	**II**	Medium
3		Rosoman	Rosoman	RALL003	**II**	**II**	Medium
4		Gradsko	Gradsko	RALL004	**III**	**III**	Medium
5		Negotino	Dubrovo	RALL005	**III**	**III**	Medium
6		Negotino	Closed site	RALLC001	**II**	**II**	Medium
7		Demir Kapija	Demir Kapija	RALL006	**II**	**II**	Medium
8		Chashka	Cashka	RALL007	**II**	**II**	Medium
9		Kavadarci	Kavadarci	RALL008	**II**	**II**	Medium

Table 7-21: Dumpsites categorization

No	Region	Municipality	Settlement	Landfill No.	Risk category	Priority Group	Time Frame
1	Vardar	Negotino	Timjanik	RAIL001	**II**	**II**	Medium
2		Negotino	Dolni Disan	RAIL002	**II**	**II**	Medium

No	Region	Municipality	Settlement	Landfill No.	Risk category	Priority Group	Time Frame
3		Negotino	Negotino	RAIL003	II	II	Medium
4		Negotino	Negotino	RAIL004	II	II	Medium
5		Negotino	v.Kurija	RAIL005	II	II	Medium
6		Negotino	Krivolak	RAIL006	II	II	Medium
7		Negotino	v. Pepelishte	RAIL007	II	II	Medium
8		Gradsko	Kochilari	RAIL008	II	II	Medium
9		Gradsko	Ulanci	RAIL009	II	II	Medium
10		Gradsko	Vodovrati	RAIL010	II	II	Medium
11		Gradsko	Dolno Chichevo	RAIL011	II	II	Medium
12		Rosoman	Rosoman	RAIL012	II	II	Medium
13		Rosoman	Rosoman	RAIL013	II	II	Medium
14		Rosoman	Sirkovo	RAIL014	II	II	Medium
15		Rosoman	Kamen Dol	RAIL015	II	II	Medium
16		Rosoman	Debrishte	RAIL016	II	II	Long
17		Rosoman	Trstenik	RAIL017	II	II	Long
18		Rosoman	Trstenik	RAIL018	II	II	Medium
19		Rosoman	Manastirec	RAIL019	II	II	Medium
20		Rosoman	Ribarci	RAIL020	II	II	Medium
21		Rosoman	Palikura	RAIL021	II	II	Medium
22		Negotino	Tremnik	RAIL022	II	II	Long
23		Demir Kapija	Bistrenec	RAIL023	II	II	Long
24		Demir Kapija	Chiflik	RAIL024	II	II	Medium
25		Demir Kapija	v. Dren	RAIL025	II	II	Medium
26		Kavadarci	Kavadarci	RAIL026	II	II	Long
27		Kavadarci	Vozarci	RAIL027	II	II	Medium
28		Kavadarci	Drenovo	RAIL028	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 7-22: 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.

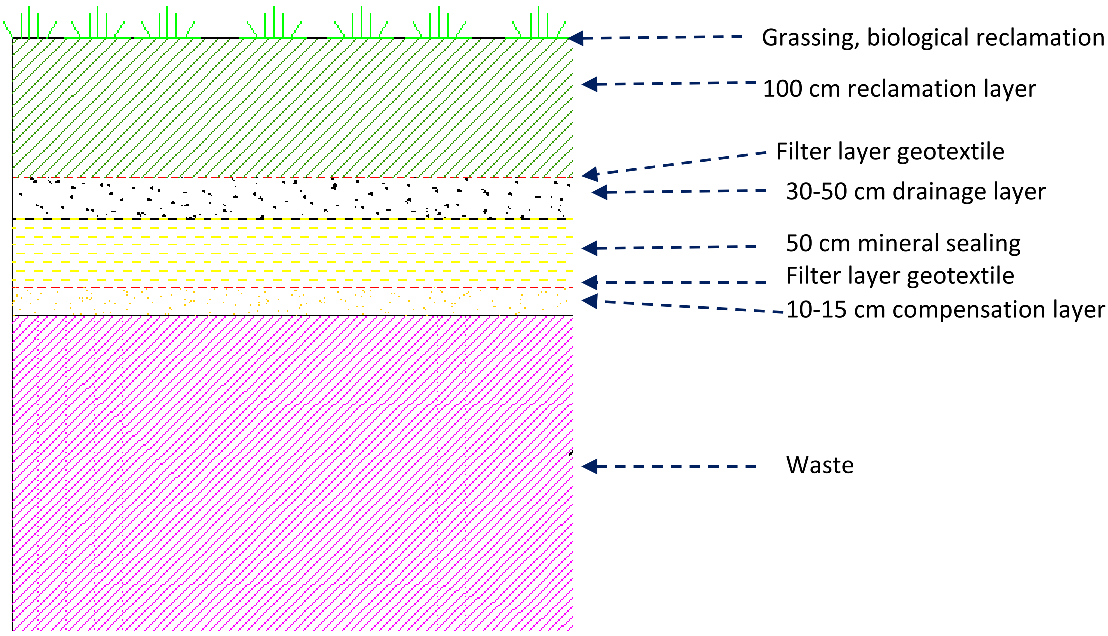
Remediation activities for the implementation of the **model A** include:

- ✓ removal ofdisposed waste which in current pricing conditions, can be performed witha bulldozer/front end loaderorexcavator at a costprice
- ✓ 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 ofnon-compliant MSW landfills with disposed waste volume up to 100,000 m^3, andranked 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 surfacelayer,at leastone meterthick, and the upper layer0.4 mcontainingorganic matter(humus) are suitable forgrass;
- ✓ separator (usually geotextile400g/m^2);
- ✓ mineral drainage - minimum 0.5 m (gravel, min. $\kappa>10^{-4}$m/s);
- ✓ sealing or impermeable layer (2 x 25cmmineral insulation with min. $\kappa>10^{-9}$m/s equivalent bentonite material);
- ✓ gasdrainageand gascollectionlayer (gravel);
- ✓ household waste

Figure7-25:Capping cross section with cost estimation for Closure and Remediation model "B"

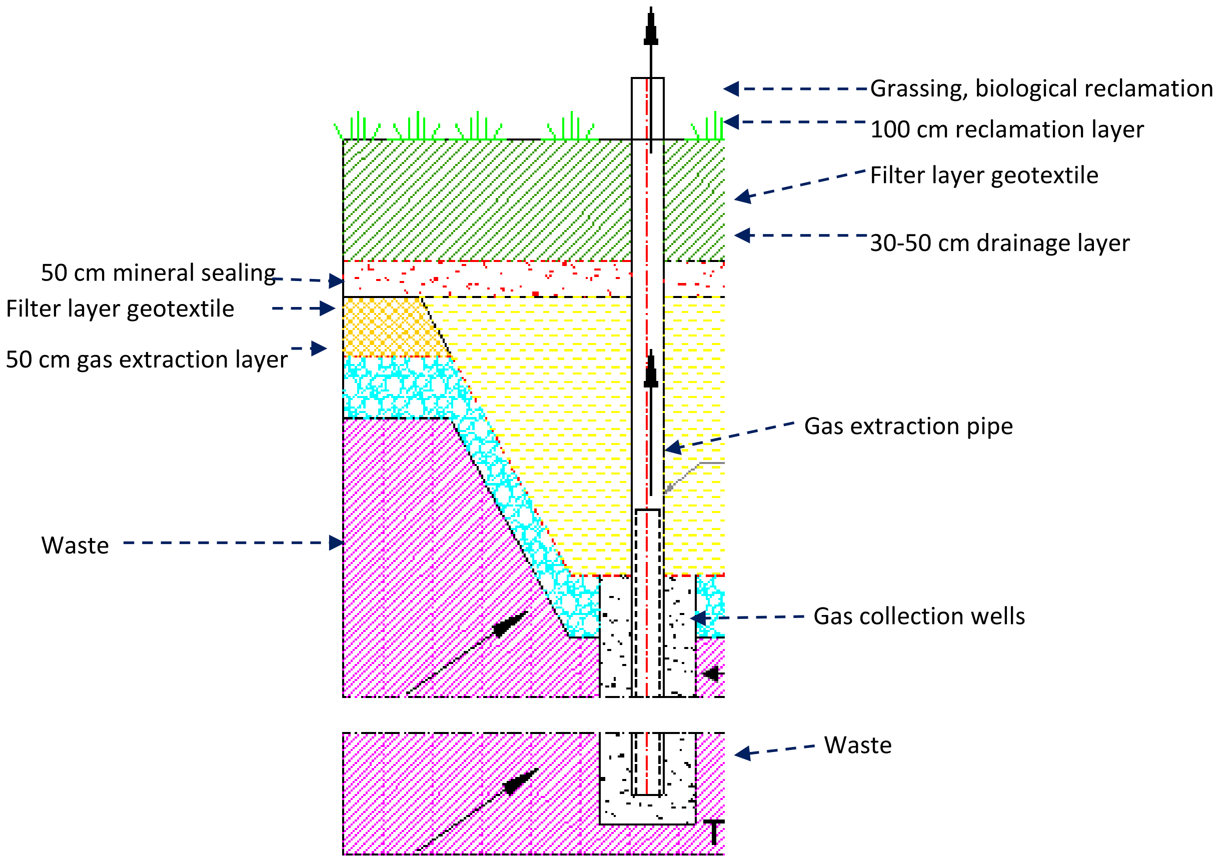


Model C approach is proposed for remediation of non-compliant MSW landfills ranked as a high riskand waste volume above 100,000 m^3in a short time plan. It is also applied for landfills with significant volume of disposed waste (above 500,000 m^3) and medium and high risks in a short term. Closure and remediation activities for Model Care presented bellow;

- ✓ profilingofdeposited waste,spreadingand levelingwitha bulldozer
- ✓ laying leveling layer of ground masses with thickness of 0.1 – 0.15 m
- ✓ construction ofgas drainagesystem (drainage blanketof gravel)
- ✓ construction of gas drainage and gas venting system:
  - o 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)
  - o 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 gravelfraction*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)

.

Figure7-26:Capping cross section with cost estimation for Closure and Remediation model "C"



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 Vardar 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 Vardar region as given at the table below.

Table 7-23: Closure and remediation approaches for identified sites in Vardar 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	✓			Negotino	Timjanik	100	250
2	RAIL002	✓			Negotino	DolniDisan	50	75
3	RAIL003	✓			Negotino	Negotino	700	1000
4	RAIL004	✓			Negotino	Negotino	100	300
5	RAIL005	✓			Negotino	v.Kurija	20	30
6	RAIL006	✓			Negotino	Krivolak	150	350
7	RAIL007	✓			Negotino	v. Pepelishte	250	250
8	RAIL008	✓			Gradsko	Kochilari	30	30
9	RAIL009	✓			Gradsko	Ulanci	80	80
10	RAIL010	✓			Gradsko	Vodovrati	90	90
11	RAIL011	✓			Gradsko	DolnoChichevo	90	90
12	RAIL012	✓			Rosoman	Rosoman	200	100
13	RAIL013	✓			Rosoman	Rosoman	50	50
14	RAIL014	✓			Rosoman	Sirkovo	50	100
15	RAIL015	✓			Rosoman	KamenDol	80	100
16	RAIL016	✓			Rosoman	Debrishte	200	300
17	RAIL017	✓			Rosoman	Trstenik	20	60
18	RAIL018	✓			Rosoman	Trstenik	400	400
19	RAIL019	✓			Rosoman	Manastirec	60	30
20	RAIL020	✓			Rosoman	Ribarci	100	30
21	RAIL021	✓			Rosoman	Palikura	300	150
22	RAIL022	✓			Negotino	Tremnik	50	100
23	RAIL023	✓			Demir Kapija	Bistrenec	100	50
24	RAIL024	✓			Demir Kapija	Chiflik	200	40
25	RAIL025	✓			Demir Kapija	v. Dren	40	20
26	RAIL026	✓			Kavadarci	Kavadari	350	875
27	RAIL027	✓			Kavadarci	Vozarci	90	360
28	RAIL028	✓			Kavadarci	Drenovo	3000	1500
29	RALL001		✓		Veles	Veles	1375	34375
30	RALL002			✓	Veles	Veles	80 000	2800000
31	**RALL003***				**Rosoman**	**Rosoman**	**13600**	**27200**
32	RALL004		✓		Gradsko	Gradsko	12000	24000
33	RALL005			✓	Negotino	Dubrovo	100000	300000
34	RALL006		✓		Demir Kapija	Demir Kapija	15000	15000
35	RALL007		✓		Chashka	Cashka	900	6570

	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				
36	RALL008			✓	Kavadarci	Kavadarci	20000	600000
37	RALLC001		✓		Negotino	Dubrovo	21600	86400
	Total	**28**	**5**	**3**				

*Note: The new regional landfill will be constructed in a site which includes the RALL003 non compliant landfill. The existing waste of the non compliant municipal landfill will be disposed in the new landfill and for this reason no remediation works (like capping etc.) will be needed.

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 Vardar Region was proposed to be located at a site that administratively belongs to Municipality of Rosoman. The anticipated set out and appearance of the landfill will be important to the 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 Vardar Region is going to be located in a site that administratively belongs to Municipality of Rosoman. The site is located in the west of the settlement of Rosoman in a distance of approx. 3km, northeast of the settlement of Sirkovo in a distance of approx. 3km and southeast of Dolno Chichevo settlement in a distance of approx. 4km (the settlement belongs to municipality of Gradsko). The above mentioned distances refer to approximate straightline/direct distance.

Figure7-27:Satellite image of the location of the site

From the national road E75 directing to the south and after approx. 4.3km of regional road A1 have access to the settlement of Rosoman. Through local road network of Rosoman settlement following the regional road which connects the settlement of Rosoman with Sirkovo settlement and at the first cross road follow the right direction for approx. 1.5km long and then turn right crossing a small drain pipe. After the culvert a paved accessible road follows for approx. 200m.

Figure7-28:Satellite image of the location of the site regarding to Rosoman

The closest settlements to the site are Rosoman and Sirkovo settlements in a distance of approximately 3km. In addition the optical isolation is in a medium level from the closest settlement (Rosoman). Also there is a low optical isolation level from the main access road. Moreover in the wider area of the site there is no archaeological site under distance of 3km. Finally in the site, currently a non-compliant municipal landfillexists.

Specifically the site is located 5 km from the deep fault which divides Vardar zone from the Pelagonija horst (Tectonic map of the Republic of Macedonia 1: 200,000). As per Seismic Risk map of R. Macedonia the area belongs to the zone 8˚ with a seismic coefficient Ks = 0.050.

The area is located an altitude that ranges from 234m to 267m (mean 254). The total expansion of the area that can be used according to the morphological characteristics is approximately 30 ha. According to the geological characteristics, there is availability of soil material for the daily cover.

Rosoman area mainly includes terrains with boundary, karst and fissure types of wells with high (greenish color) to low (grey - greenish color) yielding. Paleogene sediments are mainly waterless terrains and areas around the Crna River include wells with very high yielding > 10 l/s.

There are no protected areas nearby the site in a distance under 3km. The closest protected areas to the site are:

- Emerald site "Raechkaklisura" with code MK0000028 in the south in a distance of approx. approx. 8km.
- Point of interest with code 132 "Archaeological site Stobi" in the northeast in a distance of approx.5.5km

The soil of the site is characterized as Pathogenous due to the existence of a landfill. According to Corine Land Cover 2012, in the wider area of the site there is agricultural land, with complex cultivation patterns. Also there is an irrigation network around the site.

Moreover the Rosoman area has moderate continental climate due to Mediterranean influence. Average monthly temperature in August amounted to 35˚C. The coldest month is January, with an average minimum temperature of -1.2˚C, while the warmest month is August. This area is dry with annual precipitation of about 420mm/m^2. The most frequent wind directions are north and northwest.

Finally, the existing infrastructure conditions and requirements are the following:

- For the final access to the site approx. 200m of road needs to be improved with asphalt pavement and also redesigning of the culvert.
- Closing and rehabilitation of the existing landfill in the site.
- Connection to the public utility networks through the nearby settlement in a distance of approx. 3km.

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)

The site is located northwest of the settlement Rosoman. On one part of the location, there is a landfill containing mainly municipal waste but there are also some parts where soil stockpiles were detected. Part of the municipal waste is enclosed by wire fence on every corner. The remaining part of the location is arable land with plantings of vineyards and orchards and part are arable surfaces. At the highest parts of the scope in question, there are non-arable lands.

The survey was conducted between the period of 12.01.2017 and 15.01.2017.

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 7-29: Image of the 3D model of the terrain

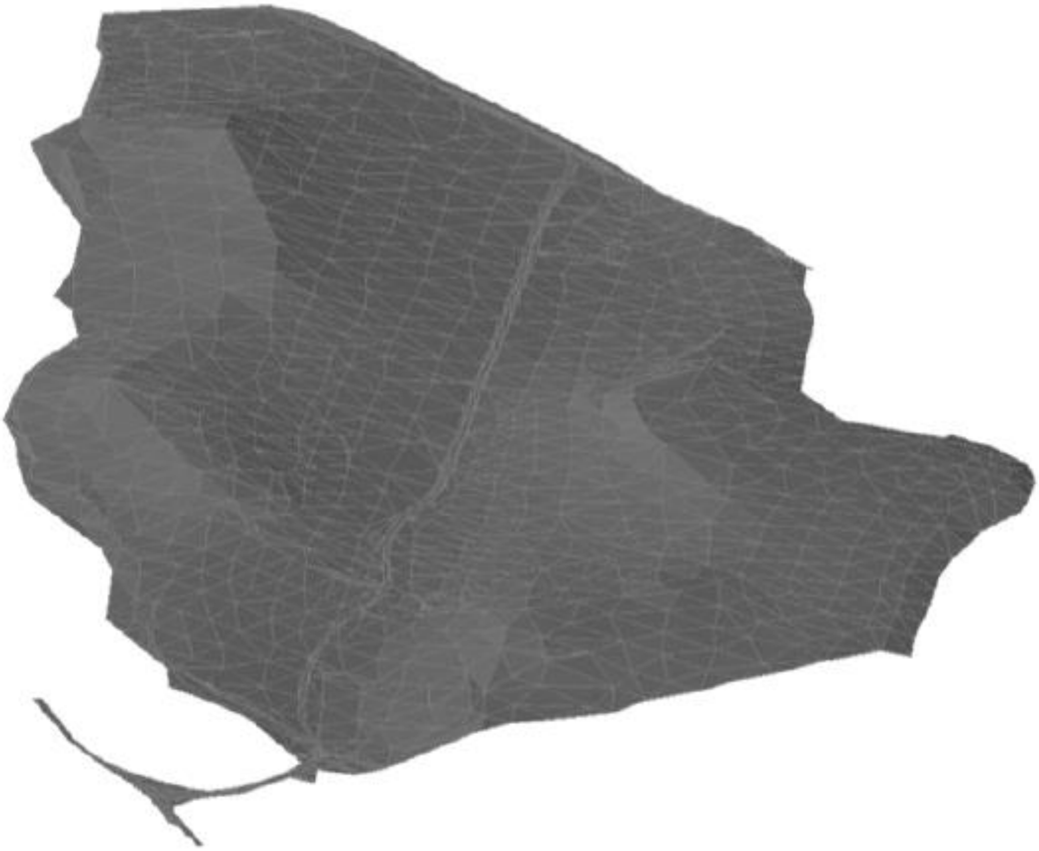


Figure 7-30: Topographic plan of existing site

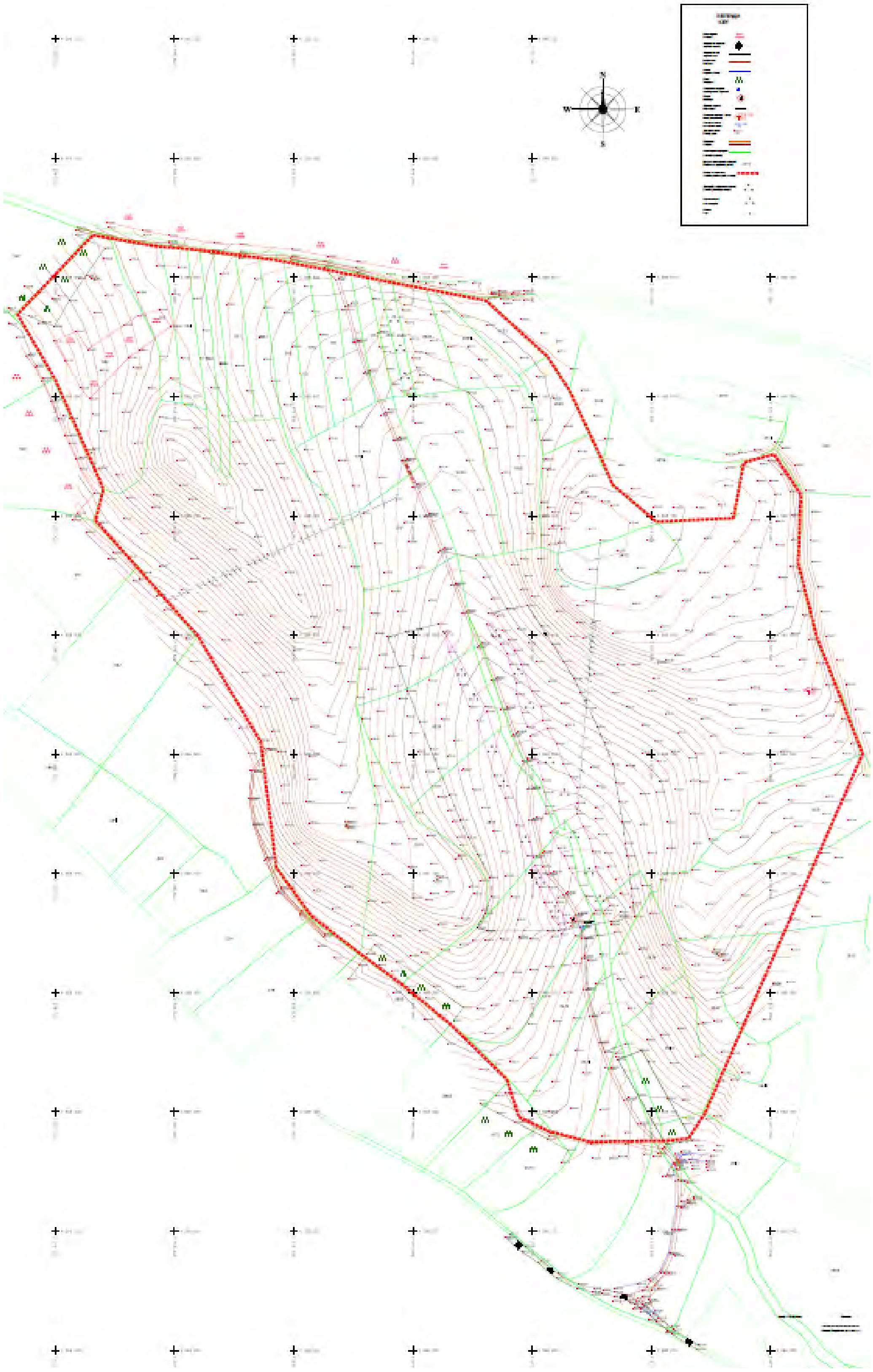
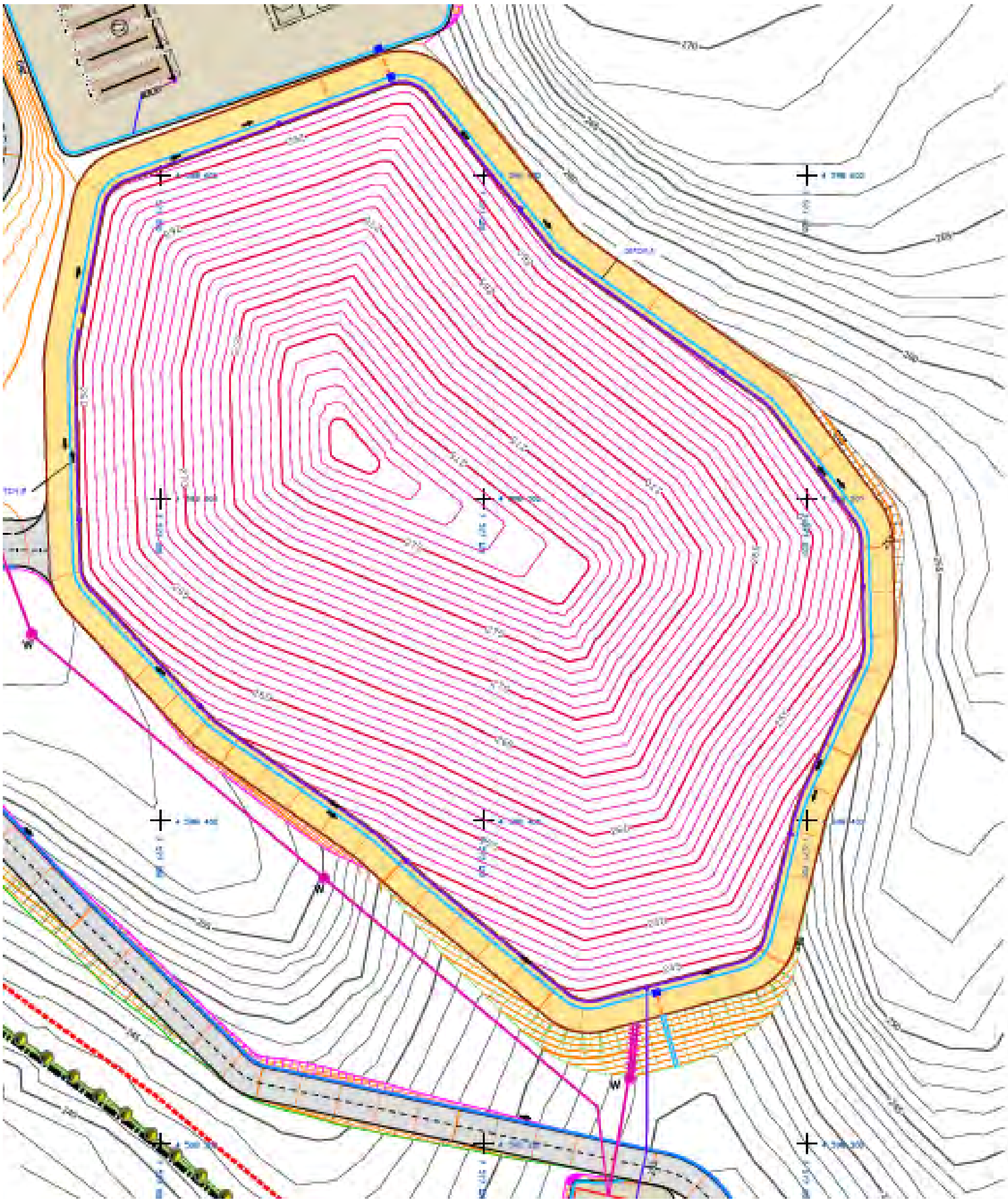


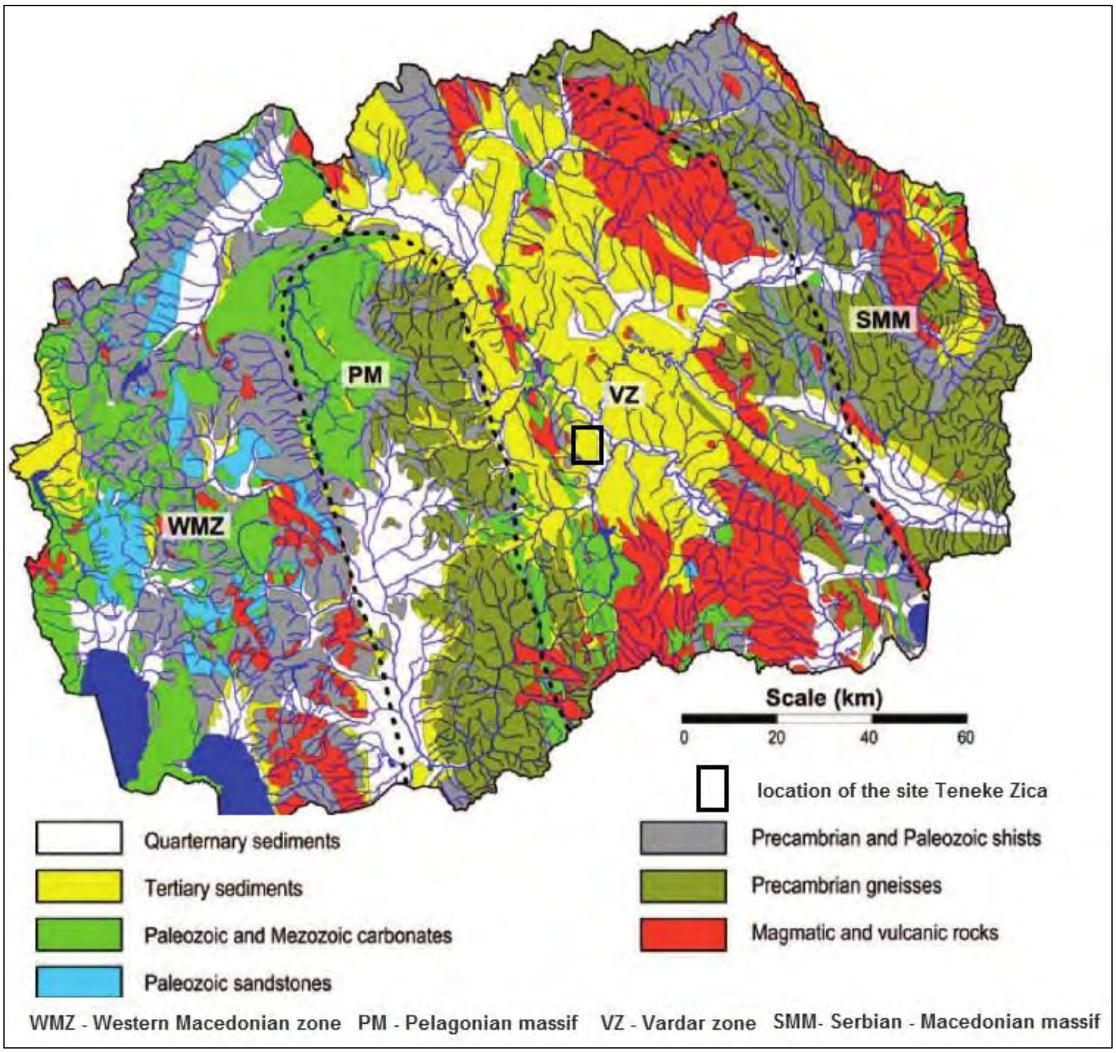
Figure 7-31: After closure topographic plan



7.1.4.3 Hydro – geological and geotechnical survey.

Geotectonicaly, Rosoman site is located within Vardar zone and general site geological composition and position within the Vardar zone are shown at the figure bellow.

Figure 7-32: Geological map of the Country with separated tectonic zones

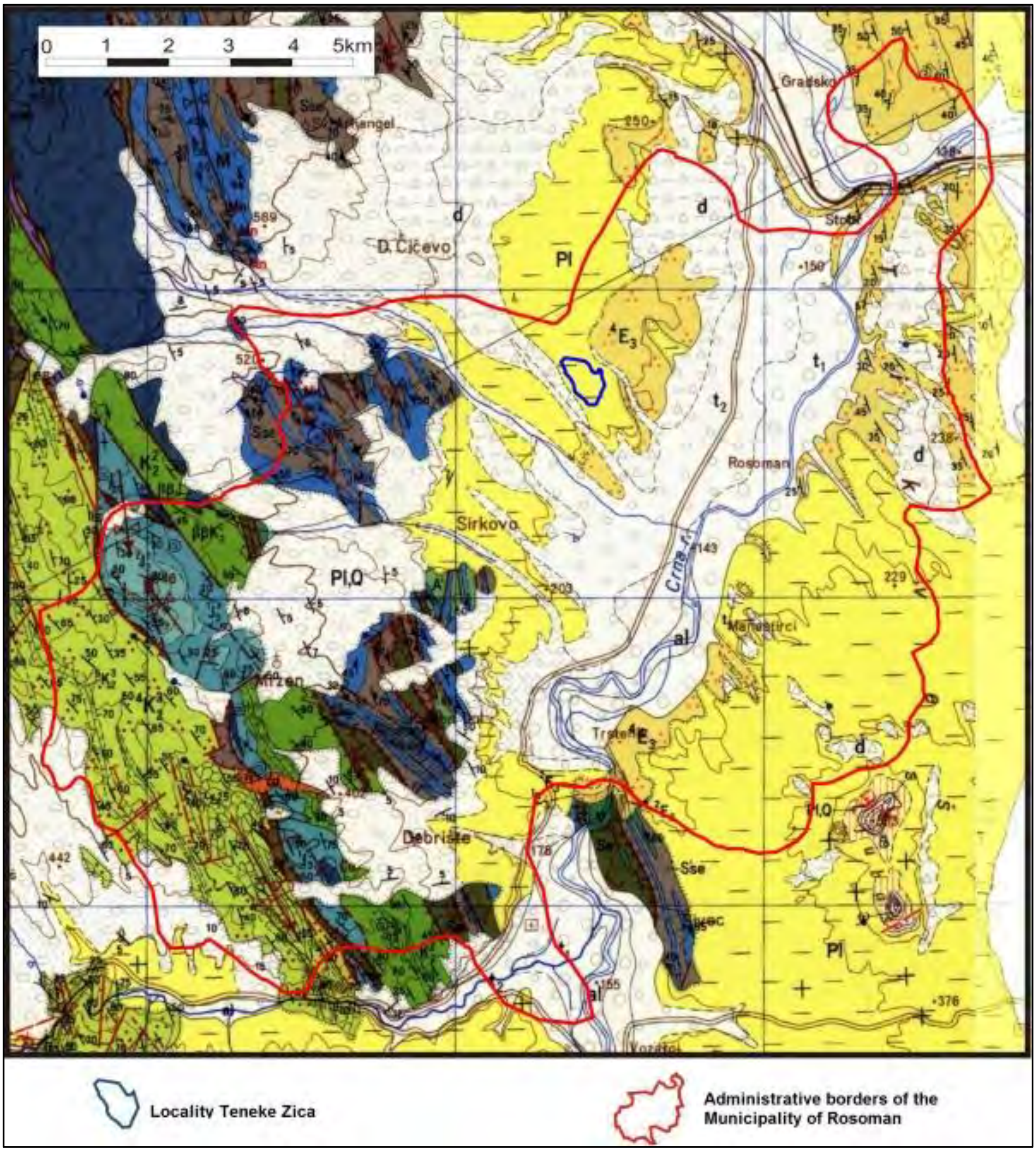


The geological composition of Vardar Zone is a real mosaic of: igneous, metamorphic and sedimentary rocks of different age, from Precambrian to the youngest Holocene forms.

Administratively, "Rosoman" site is located within the territory of Rosoman Municipality which is located in central part of the country and regarding average altitude, it is one of the lowest areas at national level.

According to the regional geological map, territory of Rosoman Municipality includes mostly Quaternary and Cenozoic (Eocene and Pliocene) sediments. Only the west side of the territory includes several types of Paleozoic and Mesozoic rocks (as shown in the following Figure).

Figure 7-33: Geological map of Rosoman Municipality



Description of the different rock formations found within the Rosoman territory (previous Figure) grouped according to respective geological eras is given below.

PALEOZOIC

Pyroxene gabbro - vpy: This gabbro is strong and tough rock with grey - green colour. Its structure is alotriomorphic granular and it is composed of plagioclases and pyroxene, as main components, and rarely amphiboles and uralite are also found.

Diabase - ββ: This rock appears in the southeast edge of gabbro massif, from both riversides of Vardar. It has green and grey-green colour, with homogeny and massive texture. It is fine grained with dimensions of grains around 1 mm. Diabase is tough and strong rock often catted with veins ofcalcite and epidote. Also, cracks from different strikes are found, especially along the Vardar river. Usually these rocks are composed of plagioclases, pyroxene and magnetite.

MESOZOIC

Triassic sediments are determined in several elongated zones with orientation northwest - southeast. Their orientation and relation with surrounding rocks is conditioned of tectonic movements with which Triassic sediments are brought above Paleozoic and Mesozoic rocks. At some places those sediments are covered with Turonian purple conglomerates. The continuity of Triassic sediments, locally, is interrupted with tectonic lines or occurrence of Tertiary and Quaternary sediments.

Rocks from Jurassic appear as elongated interrupted zone with orientation northwest – southeast, mostly presented with serpentinite (Se).

Serpentinite (Se): Serpentinite occurs in elongated masses with orientation northwest – southeast along the Vardar River valley, from the inflow of Pcinja and north of Veles. Those rocks have dark green to black colour. Main minerals in its composition are olivine, enstatite and diallage, while secondary minerals include chromite, serpentinite, magnetite and rarely carbonate. Often, cracks are filled with pure magnezite.

Upper Cretaceous sediments are developed along the river Vardar valley with orientation northwest - southeast. Investigations separated Turinian and Senonian sediments.

Turonian sediments are represented in two interrupted zones and two facies: red quartz conglomerates and plated - clay - marl limestone, massive limestone with conglomerate and sandstone.

Senonian sediments occupy almost one half of the terrain. Those are sediments with the largest spreading of all Mesozoic rocks. They have orientation as the other rocks in the surrounding, northwest - southeast. On the west side, they are placed transgresive above the gneisses, micaschists and marbles. On east, relation with Triassic sediments and serpentine is tectonic, or diapiric. On southern side, Pliocene sediments form Veles valley lay over the Senonian parts.

Senonian sediments have noticeable lithological and facies variability and include:

- in the lower part - quartz conglomerate, sandstone and limestone, and
- in upper part flysch sediments and plated limestone.

CENOZOIC

Eocene (E) is presented in upper flysch zone which is the most present lithological unit with large thickness. The most dominant members are sandstones. They have grey colour, sometimes yellow and there is present complex bedding.

Pliocene (Pl) is represented with sandstone series which cover the whole Tikves basin. Sandstone series are homogenous, composed of sands with yellow colour and small parts include gravel - sandy slate and fine grains grey sandstones. In the eastern part of the Tikves basin, those series transgresively lay over the Eocene sediments.

Quaternary (Q) is represented with agglomerate (ωQ) and terrace sediments which are related to current depressions and river valleys. Depending on the height, terrace sediments are separated as: Upper terrace (t3), Middle terrace (t2), Lower terrace (t1) and diluvium (d).

GEOLOGY OF THE STUDY AREA

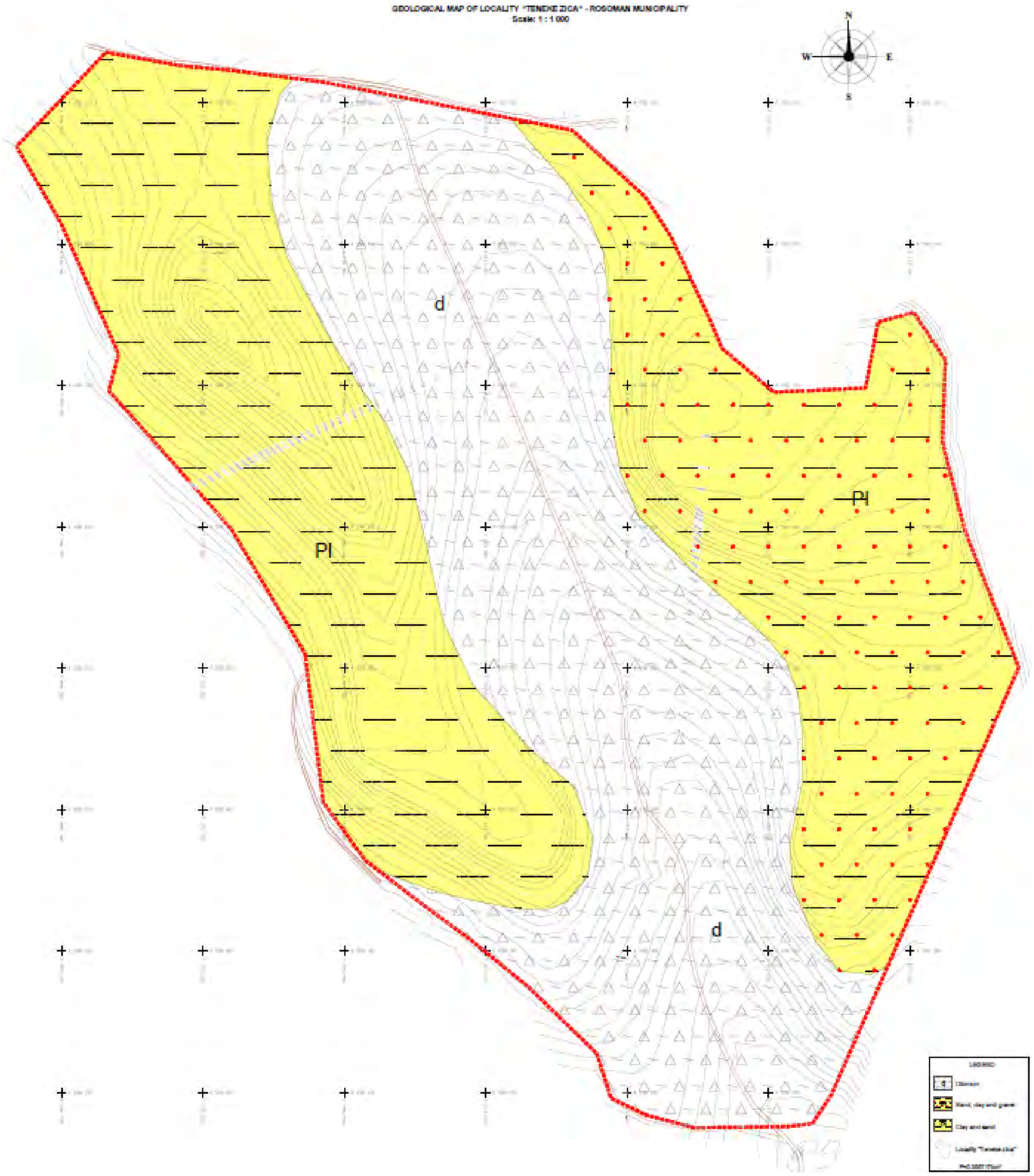
According to data from BGM (Basic Geological Map) 1 - Prilep Sheet (scale 1:100 000), study area and its immediate vicinity is composed of Pliocene sediments with large thickness (above 100 meters). Those sediments include grey -yellow sands, sandy clays, clays and very rarely gravels, and transgressively cover Eocene or so called upper Flish zone with large thickness (above 2000 meters). Area planed for landfill (and associated facilities)construction covers approximately 30 ha.Entire area was prospected and lithological units composing the area were determined. Units found are presented at detailed area map (as shown in the Figure of the geological map).

As shown on the map and photos, the study area presents a shallow depression, where central parts are filled with Holocene diluvia sediments, while both (upper) sides are composed of Pliocene sediments.

The following photos clearlyindicate the geomorphology of the study area.

Figure 7-34: Photos of the study area

Figure 7-35: Geological map of the study area (R1 site)



Diluvia sediments(d)– As mentioned above, those sediments are dominant in the central parts of the study area and formed with disintegration of the materials of the basic rocks. Those materials are transported (by washing and gravity) and deposited on the slight slopes or in the basins of the valleys. From the shallow trenches and terrain (macroscopic) examinations it can be concluded that those sediments are composed of brown dusty clays. Clay materials are fine, with equal granulometry and variable thickness which decreases toward the upper parts of the depression. The exact thickness of those sediments should be determined with further (detailed) geological investigations (excavation of pits or boreholes). The following figure shows a small exploration trench, located in the dusty clays, where their color and granulometrycan be clearly seen.

Figure 7-36: Exploration trench located in dusty clays

On site test of plasticity was performed on collected material (material is wetted and twisted in a, as thin as possible, strip).The test results indicate that material is very plasticand can be twisted in very small strips without braking(diameter smaller than 3 mm).

Figure 7-37: Plasticity test

*Pliocene sediments (Pl)*appear in the upper parts of the study area and are usually covered with several centimeters of poor quality humus mixed with clay sands. Stratigraphically, diluvia sediments are positioned above them in the larger part of the area investigated.

Initial explorations show that Pliocene sediments are very complex and represented by sands, gravels and clays. As per geological map data, coarse granular (gravel - sandy) sediments with significant amount of clay material which cover the grains of terrigenous material appear in the eastern side of the study area. The following figure showsa shallow trench created on the eastern slope and as it can be seen, the location is covered with proluvial material (gravel), with light brown to yellow color and medium to fine processed grains with diameter of 1 to 5 cm. There are several centimeters of humus - clay matter above this gravel horizon.

Figure 7-38: Coarse granular (gravel - sandy) sediments with significant amount of clay material

The western side contains finer materials of Pliocene age, while the northwestern parts of the study area are composed of fine granular quartz sands with light yellow color and equalgranulometrycovered with thin humus cover as shown in the following figure.

Figure 7-39: Fine granular quartz sands with light yellow colour

The southwestern parts of the study area are composed of well diagenesed clays which can be easily disintegratedand have a noticeably good plastic features during the onsite test of plasticity as shown in the following figure.

Figure 7-40:Diagenized clays

Initial geological investigations point that there is a clear distinction between diluvia and Pliocene sedimentswithin the study area, buttheirvolumescannot be accurately defined at this phase of investigations. Therefore, detailed geological investigations within the study area should be focused onbetterdistinguishinggeological members of Pliocene and accurately define their relationships with Holocene sediments (diluvia).

TECTONIC - SEISMIC CHARACTERISTICS OF THE STUDY AREA

The study area is in the central part of the Republic of Macedonia which belongs to Vardar zone as tectonic unit. Vardar zone has northwest - southeast orientation and includes all formations from Precambrian to Quaternary.

It should be noted that wider area of Rosoman site is composed of Neogene sediments with significant thickness and represent ridges filled with terrigenous lake material. As shown on tectonic map dominant fault structure is located 5 km west of site (Mark 22 on the tectonic map shown in the following picture). Outcrops of serpentinized peridotites which appear along this structure are very schistose and impressed along the weakened ruptures. The process of imprinting occurred at great depths and leadto metamorphism of the adjacent rocks. This is illustrated by contacts between Paleozoic rocks and the smaller parts ofmarbles inside theserpentinites. Along these unstable zones,impressing of larger masses of diabase’s and gabbro’s occurred.

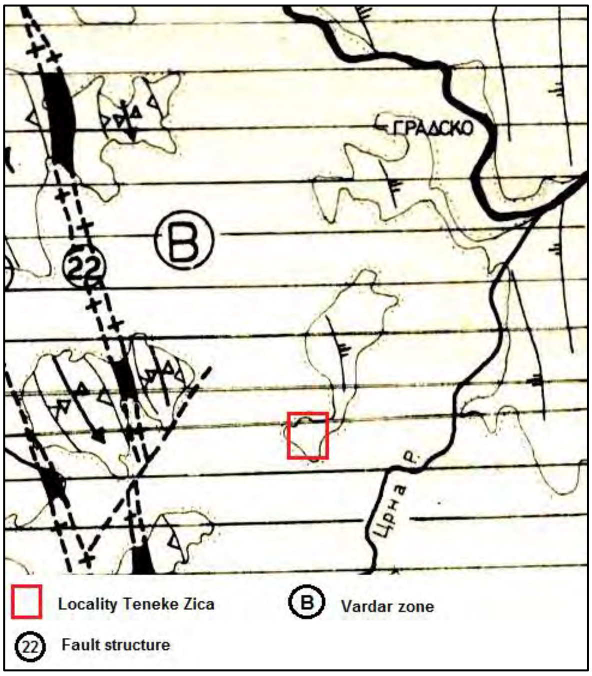


Figure 7-41:Tectonic map of the broader area of the study area

From neo-tectonic aspect, the study area presents a stable two-sided ridge filled with clayey - sandy sediments.

SEISMIC FEATURES OF THE TERRAIN

Vardar seismic zone is one of the most unstable tectonic unitswithin the Balkan Peninsula, where Alpine orogeny processes were strongly expressed and continued in the neo-tectonic stage. Seismicity in this area is particularly significant in the areas of intersection of reactivated old faults of Vardar direction with neo-tectonic faults which extend predominantly in the vertical direction. Epicenter areas of strong earthquakes within the area are: Skopje, Valandovo, Gevgelija and Mrezicko.

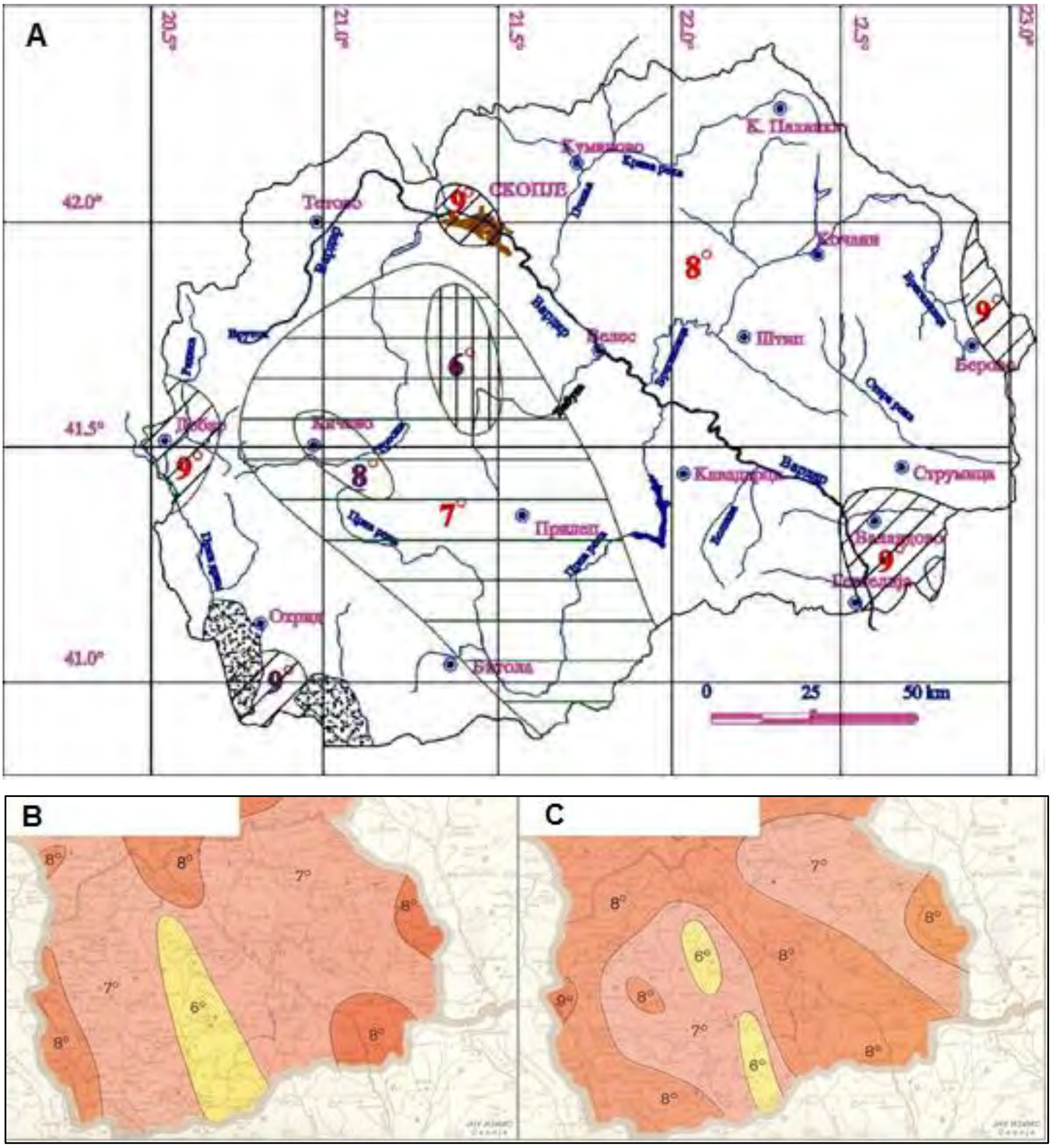


Figure 7-42: Map of intensities of Macedonia for return period of A - 500 years, B- 200 years and C – 100 years

As shown in the previous figure, earthquakes with intensity up to 9°according to 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 8°according to the MCS.

The following figure (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.

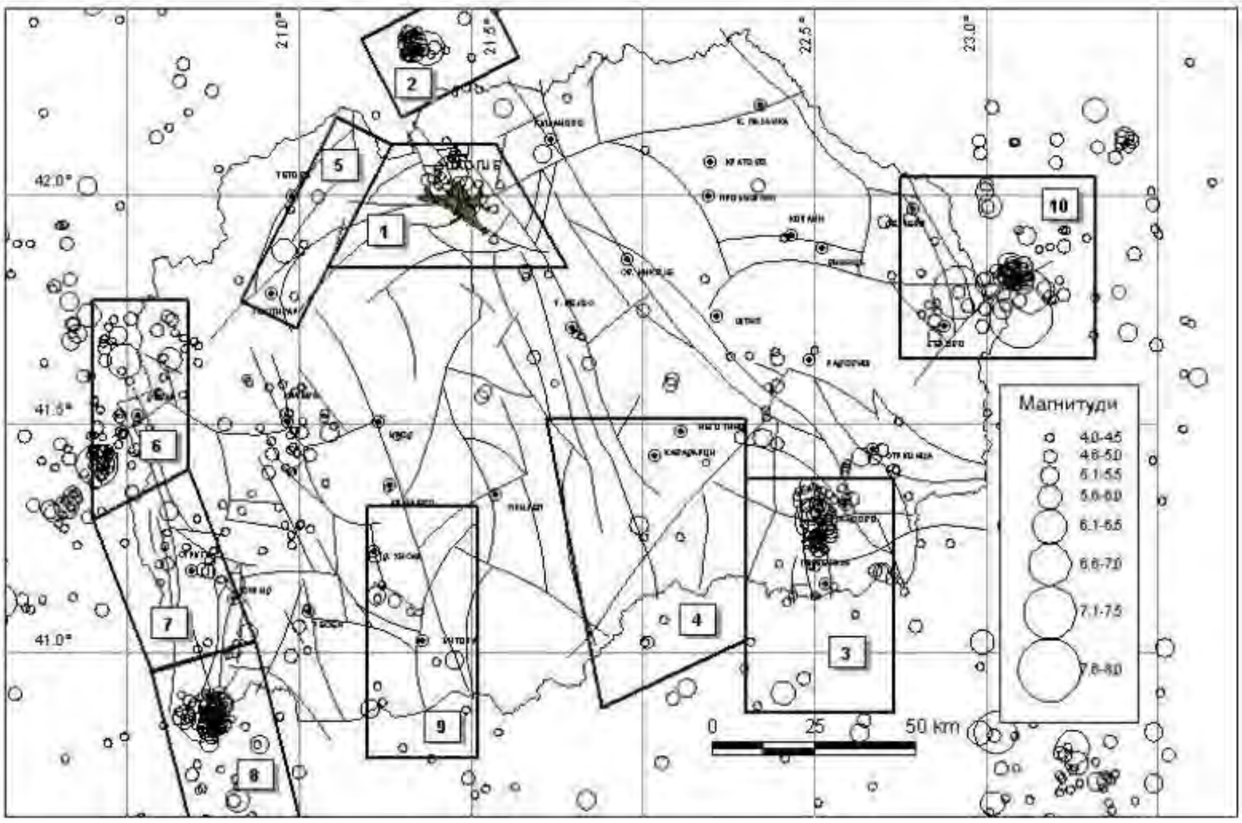


Figure 7-43: Map of seismic sources for maximal expected magnitude ML≥6.0

As shown on the map, the “Rosoman”site does not belong in the areas with the most intensive seismic activity and stronger earthquakesshould not be expected.

HYDROGEOLOGICAL FEATURES

Hydrogeological conditions within the study area were analyzed in order to determine possibilitiesfor surface or high groundwater levels occurrence, 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 totheir hydrogeological function as:

- hydrogeological insulators which include diluvia sediments composed of dusty clays,
- hydrogeological complexes which include mostly Pliocene sediments.

Within the hydrogeological complex, sands and gravels are typical collectors with inter-granular porosity were boundary springs are formed. Those collectorsallow infiltration of surface waters through the Pliocene sediments to the zone of constant underground water levels or up to clay layers as typical hydrogeological insulators.

Stratigraphic position of the diluvia dusty clays in relation with Pliocene sediments doesn't allow penetration of surface waters in the central parts of the depression. The clays are practically waterproof (from the experience is known that their filtration coefficient is k = 0.01 – 0.1 m'/day)and they act as surface insulators from surface water in the central (low) parts of the study area.

On the other hand, in the higherparts of the study area, where sands and gravels occur on the surface of the terrain (and have relatively high filtration coefficient k = 1 – 10 m'/day),penetration of water could occur and should be controlled.

Prospection site visits didn't determine existence of surface water within the study area and in the immediate vicinity.

GEOTHECNIAL CHRACTERISTCS

Geological prospection also includes general determination of site's geotechnical characteristics, as follows:

- Determination of contemporary geological processes and phenomena,
- Geotechnical categorization of rock masses,
- Terrain stability conditions,
- Surface and ground waters presence,
- Waste cover and sealing materials,
- Foundation.

SLOPE STABILITY–CONTEMPORAY PROCESES AND PHENOMENA

Site prospection did not determine presence of contemporary geological processes and phenomena (landslides, rockslides, gully'sand ravines),and terrain can be classified as a stable in natural conditions. Althoughsome natural slopeswith angles above 60° were found within the study area,occurrences 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 (verticallythe 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, sands and clays from Pliocene complex could be classified as unbounded rock masses. They are mainly medium compressed incoherent materials and because of this, direct excavation (mechanical) can be used without the need of rippingand/or blasting. The same applies to diluvia dusty clays which perhaps have even less cohesion than Pliocene sediments.

FLOOD AND RUNNOFF

Prospection visits didn't reveal permanent or periodic flows within the study area and its immediate vicinity, so possibility of flooding could be practically eliminated. Having in mind the size of the catchment area and the slope angles, significant runoff waters are also not expected.

WASTE (DAILY) COVER MATERIALS

The first impression isthat only small portions of Pliocene sediments are semi permeable and can meet the requirements for dailywaste 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 that additional quantities are needed, or excavated materials do not meet the requirements, utilization of Pliocene sands and gravels in site's immediate vicinity is suggested, as there are several appropriate locations for borrow pits.

SEALING MATERIALS

Preliminary investigationsand in situ tests indicate that diluvia and some parts of Pliocene sediments can be used for geological barriers construction (sealing). In case that additional quantities are needed or excavated materials does not meet the requirements, utilization of diluvia and proluvia sediments around the settlement Dolno Cicevo (aprox. 4 km from the "Rosoman" site) is suggested.

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" does not apply in this case because such rocks cannot be found near the surface. First impressions indicate that some measures in order to improve properties of the groundbase 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 the study area can be summarized as follow:

- According the regional geological map, territory of Rosoman Municipality includes mostly Quaternary and Cenozoic (Eocene and Pliocene) sediments. Only on the west side of the territory several types of Paleozoic and Mesozoic rocks are present.
- The study area presents a shallow depression, where central parts are filled with Holocene diluvia sediments, while both (upper) sides are composed of Pliocene sediments.
- From neo-tectonic point of view, the study area presents a stable two - sided ridge filled with clayey - sandy sediments.
- ''Rosoman'' site doesnot belong in the most intensive seismic activity areas and strong earthquakes should not be expected.
- Rockspresent within the study area,in terms of 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 stable in natural conditions. Although some natural slopes with angles more than 60° were found, occurrences of active landslides were not determined.
- There are no permanent or periodic flows within study area and flooding potential is very low.
- First impression isthat small portion of Pliocene sediments issemi permeable and can meet the requirements for daily waste cover.
- Preliminary investigations and in situ tests indicate that diluvia and some parts of Pliocene sediments can be used for geological barriers construction (sealing).

7.1.4.4 Proposed site lay out 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. Also, another constraint that was taken into consideration is the existing waste disposal along the deep area of the site.

More specific, the entrance is foreseen from the South and lowest part of the site, however an alternative entrance can be achieved from the north. Also, at the lower part of the site the Waste Water Treatment Plant is located, in order to receive the leachate/waste water by gravity.

The landfill is designed along the valley in the central area of the site, where also the geological conditions are identical. The facilities for waste treatment, as well as the auxiliary facilities (administrative building, maintenance and other infrastructures) are designed at the upper part of the site, northern from the landfill.

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. The WWTP is located at the left of the entering stream and after approximately 480 m, the first phase of the landfill is met on the right.

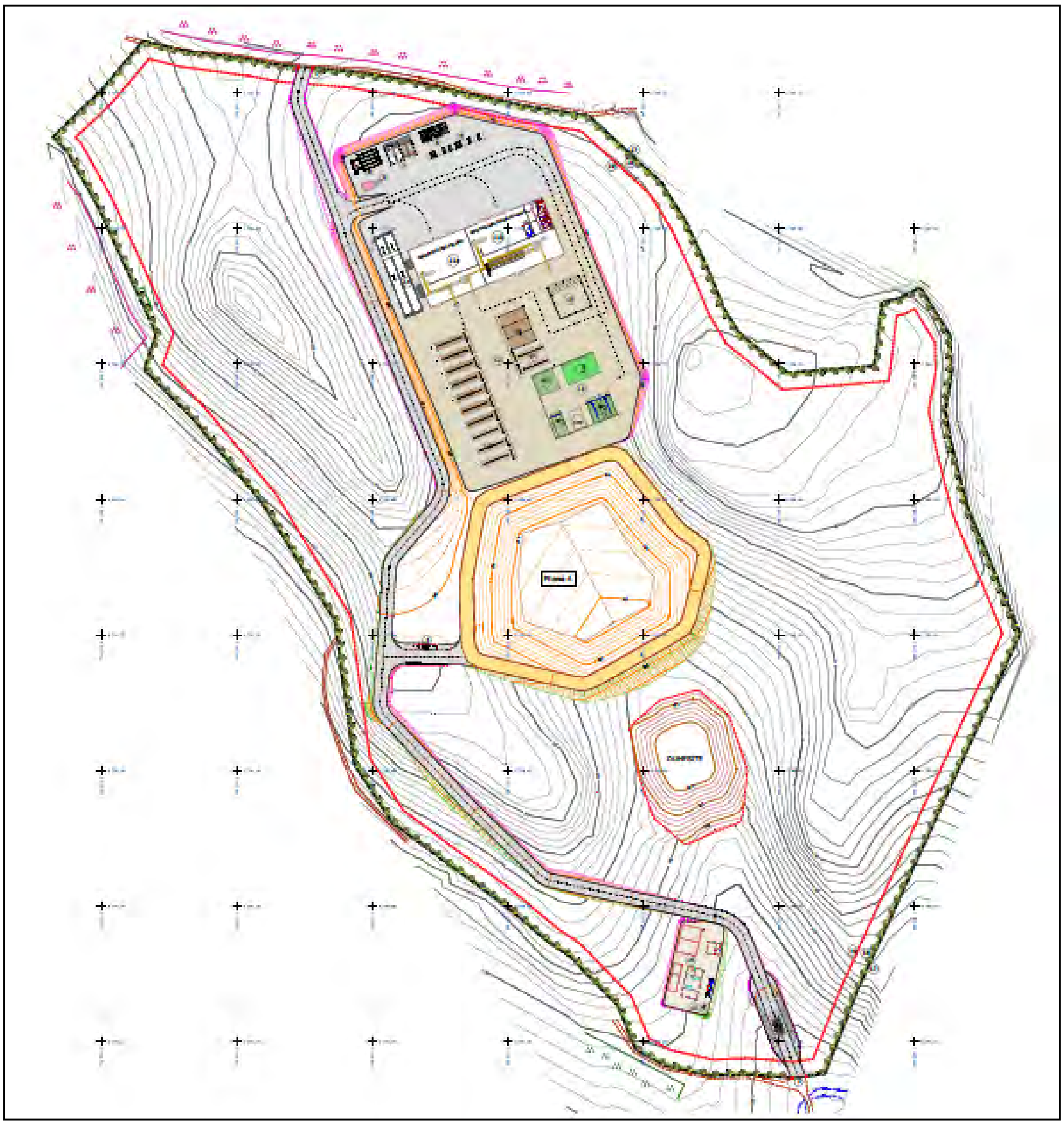
Next facilities are to be met, are the waste treatment facilities and the infrastructure buildings on the right. This area is 38,255 m^2, and it has a mean elevation at +258.00 m. The administrative building, the maintenance building, the energy building and the water tank are foreseen at the northern part of this area, whereas the reception area of the mechanical sorting building is at the left. The biological treatment facilities for the organic fraction of municipal waste and the green waste are located southern from the mechanical sorting building.

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

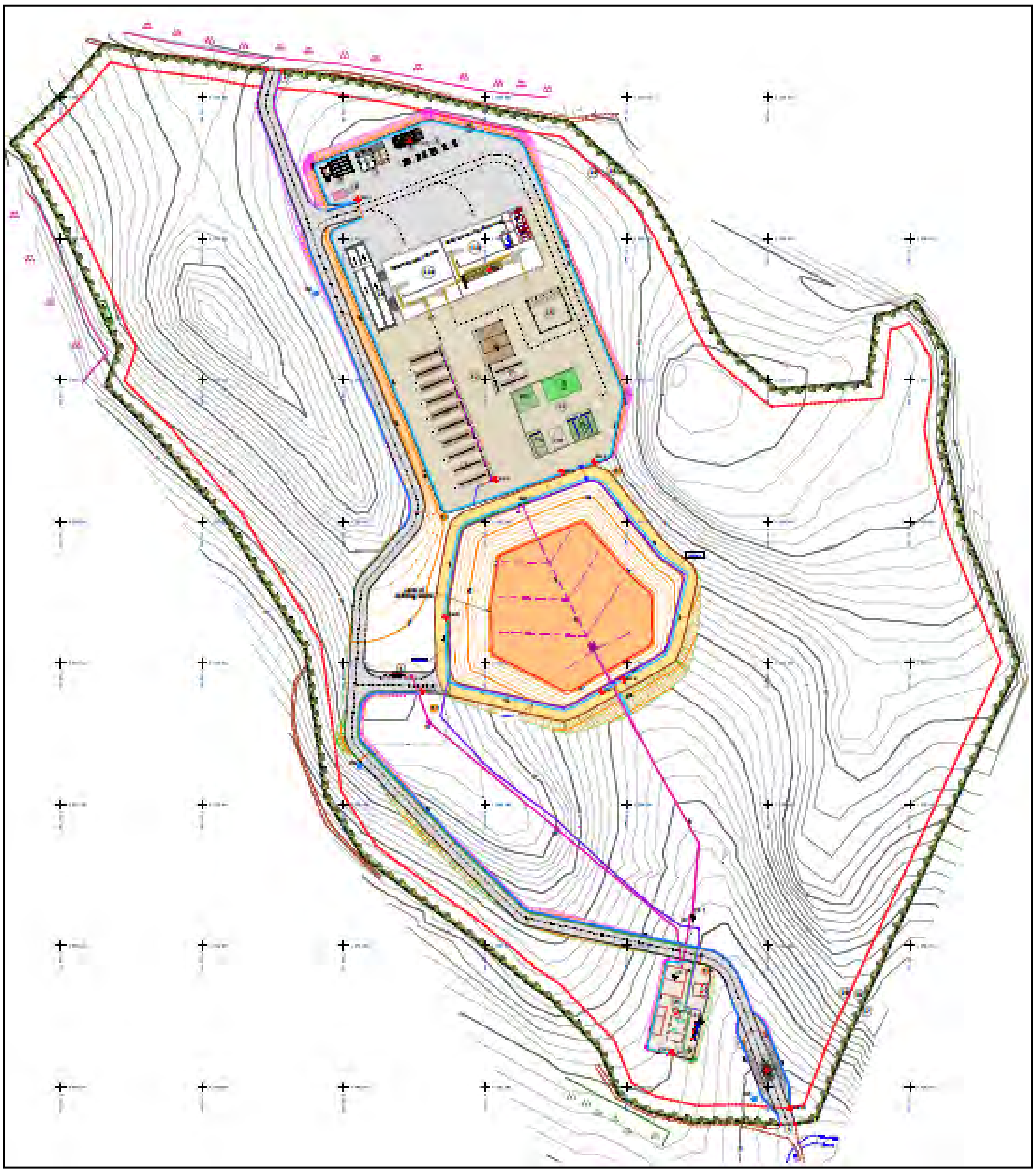
In the middle of the site there is a valley with direction from north to south that divides the site in two parts. Along the valley an amount of waste is currently disposed. According to the assessment report of Vardar region and in comparison with the topographic survey this amount is estimated around 27,000m^3. The area that is polluted by waste is around 16,000 m^2 and it is fully fenced. For the beginning of the construction of the landfill it is necessary the existing waste deposits to be collected in the southern part of the fenced area in a smaller area around 7,100 m^2 (Drawing 4.1 - General Layout of works during construction of Phase A). After that, in the northern part of the fenced area, phase "A" of the landfill basin will be developed.

Figure 7-44: General Layout of works during construction of Phase A



When the construction of phase "A" is completed, all existing waste in the field will be transferred into the basin of phase "A" (Drawing 4.2 - General Layout of works - Start of operation Phase A). The area from which all existing waste will be transferred should be fully sanitized in order to allow the passage of networks and later the construction of phase "B" of the landfill. Specifically, 30cm of soil should be removed from all the area that is covered by waste after the waste transferring into the landfill. However, in the largest part of this area much more than 30cm soil will be removed due to the configuration of the bottom level of the basin.

Figure 7-45: General Layout of works - Star of Operation of Phase A



The sanitary landfill design was based on the Landfill Directive 99/31/EC and the respective national legislation (Rulebook 78/09, RULES ON THE CONDITIONS TO BE FULFILLED BY LANDFILLS).

The overall sanitary landfill of Vardar region, will be developed in two cells - phases.

For the construction of phase "A" of the landfill, 46,500 m^3 excavations and 39,700 m^3 embankments will be required. Additionally, 118,500 m^3 excavations and 23,700 m^3 embankments for the configuration of the area for the whole central waste management facility (administration area, MRF and composting area, WWTP area, internal road connections) will be required. The surface of phase "A" will be about 22,640 m^2 (excavation level) and it will have a total capacity of 230,000 m^3. The estimated life of the landfill is expected to be almost 8 years.The lowest altitude of the cell (in absolute units above Sea level) will be +236.50 m, while the highest altitude will be +259.32 m.

The bottom of the cell has been configured in a V shape. The bottom has longitudinal inclination 5.00 %, with direction from north north-west to south south-east and transverse inclination 3.00 %, so that the leachate will be collected by gravity.

The sides of the basin are designed with grade 1:3 (height:base). The sealing system is described in next paragraph in detail.

Phase "A" and "B" will be separated with the construction of a dike. The dike will have 10 meters width and approximately 8 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 7-24: Main technical characteristics for the phase A

Element	Amount	Unit
Excavation	46,500	m^2
Backfill	39,700	m^3
Phase A-Bottom excavation level	7,450	m^2
Phase A-Slopes excavation level	15,190	m^2
Total Area	22,640	m^2
Capacity	230,000	m^3

For the construction of phase "B" of the landfill, 50,350 m^3 excavations and 25,050 m^3 embankments will be required. The surface of phase "B" will be about 28,720 m^2 (excavation level) and it will have an additional capacity of 510,000 m^3. So, the total estimated lifetime of the landfill is expected to be at least 26 years with a capacity of 740,000 m^3.

The following table presents the basic characteristics of the landfill in total.

Table 7-25: Main technical characteristics for total landfill

Element	Amount	Unit
Excavation	96,850	m^2
Backfill	64,750	m^3
Total landfill-Bottom excavation level	13,790	m^2
Total landfill-Slopes excavation level	14,930	m^2
Total Area	51,360	m^2
Capacity	740,000	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: $K \leq 1.0 \times 10^{-9}$ m/s; thickness ≥ 5 m;
- Landfill for non-hazardous waste: $K \leq 1.0 \times 10^{-9}$ m/s; thickness ≥ 1 m;
- Landfill for inert waste: $K \leq 1.0 \times 10^{-7}$ m/s; thickness ≥ 1 m.

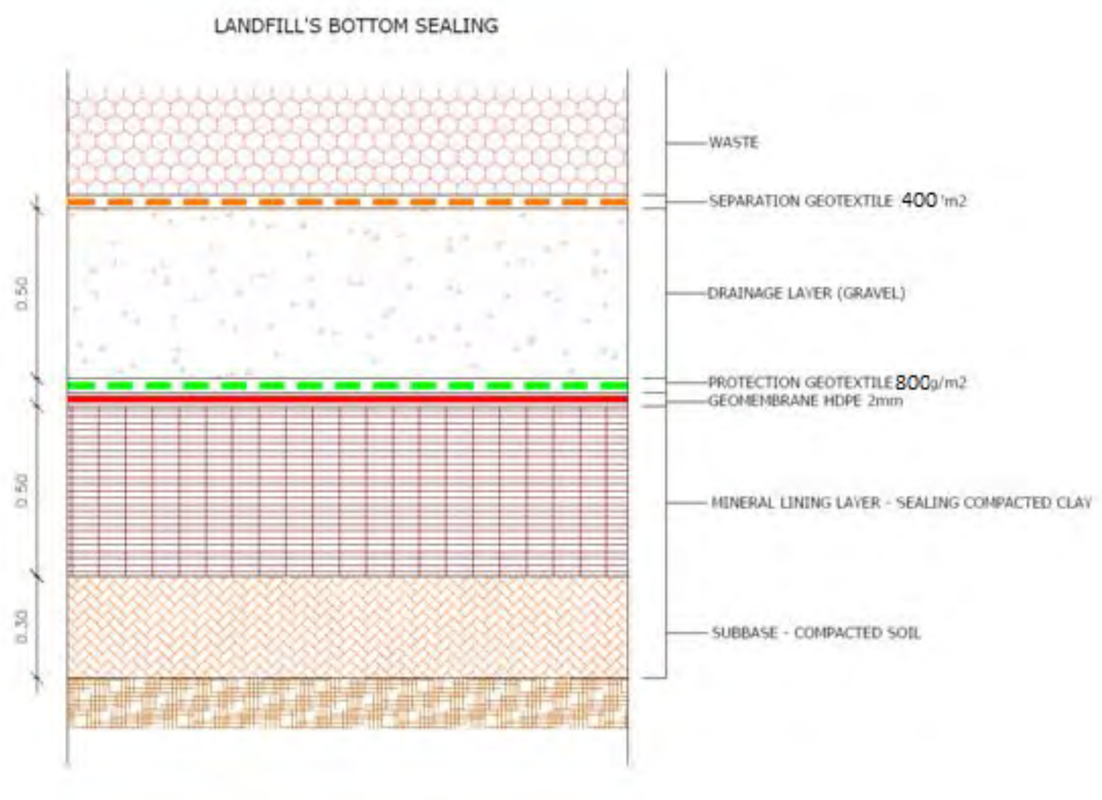
Where the geological barrier does not naturally meet the above conditions it can be completed artificially by applying a layer of sealant mineral land and use of other appropriate technical measures to provide equivalent protection of soil, groundwater and surface water. An artificially established geological 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 ≤1, 0x10^{-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 ≤1,0x10^{-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 ≥1,0 x 10^{-3}m/s.

More specifically, the selected bottom lining system for the landfill in Rosoman consists of the following layers:

- Sub base ofcompacted 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 ≤1,0x10^{-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 ≥1,0 x 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> 1x10^{-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

Figure7-46: 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.

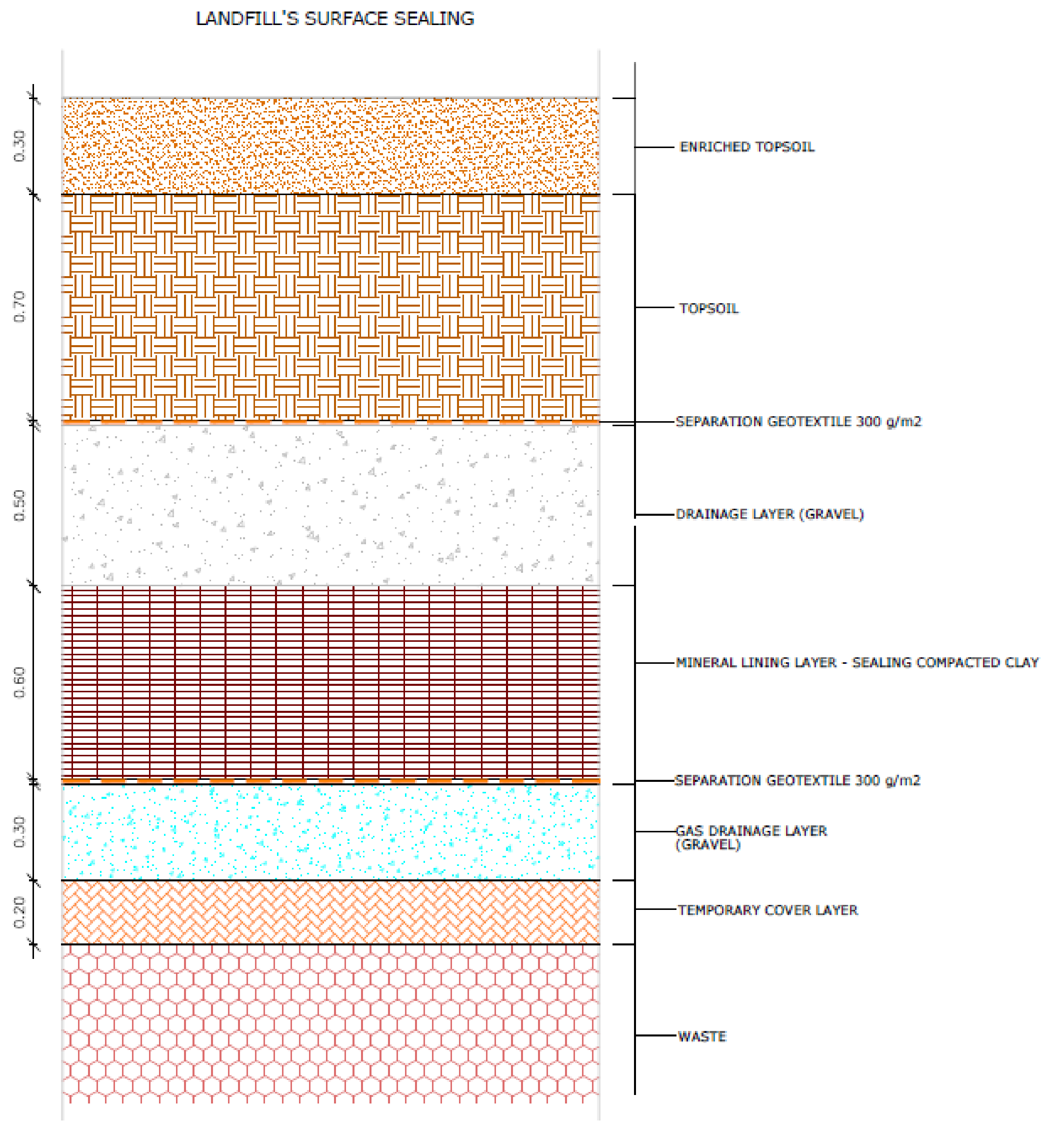
The objectives of the surface sealing system are to:

- 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
- Gas drainage layerwith 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 soilwith a minimum thickness of 0,2m

Figure7-47: 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 it utilizing 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 7-48: Compaction at the landfill and loading of soil cover material

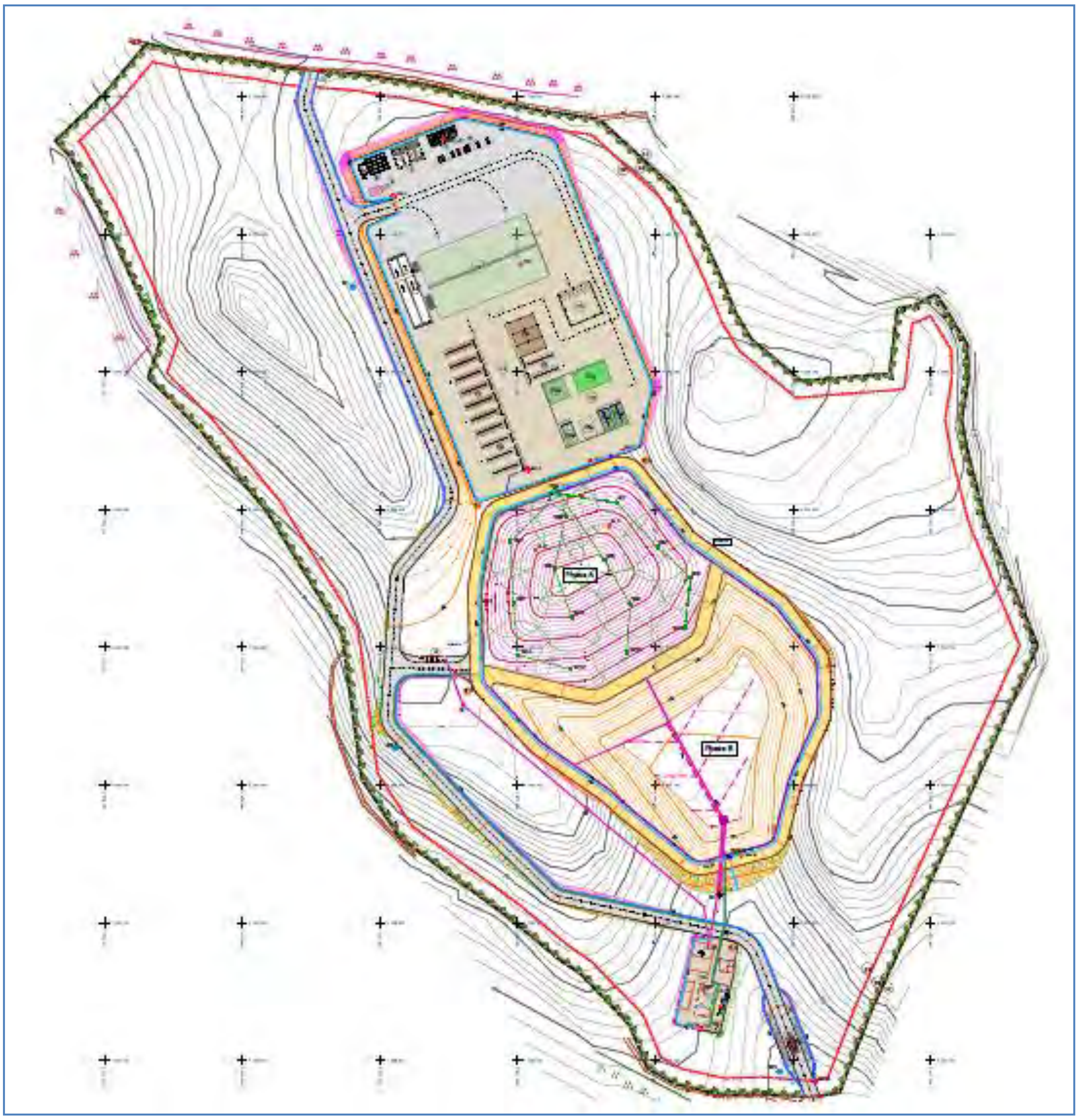
The regular application of daily cover soil is perhaps the most fundamental control on direct effects arising from landfilling. There will be availability of soil material for the daily cover of which was accumulated and during the construction phase of the landfill. For the placement of required cover 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 materialis propelled onto 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 residues 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 southern 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 residues 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 Phase A (north, north-east and north-west) may be covered with final top cover layers.

Figure 7-49: 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 7-50: Monitoring the gas system

Table 7-26: 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 deviceswill be specified in the operations plan. The operator will adjust the flow rate asrequired by adjusting control valves, the pumping system, or altering the devicesused for addition
Cumulative liquids added	Volume (gal., L)	For some devices or landfill areas, a maximum allowable volume of addedliquids 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

Monitoring parameter	Typical units	Description
Liquid pressure	Pressure (psi, in. w.c.)	The pressure of added liquids may be limited to avoid concerns with seeps andslope stability. Operator will need to monitor pressure and adjust or ceaseoperation if thresholds are exceeded
Liquid depth	Depth (in., m)	The depth of liquid may be limited, such as depth of leachate on liner system orin a vertical well. The operator will need to monitor depth and adjust or ceaseoperation if thresholds are exceeded
Leachate composition	Concentration (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
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 specificin the operation plan. For gas extraction, for wells with large flow rates(especially at small vacuums) may suggest that additional extraction points arewarranted. Flow rate can be directly measured or calculated (e.g., based ondifferential pressure across an orifice plate)
Gas pressure	Pressure (psi, in. H_2O)	Gas pressures at well heads, points in the GCCS network, or points withinlandfill 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 carried 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 backfilling, for the construction of the landfill, the facilities 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.

Also, the mass balance presented below contains the sanitation works, where needed, from the area that is covered by existing waste. Specifically, 30cm of soil should be removed from all the area that is covered by waste after the waste transferring into the landfill. However, in the largest part of this area much more than 30cm soil will be removed due to the configuration of the bottom level of the basin.

At the end of the mass balance table, it is separately presented the volume of the existing waste excavation, removal and backfilling.

Table 7-27:Earth materials balance

		Cut Volume (m^3)	Fill Volume (m^3)	
1. Landfill	(phase A)	**+46,500**	**-39,700**	
	(phase B)	**+50,350**	**-25,050**	
2. Sanitation of existing waste area		**+870**	**-**	
3. Bottom sealing (sub base - compacted soil 30cm)	(phase A)	**-**	**-6,792**	
	(phase B)	**-**	**-8,620**	
4. Facilities area (including road network)		**+118,500**	**-23,700**	
5. Buildings and infrastructures		**+32,900**		
6. Rainwater collection network	(phase A)	**+1,135**	**-**	
	(phase B)	**+150**	**-**	
7. Waste cover material	(phase A)		**-23,000**	
	(phase B)		**-51,000**	
		+250,405	-177,862	
TOTAL				***+72,543 m^3***
1. Excavation of existing waste and backfilling		**37,000**	-	

Finally, for the construction of phase A a quantity of 199,905m^3 soil excavations and 93,192m^3 of fillings will be needed. Respectively, for works Phase B additional 50,500m^3 of soil excavations and additional 84,670 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 Vardar 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 equal to 0.90 t/m^3. The life-time, area and the capacity in m^3 are shown in the table below.

Table 7-28: Capacity of landfill cells

Landfill Phases	Period (y)	Area (m^2)	Actual Capacity, m^3
A PHASE*	8	22,640	230,000
B PHASE**	18	28,720	510,000
TOTAL	26	51,360	740,000

* 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	23,037			28,156.53	28,156.53
2022	23,103			28,236.40	56,392.93
2023	23,169			28,317.28	84,710.21
2024	23,236			28,399.20	113,109.41
2025	23,304			28,482.17	141,591.58
2026	23,359			28,550.48	170,142.06
2027	23,417			28,620.49	198,762.55
2028	23,475			28,692.22	227,454.77
2029	23,536			28,765.66	256,220.43
2030	23,597			28,840.83	285,061.27
2031	23,582			28,822.17	313,883.44
2032	23,568	**0.90**	**0.10**	28,805.19	342,688.63
2033	23,555			28,789.86	371,478.49
2034	23,544			28,776.16	400,254.64
2035	23,534			28,764.07	429,018.71
2036	23,496			28,716.83	457,735.55
2037	23,458			28,671.23	486,406.77
2038	23,422			28,627.23	515,034.00
2039	23,388			28,584.81	543,618.81
2040	23,354			28,543.94	572,162.75
2041	23,296			28,473.27	600,636.02
2042	23,240			28,404.23	629,040.25
2043	23,185			28,336.79	657,377.05
2044	23,131			28,270.93	685,647.98
2045	23,078			28,206.60	713,854.58
2046	23,006			28,118.47	741,973.05

The estimated life of the landfill is expected to be almost 8 years for the first phase. The total lifetime of landfill (phases A and B) will be 26 years. The landfill’s basin is divided in phases (according to 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 5% longitudinal and 3% 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 figures (source: conceptual design).

Figure 7-51: Landfill (End of Phase A operation & Start of Phase B)

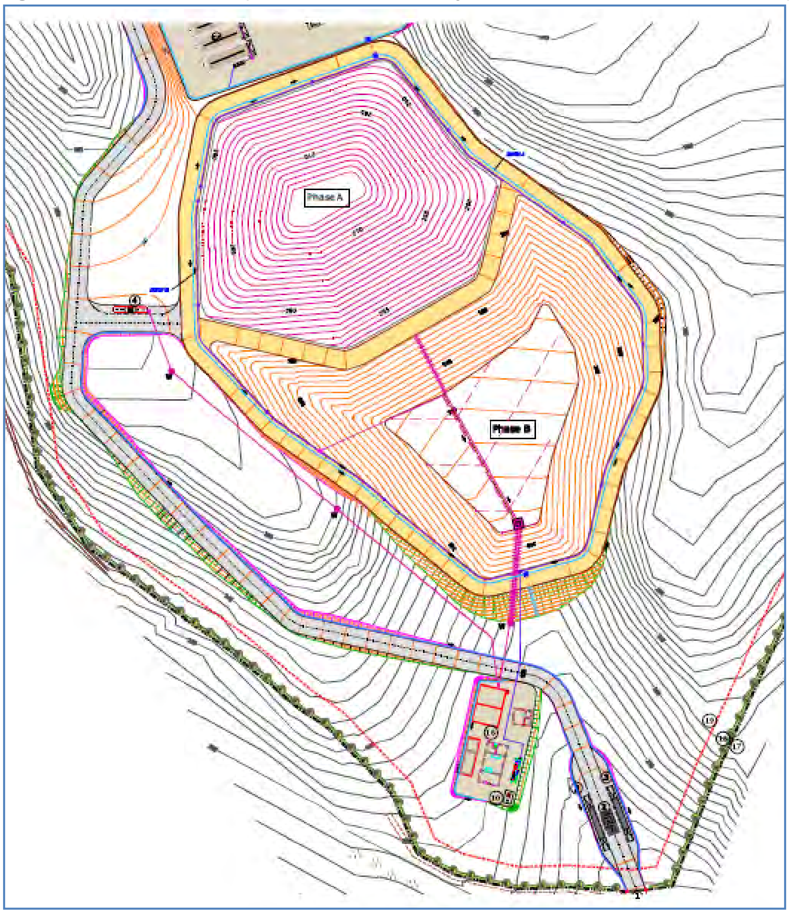
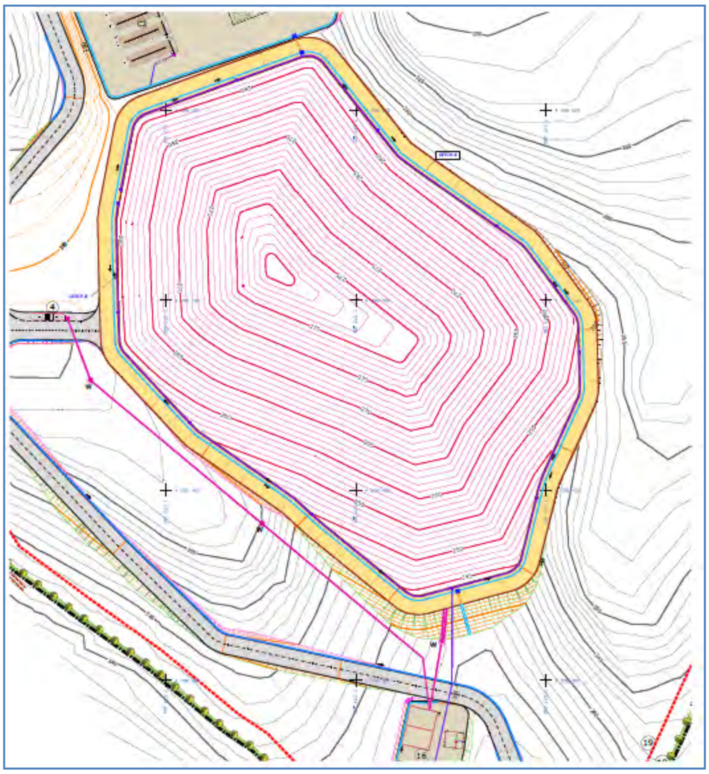


Figure7-52: Landfill (End of Phase B operation)



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. 40^oC. waste density: 1.5 Mg/m^3)
- 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 5 % 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 (“fishbone” shape), according to Drawing 16- 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 one main pipe will be established and is gathered finally by gravity into the collection manhole inside the bottom of the landfill. The pipe enters 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, one similar perforated pipe of HDPE DN500 will be placed along the deepest line of the bottom, continuing as full (non-perforated) pipe through the embankment and ending to the same manhole W.
Finally, a network of collection pipes will be established in the area of wheel washing facilitytransfer 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
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 (m^2)

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

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 (m^3/s)
A = "wet" area (m^2)
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 mostrainy month during the first phase, i.e. 23.2 m^3/d. During the second phase, leachate flow will be approx. doubled, 46.2 m^3/d, and a WWTP extension will be constructed at that time.

In particular, the various sources of wastewater generation are as follows:

1. Landfill leachate: 23,2 m^3/d (Phase A)
2. Composting process, 3,6 m^3/d
3. Washes of floors, mechanical equipment and trucks, 1 m^3/d
4. Reception area, 0,8 m^3/d
5. Personnel sewage (domestic wastewater), 4 m^3/d
6. Biofilter, 3 m^3/d
6. Recirculation, condensates, safety factor, etc (depends on the selected technology) 14,4 m^3/d
   Total: 50 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 7-29: Composition of produced mixed wastewater

PARAMETER	Landfill leachate - recirculation	Biofilter	MBT-composting	Personnel sewage	Washes	Average values, mg/l	Average values,kg/d
Flow m^3/day	37,6	3	4,4	4	1	50	50
BOD_5, mg/l	1.800	100	10.000	300	500	2.280	114
COD, mg/l	4.800	150	18.000	500	1.000	5.270	263,5
NH_4-N mg/l	800	50	3.500	30	150	920	46
NO3-N mg/l	10	0	30	20	20	20	1
Suspended solids SS mg/l	500	500	500	400	500	500	25
Phosphor P, mg/l	0,1	0	5	15	0	10	0,5

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, is set in the Gazette; the most important for the design are presented in next Table:

Table 7-30: Basic effluent limits

PARAMETER	Value (mg/l)
pH	6,5-9
Colour	colourless
BOD	25
COD	125
Aromatic hydrocarbons	0,1
Phenols	0,1

PARAMETER	Value (mg/l)
Total Suspended Solid (TSS)	35
Total Phosphorus (P)	1
Total Nitrogen	10
Total Ammonium	10
Total Nitrates	2

7.1.4.9.3 Alternative option 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 50 m^3/d, where at the same time sufficient equalization volume must be provided in order to account for heavy rain falls.

Option A

This system comprises of an Aeration lagoon with preliminary dimensions 35 x 25 x 2m and effective volume of 1.500 m^3. The liquid flows afterwards to a second, Maturation - Sedimentation lagoon with dimensions 35 x 25 x 2m and effective volume of 1.500 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 1.500 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 (preferably second phase) for a number of days, i.e.:

$$46.2 \text{ m}^3/\text{d} \times 30\text{d} = 1{,}386 \text{ m}^3$$

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 diffusers placed at bottom, air distribution system and blowers in a service building. The capacity will be around 400 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 7-31: 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	246	258
PHASE 1a – 1b REPEAT 5 TIMES				1290
3.	Sludge removal	Sludge Pump ON	30	1320
4.	Sedimen-tation	Aeration OFF Mixer OFF	60	1380
5.	Supernatant removal	Decant ON	60	1440

No	Operation phase	Equipment status	Duration (min)	Time from start (min)
6.	Idle	Mixer ON	Δt	1440+Δt
	END OF CYCLE			

Installed equipment will be:

- ✓ Aeration system
- ✓ 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 1,500 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.

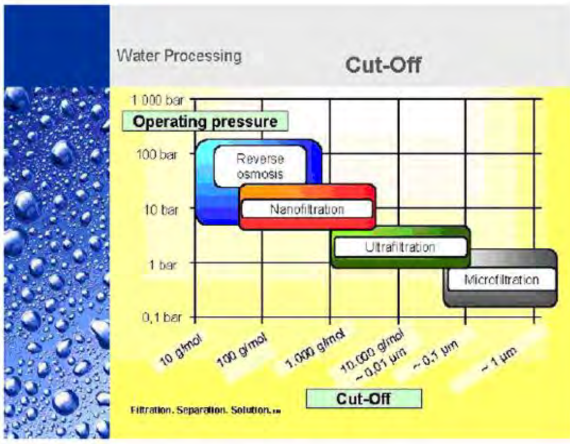


Figure 7-53: Cut off size for membrane applications

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.

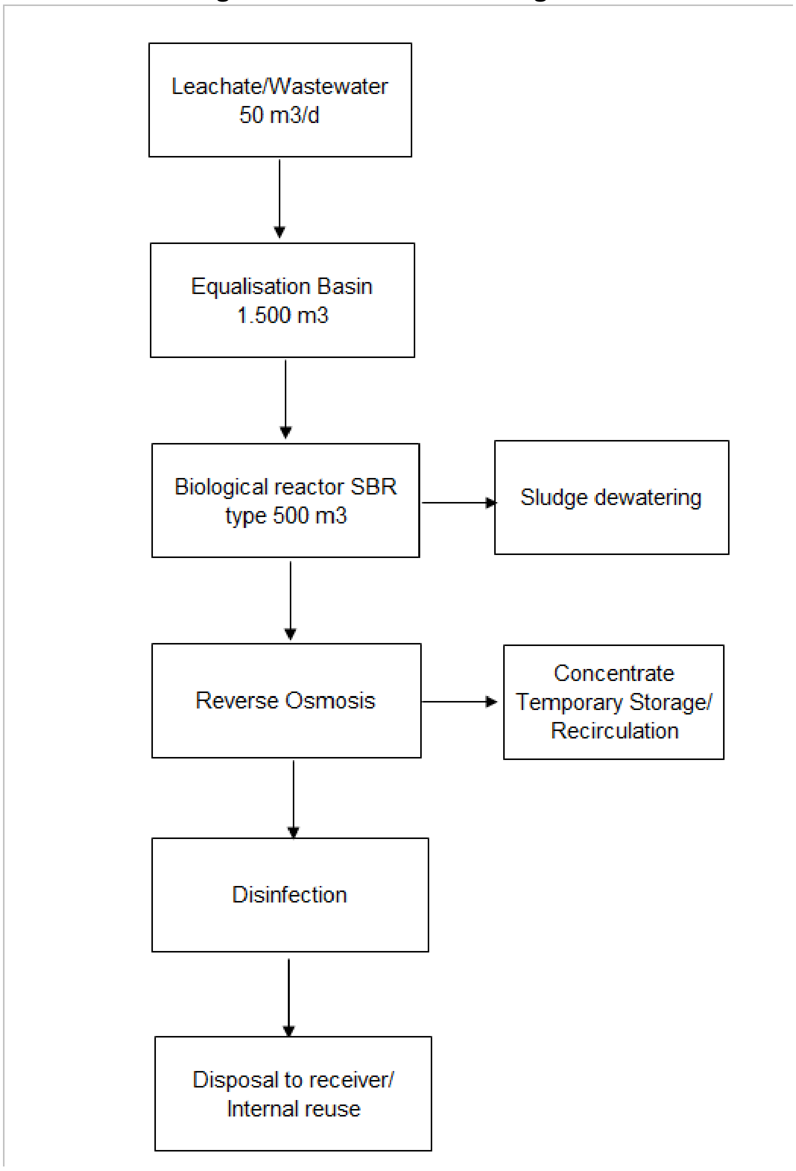
The saline concentrate from RO will be stored in a temporary storage tank and from there it is recirculated to the landfill via a mono pump.

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 7-54: WWTP flow diagram



The Waste Water 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 will be C30/37 sulphate resistant. 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. Phase A in operation: 19,000 m^2, c=0.0
2. Scenario 2. Phase A filled and phase B in operation. This phase includes a temporary sealed area of phase A towards the perimeter of the landfill and a sloped area of waste towards phase B. 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: 9,500 m^2 with c=0.7, 35,500 m^2 with c=0.0
3. Scenario 3. All phases A and B filled: 45,000 m^2 with c=0.7.
4. Scenario 4. All phases A and B filled and sealed: 45,000 m^2 with c=0.90

From the leachate production calculations, the worst scenario of the landfill (greatest leachate quantity generated) is No 2, phase A is filled and phase B 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)

$$(PE)_x = 16x\left(\frac{10xTi}{J}\right)^a$$

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° and 47° 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 presented in the following table.

The temperature data were provided from the station located in the municipality of Prilep and refer to the last 20 years (1997 – 2016). The precipitation data were provided from the station located in the municipality of Gradsko and refer to 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 presented in the following tables.

Table 7-32: Leachate production (mm/month)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation (mm/month)	29.6	27.6	31.6	35.4	45.2	41.3	20.5	26	40	59.9	42.2	40.5
Temperature (°C)	0.7	2.8	6.6	11.3	16.4	20.5	23.2	22.8	17.6	12.3	7.1	1.6
Monthly heat index (J_i)	0.05	0.42	1.53	3.42	5.98	8.35	10.06	9.80	6.65	3.88	1.70	0.18
Annually heat index (J)	52.02											
Surface flow coefficient (a)	1.62											
Average potential evapotransporation (PE)x (mm/month)	0.93	5.78	22.14	48.35	88.43	119.35	143.41	132.23	82.52	48.13	20.38	2.75
Corrected potential evapotransporation (ETP)(mm /month)	0.92	5.21	15.92	26.37	38.81	39.00	20.48	25.84	34.92	33.08	16.17	2.66

Table 7-33: Monthly average leachate production (m³/month)

Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Phase A in operation	545	425	298	172	121	44	0	3	97	510	495	719
Phase A filled and phase B in operation	1,094	824	587	354	270	121	20	30	218	1,009	964	1,434
All Cells filled	358	138	142	159	203	186	92	117	180	270	190	427
All Cells sealed	92	124	142	159	203	186	92	117	180	270	190	63

Table 7-34: Daily average leachate production (m³/day)

Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Phase A in operation	17.58	15.19	9.61	5.72	3.92	1.45	0.01	0.10	3.22	16.44	16.49	23.19
Phase A filled and phase B in operation	35.28	29.42	18.93	11.81	8.70	4.02	0.65	0.98	7.28	32.55	32.14	46.24
All Cells filled	11.56	4.93	4.59	5.31	6.56	6.20	2.98	3.77	6.00	8.70	6.33	13.78
All Cells sealed	2.96	4.44	4.59	5.31	6.56	6.20	2.98	3.77	6.00	8.70	6.33	2.02

Table 7-35: Hourly average leachate production (m³/hour)

Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Phase A in operation	0.73	0.63	0.40	0.24	0.16	0.06	0.00	0.00	0.13	0.68	0.69	0.97
Phase A filled and phase B in operation	1.47	1.23	0.79	0.49	0.36	0.17	0.03	0.04	0.30	1.36	1.34	1.93
All Cells filled	0.48	0.21	0.19	0.22	0.27	0.26	0.12	0.16	0.25	0.36	0.26	0.57
All Cells sealed	0.12	0.18	0.19	0.22	0.27	0.26	0.12	0.16	0.25	0.36	0.26	0.08

From the above, the following can be concluded:

- The maximum leachate production during the operation of phase A amounts to 23.19 m^3/day
- The maximum leachate production, which is 46.24 m^3/day occurs when phase A filled and phase B is 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 three steps phase includes:

   - 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 5000 kcal/m^3, while the highest caloric capacity is approx. 9350 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 %
Carbon dioxide	CO_2	0 - 88 Vol %
Carbon monoxide	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
Ethyl mercaptans	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) V 3.02 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 ith 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):

$$C_aH_bO_cN_d + nH_2O \rightarrow xCH_4 + yCO_2 + wNH_3 + zC_5H_7O_2N \qquad (1)$$

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 m^3 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
- Residues from recyclables which collected at source
- CLO from biological treatment

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 behavior 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 Waste Management Plan for Vardar Region, the quantities of biodegradables(included in the residues) that will be disposed in the landfill site,are presented in the following table.

Table 7-39: Biodegradable waste disposed on landfill (t/y)

Year	Quantities (t)
2021	5,519
2022	5,535
2023	5,550
2024	5,566
2025	5,582
2026	5,595
2027	5,609
2028	5,622
2029	5,636
2030	5,651
2031	5,647
2032	5,643
2033	5,640
2034	5,637
2035	5,634
2036	5,624
2037	5,615
2038	5,606
2039	5,597
2040	5,589
2041	5,575
2042	5,561
2043	5,547
2044	5,534
2045	5,521
2046	5,504

The average composition of the biodegradables that will be disposed in the landfill is presented in the following table.

Table 7-40: Average composition of biodegradables

Residues composition	%
Organic	52.8%
Paper/Cardboard	46.5%
Others	0.7%

Moreover, it is concerned that in the new landfill site, will be disposed 27,000 t of waste from the dumpsite which is located near the landfill site.

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 7-41: Biogas production and recovery from landfill site

Year	BiogasProduction (m^3/y)	BiogasProduction (m^3/h)	BiogasRecovery (m^3/h)
2021	281,143	32.1	19.3
2022	552,056	63.0	37.8
2023	777,716	88.8	53.3
2024	965,810	110.3	66.2
2025	1,122,724	128.2	76.9
2026	1,253,764	143.1	85.9
2027	1,363,153	155.6	93.4
2028	1,454,591	166.0	99.6
2029	1,531,148	174.8	104.9
2030	1,595,376	182.1	109.3
2031	1,649,391	188.3	113.0
2032	1,693,889	193.4	116.0
2033	1,730,508	197.5	118.5
2034	1,760,612	201.0	120.6
2035	1,785,329	203.8	122.3
2036	1,805,598	206.1	123.7
2037	1,821,789	208.0	124.8
2038	1,834,618	209.4	125.7
2039	1,844,678	210.6	126.3
2040	1,852,463	211.5	126.9
2041	1,858,379	212.1	127.3
2042	1,862,419	212.6	127.6
2043	1,864,922	212.9	127.7
2044	1,866,170	213.0	127.8
2045	1,866,399	213.1	127.8
2046	1,865,802	213.0	127.8
2047	1,864,257	212.8	159.4
2048	1,550,275	177.0	132.0
2049	1,289,279	147.2	109.7
2050	1,072,325	122.4	91.2
2051	891,976	101.8	75.8
2052	742,051	84.7	63.0
2053	617,416	70.5	52.3
2054	513,800	58.7	43.5
2055	427,655	48.8	36.1
2056	356,033	40.6	30.0
2057	296,482	33.8	25.0
2058	246,964	28.2	20.8
2059	205,788	23.5	17.2

Year	BiogasProduction (m^3/y)	BiogasProduction (m^3/h)	BiogasRecovery (m^3/h)
2060	171,544	19.6	14.3
2061	143,064	16.3	11.9
2062	119,374	13.6	9.9
2063	99,668	11.4	8.2
2064	83,272	9.5	6.8
2065	69,630	7.9	5.7
2066	58,276	6.7	4.7
2067	48,824	5.6	3.9
2068	40,955	4.7	3.3
2069	34,402	3.9	2.7
2070	28,943	3.3	2.3

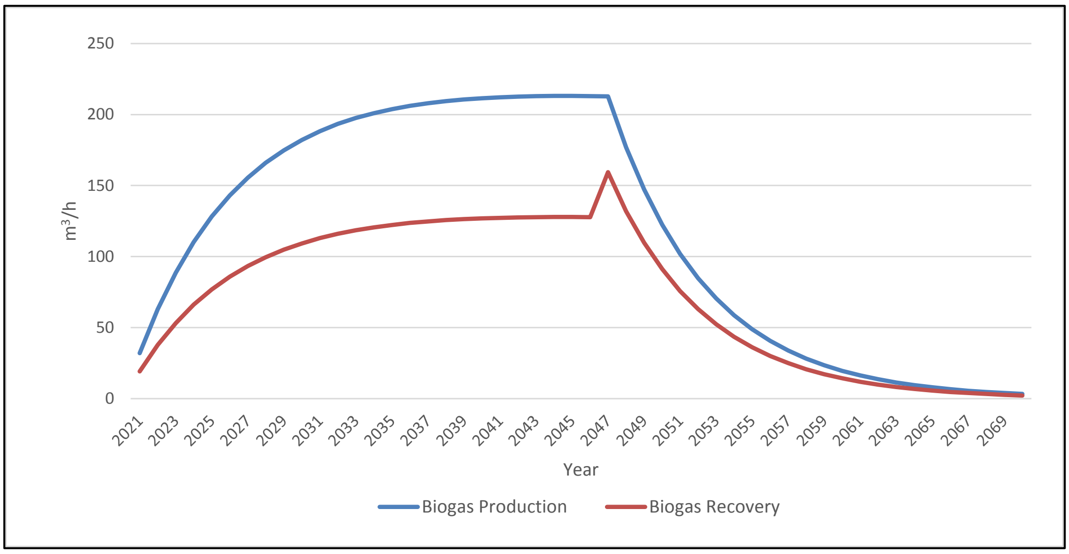


Figure7-55:Biogas production and recovery over time

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 212.8m^3/h. What is more, it is estimated that the biogas quantity that it can be recovered is 159.4 m^3/h. Therefore, it is proposed to use a flare unit with capacity of 160Nm^3/h, which can sufficiently cover the biogas management needs of the examined landfill site, during its operation and afterits 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 work, condensate collection units and biogas collection sub-station
- 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.

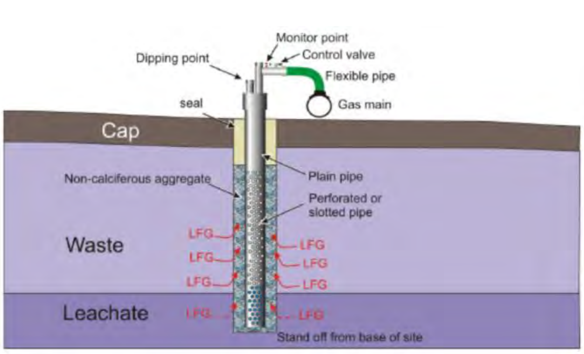
As mentioned above, due to accelerated biodegradation gas wells should be installed into the landfill to collect landfill gas at the early phase.Landfill gas can be extracted soon after gas generation begins, which is rapidly initiated in landfills. Considering the fact that landfill gas generation starts 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 is 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 1m and will be filled with a material as gravel or crashed stone. Inside, HDPE perforated pipe with an internal diameter of at least 90mm will be immersed. HDPE is an erosion resistant material. 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 2m 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 waters 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) 

Figure7-56: 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.

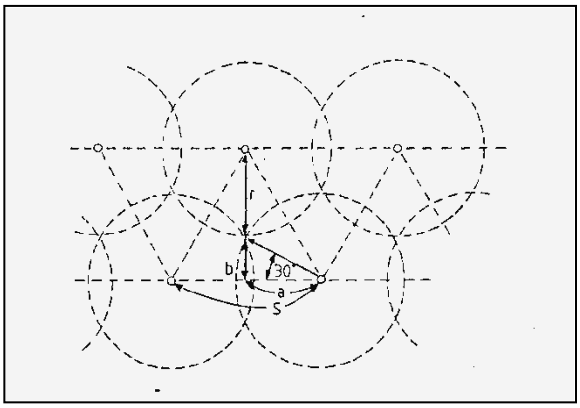


Figure 7-57: Landfill gas vertical wells positioning

7.1.4.10.6 Biogas transfer piping network

Connecting the wells to a main collection pipe is the most common way to get the LFG to the recovery system. In particular, each collection well will be connected to the gas collection stations through a pipe. The pipes are connected to one another and eventually connected to a Landfill gas collection station. Gas transfer pipes shall be installed with a slope to the gas collection station, 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 pipes are solid and made of HDPE.

The transfer pipe diameter will be ≥ 90 mm, such as to ensure a gas velocity not higher than 10 m/s. The gas pipes will bear butterfly valves at their connection to the station. Within the stations, individual pipes are connected via a manifold to the main discharge pipe. The number of the gas stations is determined upon the landfill shape, the number of wells and their distribution and will be defined in the technical design. Within the gas station, each pipe is fitted with a sampling device. Between the measuring area and the collecting cylinder, a butterfly valve is placed for regulation. One more butterfly valve is placed between the collection cylinder and the main discharge pipe.

The gas collection stations 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 and finally to the Energy recovery system. The stations are connected with the main pipe that leads biogas to the blower. The main transfer pipes shall be are solid and made of HDPEwith a pressure resistance ≥ PN 6. The pipes will be installed underground and they shall be protected against freezing at the surface with a layer of soil or waste of 80 cm thick. This main pipe should allow for easy access for any damages.

Since biogas is saturated with water vapours and this leads to condensate formation in the pipe network. Inside the main pipe, in the lowest level points, condensate HDPE trap systems separators are installed, accessible through manholes.

7.1.4.10.7 Flare station

At this station, the landfill gas will be combusted in compliance to EU environmental protection standards. The flare station shall be a closed-type, allowing high efficiency with combustion at least at 850 °C and 0,3 s residence time to ensure compliance with the emission regulations. The capacity of the flare station is proposed to be 60 m^3/h, with turn down ratio 1:5.

The landfill gas flare shall be of compact design and consists of blower, analyzer, controlled combustion unit and the local PLC. The flare shall be installed on a concrete base and enclosed in fenced area of the energy recovery system. It will be equipped with:

- Blower unit with EEx-proof motor
- Ignition burner
- Combustion chamber
- Pressure, temperature control and monitoring
- Electrical control weather proof cabinet
- Portable CH_4, O_2, CO_2 analyzer
- Ability to operate at 1:5 of nominal capacity.
- Condensate trap

The compact plant shall be also 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.

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:
$Q = 0.000278 \times c \times i \times A$ (lt/sec)
where:

c: runoff coefficient
i: rainfall intensity in the time of concentration (mm/hr)
A: area of catchment basin (m^2)

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, Tsobanoglou et. 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

$Q = A \times V$ (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.

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
- Administrative 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 south side, where the security house and weighbridges are placed. The maintenance and service buildings are situated in the north side. 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.

Figure7-58: 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 m^{2}surface and the following rooms:

- Entrance (4.18 m^2)
- Control room (9.11 m^2)
- Office (18.87 m^2)
- Meeting room (2.50 m^2)
- Laboratory (7.15 m^2)

- Respiratory (4.91 m^2)
- WC (3.58 m^2)
- Washroom/Showers/WC/Lockers women (18.09 m^2)
- Washroom/Showers/WC/Lockers men (17.60 m^2)
- Kitchen (8.24 m^2)
- Corridor (19.20 m^2)

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 m^2)
- Storage room (7.42 m^2)
- Office (9.62 m^2)
- 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 Par. 7.1.4.16 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 power.

Figure7-59: 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 power.

Figure7-60: 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.

Figure7-61: 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 7-42: 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 7-43: 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 7-44: Potential monitoring alternatives

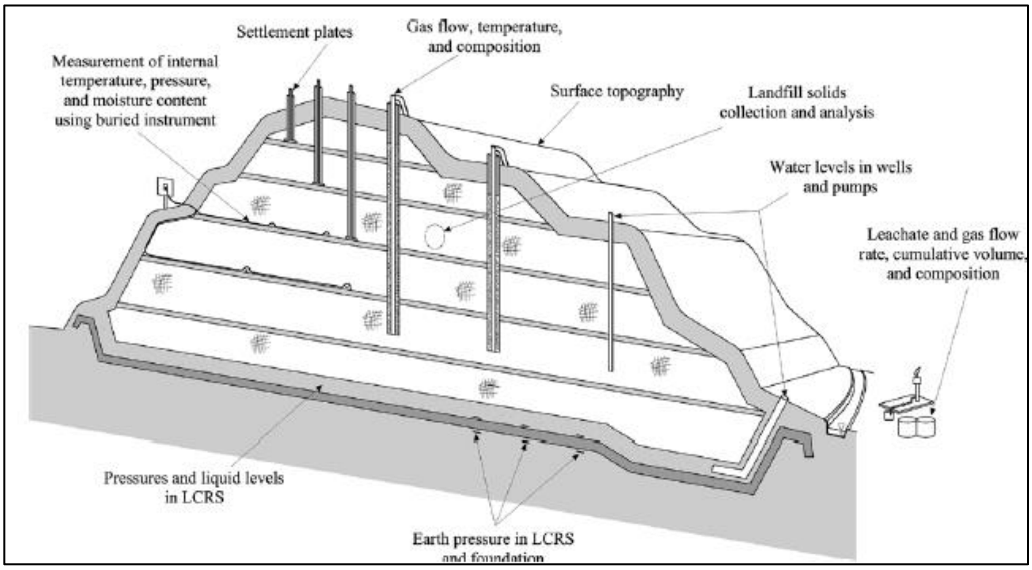
Monitored parameter	Considerations
Leachategeneration	Leachate volumes will be monitored at most landfill sites, but tracking the water balance in systems where liquids are added is more critical. More frequent and spatially distinct monitoring may be necessary
Leachatequality	Tracking leachate quality 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

Monitored parameter	Considerations
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 7-62: 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 7-45: 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 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 7-46: 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_{-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)
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 7-47: 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 7-48: Proposed Monitoring works and frequency for Vardar 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.

Closure system design
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 paragraph 7.1.4.5 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 7-49: 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	Equipment and instruments may be installed during closure to allow data	Sustainable landfill technologies often involve a greater degree of monitoring

Closure element	Description	Potential issues with sustainable landfill practices
installation	collect in post-closure period	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 management	GCCS must be maintained, operated, and monitored for a designated period following closure	Additional gas volumes requires more 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 following its 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, and other 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 foreseen is to

delay closure construction while waste filling continues, expanding laterally in new disposal areas as necessary, with a final cover system constructed over a very large areas, often the entire landfill unit.

The total estimated lifetime of the landfill is expected to be at least 26 years (8 years for phase A and 18 years for phase B) and 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.

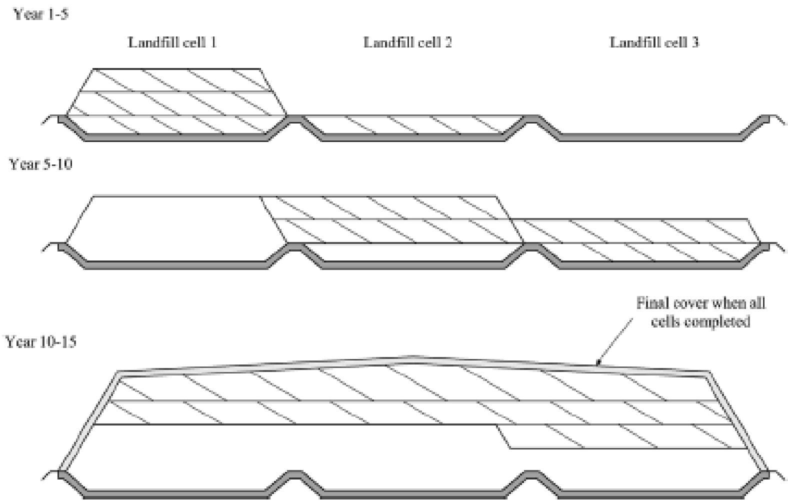


Figure 7-63: Illustration of landfill final cover system installation after entire landfill reaches final permitted elevation

<u>Alternative covering systems</u>
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 as part 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 gas removal 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 operating life 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 7-64: 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 the exposure 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. Following figure shows an example of such a product being installed on the surface of a landfill.

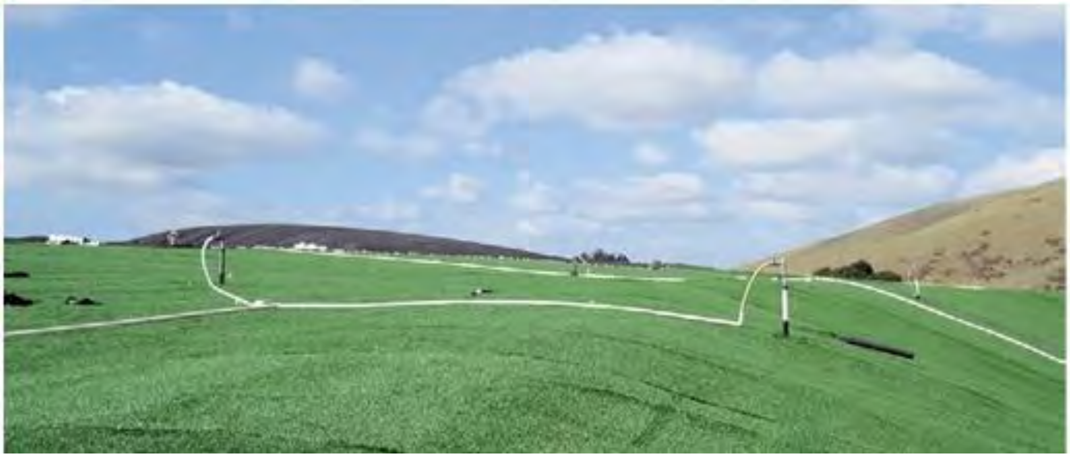


Figure 7-65: Closure Turf used as final cover

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 in facilities 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 to major fluctuations in response to wet weather, and should decline or remain relatively constant. 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.

Final Site Use and Configuration

Once a landfill site has been successfully closed, the owner then decides whether to isolate 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, particularly any 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 the cover material; maintenance work is required to keep the fill surface from being eroded 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 investment cost that is presented in the following table does not include contingencies and VAT.

Table 7-50: Investment Cost of Landfill

No	Item	Unit	Quantity	Unit Cost (€)	Total Cost (€)
1	LANDFILL				
1.1 Earthworks					
1.1.1	General excavation of unsuitable soil removal	m^3	16,500.00	1.5	24,750
1.1.2	General excavation in soil, 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	m^3	91,150.00	2.3	209,645
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	m^3	95,000.00	2	190,000
1.1.4	Soil supply	m^3	38,300.00	4.0	153,200
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	m^2	32,000.00	1	32,000
1.1.6	Transferring of waste and cleaning the area of existing dumpsite - Relocation of the waste to the new landfill	lump sum	1.00	200,000	200,000
			Subtotal 1.1.Earthworks		**809,595**
1.2. Bottom Lining					
1.2.1	Excavation of anchoring trenches	m^3	460.00	2.3	1,058
1.2.2	Subbase layer (0.30 m)	m^3	7,150.00	2	14,300
1.2.3	Compacted clay layer (0.50 m)	m^3	11,900.00	10	119,000
1.2.4	Drainage gravel	m^3	11,550.00	20	231,000
1.2.5	Smooth Geomembrane HDPE liner, t = 2 mm	m^2	8,150.00	6	48,900
1.2.6	Textured Geomembrane HDPE liner, t = 2 mm	m^2	16,900.00	7	118,300
1.2.7	Separation geotextile G=400g/m2	m^2	24,500.00	3	66,150
1.2.8	Protection G=800g/m2	m^2	25,000.00	4	87,500
			Subtotal 1.2.Bottom Lining		**686,208**
1.3. Leachate management system					
1.3.1	HDPE PN10 DN500 Leachate pipe perforated	m	90.00	155	13,950
1.3.2	HDPE PN10 DN500 Leachate pipe non-perforated	m	235.00	140	32,900
1.3.3	HDPE PN10 DN250 Leachate pipe perforated	m	460.00	38.5	17,710
1.3.4	HDPE PN10 DN250 Leachate pipe non perforated	m	40.00	35	1,400

No	Item	Unit	Quantity	Unit Cost (€)	Total Cost (€)
1.3.5	HDPE PN10 DN75 leachate pressure pipe	m	910.00	5.4	4,914
1.3.6	Wells for cleaning pipes	items	1.00	220	220
1.3.7	Collection manhole including all elements	items	1.00	2500	2,500
1.3.8	Recirculation control wells	items	15.00	400	6,000
1.3.9	Filling the pipe trenches, including sand bedding and surrounding,	m^3	950.00	2.3	2,185
1.3.10	Reduced tees and joints DN500/250 including all interim parts	items	7.00	500	3,500
1.3.11	Collection manhole including all elements	items	1.00	2000	2,000
			Subtotal 1.3. Leachate management system		**87,279**
1.4.Waste Water Treatment plant					
1.4.1Civil Works					
Reception - Equalisation Basin					
1.4.1.1	Concrete C30/37 sulphate resistant	m^3	284.00	250	71,000
1.4.1.2	Excavations	m^3	2,820.00	2.3	6,486
1.4.1.3	Backfilling with excavated material	m^3	760.00	2	1,520
1.4.1.4	Waterproofing internal sealing	kg	1,588.00	5.5	8,734
1.4.1.5	Concrete additive (1,5 kg/m3 concrete)	kg	426.00	1.8	767
1.4.1.6	Concrete non-reinforced C10/12	m^3	38.00	75	2,850
1.4.1.7	Metallic protective hand railing	m	73.00	60	4,380
SBR/storage tanks/pumping station					
1.4.1.8	Concrete C30/37 sulphate resistant	m^3	348.00	250	87,000
1.4.1.9	Excavations	m^3	520.00	2.3	1,196
1.4.1.10	Backfilling with excavated material	m^3	220.00	2	440
1.4.1.11	Waterproofing internal sealing	kg	1,734.00	5.5	9,537
1.4.1.12	Concrete additive (1,5 kg/m3 concrete)	kg	522.00	1.8	940
1.4.1.13	Concrete non-reinforced C10/12	m^3	21.00	75	1,575
WWTP Technical Building					
1.4.1.14	Surface	m^2	188	400	75,200
1.4.2. Mechanical Works					
1.4.2.1	Venturi aerator 9kW	item	1.00	6000	6,000
1.4.2.2	Level and flow measurement units	item	2.00	2200	4,400
1.4.2.3	Submerged feed pumps and valves	item	2.00	2500	5,000
1.4.2.4	Rotary screen	item	1.00	5000	5,000
1.4.2.5	Submersible aerator 45 kW with inverter	item	1.00	58000	58,000
1.4.2.6	SBR denitrification mixer 2kW	item	1.00	2500	2,500
1.4.2.7	Floating decant system	item	1.00	3000	3,000
1.4.2.8	SBR sludge pump	item	1.00	1800	1,800
1.4.2.9	Chemical Tanks, 500 lt	item	5.00	400	2,000
1.4.2.10	Chemical dosing pumps	item	10.00	750	7,500
1.4.2.11	Agitators for chemical tanks	item	3.00	1800	5,400
1.4.2.12	SBR pH, level and DO measuring units	item	3.00	2000	6,000
1.4.2.13	RO feed pumps, valves and RO bypass valves	item	2.00	2800	5,600

No	Item	Unit	Quantity	Unit Cost (€)	Total Cost (€)
1.4.2.14	Sludge feed pumps and valves	item	2.00	2800	5,600
1.4.2.15	Reverse Osmosis Plant, 50 m3/d 2 stages, complete, in container, including shipment, installation, start-up and training	item	1.00	300000	300,000
1.4.2.16	Concentrate recirculation pumps 1,1 kW, mohno type chlorine resistant with valves	item	2.00	6000	12,000
1.4.2.17	Sludge decanter 10,5 kW - 20% DS AISI 316	item	1.00	60000	60,000
1.4.2.18	Polyelectrolyte preparation unit with dosing pumps and static mixer	item	1.00	8000	8,000
1.4.2.19	Sludge screw conveyor 2 m3/h - 5m and storage container	item	1.00	10000	10,000
1.4.2.20	Water system for washing	item	1.00	500	500
1.4.2.21	Other (portable pump, level switches, metal covers, railings, crane, lifting device etc)	item	1.00	12000	12,000
1.4.2.22	Irrigation/ water reuse system	item	1.00	14000	14,000
1.4.2.23	HDPE pipelines, total including excavations and 10 cm sand layer	item	1.00	10000	10,000
1.4.2.24	Spare parts, tools, furniture	item	1.00	8000	8,000
1.4.2.25	Cabling, LV electric panels, Switchboards, Building electrical equipment	item	1.00	20000	20,000
1.4.2.26	Automation PLC/SCADA	item	1.00	20000	20,000
1.4.2.27	Earthing, Lightning protection	item	1.00	20000	20,000
1.4.2.28	Others works	item	1.00	85000	85,000
			Subtotal 1.4.WWTP		**968,924**
1.5. Biogas management Works					
1.5.1	Horizontal transfer pipes from biogas collection stations to flare HDPE PN10 DN110 mm	m	690	6325	4,364
1.5.2	Prefabricated Biogas collection stations	item	1	5900	5,900
1.5.3	Condensate separators	pcs	1	1100	1,100
1.5.4	Foundation base for biogas collection stations	m^3	2.5	30	75
1.5.5	Portable pump for condensate removal with pipes (supply only)	Pcs	1	1155	1,155
1.5.6	Landfill gas flare Q=150 m3/h	pcs	1	85000	85,000
1.5.7	Foundation base for flare unit from reinforced concrete	m^3	11	200	2,200
1.5.8	Excavations	m^3	455	2.3	1,047
1.5.9	Filling the pipe trenches, including sand bedding and surrounding	m^3	450	2.3	1,035
			Subtotal 1.5. Biogas management Works		**101,876**
1.6. Stormwater management Works					
1.6.1	Precast concrete pipes (int.diameter 2000mm)	m	14	500	7,000
1.6.2	Precast concrete pipes (int.diameter 1000mm)	m	27	133	3,591
1.6.3	Precast concrete pipes (int.diameter 500mm)	m	39	60	2,340
1.6.4	C12/15 Concrete reinforced	m^3	1	80	80

No	Item	Unit	Quantity	Unit Cost (€)	Total Cost (€)
1.6.5	C20/25 Concrete reinforced	m^3	370	85	31,450
1.6.6	Reinforcement steel B500c	t	30	1510	45,300
1.6.7	Formworks	m^2	4200	10	42,000
1.6.8	General Excavations of soft and hard Soil with machine	m^3	1000	2.3	2,300
1.6.9	Gridiron	kg	4470	5.5	24,585
1.6.10	Cast iron manholes cap (circular)	pcs	6	110	660
1.6.11	Completion / finishing with rip-rap pavement in concrete	m^3	7	150	1,050
1.6.12	Stepped gutter	m	20	25	500
1.6.13	Guard screen made of galvanized steel, round bar Ø15mm, bar spacing 50mm	pcs	2	700	1,400
1.6.14	Inlet	pcs	4	200	800
			Subtotal 1.6. Stormwater management Works		**163,056**
1.7. Monitoring					
1.7.1	Groundwater monitoring drillings (3)	m	3	7,080	21,240
1.7.2	Groundwater level indicator	items	1	5,500	5,500
1.7.3	Biogas monitoring wells (4)	m	7	900	6,300
1.7.4	Portable gas analyzer	items	3	7,080	21,240
1.7.5	Methane detectors-transmitters	items	1	1,100	1,100
			Subtotal 1.7.Monitoring		**38,808**
1.8. Mobile Equipment					
1.8.1	Compactor	item	1	375,000	375,000
1.8.2	Backhoe Loader	item	1	70,000	70,000
1.8.3	Tipping truck	item	1	60,000	60,000
			Subtotal 1.8.Mobile Equipment		**505,000**
			Subtotal 1 LANDFILL		**3,360,746**

Table 7-51: Investment Cost of Infrastructures

No	Item	Unit	Quantity	Unit Cost (€)	Total Cost (€)
2	**INFRASTRUCTURE WORKS**				
2.1. Buildings and Utilities					
2.1.1	Weighbridge	item	1	56,000	56,000
2.1.2	Wheel washing facility	item	1	20,793	20,793
2.1.3	Fencing				
2.1.3.1	High fence	m	2,650.00	40	106,000
2.1.3.2	Low fence, including gate(1.00mx1.50m)	m	20.00	20	400
2.1.3.3	Entrance gate 8.00mx2.50m	pcs	2.00	2,000	4,000
2.1.4	Guardhouse	item	1	32,509	32,509
2.1.5	Administrative Building	item	1	110,659	110,659
2.1.6	Maintenance Building	item	1	170,704	170,704
2.1.7	Energy Building	item	1	99,039	99,039
2.1.8	Thermo technical part	item	1	34,370	34,370
2.1.9	Water tank	item	1	123,178	123,178
2.1.10	Water and Sanitation Networks	item	1	248,695	248,695
2.1.11	Fire fighting network	item	1	9,180	9,180
2.1.12	Electrical power supply networks	item	1	70,978	70,978

No	Item	Unit	Quantity	Unit Cost (€)	Total Cost (€)
2.1.13	SCADA	item	1	50,000	50,000
2.1.14	CCTV for infrastructure	item	1	25,000	25,000
2.1.15	Software for documantation	item	1	15,000	15,000
2.1.16	Landscaping	item	1	12,050	12,050
			Subtotal 2.1.Buildings and Utilities		**1,188,555**
2.2. Road areas					
2.2.1	General Excavations of soft and hard Soil with machine	m^3	20850	2.3	47,955
2.2.2	Embankments / compacted soil	m^3	6210	2	12,420
2.2.3	Ballast foundation	m^3	1550	25	38,750
2.2.4	crush stone foundation	m^3	3250	35	113,750
2.2.5	asphalt concrete BA16	m^2	12800	10	128,000
2.2.6	Wearing course asphalt pavement	m^2	12800	8	102,400
2.2.7	ditch	m	1,750.00	1.3	2,275
2.2.8	shoulder	m^3	130.00	3	390
			Subtotal 2.2.Road areas		**445,940**
2.3. Traffic design					
2.3.1	Traffic signs standard	pc	18	125	2,250
2.3.2	Traffic signs non-standard	pc	2	150	300
2.3.3	Boards	pc	3	60	180
2.3.4	White paint for marikng the pavement	kg	264	5.5	1,452
2.3.5	Yellow paint for marking the pavement	kg	1.5	5.5	8
			Subtotal 2.3.Traffic Design		**4,190**
2.4. Perimetric planting & Irrigation					
Woody Plants					
2.4.1	Robinia pseudoacacia pyramidalis	items	400	42	16,800
2.4.2	Lonicera tatarica	items	23	23	529
Planting works					
2.4.3	Grass filled areas (grass mixure)	m^2	1,210	0.4	484
2.4.4	Planting midsize deciduous trees in holes 60/60/60 cm, incl. digging holes	items	400	5	2,000
2.4.5	Planting shrubs in holes 50/50/40 cm, incl. digging holes	items	23	4.5	103.5
			Subtotal 2.4. Perimetric planting & Irrigation		**19,917**
Subtotal 2. INFRASTRUCTURE WORKS					**1,658,602**

***Note:**_Software for documentation_: *It is used for the registration of the data from the monitoring system of the project i.e. (i)Waste registration/control, (ii) Recovery of recyclables, (iii) Daily operational hours, (iv) Annual power consumption, fuel consumption, etc, (v) Environmental monitoring ofleachate from the landfill body, groundwater, surface waters, collection of landfill gas, (vi) Registration of accidents, unscheduled interruption of operations, and incidents connected with occupational health and safety, (vii) Registration of complaints and incidents leading to complaints, (viii) 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 will be at the same area as the new regional landfill.
The new regional landfill in Vardar Region as well as the proposed facilities are going to be located in a site that administratively belongs to Municipality of Rosoman and it is located in the west of the settlement of Rosoman in a straight line/direct distance of 3km. This specific site is analytically described in a previous paragraph.

7.1.5.2 Site preparation, lay out and environmental protection measures

The concept of the general layout design follows the topography and geology of the site. Also, another constraint that was taken into consideration is the existing waste disposal along the deep area of the site.

More specifically, the entrance is foreseen from the South and lowest part of the site, however an alternative entrance can be achieved from the north. Immediately after entering the site from South, 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. The WWTP is located at the left of the entering stream and after approximately 480 m, the first phase of the landfill is met on the right.

The facilities for waste treatment, as well as the auxiliary facilities (administrative building, maintenance and other infrastructures) are designed at the upper part of the site, northern from the landfill. This area is 38,255 m2, and it has a mean elevation at +258.00 m. The administrative building, the maintenance building, the energy building and the water tank are foreseen at the northern part of this area, whereas the reception area of the mechanical sorting building is at the left. The biological treatment facilities for the organic fraction of municipal waste and the green waste are located southern from the mechanical sorting building.

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 on excavated levels.

The total earthworks for the construction of this platform together with the road works result to 118,500 m^3excavations and 23,700 m^3 fillings.

The following paragraphs provide a summary for the proposed waste treatment facilities in Vardar Region. The proposed CWMF include the following elements:

i) Entrance, administrative building and control,
ii) Mechanical and Biological Treatment Plant (MBT) with recyclable storage building
iii) Windrow composting for Green Waste
iv) Landfill for residues
v) Buildings area (for the personnel, maintenance and other daily activities),
vi) Internal roads
vii) Waste Water Treatment Plant (WWTP) and
viii) Utilities (such as wheel washing system, water tank, etc)

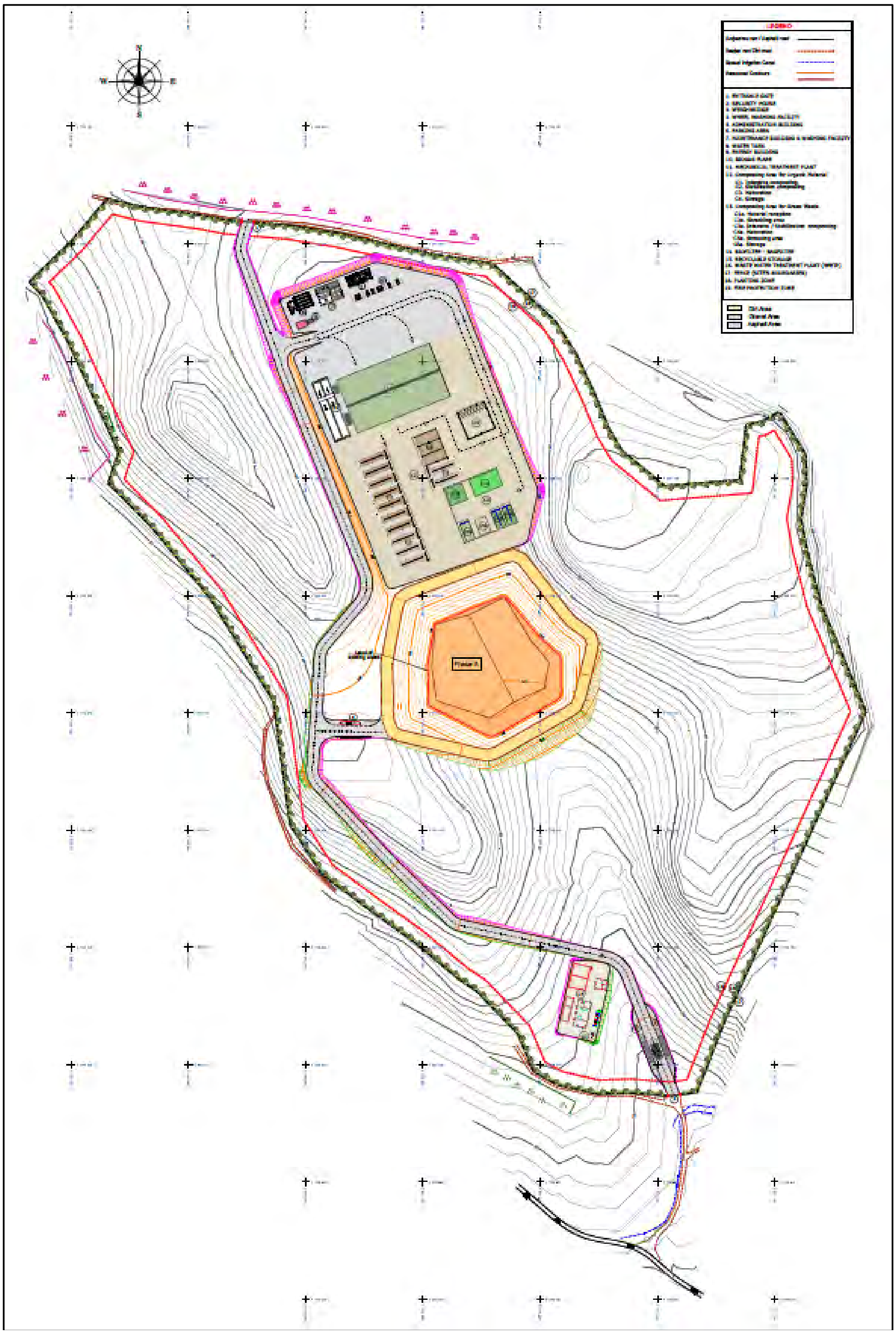


Figure 7-66: General layout of the Waste Management Center (Phase A)

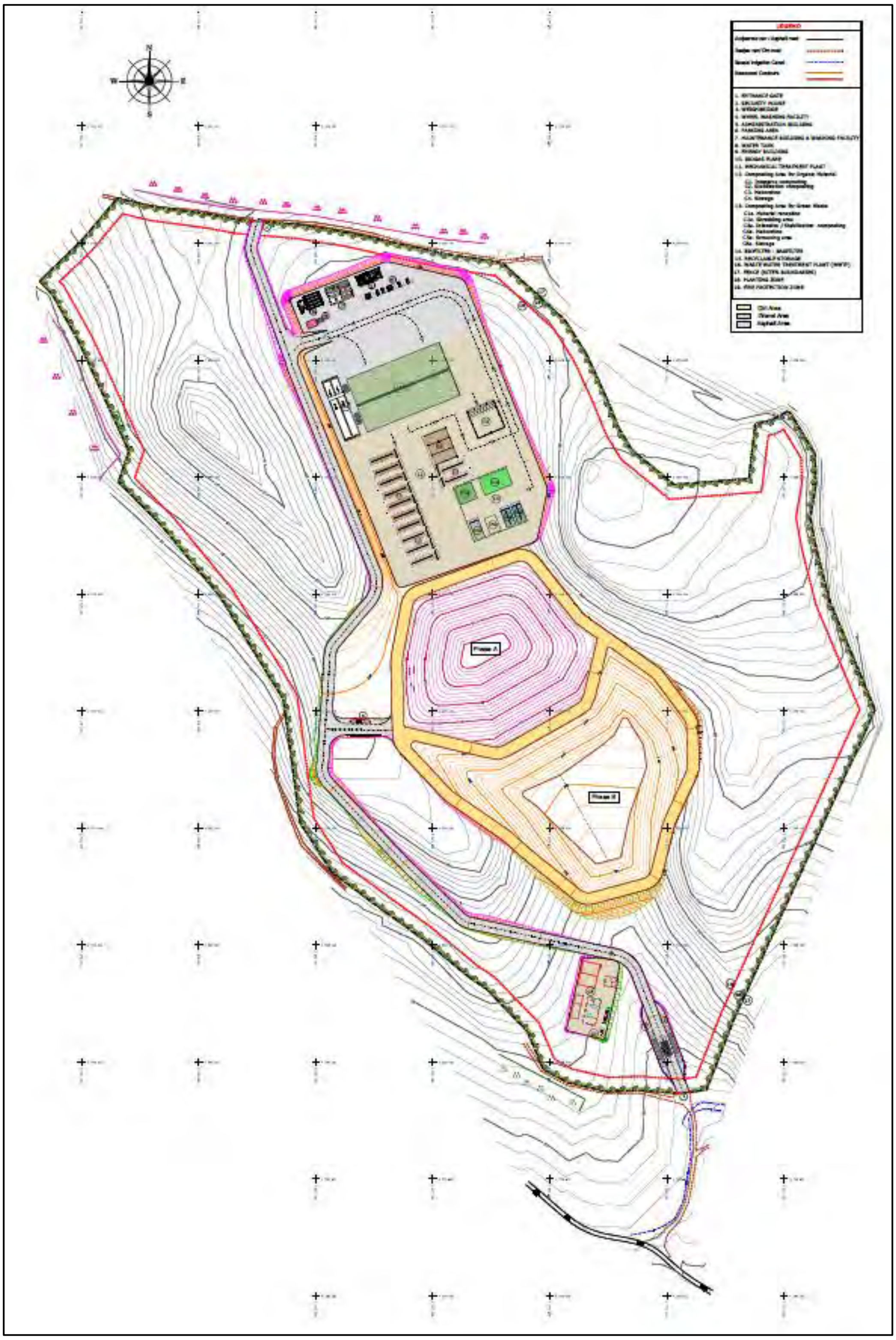


Figure 7-67: General layout of the Waste Management Center (Phase B)

The area allocated for the construction of the various parts is as follows:

Table 7-52: Area allocated for the WMC facilities

WMC FACILITIES	AREA (m^2)
Mechanical Treatment Plant	3,990
Biological Treatment area	11,910
Recyclables storage area	620
Landfill (A phase) (2D)	24,755
Administration Building	155
Maintenance Building and Washing Facility	255
Waste Water Treatment area	2,225
Total area for facilities	**43,910**
Total plot area	**306,0.35**

The following tables present the overall mass balance of the MBT plant and landfill site.

Table 7-53: Mass Balance of MBT Plant of Residual Waste Bin (Scenario 3c)

Total Mass	Quantities (t/y)	Percentage
Input waste to Mechanical Separation (Residual Waste Bin)	**28,503**	**100%**
Mechanical Separation	28,503	
Fe, Al	*198*	*0.7%*
Residues	*12,826*	*45.0%*
Special Municipal Waste	*81*	*0.3%*
To Biological Treatment	*15,398*	*54.0%*
To Biological Treatment (Aerobic Composting)	15,398	
H_2O &CO_2 losses	*6,159*	*40.0%*
CLO	*9,239*	*60.0%*
Residues to landfill	**12,826**	

Table 7-54: Mass Balance of Mechanical Treatment of Recyclables Waste Bin

Total Mass	Quantities(t/y)	Percentage
Input waste to Mechanical Separation (Recyclables Waste Bin)	**8,556**	**100.0%**
Mechanical Separation		
Recyclables	*7,272*	*85%*
paper and cardboard	*4,031*	*47,1%*
glass	*857*	*10,0%*
Fe	*175*	*2.0%*
Al	*94*	*1.1%*
plastic	*2,116*	*24.8%*
Residues to Landfill	***1,283***	***15%***

Note: The quantities mentioned in the above tables correspond to average quantities for period 2021-2046

Table 7-55: Mass Balance of Windrow Composting of Green waste

Total Mass	Quantities (t/y)	Percentage
Input to windrow composting (Green Waste)	**2,301**	**100.0%**
Compost	*1,380*	*60%*
Losses	*921*	*40%*

Note: The quantities mentioned in the above table correspond to average quantities for period 2021-2046

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	12,826
Residues from Mechanical treatment of Recyclables waste Bin	1,283
CLO for landfilling	9,239
Total waste that landfilled	**23,349**

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 **28,503 t/y** of mixed municipal waste (residual waste bin) for metals recovery. Other recyclables will not be sorted thus the oversized fraction from trommel will be discharged as a residue. The undersized fraction will be transferred to biological treatment.

Moreover, the facility is designed to be flexible to sort **8,556 t/y** of the source separated recyclables from recyclables waste bin, in the same sorting line during defferent operation hours. The separation process of source separated recyclables will be aided by the use of optical sorters.

The operational system of Mechanical Treatment will be as follows:

<u>Mechanical Treatment of the Residual Waste Bin</u>

After residual waste collection vehicles are weighted and recorded, they will unload residual waste in the reception area, which has a store capacity for incoming residual waste for three (3) days, thus, providing contigency in case the mechanical processing equipment is not available.

The reception area is equipped with one wheel loader for the loading of the incomming waste into the next stage of the treatment process. The wheel loaderwill 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 next steps will be screening. The drum screen shall enable the separation of the materials into two fractions as follows:

- the mainly organic ‘small fraction’ (< 80mm)
- the remaining >80mm of the materials. These materials are diverted though the end of the sieve drum to ferrous and non-ferrous separation. The transfering of these materials shall be done via a conveyor system.

The >80mm fraction 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 transferred to the ‘eddy current’ aluminium separator. Other recyclables will not be sorted thus the oversized fraction from trommel will be discharged as a residue. The undersized fraction will be transferred to biological treatment.

The fraction < 80mm is biologically treated in an aerobic composting unit. Prior to this, it will be subjected to magnetic separation to reclaim any remaining scrap ferrous metals and to avoid heavy metal contamination during the process of biological treatment. Once ferrous materials have been removed from the <80mm organic stream, the organic fraction will be led to composting unit.Composting takes place in aerated static pile covered by membrane.

The following diagram presents the stages of mechanical treatment process of Residual Waste Bin with quantities in t/y (Average 2021-2046).

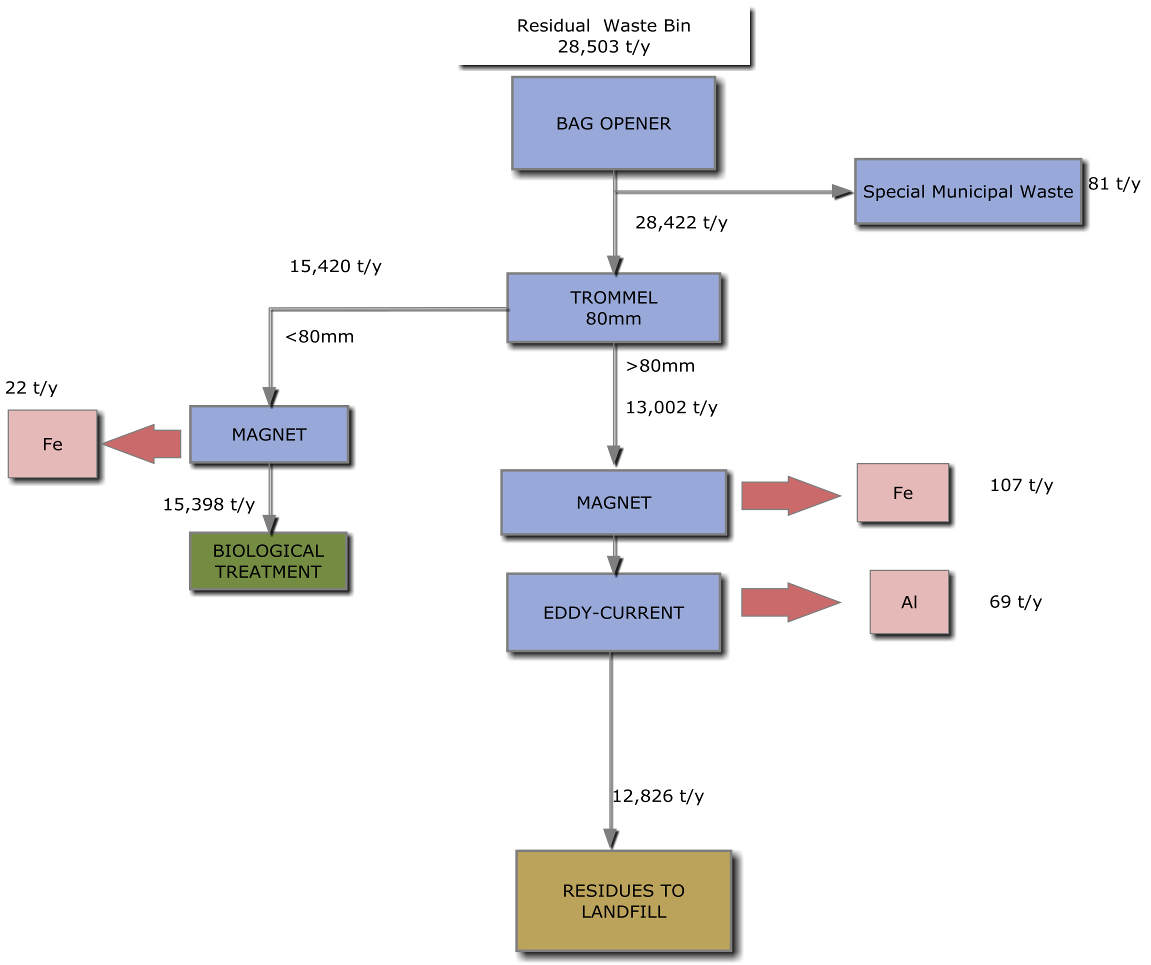


Figure 7-68: Flow-Diagram of mechanical treatment plant for Residual Waste Bin

Mechanical Treatment of the Recyclable Waste Bin

Moreover, the facility is designed to be flexible to sort **8,556 t/y** of the source separated recyclables from recyclables waste bin, in the same sorting line during different operation hours. The separation process of source separated recyclables will be aided by the use of optical sorters as follows.

After recyclables waste collection vehicles are weighted and recorded, they shall unload recyclable waste in the waste reception area, designed to store incoming recyclables waste for three (3) days. The reception area is located next to the reception area of residual waste.

The mechanical process from bag opener until the eddy current is the same with the one described above for residual waste. However, after recovering the metals, the fraction >80mm is driven to the ballistic separator.

The ballistic separator further separates this fraction by weight. With the vibrations of the separator, the bulky ‘3D’ materials (PET, mixed bottles, other plastics such as PE / PP)will ‘roll’ toward the lower edge of the inclined sorting surface, while the light ‘2D’ materials (such as plastic films and paper) will be moved along and collected at the upper end of the device.

Conveyors then will move these fractions of waste to a set of optical separators (NIRs). Each NIR further separates the different waste streams into cleaner (higher quality) products (mixed paper, PP/PE, PET).

The separated recyclables will be compressed and baled into individual parcels through compression provisions. The fraction < 80mm will be discharge as a residue.

The following diagram presents the stages of mechanical treatment process of Recyclable Waste Bin with quantities in t/y (Average 2021-2046).

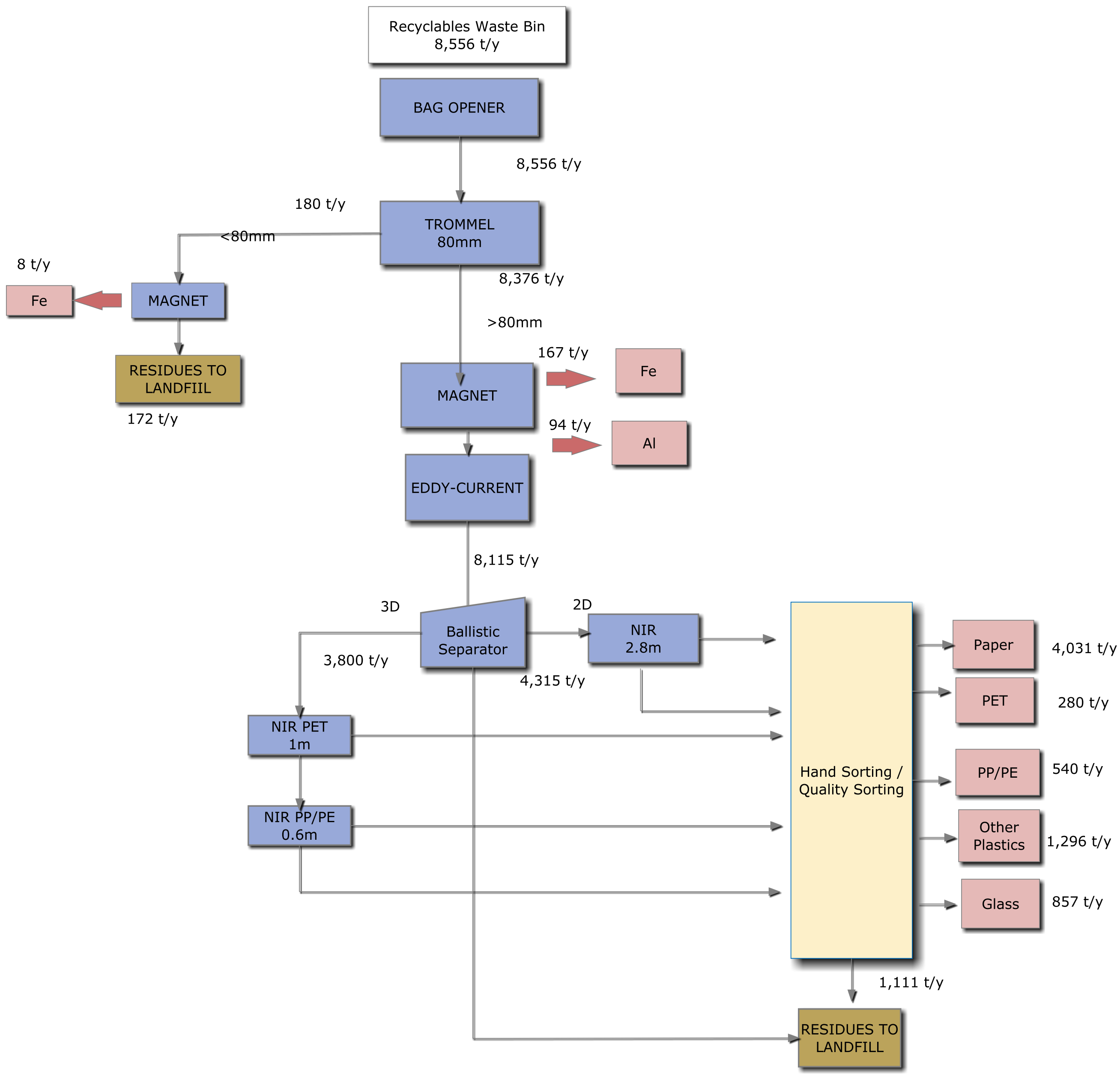


Figure 7-69: Flow-Diagram of mechanical treatment plant for Recyclable Waste Bin

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 = 28,503 t/y / 300 d/y = 95t/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/m^3. Therefore the minimum volume required for the storage of waste daily is:

Vd = 95 t : 0.3 t / m^3 = 317 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) = 317 m^3 x 3 days = 951 m^3

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 = 8,556 t/y / 300 d/y = 29 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 = 29 t : 0.25 t / m^3 = 116 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) = 116 m^3 x 3 days = 348 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
- ⇒ One operational line 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)	28,503 t/y
Incoming amount of source separated recyclables (Recyclable waste Bin)	8,556 t/y
Days of Operation	300 days / year
Daily Capacity for residual waste	95 t/d
Daily Capacity for recyclable waste	29 t/d
Capacity of line	1 line, 15t/h

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 20 production days.

Table 7-58: Storage Area for Recyclables Products form the sorting of residual waste bin

Material	Baler (set output dimensions)	Area per bale (m^2)	Specific Weight (kg/m^3)	Weight per Bale (tn)	Recovered Materials (t/d)	No. of bales per day	No of bales for approx. 20 days	No of bales staked (4 stacks on height)
Alluminium	0.75 m x 0.85m x1.1m	0.83	350	0.25	0.23	1	20	5
Area for bales (20% safety factor)								5 m^2

The ferrous will be stored in containers with nominal capacity of 24 m^3.

Table 7-59:Storage Area for Ferrousform the sorting of residual waste bin

Description	Quantities
Ferrous quantities per day	0.43 t/d
Estimated density	0.35 t/m^3
Volumetric Flow	1.22 m^3/d
Nominal Capacity of containers	24m^3
Filling Factor	75%
Effective capacity	18.0m^3
Containers for 20 days' storage	2
Area for each container (lxwxh)	6mx2.5mx2.4m
Total area for storage of containers	30m^2
TOTAL AREA (safety factor 20%)	**36 m^2**

Table 7-60: Storage Area for Recyclables Products form the sorting of recyclable waste bin

Material	Baler (set output dimensions)	Area per bale (m^2)	Specific Weight (kg/m^3)	Weight per Bale (tn)	Recovered Materials (t/d)	No. of bales per day	No of bales for approx. 20 days	No of bales staked (3 stacks on height)
Paper / Cardboard	0.75 m x 0.85m x1.1m	0.83	450	0.32	13,44	43	860	215
Plastic			350	0.25	7,06	29	580	145
Alluminium			350	0.25	0,31	2	40	10
Area for bales (20% safety factor)								370 m^2

The glass 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
Glass quantities per day	2.85 t/d
Estimated density	1.00t/m^3
Volumetric Flow	2,85 m^3/d
Nominal Capacity of containers	24m^3
Filling Factor	75%
Effective capacity	18m^3
Containers for 20days' storage	4
Area for each container (lxwxh)	6mx2.5mx2.4m
Total area for storage of containers	60m^2
TOTAL AREA (safety factor 20%)	**72 m^2**

The ferrous will be stored in containers with nominal capacity of 24 m^3.

Table 7-62:Storage Area for Ferrous

Description	Quantities
Ferrous quantities per day	0.58 t/d
Estimated density	0.35 t/m^3
Volumetric Flow	1.67 m^3/d
Nominal Capacity of containers	20 m^3
Filling Factor	75%
Effective capacity	18 m^3
Containers for 20 days' storage	2
Area for each container (lxwxh)	6mx2.5mx2.4m
Total area for storage of containers	30 m^2
TOTAL AREA (safety factor 20%)	**36 m^2**

The calculations reveal that a storage building of approx. **620 m^2** caters for this 20 days production capacity which also includes extra area enabling ease and safety of movements.

7.1.5.2.6. Biological treatment (aerobic composting of organic fraction of residual waste)

After the mechanical treatment process and recovery of recyclable materials and RDF, the 54% of the initial amount 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 three distinct phases. The 1st phase (high rating composting) takes places in windrows with useful capacity of 400 m^3.The composting's windrows filling is achieved by wheel loader. After a period of 35 days the material is directed via wheel loader to stabilisation. The stabilisation phase takes place in aerated static piles covered with membrane. After a period of the 21 days the material is led to the maturation via wheel loader. Then, after a period of 14 days the CLO is transfer 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 7-63:Input design parameters

Description	Values
Input organic fraction to biological treatment	15,398t/year
Operation	365 days/year
Material Densities	0.6 t/m^3
Biological Stages	• High rate composting (1st phase) • Biostabilisation (2nd phase) • Maturation (3rd phase_
Retention time in biostabilisation	70 Days (3 stages) 1. High rate composting 5 weeks - 35 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.

Table 7-64:Dimensioning of the number of piles

Composting (Stage I – High Rate Composting)	Stage I
Material to Stage I – High Rate Composting	15,398t/y
Specific density	0.60t/m^3
Volume of material to Stage I – High Rate Composting	25,663 m^3/y
Retention time	35 days
Annual Working Cycles	10
Pile Dimensions	length 25m width 8m height 3m Useful volume 400m^3
Material per cycle (m^3)	2,566 m^3
Number of piles	6
Composting (Stage II – Stabilisation)	**Stage II**
Material to Stage II – Stabilisation (20% mass losses)	12,318t/y
Specific density	0.60t/m3
Volume of material to Stage II – Stabilisation	20,531m3/y
Retention time	21 days
Pile Dimensions	length 25m width 8m height 3m Useful volume 400m^3
Annual Working Cycles	17
Material per cycle (m^3)	1,208m^3
Number of cells	4
Maturation	**Stage III**
Material to maturation (10% mass loss stage II)	11,087t/y
Specific density	0.60t/m^3
Volume of material to maturation	18,478m^3/y
Retention time	14 days
Annual Working Cycles	26
Pile Dimensions	length 25m width 8m height 3m Useful volume 400m^3
Material per cycle (m^3)	710 m^3
Number of cells	2

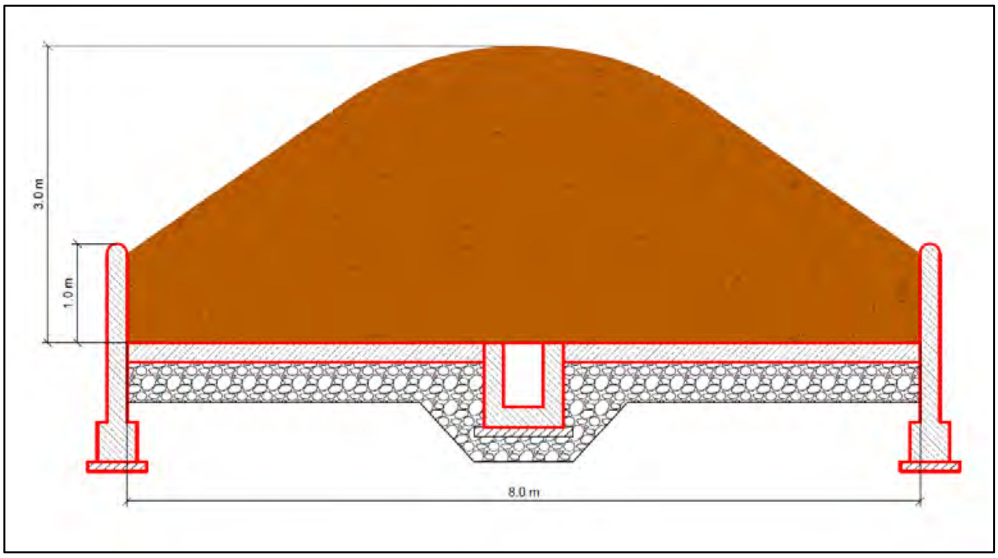


Figure 7-70: Static pile (Section)

7.1.5.2.7. Biological treatment (windrowcomposting of green waste)

The composting plant for green waste shall be designed to treat 2,301 tonnes of green waste per year. For the purposes of this feasibility study, the selected composting method will be the same as the biological treatment 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 composting area

1st phase composting	
Material to composting	2,301 t/y
Specific density after shreeding	0.45 t/m^3
Volume of material to composting	5,113m^3/y
Retention time (days)	21 days
Annual Working Cycles	17
Piles Dimensions	Length: 15m Width: 8m Height: 3m Useful volume:240 m^3
Material per cycle (m^3)	300 m3
Number of Reactors	1
2nd phase maturation	
Material to maturation	1,726 t/y
Specific density	0.45 t/m^3
Volume of material to maturation	3,835 m^3/y
Retention time (days)	14 days
Annual Working Cycles	26
Piles Dimensions	Length: 15m Width: 8 m Height: 3 m Useful volume: 240 m^3
Material per cycle	147 m^3
Number of cells	1

The composting / maturation area should provide sufficient space, in front of cells, for wheel loader movements.

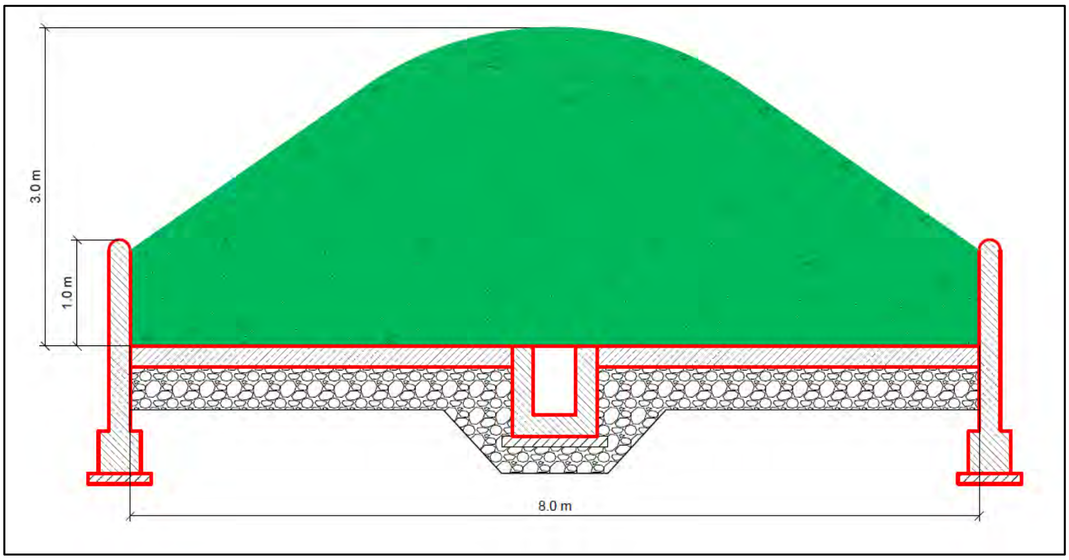


Figure 7-71: Pile of green waste

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 for green waste

Dimensioning of the storage area	
Material tostorage	1,380 t/y
Days of operation	365 days/year
Daily capacity	3.8 t/d
Storage time	21 days
Specific density of compost	0.45 t/m^3
Volume of material in storage (for 21days)	180 m^3/d
Total area	120 m^2

7.1.5.3 Water Balance

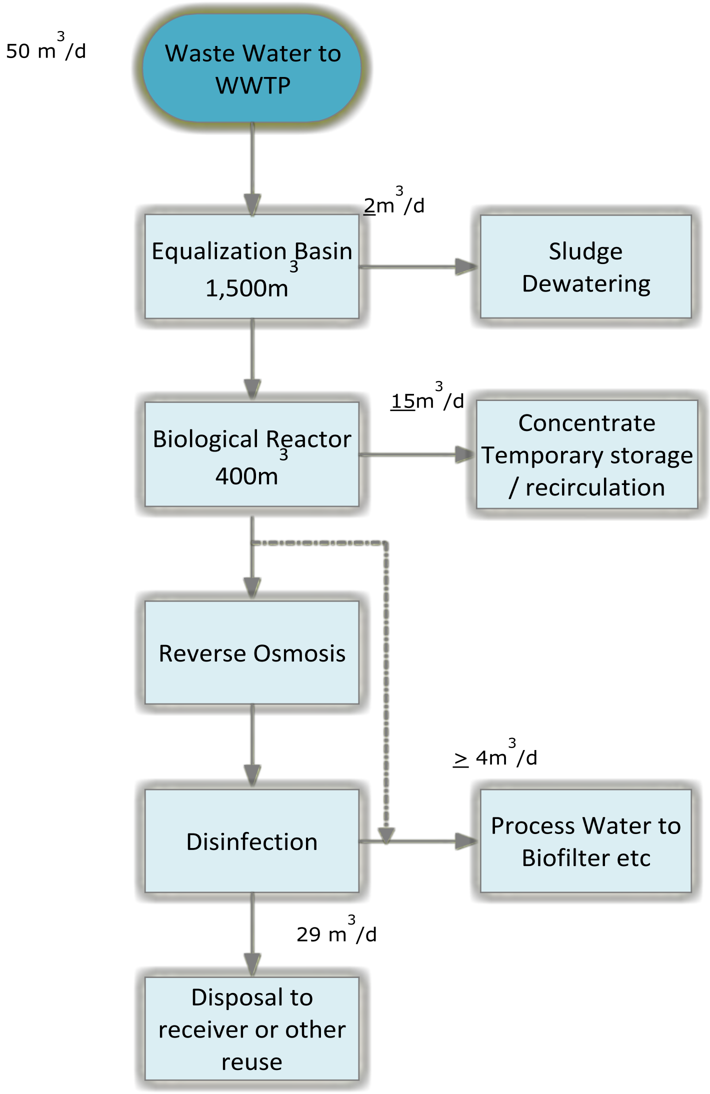
The daily water consumption in the WMC is as follow:
1. Washes of floors, mechanical equipment and trucks, 1 m^3/d
2. Personnel needs, 4 m^3/d
3. Biofilter, 3 m^3/d
4. Irrigation, 1m^3/d

Total: 9 m^3/d
Based on the above, needs for the washes and personnel (aprox. 5m^3/d) will be covered by the potable water supply network.

The water amount for 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 temporarily not available, the needs will be covered by potable water.

The surplus water amounts that may remain will be directed to a nearby receiver. The water balance can be seen in the following flow diagram and is based on WWTP design assumptions.

Figure 7-72: Indicative water balance



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 Par. 7.1.5.8 of the present Chapter):

a) Wheeled loader: Wheeled loaders are foreseen for three positions:

- Mechanical Treatment Facility
- Biological Treatment Facility
- Windrow composting Facility

Figure 7-73: 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 7-74: 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) Container transport vehicle: The role of this vehicle is the transport of various materials (waste residues, recovered metals) originating from the treatment to the appointed unloading areas. Its role has been described in a previous paragraph.

d) 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 7-75:Container transport vehicle

e) 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 7-76: 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	1
3. Electrical/Mechanical installation technician	1
4. Weighbridge operator	2
5. General secretary/administrator	1
6. Drivers	4
7. General tasks workers	14
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.

The operator from the Central Control System and also from the Station Control rooms has the possibility of supervision with two ways: via the above mentioned SCADA system or via manual operation from the localised control panels if necessary.

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 required infrastructure

The table below presents our estimations regarding the investment cost of Mechanical and Bilogical Treatment. 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	Quantity	Unit Cost(€)	Total Cost(€)
1	**Mechanical treatment for Mixed Municipal Waste & Recyclable waste**				
1.1	**Mechanical Equipment**				
1.1.1	Bag Opener	item	1	235,000	235,000
1.1.2	Trommel Screen d=90mm	item	1	180,000	180,000
1.1.3	Handsorting Cabin (16 chutes)	item	1	100,000	100,000
1.1.4	Magnet	item	2	40,000	80,000
1.1.5	Eddy Current Separator	item	1	80,000	80,000
1.1.6	Ballistic Separator	item	1	165,000	165,000
1.1.7	Baler with feeding conveyor	item	1	395,000	395,000
1.1.8	NIR 1m PE/PP	item	1	140,000	140,000
1.1.9	NIR 0,6m PET	item	1	130,000	130,000
1.1.10	NIR 2m film	item	1	190,000	190,000
1.1.11	Conveyors	m	150	2,000	300,000
1.1.12	Commisioning (planning, supply, installation, transportation, test)	item	1	90,000	90,000
			Subtotal 1.1. Mechanical Equipment		**2,085,000**
1.2	**Buildings Constructions (Civil works)**				
1.2.1	Excavations	m3	8,340	2	19,182
1.2.2	MBT Metallic building	m2	4,170	400	1,668,000
1.2.3	Storage for recyclables	m2	620	250	155,000
1.2.4	Control room	item	1	80,000	80,000
			Subtotal 1.2.Civil works		**1,922,182**
1.3	**Infrastructure**				
1.3.1	Electrical and mechanical installation (fire protection, sewage, electrical cables, etc)				
1.3.1.1	*General electrical / electronic installations*	item	1	75,000	75,000
1.3.1.2	*Fire detection and protection installations*	item	1	50,000	50,000
1.3.1.3	*Sewage and plumbing installation*	item	1	30,000	30,000
1.3.1.4	*Automation System*	item	1	50,000	50,000
1.3.2	Asphalted and gravel areas	m^2	7,800	25	195,000
1.3.3	De-dusting bag filter, fans for air exchange system (for Mechanical Treatment & Clean MRF)				
1.3.3.1	*Dedusting - deodorization - Civil works for biofilter*	lump sum	1	111,000	111,000
1.3.3.2	*Dedusting - deodorization - Electrical works*	lump sum	1	80,000	80,000
1.3.3.3	*Dedusting - deodorization - Mechanical works (Air ducts galv steel 2mm, Bagfilter, centifugal fan, biofilter packing media, dampers, pumps, fittings, etc)*	lump sum	1	429,000	429,000
			Subtotal 1.3.Infrastructure		**1,020,000**
1.4	**Mobile Equipment**				
1.4.1	Wheeled front end Loader with bucket capacity 5.5m^3	unit	1	110,000	110,000
1.4.2	Transport truck with hook lift (for residuals disposal)	unit	1	120,000	120,000
1.4.3	Sweeper	unit	1	100,000	100,000
1.4.4	Container 24m^3 for residues & Fe storage	unit	10	8,000	80,000
1.4.5	Container for ferrous, non ferrous products (1,1m^3)	unit	10	300	3,000
1.4.6	Forklift	item	1	30,000	30,000
1.4.7	Small wheeled front loader (skid steer)	item	1	30,000	30,000
			Subtotal 1.4. Mobile Equipment		**473,000**
1.5	**Trial Operation**				
1.5.1	Trial Operation for 3 months	unit	1	50,000	50,000

			Subtotal 1.5.Trial Operation		50,000
Subtotal 1. Mechanical Treatment of Mixed Municipal waste & Recyclable waste					5,550,182

Table 7-69: Investment Cost of Biological Treatment

No	Item	Unit	Quantity	Unit Cost(€)	Total Cost(€)
2	Biological Treatment				
2.1	Biological Process				
2.1.1	Civil Works				
2.1.1.1	Concrete base and side walls for composting cells	m^3	1250	250	312,500
2.1.1.2	Storage area for CLO (Sheeded area)	m^2	600	250	150,000
2.1.1.3	Asphalted and gravel areas	m^2	10,000	15	150,000
2.1.1.4	Others works	item	1	10,000	10,000
2.1.2	Plant and Machinery				
2.1.2.1	Semi - permeable mebrane, fans, channels for composting cells (25 m x8m x3m) (lxwxh)	item	12	85,000	1,020,000
2.1.2.2	Auxialiary machine (towed mobile winder)	item	1	70,000	70,000
2.1.2.3	Testing equipment & other works	item	12	5,000	60,000
			Subtotal 2.1. Biological Process		1,772,500
2.2	Electrical and Mechanical Installations (fire protection, sewage, plumbing, electrical cables etc)				
2.2.1	General electrical/electronic installations	item	1	50,000	50,000
2.2.2	Sewage and plumbing installation	item	1	10,000	10,000
2.2.3	Other works	item	1	10,000	10,000
			Subtotal 2.2. Electrical and Mechanical Installations		70,000
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 3 months	unit	1	30,000	30,000
			Subtotal 2.4.Trial Operation		30,000
Subtotal 2.Biological Treatment					1,982,500

Table 7-70: Investment Cost of Windrow Composting for Green Waste

No	Item	Unit	Quantities	Unit Cost(€)	Total Cost(€)
3.	Windrow Composting for Green Waste				
3.1	Civil Works				
3.1.1	Concrete base and side walls for composting cells	m^3	140	250	35,000
3.1.2	Shreeder area - asphalted area C2a	m^3	30	250	7,500
3.1.3	Shedeed area - Reception of green waste (C1a)	m^2	380	250	95,000
3.1.4	Asphalted and gravel areas	m^2	7,000	15	105,000
3.1.5	Other works	item	1	10,000	10,000
			Subtotal 3.1.Civil Works		252,500
3.2	Plant and Machinery				
3.2.1	Semi - permeable mebrane, fans, channels for composting cells (15 m x8m x2,7m) (lxwxh)	item	2	87,500	175,000
3.2.2	Testing equipment & other works	item	2	5,000	10,000
			Subtotal 3.2. Plant and Machinery		185,000
3.3	Electrical and mechanical installation (fire protection, sewage, plumbing, electrical cables etc)				
3.3.1	General electrical/electronic	item	1	20,000	20,000

	installations				
3.3.2	Sewage and plumbing installation	item	1	5,000	5,000
3.3.3	Other works	item	1	10,000	10,000
			Subtotal 3.3.Electrical and mechanical installation		**35,000**
3.4	**Mobile Equipment**				
3.4.1	Shredder	item	1	60,000	60,000
3.4.2	Drum Screen	unit	1	80,000	80,000
			Subtotal 3.4. Mobile Equipment		**140,000**
3.5	**Trial Operation**				
3.5.1	Trial Operation for 3 months	item	1	10,000	10,000
			Subtotal 3.5.Trial Operation		**10,000**
Subtotal 3. Windrow Composting for Green Waste					**622,500**

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.

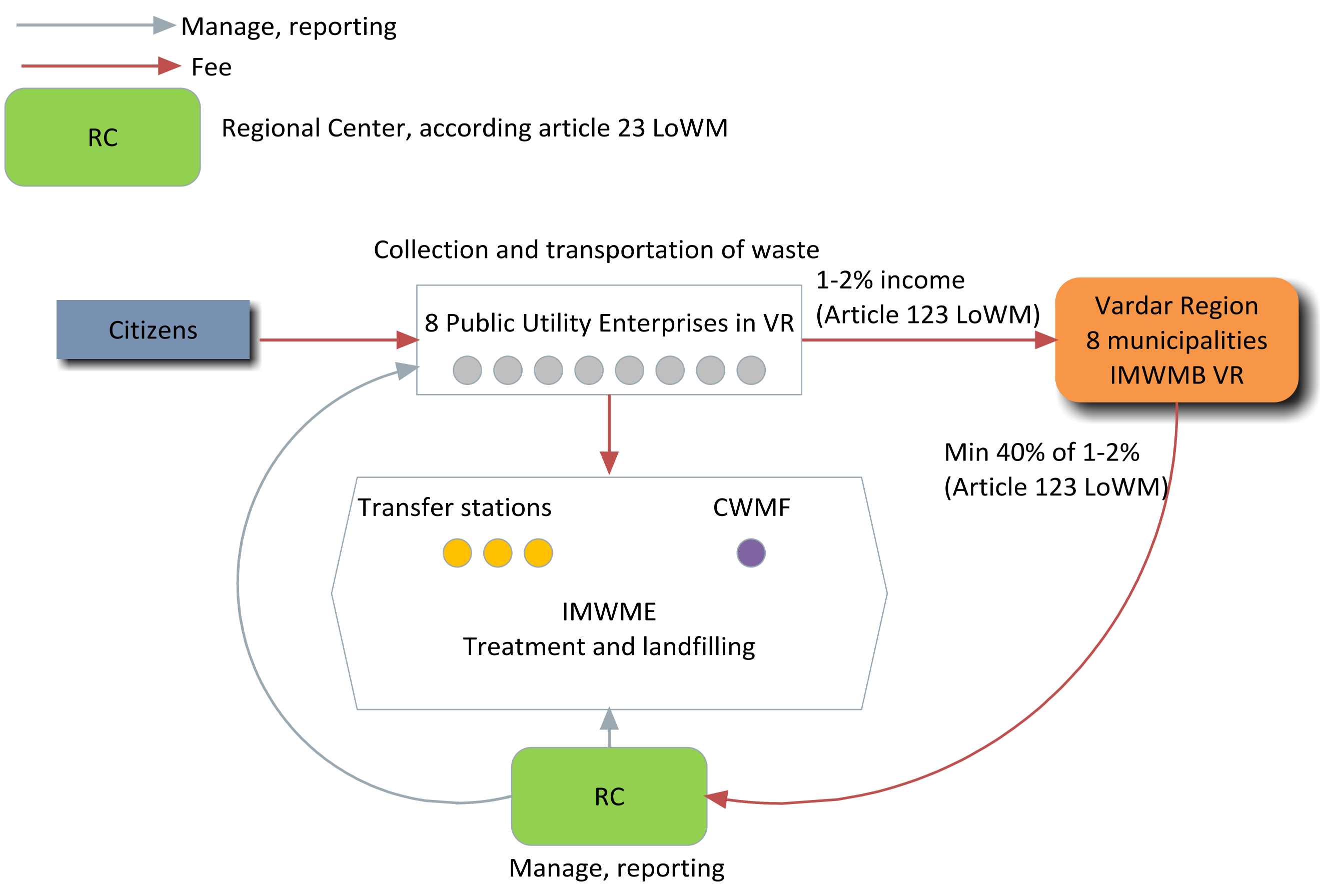


Figure 7-77: Proposed Model

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
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 bodies of 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.

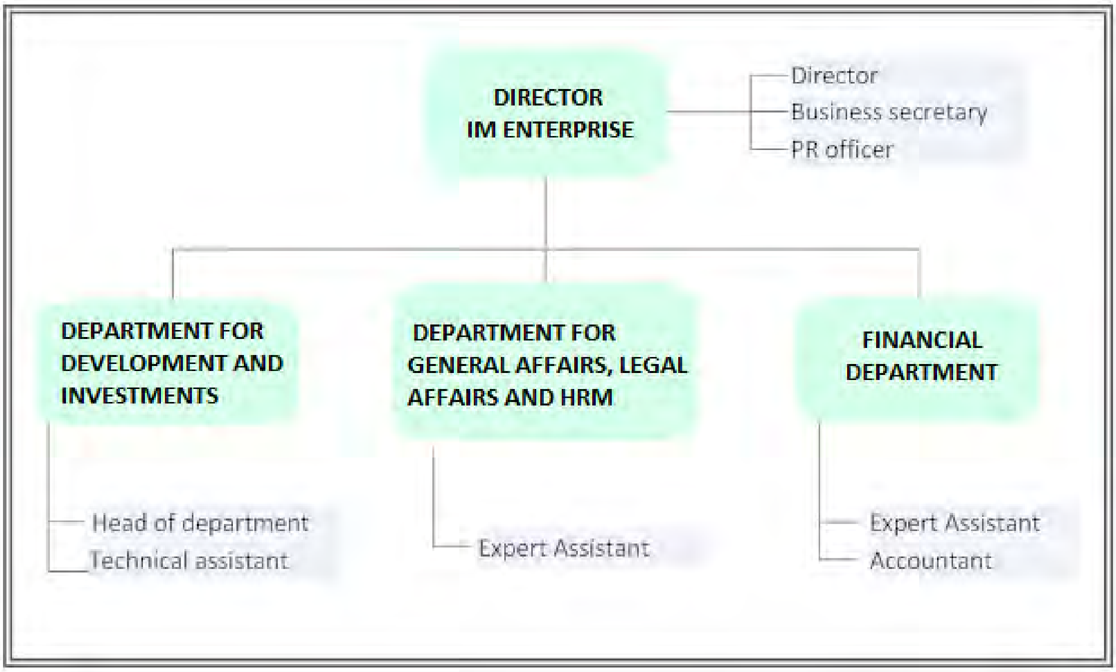


Figure 7-78: Proposed organizational scheme

7.3 CAPEX, OPEX and reinvestment cost determination

7.3.1 Capex

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 €

Project Component	Total Project Cost, €
Mechanical Treatment	5,550,182 €
Biological Treatment	1,982,500 €
Residual Landfill (WWTP included)	3,360,746 €
Windrow Composting for green waste	622,500 €
Infrastucture works	1,658,602 €
Transfer Station Veles	1,178,591 €
Transfer Station Kavardatsi	918,324 €
Transfer Station Negotino	857,314 €
Collection Equipment (Bins & Trucks)	3,122,657 €
Technical Assistance, Supervision during implementation & Publicity	1,450,000 €
Public Utilities	600,000 €
Acquisition of land	150,000 €
TOTAL	**21,451,416 €**

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)

Subsequent project cost	**REINVESTMENT COST - Non Eligible Cost**				
(in constant EUR)	**2021-2026**	**2027**	**2028**	**2032**	**2033-2046**
Land acquisition	**0**	**0**	**0**	**0**	**0**
Acquisition of land	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**
Civil construction					
Mechanical Treatment					
Biostabilisation	0	0	0	0	0
Residual Landfill	0	631,321	631,321	0	0
Waste Water Treament Plant					
Windrow Composting for green waste					
Infrastucture works	0	0	0	0	0
Transfer Station Veles	0	0	0	0	0
Transfer Station KAVARDATSI	0	0	0	0	0
Transfer Station NEGOTINO	0	0	0	0	0
Collection Equipment	0	0	0	0	0
Public Utilities (Access Roads)	0	0	0	0	0
Total	**0**	**631,321**	**631,321**	**0**	**0**
Plant and machinery					

Mechanical Treatment				1,250,000	
Biostabilisation	0	0	0	492,800	0
Residual Landfill	0	0	0	4,840	0
Waste Water Treament Plant			300,000	34,865	
Windrow Composting for green waste	0	0	0	89,600	0
Infrastucture works	0	0	0	143,827	0
Transfer Station Veles	0	0	0	32,000	0
Transfer Station KAVARDATSI	0	0	0	32,000	0
Transfer Station NEGOTINO	0	0	0	32,000	0
Collection Equipment				709,311	
Public Utilities (Access Roads)				0	
Total	**0**	**0**	**300,000**	**2,821,243**	**0**
Mobile equipment					
Mechanical Treatment				483,000	
Biostabilisation	0	0		116,000	0
Residual Landfill	0	0		505,000	0
Waste Water Treament Plant				0	
Windrow Composting for green waste	0	0		142,000	0
Infrastucture works	0	0		0	0
Transfer Station Veles	0	0		414,074	0
Transfer Station KAVARDATSI	0	0		257,580	0
Transfer Station NEGOTINO	0	0		234,205	0
Collection Equipment				2,806,124	
Public Utilities (Access Roads)	0	0		0	0
Total	**0**	**0**	**0**	**4,957,983**	**0**
Contingencies					
Mechanical Treatment				62,500	
Biostabilisation	0	0	0	24,640	0
Residual Landfill	0	63,132	63,132	484	0
Waste Water Treament Plant		0	15,000	1,743	
Windrow Composting for green waste	0	0	0	4,480	0
Infrastucture works	0	0	0	14,383	0
Transfer Station Veles	0	0	0	3,200	0
Transfer Station KAVARDATSI	0	0	0	3,200	0
Transfer Station NEGOTINO	0	0	0	3,200	0
Collection Equipment				35,466	
Public Utilities (Access Roads)				0	
Total	**0**	**63,132**	**78,132**	**153,295**	**0**
Totals excluding intangibles					
Mechanical Treatment				1,795,500	
Biostabilisation	0	0	0	633,440	0
Residual Landfill	0	694,453	694,453	510,324	0
Waste Water Treament Plant		0	315,000	36,608	
Windrow Composting for green waste	0	0	0	236,080	0
Infrastucture works	0	0	0	158,210	0
Transfer Station Veles	0	0	0	449,274	0
Transfer Station KAVARDATSI	0	0	0	292,780	0
Transfer Station NEGOTINO	0	0	0	269,405	0
Collection Equipment				3,550,900	
Public Utilities (Access Roads)				0	

Total	**0**	**694,453**	**1,009,453**	**7,932,521**	**0**
Intangible components					
Technical Assistance & Supervision during implementation					
Publicity					
Public utilities (connection of power supply network, water supply network etc)					
Grand total	**0**	**694,453**	**1,009,453**	**7,932,521**	**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	Quantity	Unit Cost(€)	Total Cost(€)
1	**Collection Equipment**				
1.1	**Collection bins**				
1.1.1	Collection Bins for Mixed Waste (1,1m^3)	item	1,390	341	473,990
1.1.2	Collection Bins recyclables (1,1 m3)	item	1,671	240	401,040
1.1.3	120 lt plastic bin	item	1,555	28	43,540
1.1.4	Bins for home composting (≥ 240 lt)	item	2,429	39	94,731
			Subtotal 1.1.Collection bins		**1,013,301**
1.2	**Collection Trucks**				
1.2.1	RCV, Collection truck 14 m^3	item	14	116,128	1,625,792
1.2.2	Green waste collection tipping truck 6 m^3	item	6	80,594	483,564
			Subtotal 1.2. Collection trucks		**2,109,356**
Subtotal 1.Collection Equipment					**3,122,657**

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	Quantity	Unit Cost(€)	Total Cost(€)
2	**Transfer Stations**				
2.1	**Transfer Station Veles**				
2.1.1	**Civil works**				
2.1.1.1	Fence	m	669	48	32,034
2.1.1.2	Entrance gate	items	1	1,268	1,268
2.1.1.3	Plateau and roads (incl flood works)	sqm	3805	73	279,585
2.1.1.4	Administration building	sqm	60	500	30,000
2.1.1.5	Water supply	items	1	8,539	8,539
2.1.1.6	Sewerage system	items	1	4,825	4,825
2.1.1.7	Electrical installations (lighthing, electricity, phone, fire fighting)	items	1	108,592	108,592
2.1.1.8	Hopper	items	2	54,957	109,913
2.1.1.9	Landscaping (incl earthworks)	items	1	109,760	109,760
			Subtotal 2.1.1. Civil works		**684,517**
2.1.2	**Mobile 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.		**80,000**

			Mobile Equipment		
2.1.3	**Mobile Equipment**				
2.1.3.1	Truck with hook lift	items	2	133,119	266,238
2.1.3.2	Tires for trucks (Included on maintenance costs)				0
2.1.3.3	Press containers 24 m3 (for mixed waste)	items	4	23,375	93,500
2.1.3.4	Press containers 24 m3 (for recyclable waste)	items	2	23,375	46,750
2.1.3.5	Containers 24 m3 (for green waste)	items	1	7,586	7,586
			Subtotal 2.1.3. Mobile Equipment		**414,074**
			Subtotal 2.1 TS Veles		**1,178,591**
2.2	**Transfer Station Kavadartsi**				
2.2.1	**Civil Works**				
2.2.1.1	Fence	m	561	48	26,875
2.2.1.2	Entrance gate	items	1	1,268	1,268
2.2.1.3	Plateau and roads (incl flood works)	sqm	3,510	73	255,193
2.2.1.4	Administration building	sqm	60	500	30,000
2.2.1.5	Water supply	items	1	10,510	10,510
2.2.1.6	Sewerage system	items	1	4,825	4,825
2.2.1.7	Electrical installations (lighthing, electricity, phone, fire fighting)	items	1	107,810	107,810
2.2.1.8	Hopper	items	2	42,624	85,248
2.2.1.9	Landscaping (incl earthworks)	items	1	59,014	59,014
			Subtotal 2.2.1. Civil Works		**580,744**
2.2.2	**Equipment**				
2.2.2.1	Weighbridge	items	1	28,000	28,000
2.2.2.2	Skid Steer Loader	items	1	30,000	30,000
2.2.2.3	Oil separator	items	1	20,450	20,450
2.2.2.4	Skip	items	1	1,550	1,550
			Subtotal 2.2.2.Equipment		**80,000**
2.2.3	**Mobile Equipment**				
2.2.3.1	Truck with hook lift	items	1	133,119	133,119
2.2.3.2	Tires for trucks (Included on maintenance costs)				0
2.2.3.3	Press containers 24 m3 (for mixed waste)	items	3	23,375	70,125
2.2.3.4	Press containers 24 m3 (for recyclable waste)	items	2	23,375	46,750
2.2.3.5	Containers 24 m3 (for green waste)	items	1	7,586	7,586
			Subtotal 2.2.3.Mobile Equipment		**257,580**
			Subtotal 2.2. TS Kavadartsi		**918,324**
2.3	**Transfer Station Negotino**				
2.3.1	**Civil Works**				
2.3.1.1	Fence	m	541	48	25,922
2.3.1.2	Entrance gate	items	1	1,268	1,268
2.3.1.3	Plateau and roads (incl flood works)	sqm	1490	154	229,326
2.3.1.4	Administration building	sqm	60	500	30,000
2.3.1.5	Water supply	items	1	8,308	8,308
2.3.1.6	Sewerage system	items	1	4,825	4,825
2.3.1.7	Electrical installations (lighthing, electricity, phone, fire fighting)	items	1	96,938	96,938
2.3.1.8	Hopper	items	2	53,676	107,352
2.3.1.9	Landscaping (incl earthworks)	items	1	39,170	39,170
			Subtotal 2.3.1. Civil Works		**543,109**
2.3.2	**Mobile 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	**Trial Operation**				
2.3.3.1	Truck with hook lift	items	1	133,119	133,119
2.3.3.2	Tires for trucks (Included on maintenance costs)	items			0
2.3.3.3	Press containers 24 m3 (for mixed waste)	items	2	23,375	46,750
2.3.3.4	Press containers 24 m3 (for recyclable waste)	items	2	23,375	46,750
2.3.3.5	Containers 24 m3 (for green waste)	items	1	7,586	7,586
				Subtotal 2.3.3. Mobile Equipment	**234,205**
				Subtotal 2.3. TS Negotino	**857,314**
				Subtotal 2. Transfer Stations	**2,954,229**

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 Veles	12,603	3,783	1,017	17,404	8.4	145,988
TS Kavadartsi	10,361	3,110	836	14,307	6.1	87,800
TS Negotino	4,439	1,333	358	6,130	12.8	78,416
			Total	**37,842**	**8.3**	**312,204**

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 (workers skilled/unskilled, drivers, 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. Variable cost is assumed to remain flat.

For the calculation of the operational cost of the various waste management facilities, the following cost categories have been considered:

Maintenance costs: 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% for landfill and landfill and 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	17	1	1	1
WORKER SKILLED	4	2	3	-
ENGINEERS/ CHEMISTS/ SUPERVISORS	2	-	-	-

Energy – Fuel: Electricity and fuel is needed for the operation of the mechanical separation, biological treatment, the landfill, 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) @ 0.140EUR/KWh	Fuel (l/t) @ (0.856EUR/l)
Mechanical treatment	20	3
Biostabiliasation	5	1
Windrow composting	5	2
Landfill	5	5
Infrastructure works	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 given percentage of the investment cost, i.e. 0.70% of investment cost.

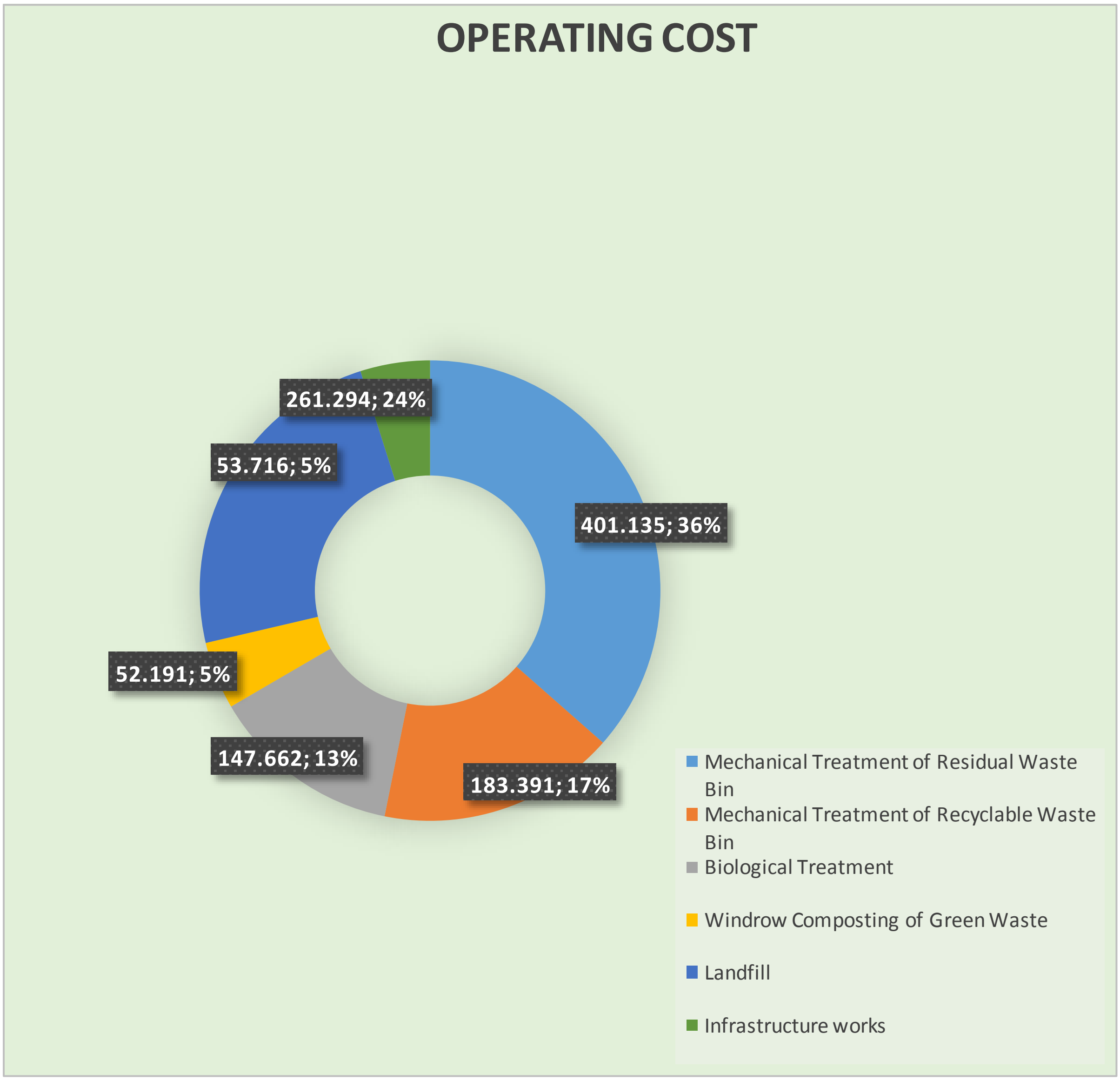
The average operating cost from operation during the period 2021-2046, is presented in the following table:

Table 7-79: Average Annual Operating Cost for period 2021-2044

OPERATING COST	€/year (Average 2021-2046)	€/year (Average 2021-2046)
Mechanical Treatment of Residual Waste Bin	401,135	14.07
Mechanical Treatment of Recyclable Waste Bin	183,391	21.44
Biological Treatment	147,662	9.59
Windrow Composting of Green Waste	52,191	22.68
Landfill	261,294	11.19
Infrastructure works	53,716	1.88
Total Operating Cost, EUR	**1,099,389**	**38.57**

The figurebelow shows the estimated operating cost of each unit, in EUR.

Figure 7-79: Average Operating Cost of each treatment unit



7.3.4.2. Revenues

Concerning 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.

<u>Revenues from Recyclables, Compost and Energy</u>

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

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

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/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 Cost estimation and the related revenues, for selected years, after imposing of an adequate tariff, as mentioned above.

Table 7-82: LUC Calculation "With project"

LUC/DPC Calculation With Project	NPV	
Discount rate	4.0%	
Investment Cost Total (reinvestments included)	EUR	26,066,708
Operating Cost	EUR	50,118,662
Revenues	EUR	9,419,303
Total Cost	EUR	66,766,067
Total Waste input into the system	t/year	559,390
LUC, Investment	EUR/t.	47
LUC, O&M	EUR/t.	90
LUC, net O&M	EUR/t.	73
LUC, Total	EUR/t.	**119**

Revenues from 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 2042 will cover the Full LUC.

Total Revenues WITH PROJECT scenario

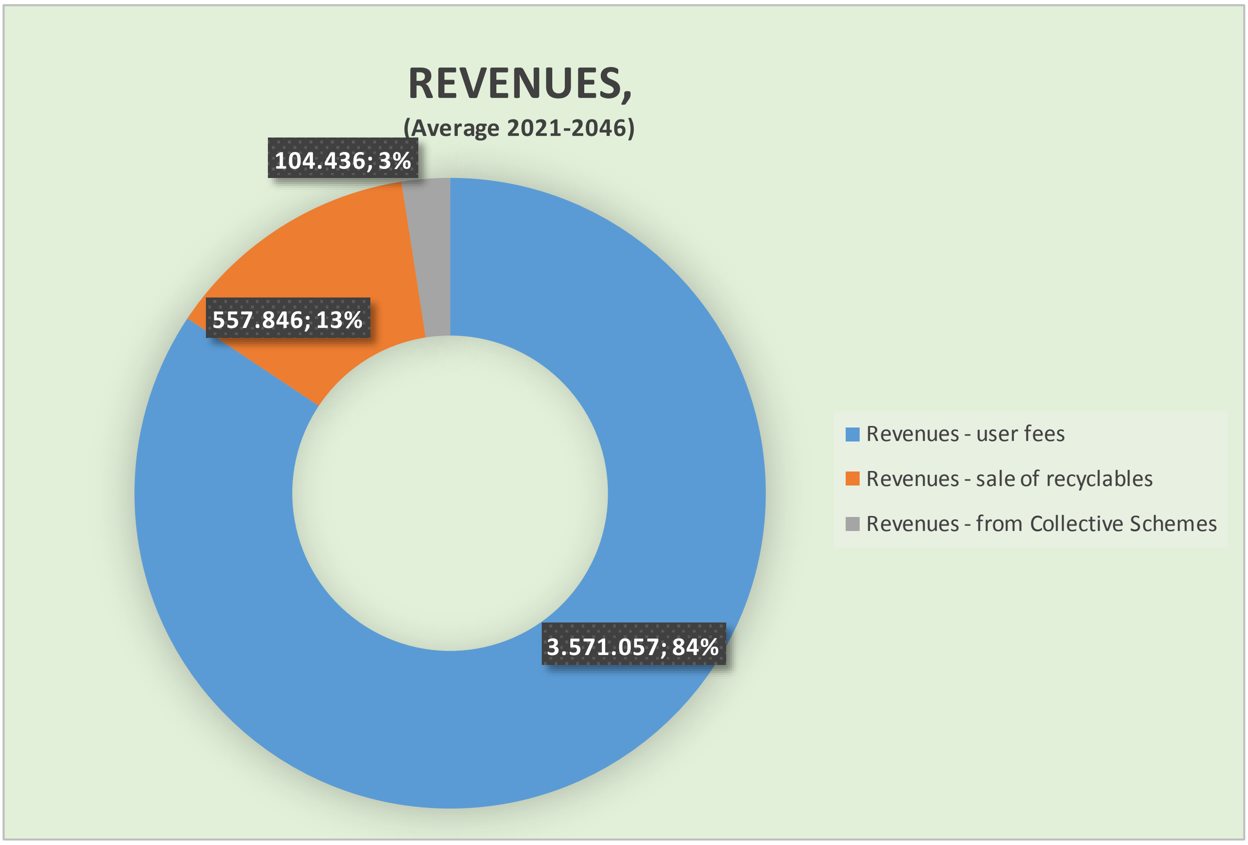
The prices assumed constant during the analysis period in the level of 2017. The following table illustrates the Total Revenues after the completion of the project construction and start of operation.

Table 7-83: Revenues of “With project” scenario, prices in EUROS (constant price in 2017)

Year	Revenues - user fees	Revenues - sale of recyclables	Revenues - from Collective Schemes	Total Revenues
2021	2,618,033	553,232	103,640	3,274,905
2022	2,561,487	554,627	103,897	3,220,011
2023	2,622,877	556,042	104,158	3,283,076
2024	2,686,416	557,476	104,422	3,348,315
2025	2,752,184	558,931	104,691	3,415,806
2026	2,818,613	560,022	104,889	3,483,525
2027	2,887,428	561,148	105,094	3,553,670
2028	2,958,718	562,307	105,305	3,626,330
2029	3,129,114	563,500	105,523	3,798,138
2030	3,208,989	564,728	105,747	3,879,465
2031	3,280,826	564,092	105,621	3,950,539
2032	3,355,136	563,491	105,503	4,024,129
2033	3,432,004	562,925	105,390	4,100,319
2034	3,511,514	562,393	105,284	4,179,192
2035	3,593,756	561,896	105,185	4,260,837
2036	3,674,123	560,716	104,958	4,339,797
2037	3,811,660	559,571	104,738	4,475,968
2038	3,953,552	558,460	104,524	4,616,536
2039	4,099,949	557,383	104,316	4,761,649
2040	4,251,003	556,340	104,115	4,911,458
2041	4,402,026	554,719	103,806	5,060,550
2042	4,671,155	553,133	103,503	5,327,791
2043	4,659,537	551,582	103,207	5,314,326
2044	4,648,185	550,065	102,918	5,301,168
2045	4,637,094	548,582	102,635	5,288,311
2046	4,622,097	546,638	102,266	5,271,001

The figure shows the estimated revenues, in EUR/y.

Figure 7-80: Average Revenues


REVENUES,
(Average 2021-2046)
104.436; 3%
557.846; 13%
3.571.057; 84%
Revenues - user fees
Revenues - sale of recyclables
Revenues - from Collective Schemes

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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 of from the implementation of the planning documents (strategies, plans andprogrammes), 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 stipulate 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 Vardar region is proposed to be constructed at the site R1 near the settlement of Rosoman and administratively belongs to Municipality of Rosoman. An Environmental Impact Assessment Study for the Integrated Waste Management System in Vardar 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

The closest protected areas in CWMF of R1 site are:

- Emerald site "Raechka klisura" with code MK0000028 in the south in a distance of approx. 8km.
- Point of interest with code 132 "Archaeological site Stobi" in the northeast in a distance of approx.5.5km
- Three Transfer Stations will be established: TS in Negotino municipality in a distance of 3.6km from designated area "Orlovo Brdo" (Code 196505), TS in Kavadartsi municipality in a distance of 7,4km from emerald site "Raechka Klisura" (code MK0000035) ,and finally TS in Veles municipality which is situated inside the boundaries of emerald site "Ovche Pole".

Therefore, the Waste Management Centre will not pose an environmental threat to these areas. The location of the Region's CWMF is not in the area of cultural and historical heritage (only recorded archaeological site Stobi in a distance of 5.5km).

The main environmental data for the site R1 – Rosoman municipality are presented at the following paragraphs:

Figure 8-1: Future location of CWMF in R1 Site, Rosoman municipality

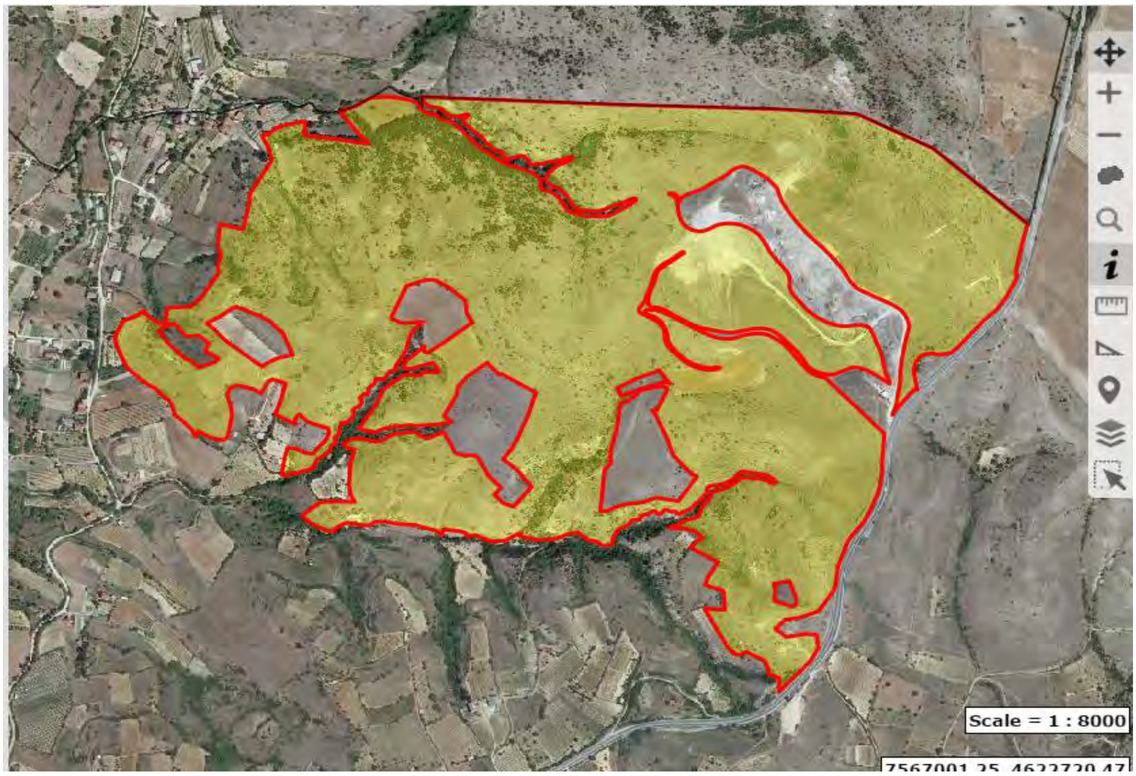


Figure 8-2: Proposed site for the location of TS in Veles municipality

Figure 8-3: Proposed site for the location of TS in Kavadartsi municipality

Figure 8-4: Proposed site for the location of TS in Negotino 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.
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 has been established:

	Jan	Feb	March	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Average monthly temperature (°C)	0.7	2.8	6.6	11.3	16.4	20.5	23.2	22.8	17.6	12.3	7.1	1.6
Average monthly precipitation (mm)	29.6	27.6	31.6	35.8	42.8	41.7	20.8	24.2	38.7	60.9	42.7	42.6

The temperature data were provided from the station located in the municipality of Prilep and refers to the last 20 years (1997 – 2016). According to those data, the average annual temperature is 11.9 °C, the lowest temperature was -5.5 °C recorded in December of 2001, and the highest was 25,6 °C recorded in July of 2012.

8.2.3 Geological, Hydrogeological, Seismotectonic and Geotechnical characteristics of the site

8.2.3.1 Geological characteristics

Geotectonicaly, Rosoman site is located within Vardar zone. The geological composition of Vardar Zone is a real mosaic of: igneous, metamorphic and sedimentary rocks of different age, from Precambrian to the youngest Holocene forms.

Rosoman Municipality which is located in central part of the country and regarding average altitude, it is one of the lowest areas at national level.
According to the regional geological map, territory of Rosoman Municipality includes mostly Quaternary and Cenozoic (Eocene and Pliocene) sediments. Only the west side of the territory includes several types of Paleozoic and Mesozoic rocks.

The study area and its immediate vicinity are composed of Pliocene sediments with large thickness (more than 100 meters). Those sediments include grey -yellow sands, sandy clays, clays and very rarely gravels, and transgressively cover Eocene or so called upper Flish zone with large thickness (above 2,000 meters). Entire area was prospected and lithological units composing the area were determined. The study area presents a shallow depression, where central parts are filled with Holocene diluvia sediments, while both (upper) sides are composed of Pliocene sediments.

Geological prospection in R1 site also includes general determination of site geotechnical characteristics, concluding that:

- From neo-tectonic point of view, the study area presents a stable two - sided ridge filled with clayey - sandy sediments.

- Landslides, rockslides, gully's and ravines where not determined and terrain can be classified as stable in natural conditions. Although some natural slopes with angles more than 60° were found, occurrences of active landslides were not determined.
- First impression is that small portion of Pliocene sediments is semi permeable and can meet the requirements for daily waste cover.
- Preliminary investigations and in situ tests indicate that diluvia and some parts of Pliocene sediments can be used for geological barriers construction (sealing).

Analytical description is included in Chapter 7 of the present study.

Regarding Resen municipality, where TS Resen will be established, it is composed mainly of Quaternary and Cenozoic (Pliocene) sediments, but the central part, from northwest to southeast is a mosaic of different rocks from Paleozoic to Mesozoic. According to desktop study and the on site visit, the main geological features of the TS site are Pliocene sands and clays.
Regarding Kavadartsi municipality, where TS Kavadartsi will be established, it is built from Pliocene and Quaternary sediments, while very small part includes Paleozoic rocks which appear mostly toward the Mountain Kozuf and Prilep. According to desktop study and the on site visit, the main geological features of the TS site are Pliocene sandy clays which have been covered by waste from the extension of the existing non compliant municipal landfill "Melci".
Regarding Negotino municipality, where TS Negotino will be established, it includes mostly Quaternary and Cenozoic (Eocene and Pliocene) sediments (almost 90% of its territory), while only a small part (on east - southeast of municipality) it is covered by igneous and metamorphic rocks like granites and different types of schists. According todesktop studyand the on site visit, the study area consists of well bound Eocene sediments build of sandstone and claystone covered with decomposed material and clay sediments.

8.2.3.2 Seismotectonic characteristics

The study area is in the central part of the beneficiary country which belongs to Vardar zone as tectonic unit. Vardar zone has northwest - southeast orientation and includes all formations from Precambrian to Quaternary.

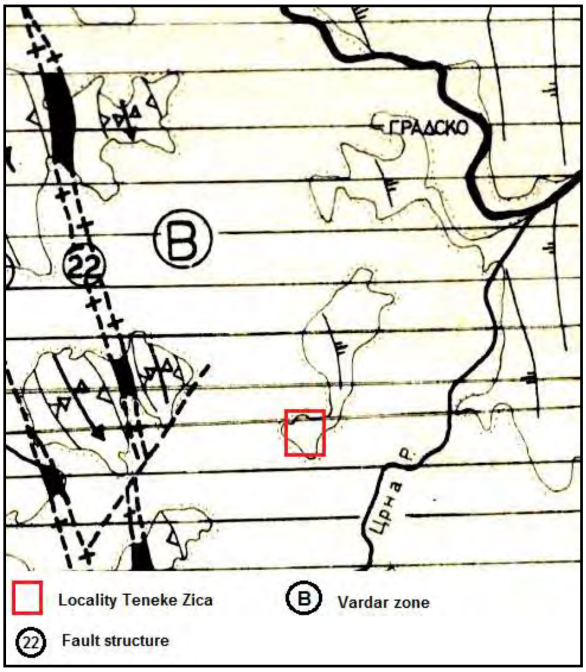


Figure 8-5: Tectonic map of the broader area of the study area

It should be noted that wider area of Rosoman site is composed of Neogene sediments with significant thickness and represent ridges filled with terrigenous lake material. As shown on tectonic map dominant fault structure is located 5 km west of site (Mark 22 on the tectonic map shown in the picture). Outcrops of serpentinized peridotites which appear along this structure are very schistose and impressed along the weakened ruptures. The process of imprinting occurred at great depths and lead to metamorphism of the adjacent rocks. This is illustrated by contacts between Paleozoic rocks and the smaller parts of marbles inside the serpentinites. Along these unstable zones, impressing of larger masses of diabase’s and gabbro’s occurred.
From neo-tectonic aspect, the study area presents a stable two-sided ridge filled with clay - sandy sediments. The area of Rosoman does not belong in area with the most intensive seismic activity and stronger earthquakes should not be expected.

8.2.3.3 Hydrogeology and hydrology

Hydrogeological conditions within the study area were analyzed in order to determine possibilities for surface or high groundwater levels occurrence, 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 insulators which include diluvia sediments composed of dusty clays,
- hydrogeological complexes which include mostly Pliocene sediments.

Within the hydrogeological complex, sands and gravels are typical collectors with inter-granular porosity were boundary springs are formed. Those collectors allow infiltration of surface waters through the Pliocene sediments to the zone of constant underground water levels or up to clay layers as typical hydrogeological insulators.

Stratigraphic position of the diluvial dusty clays in relation with Pliocene sediments doesn't allow penetration of surface waters in the central parts of the depression. The clays are practically waterproof (from the experience is known that their filtration coefficient is k = 0.01 – 0.1 m'/day) and they act as surface insulators from surface water in the central (low) parts of the study area.
On the other hand, in the higher parts of the study area, where sands and gravels occur on the surface of the terrain (and have relatively high filtration coefficient k = 1 – 10 m'/day), penetration of water could occur and should be controlled.

Prospection site visits didn't determine existence of surface water within the study area and in the immediate vicinity.

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, significant runoff waters are also not expected.

Regarding Veles Municipality where TS Veles will be established, it includes water bearing terrains with boundary, fissure and type karst of wells which have high to low yielding. Territory includes several rivers (Babuna, Topolka and Otovica) and therefore abundant with wells of very high yielding > 10 l/s. Municipality of Veles covers area of larger waterways: Babuna, Topolka and Otavica, which belong to the Vardar basin.

Regarding Kavadarci Municipality where TS Kavadarci will be established, it has very complex hydrogeology, starting from waterless terrains to areas with medium to low yielding and wells with very high yielding > 10 l/s. Most important water flows include Luda Mara River and its tributaries and numerous small springs. The Luda Mara rises from Vitachevo Plateau and flows through the settlement of Kavadarci. Tikvesh Lake is artificial lake formed on river Crna, 12 km southwest from Kavadarci and it is the largest in the Republic of Macedonia.

Regarding Negotino Municipality where TS Negotino will be established, it has waterless terrains in the northern parts, while the southern terrains include carst and fissure types of wells with low yielding. The most important water occurrence is the River Vardar. Hydrographic network of Negotino covers the Vardar River and its tributaries.

8.2.4 Natural features

8.2.4.1 Land use features

Land cover and land usage in the Vardar region are presented according to CORINE Land COVER for period 2006 – 2012. According to CORINE methodology, geophysical cover of the Earth's surface is approached 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, the highest percentage of the land in Vardar region is under forests cover 1,292 km^2 or 44.2% of the total surface area. The category agricultural area takes 976 km^2 or 18.8% of the total area, the category artificial lakes covers 14 km^2 or 0.04% of the total area. Rest of the surface are covered with semi natural or artificial areas. According to CORINE Land COVER, major changes between2006 and 2012 can be noted in artificial areas and forests and semi-natural areas, accompanied by decreased agricultural areas and water areas.

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.

According to Corine Land Cover 2012, in the wider area of the R1 site there is agricultural land, with complex cultivation patterns. Also there is an irrigation network around the site. According to the site visit, the largest part of the location is covered by a non-compliant landfill containing mainly inappropriate disposed municipal waste.

According to Corine Land Cover 2012, in the wider area of the TS Veles site there are pastures. According to the site visit, the area is covered by poor pastures, and another part is afforested, and located near a non compliant municipal landfill.

According to Corine Land Cover 2012, in the wider area of the TS Kavadarci site, there are pastures, but according to the site visit, the largest part of the location is covered by a non-compliant landfill containing mainly inappropriate disposed municipal waste.

According to Corine Land Cover 2012, in the wider area of the TS Negotino site, there are complex cultivation patterns, but according to the site visit, the largest part of the location is used as a parking /multi purpose area.

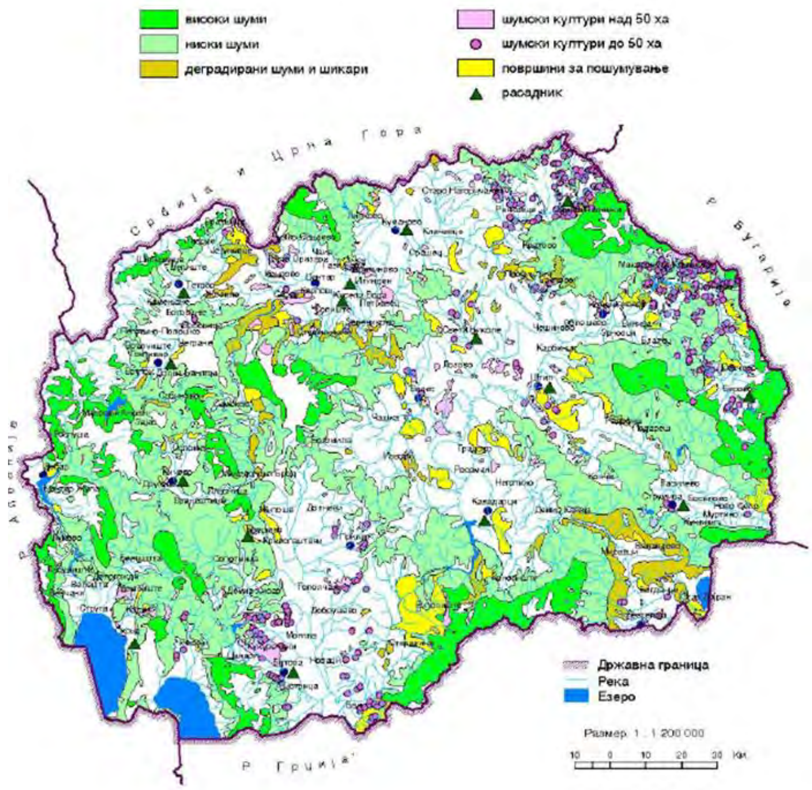
8.2.4.2 Nature and biodiversity

The richness and heterogeneity of the types and ecosystems are the basic features of the biodiversity in the beneficiary country. This situation is result of the specific geographic location, climate, geological, geomorphological, hydrographic, pedologic and other characteristics, including changes that have been happening in the past geologic periods. All of this left deep imprint on the recent flora and fauna, shown by the many rare species and ecosystems – there are over 18000 taxons from the flora and fauna, of which over 900 taxons are Macedonian endemites, including a large diversity of ecosystems in the frames of which over 260 plant communities are registered.

The territory of the beneficiary country is small but features a diversity of relief forms with very heterogeneous geological base, with complex pedological composition and combined climate influence. During the long geological history, a network was created of most diverse relic and recent ecosystems – water, bogs, meadows, halophytes, steps, hilly pastures, forests, and those created by the human influence: weed and ruderal, along with cultural ecosystems.

Among the various water ecosystems in the Republic of Macedonia, of key importance are the lake and river ecosystems, especially the one at Vardar river. The three natural lakes provide favorable conditions for development of the water macrophites, including coastal vegetation. The land water ecosystems include the flowing, the stagnant, the temporal and ground waters. From water ecosystems, the stagnant rivers are the most sensitive to the anthropogenic influence and their revitalization is difficult. Therefore, it is necessary to pay special attention on their complete protection. The river ecosystems, being the main recipients of the waste waters, are under large anthropogenic pressure. The most alarming is the situation with the rivers of Vardar, Bregalnica, Crna River and Pchinja. Some of the reservoirs that provide drinking or industrial water have worse water quality due to improper exploitation.

Figure 8-6: Forest ecosystems in the Republic of Macedonia per type of cultivation



Habitats and vegetation

The forest ecosystems in the Vardar region cover an area of 150009 ha, which is 15% of the total area of forests in the country. The wood mass is 8,8 million m^3 i.e. 11 % of the total wood mass in Macedonia while the part of wooden mass planned for cutting is 10%.
The Vardar region features excellent climate conditions for development of the agriculture, especially for cultivation of vineyards. The agricultural land spreads on 145,699 ha (12%) of the total agricultural land in Macedonia, of which 70,006 ha is arable land and 75,666 ha are pastures. Approximately 45% of the vineyard plantations on national level are located in this region.

Local Fauna

The first data on the ornithofauna in the Republic of Macedonia is since 1845. Since then we have a total of 332 species. Eight species are included in this list, regardless of the fact that it is likely that the species are determined incorrectly and two more species in the neighboring countries. From the remaining 322 species, most of them (210) are species that nest regularly in Macedonia and four species do that in irregular basis, or they probably only nest (where 127 species are indigenous i.e. they are present here throughout the year). Additional 19 species can be always seen during winter and 32 species are present only during their spring and/ or autumn migrations.

There are also species (two) that are present in Macedonia only during summer, although they do not nest in our country. The number of species that can be occasionally noticed in Republic of Macedonia is relatively high (27), because Macedonia is not in their main migration paths, or these are just individual animals that, roaming from their nesting locations in the wider region, were also noticed in Macedonia. Until recently, 15 more species were registered on the territory of Republic of Macedonia during winter, or during migration, or just occasionally, but in the last 2-3 decades there is no information about them. Unfortunately, eight species that used to nest in the Republic of Macedonia have now completely disappeared, which is likely the case with one more species for which the recent data is unconfirmed.

The development of the ICUN Red Lists in the 1980s provides the basis for identification of the most threatened wild species according to international criteria. BirdLife International is the second authority for the Red Lists of birds and coordinates the annual process of determination of the global threat status of the birds in the world for which there are indications for worsening or improvement of the status of their population.

In Republic of Macedonia there are several globally concerned bird species for which the Government has international obligation to assist their protection on its territory. The most concerned birds on global level (categorized as threatened by the IUCN) that can be encountered in Republic of Macedonia are the Egyptian vulture and the saker falcon. The Egyptian vulture (Neophron percnopterus) is regularly present for nesting during spring and summer months. Individual birds or couples of the saker falcon (Falco cherrug), in addition to migration and wintering, can be often seen during the reproduction period, which points out to probable nesting in Republic of Macedonia. There are three additional bird species categorized as sensitive. The first one is the Dalmatian pelican (Pelecanus crispus) which can be seen in large numbers at the Prespa Lake during summer, thanks to the successful efforts for its protection in Mala Prespa (Greece), where it is nesting. The second one is the Eastern Imperial Eagle (Aquila heliaca), species today limited only to nesting in the Kumanovo Valley, Ovche Pole region and the Povardarie region (between Veles and Demir Kapija). Until recently this species used to nest very frequently in all flat land areas and probably also in the lower parts of the mountains all over Republic of Macedonia.[1]
The third species are the little-known log-tailed duck (Clangula hyemalis), northern species, whose number significantly declined (and is considered sensitive species since 2012) and has not been seen in Republic of Macedonia around 30 years.

The Directive for Protection of the Wild Birds 2009/147/EC is the most important document on European Union level for protection of the priority species. In a lack of European Red List of Birds, it is the driver of the common plans for protection of the priority species, through development and implementation of action plans, declaring of Natura 2000 areas and identification of species that can be subject to use.

The most concerned birds on national level are the griffon vulture (Gyps fulvus) and the Egyptian vulture. Their numbers are declining rapidly and if no intensive steps are undertaken for their protection and if the use of poisonous baits is not prohibited, the last birds of this species will disappear in the next 15 to 20 years. It is therefore necessary to consider these species as critically endangered on national level. There are two more species that are very rare: the lesser spotted eagle (Aquila pomarina) and the Ural owl (Strix uralensis). Typical for these two is that they choose old forests for nesting, but only fragments of these forests have been preserved in Republic of Macedonia. It is estimated that there are

[1] State of the birds in Macedonia, Skopje 2013

no more than 15 couples left of the lesser spotted eagle and no estimates can be given for the Ural owl which was recently rediscovered after being lost for around 40 years.

<u>Regarding the R1 area</u>

<u>Description of habitats</u>

According to Corine Land Cover the wider area of the Central Waste Management Facilities is characterized as agricultural land, with complex cultivation patterns. Also there is an irrigation network around the site. The vegetation on the site location is very sparse and low and no special important species occur. In general, the wider area is much degraded due to the existence of a non compliant municipal landfill which is within the proposed site. This fact led to a deterioration of the wider area. Also, the site is not situated in an emerald area and the closest emerald site is in a great distance approx. 8km. In addition, no important habitat which could include special species of flora and fauna is detected on and near the site. On the other hand this is one of the most important regions for food production – fruit, vegetables and grape for wine production. Detailed information for the habitats for the study area are given in the "Ecological Baseline Survey & biodiversity of management plan" (ANNEX I of the EIA study of the Region).

In the project area and its surrounding 5 types of habitat can be distinguished. Among them as the most important habitat are grasslands-hill pastures. Almost all of the habitats in the studied area are of anthropogenic origin (orchards, vineyards, fields and acres) and big part of the area is active landfill. Only grasslands around the existing landfill represented by the category "*hill pastures*" are natural habitat, which is characteristic of the hilly areas in all valleys and plateaus in the beneficiary country. As a secondary formation, *hill pastures* are surrounded by sparse vegetation of different degradation stages. *Hill pastures with sparse vegetation* are another habitat, and in the region of the landfill it is of very similar vegetation composition to that of typical hill pastures.

<u>Flora and fauna</u>

As far as flora of the study area no important flora species are detected. The following plant species listed as present for part of the route are of particular interest:

- ⇨ Species which are on the IUCN Global Red List of threatened species; *none are known to be present in the Study Area*;
- ⇨ Species which are on the CORINE European List: *none are known to be present in the Study Area*;
- ⇨ IPA species in area: *none are known to be present in the Study Area, only in vicinity* ; and
- ⇨ Macedonian endemic species present in space around the route: *none are known to be present in the Study Area*.

As the grasslands are dominant habitat in the project area, their functions or ecological is important. Grasslands, mixture of grass, clover and other leguminous species, dicotyledonous, herbs and shrubs, contribute to a high degree to the struggle against erosion and to the regularizing of water regimes, to the purification of fertilizers and pesticides and to biodiversity and they have aesthetic role and recreational function. But even for grassland it is very difficult to create a good frame for its different tasks the provision of forage for livestock protection and conservation of soil and water resources, furnishing a habitat for wildlife, both flora and fauna and contribution to the attractiveness of the landscape.

Nevertheless it is the only crop able to fulfill so many tasks and to fit so many requirements. The area provides some ecosystem services of value to the local communities mostly for collection of Medicinal and aromatic plants. The most common medicinal and aromatic plants in the area are: *Achillea millefolium, Althaea officinalis, Chamomilla recutita, Crataegus monogyna, Cornus mas, Equisetum arvense, Rosa canina, Hypericum perforatum, Malva silvestris, Onionis spinosa, Plantago lanceolata, Plantago major etc.*

Despite pastures, anthropogenic ecosystems in the study area provide conditions for growing food especially peach trees and grape. Food comes principally from managed agro-ecosystems. Because of the usage of fertilizers and pesticides for fields, this area is not suitable for maintenance of biodiversity.

Regarding the TS Veles area

The area is covered by poor pastures, and another part is afforested (mostly with degraded forests). This is the area of pubescent oak and Oriental hornbeam forests and woodlands.

Degraded belts are characterized by the presence of the, invasive species *Paliurus spina-christi, Pyrus amygdaliformis, Prunus spinosa* etc. The dominant plant community representing this habitat is *Paliuretum submediterraneum* (Riz, prov.) with dominant species *Paliurus spina-christi*.

Common species are the following: hedgehog (*Erinaceus concolor),* marbled polecat (*Vormela peregusna*), Levant vole (*Microtus guentheri*), also: *Apodemus flavicolis, A. agrarius, Rattus rattus, Mus macedonicus, Lepus europeus, Canis lupus, Vulpes vulpes, Mustela nivalis, Meles meles, Felis sylvestris, Sus scrofa*. Birds are represented by *Passer hispaniolensis, Hippolais pallida, Sylvia* spp.*, Lanius collurio, L. minor, L. senator,* as well as some types of species *Emberiza* characteristic for hilly meadow. Most common species are snakes *Natrix natrix* and *N. tesselata*, and also *Elaphe longissima* and *Vipera ammodytes.* Other more common are turtles (*Eurotestudo hermanni*, *Testudo graeca)* and lizards (*Lacerta erhardii riveti*, *L. viridis*, *L. trilineata*, *Anguis fragilis*). Characteristic species of butterflies in this dwelling consists of: typical species that has a dry, shrubby vegetation as: *Thymelicus sylvestris, Phengaris arion, Melitaea phoebe, Arethusana arethusa*, as well as species that are common to a variety of habitats: *Iphiclides podalirius, Papilio machaon , Aporia crataegi, Carcharodus alceae, Gonepteryx rhamni, Limenitis reducta, Nymphalis antiopa, N. polychloros, Erebia medusa, Argynnis niobe, Aglais io, Plebeius agestis, Vanessa cardui, V. atalanta, Melanargia larissa, Coenonympha pamphilus, Leptidea sinapis, Colias crocea , Satyrium acacia, Hamearris lucina* etc.

Regarding TS Kavadarci area

The nearest area (east from the TS of Kavadarci) is characterized by a degraded oak native forest located within the steep side. It is presumed that historically the land was cleared for farming. The current second-generation /scrub vegetation is likely to be a result of wind and avifaunal dispersal from areas of native vegetation in the surrounding.

From mammals, here can be found the mole (*Talpa europea*), the hedgehog (*Erinaceus concolor*), the fox (*Vulpes vulpes*), the hare (*Lepus europeus*), some rodents (*Mus macedonicus, Apodemus sylvaticus*) and other species. Characteristic kinds of lizards are the green one (Lacerta viridis) and the Balkan green lizard (Lacerta trilineata), and from the snakes it can be found *Zamenis longissimus and Platyceps najadum.*

Common inhabitants of the oak forests in vicinity are the birds: blackbird *(Turdus merula*), jay (*Garrulus glandarius*), chaffinch (*Fringilla coelebs*), great tit (*Parus major*), the red robin (E*rithacus rubecula*). It can also be found: *Parus lugubris, Streptopelia decaocto, S. turtur, Otus scops, Oriolus oriolus, Buteo buteo, Picus viridis, Troglodytes troglodytes, Turdus viscivorus, Aegithalos caudatus, Carduelis carduelis, C. chloris.* Since, there is protected ornithological area in the vicinity, the important species must be mentioned. World Red List of IUCN , included three endangered bird species with a relatively large population of territory of SNR "Tikves": Egyptian Vulture (*Neophron percnopterus*) in category Endangered (EN), Imperial eagle (*Aquila heliaca*) in the category of Vulnerable (VU), and Steppe Kestrel (*Falco naumanni*) in the category Vulnerable (VU). Three other bird species: European roller (*Coracias garrulus*), black vulture (*Aegypius monachus*), which disappeared from the territory of Macedonia and ferruginous duck *(Aythya nyroca*) are included in the category -Near threatened (NT). Due to the proximity of the Tikvesh Lake, waterfowl species are expected to be seen in search for food.

Regarding TS Negotino area

In order to prevent erosion, near highway Demir Kapija -Smokvica trees are planted. Most of them are The Black locust's stands and confer trees. They are very open and ground vegetation is well developed and it is similar to that of the neighboring grasslands. Many ruderal elements are present in the Black locust's stands because of their proximity to the roads and settlements. Fauna of Black locust's stands is not specific and represents a mixture of the thermophyllous species inhabiting neighboring localities. The most common species of butterflies are *Artogeia rapae, Polyommatus icarus, Gonepteryx rhamn*i i.e. the species that are common in most of the habitat types. As it was the case with the previous habitat, the mixed stands of *Cupressus arizonica and Cupressus sempervirens with Pinus halepensis,* are also planted here. The *Cupressus spp*. thin and high tree crowns mark the physiognomy of the biotope. The notes for ground flora composition in previous habitat can be applied for this habitat, as well. The most common species of butterflies are Artogeia.

8.2.5 Architectural historical and cultural heritage

In the wider area of the site R1 there is no archaeological site under distance of 3km. The nearest point of interest to the site is the Archaeological site Stobi with site code 132, located in the northeast in a distance of approximately 5.5km.

There are no important architectural or archaeological heritage monuments in the wider area of the TS sites.

8.2.6 Settlements and population

The site R1 administratively belongs to Municipality of Rosoman. The site is located in the west of the settlement of Rosoman in a distance of approx. 3km, northeast of the settlement of Sirkovo in a distance of approx. 3km and southeast of Dolno Chichevo settlement in a distance of approx. 4km (the settlement belongs to municipality of Gradsko). The above mentioned distances refer to approximate straight line/direct distance.

The closest settlements to the R1 site are Rosoman and Sirkovo settlement in a distance of approximately 3km. According to the Census of 2002 the settlement had 603 inhabitants and according to State Statistical Office's estimation in 2015 had 593 inhabitants.

The closest settlement to the TS Veles is Veles settlement. According to the Census of 2002 the settlement had 46,714 inhabitants and according to State Statistical Office's estimation in 2015 had 46,363 inhabitants.

The closest settlement to the TS Kavadarci is Kavadarci settlement. According to the Census of 2002 the settlement had 29,188 inhabitants and according to State Statistical Office's estimation in 2015 had 29,275 inhabitants.

The closest settlement to the TS Negotino is Negotino settlement. According to the Census of 2002 the settlement had 13,284 inhabitants and according to State Statistical Office's estimation in 2015 had 13,381 inhabitants.

8.2.7 Transportation network

According to the Development program of the Vardar region, the region is relatively well covered with road network, but the local road network is generally in poor condition. Maintenance of local roads is inadequate and insufficient, which is mainly due to lack of funds,

The road A1, Prilep – Bitola – Ohrid is main conection for Rosoman area. All other settlements are connceted with local road network.

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 TSs 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

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 proposed site is situated on an existing non compliant landfill, which led to a deterioration of the wider area. As far as vegetation and habitats, no important species were detected in the site due to the deterioration of the vegetation and the environmental features. In the wider area of the site there is agricultural land, with complex cultivation patterns. In addition, the study area is not located in an environmental protected area so the impact is expected to be insignificant. The likely impact concerning the earthworks (dust emissions, noise produced from machinery) in the site and the movement of trucks and vehicles, may cause an attenuation of small animals. This impact is characterized as insignificant for a limited time period concerning the construction period.

The first TS is located in Negotino municipality in a great distance (>3km) from the closest protected area. The vegetation in the site is very sparse and low without any ecological importance and at some points there are isolated shrubs with medium height. The second TS is located in Kavadartsi municipality, in a great distance (>3km) from the closest protected area. Also the site is situated in an existing landfill site with the absence of any important species of flora and fauna with the existence of sparse and low vegetation, while the wider area of the site is characterized as agricultural land, mixed of pastures and vineyards, according to Corine Land Cover 2012. These two TS will be established is an great distance from protected areas so no impact on special protected species of flora and fauna is expected.

Finally, the third TS will be established in Veles municipality which is situated in a distance of approx. 0,6 km from the boundaries of emerald site "Ovche Pole". The TS site is located in proximity with an existing non-compliant municipal landfill site. Due to the existence of the landfill, the vegetation is very sparse and low without any ecological importance and the wider area is agricultural land with pastures and non-irrigated arable land according to Corine land cover 2012.
All three TS are not situated on protected areas, without vegetation or/with sparse and low vegetation and without ecological importance.

8.3.2.6 Impact on landscape

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 currently located in a non-compliant landfill, so the aesthetic of the environment is in general very low.
Also the optical isolation is in a medium level from the closest settlement (Rosoman). Also there is a low optical isolation level from the main access road.
The TS in Veles municipality is situated on the sideway of regional road R-1312 which connects the Veles settlement with Lozovo and Shtip settlements. The optical isolation is in a medium level from the closest settlement and low level from the access regional road R-1312. The optical isolation from the TS in Kavadarci municipality is in a good level and it cannot be seen from the closest settlement (Kavadartsi). Also there is a medium to low optical isolation level from the closest regional road.
Finally the TS in Negotino municipality is situated on the sideways of the national road (E-75) and it can easily be accessed from Negotino junction traveling to northwest. The optical isolation both from the nearby settlement (Negotino settlement) and the highway is low.

The impacts will be limited during the construction period due to the produced dust and are characterized as short-term low impacts.

From the above is considering that the level of the impact could be characterized as low.

8.3.2.7 Impact from traffic

The proposed site can be accessed, exiting Rosoman settlement through local road network and then following the regional road which connects the settlement of Rosoman with Sirkovo settlement.

The TS in Veles municipality is situated on the sideway of regional road R-1312 which connects the Veles settlement with Lozovo and Shtip settlements while the TS in Kavadarci municipality is very close to the regional main access road.
Finally the TS in Negotino municipality is situated on the sideways of the national road (E-75) and it can easily be accessed from Negotino junction traveling to northwest.

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 impacts

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 may cause fire, 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

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.

<u>MBS/MRF/*Windrow composting and other main facilities*</u>:
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 MBS, solid waste will be produced from (i) mechanical treatment and (ii) biostabilization process 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. Vardar river is situated in a distance of almost 600m from the TS of the Negotino municipality.

Significant will be the positive impacts on water quality/hydrology/soil due to the closure and rehabilitation of existing noncompliant 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 (MBS) with stabilization, recycling of materials (MRF) and composting facilities (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.

MBS/MRF: The main air emissions from the mechanical pre-treatment of waste at MBS and MRF facilities will be particulates, odours, bioaerosols and dust.

Biological treatment (stabilization): The main air emissions from the biological treatment will be H_2S, CO_2, NH_3, 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:
MBS/MRF: During the operation of the MBS/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. 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

In the site currently exists non-compliant municipal landfill site so the soil and vegetation could be characterized as degraded. Also the site is not situated in a protected area and the closest area is in a great distance (approx. 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 due to the absence of high and important vegetation and habitats (high shrubs, trees etc.), result during the construction period and no new impacts will be created during the operation period.

As mentioned in the previous chapter, three Transfer Stations will be established in the region. The first TS is located in Negotino municipality in a great distance (>3km) from the closest protected area. The vegetation in the site is very sparse and low without any ecological importance and at some points there are isolated shrubs with medium height. The second TS is located in Kavadartsi municipality, in a great distance (>3km) from the closest protected area. Also the site is situated in an existing landfill site with the absence of any important species of flora and fauna, while the wider area of the site is characterized as agricultural land, mixed of pastures and vineyards, according to Corine Land Cover 2012. These two TS will be established in a great distance of protected areas so no impact on special protected species of flora and fauna is expected.

Finally, the third TS will be established in Veles municipality which is situated in a distance of approx 0,6km from emerald site "Ovche Pole". The TS site is located in proximity with an existing non-compliant municipal landfill site. Due to the existence of the landfill and the deterioration of the area, the vegetation is very sparse and low without any ecological importance and the wider area is agricultural land with pastures and non-irrigated arable land according to Corine land cover 2012.

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 (MBS, MRF, landfill, green waste composting plant) will be established, is characterized as degraded due to the existence of the non compliant landfill. The main economical activities in the wider area are based on agriculture. The location of the site is in a great distance from the most populated settlement of the wider area (Rosoman settlement). The distance from Rosoman settlement is approximately 2 km (direct distance).

Moreover, the final access to the site could be achieved through local road, connecting the settlements Rosoman and Sirkovo. The optical isolation is in a medium level from the closest settlement (Rosoman). Also there is a medium optical isolation level from the main access road. 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 due to the fact that the surrounding area is already degraded.

Another impact during the operation of CWM facilities is the aesthetic deterioration, but due to the fact that the aesthetic and landscape of the area is degraded, the impacts could be characterized insignificant.

The TS in Veles municipality is situated on the sideway of regional road R-1312 which connects the Veles settlement with Lozovo and Shtip settlements. The optical isolation is in a medium level from the closest settlements and low level from the access regional road R-1312. The optical isolation from the TS in Kavadarci municipality is in a good level and it cannot be seen from the closest settlement (Kavadartsi). Also there is a medium to low optical isolation level from the closest regional road.

Finally the TS in Negotino municipality is situated on the sideways of the national road (E-75) and it can easily be accessed from Negotino junction traveling to northwest. The optical isolation both from the nearby settlement and the high way is low.

8.3.3.5 Impact on cultural and historical heritage

In the wider area of the site where CWM facilities (MBS, MRF, Green composting plant), landfill and other facilities) will be established, no cultural and historical monuments or archaeological sites detected in a distance of 3 km. No effect on cultural and historical heritage expected due to the operation of the CWM facilities.
Transfer stations in the region will be established in locations where no archaeological signs are detected. The TS are situated in a great distance from archaeological, cultural and historical heritage sites.
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 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.

8.3.4 Impact assessment

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 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 be 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

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 and landscape

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 Stations 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 MBS plant (H_2S, CO_2, CH_4, N_2O, NH_3, 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.

MBS/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.
- etc.

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 lay 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 MBS 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

1. 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.
2. 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, BOD5, 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 (NH3), 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).
3. 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

4. Measure, every 3 months, the concentration of non-methane VOCs, ammonia (NH_3), hydrogen sulfide (H_2S) and dust particles, using a biofilter.
5. Measure, every 3 months, the concentration of nitrogen compounds (NOx) and solid particles of dust at the biogas plant.
6. 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.

7. 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.
8. 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

9. 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.
10. 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

11. 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.

    12.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.

    13.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:

14 Number of remedied and closed municipal and unregulated landfills and dumpsites

15 Results from the survey on protection of the biodiversity
16 Number of destroyed natural habitats
17 Trends of loss of the biodiversity
18 Trends of increase and/ or reduction of endemic species
19 Damages reported for particular locations

8.4 GHG FOOTPRINT CALCULATIONS

8.4.1 Introduction

Green house 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 8-1: 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,

Activity	GHG Type	Potential sources of emission
		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 manufacture	CO_2	Pulp and paper manufacture: power boilers, gas turbines, and other combustion devices producing 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.

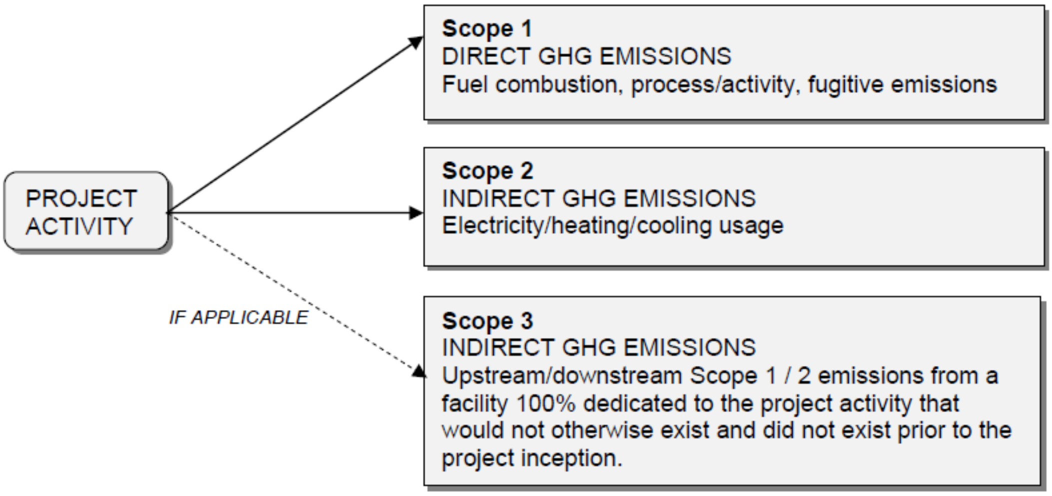


Figure 8-7: Project scope – all projects excluding road, rail and urban public transport infrastructure

The following table provides an overview of the scope of GHG emissions produced by different waste management activities.

Table 8--2: 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.

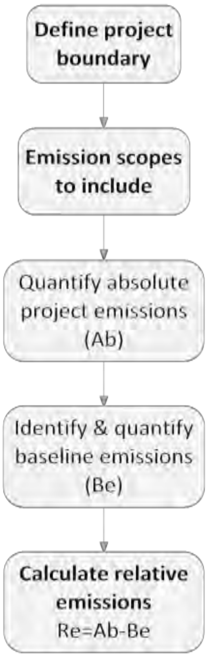


Figure 8-8: Project carbon footprint calculation flow

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 3c: two bins collection system with MRF plant, MBS plant 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--3: 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)

	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--4: Assumptions regarding GHG emission factors for collection and transportation of waste for different treatment options of scenario 3c

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--5: 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 8-6: 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, includes energy consumption from the grid, 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--7: 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

Source: AEA Study (Waste Management Options and Climate Change, 2001)

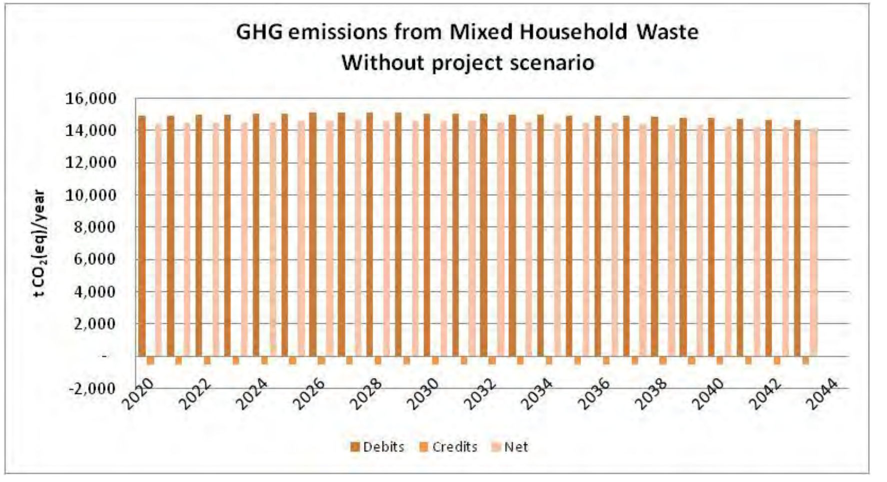
8.4.5 RESULTS FROM GHG EMISSION CALCULATIONS

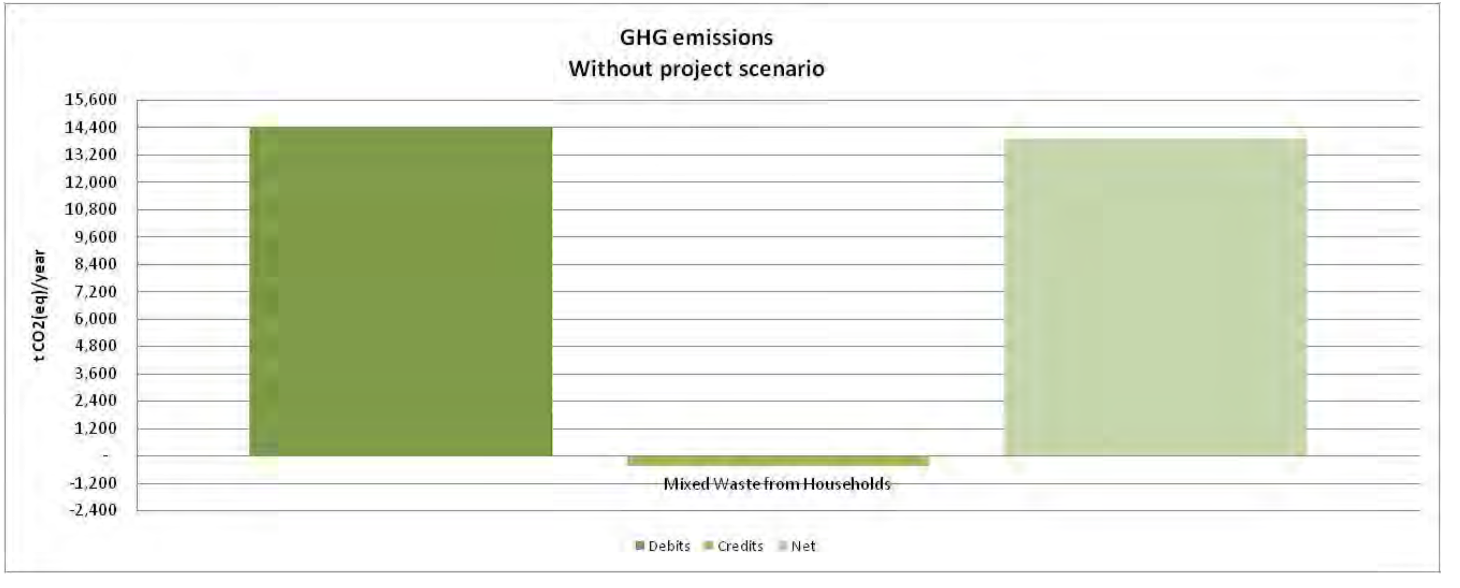
8.4.5.1 GHG emission calculations in without project scenario

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--8: 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))	288
GHG emissions from waste treatment (t CO_2(eq))	-
GHG emissions from landfills (t CO_2(eq))	14, 183
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))	-492
Total net GHG emissions (t CO_2(eq))	***14,471***


GHG emissions from Mixed Household Waste
Without project scenario
t CO2(eq)/year
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

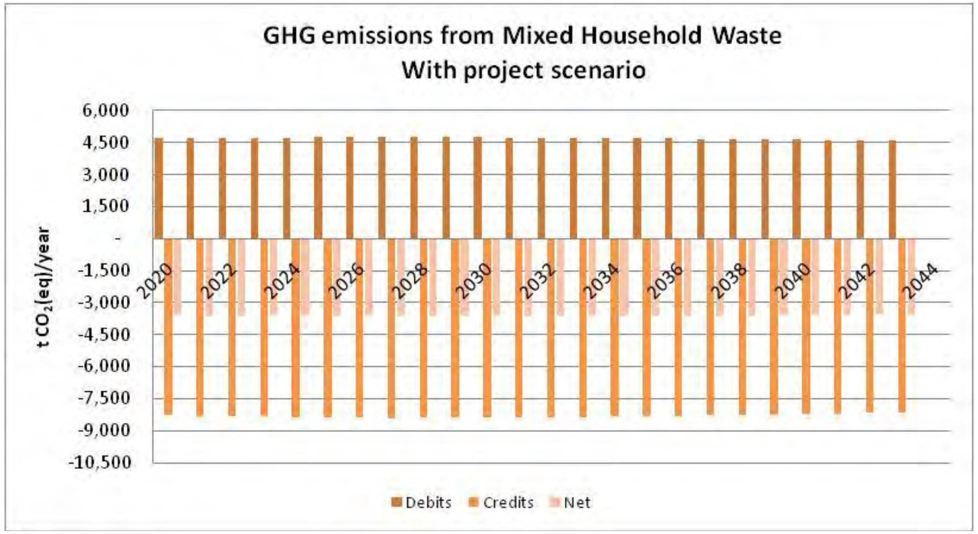

GHG emissions
Without project scenario
t CO2(eq)/year
15,600
14,400
13,200
12,000
10,800
9,600
8,400
7,200
6,000
4,800
3,600
2,400
1,200
-
-1,200
-2,400
Mixed Waste from Households
Debits
Credits
Net

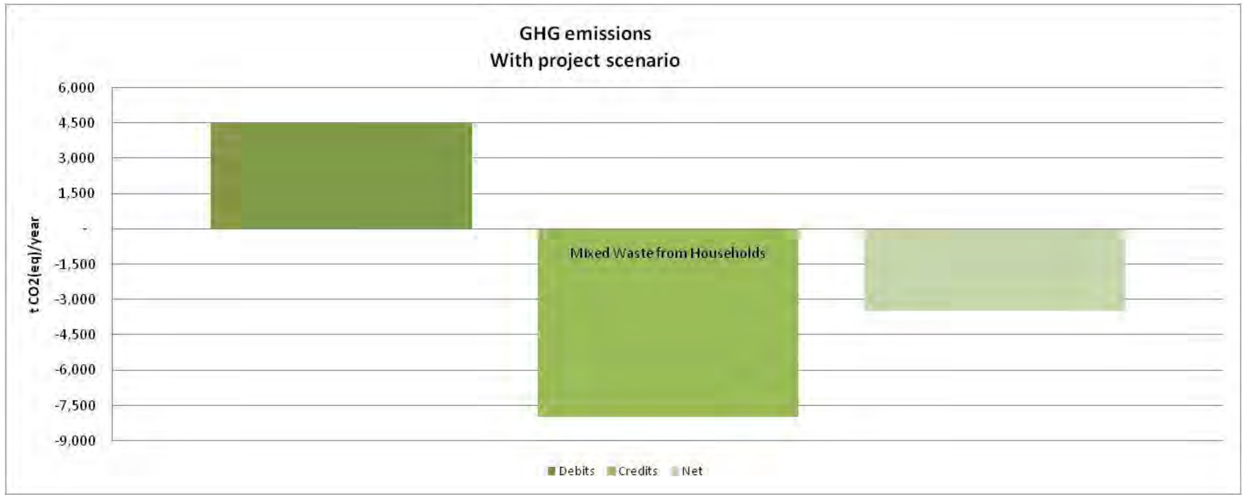
8.4.5.2 GHG emission calculations in with project scenario

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--9: 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))	245
GHG emissions from waste treatment (t CO_2(eq))	1,119
GHG emissions from landfills (t CO_2(eq))	3,240
GHG emissions avoided through recycling of materials recovered from waste (t CO_2(eq))	-8,213
GHG emissions avoided through recovery of energy from waste (t CO_2(eq))	
Total net GHG emissions (t CO_2(eq))	**-3,609**
TOTAL WITH PROJECT SCENARIO GHG EMISSIONS (t CO_2(eq))	***-3,609***


GHG emissions from Mixed Household Waste
With project scenario
6,000
4,500
3,000
1,500
-
-1,500
-3,000
-4,500
-6,000
-7,500
-9,000
-10,500
t CO2(eq)/year
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
Debits
Credits
Net


GHG emissions
With project scenario
6,000
4,500
3,000
1,500
-
-1,500
-3,000
-4,500
-6,000
-7,500
-9,000
t CO2(eq)/year
Mixed Waste from Households
Debits
Credits
Net

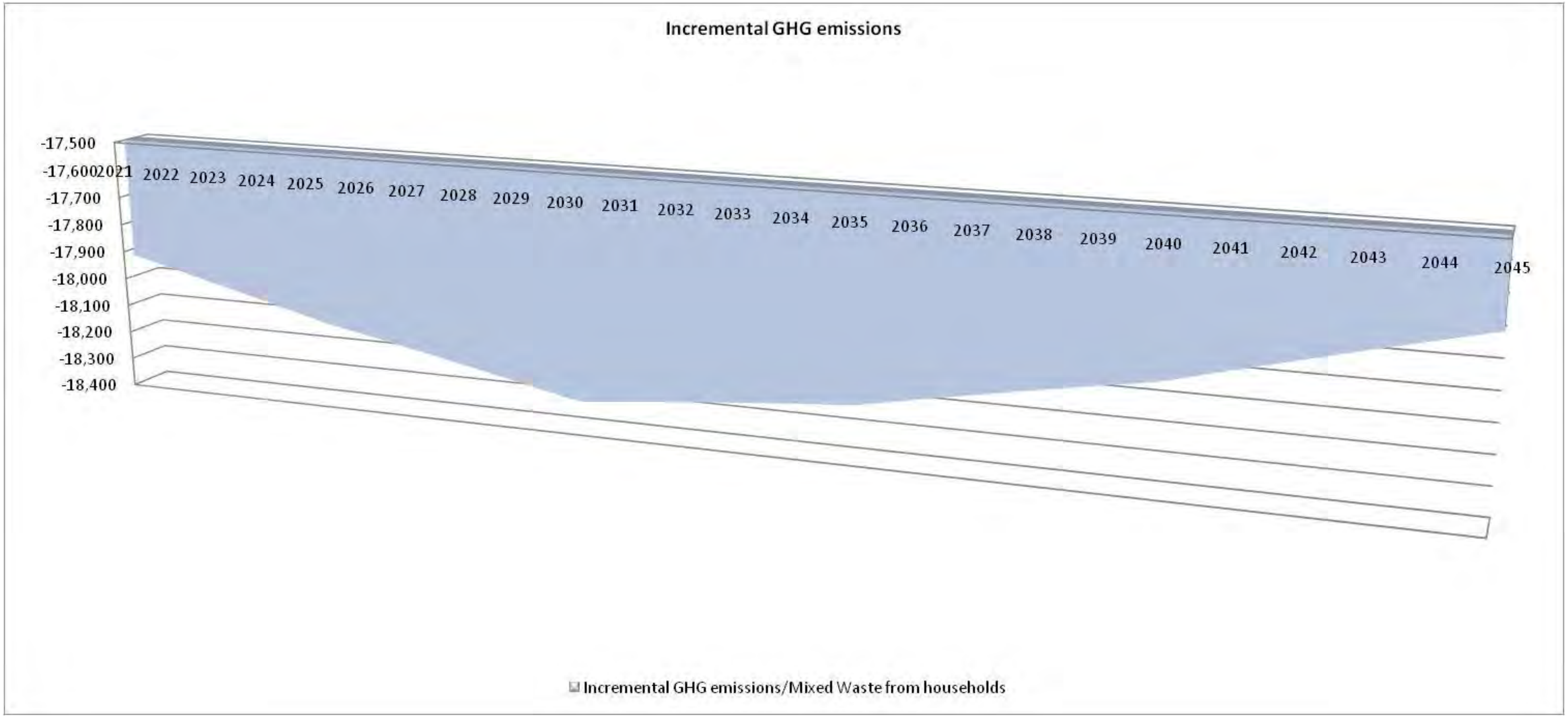
8.4.5.3 GHG emissions-Incremental calculations

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--10: Incremental Approach

INCREMENTAL APPROACH	
Mixed Waste from Households	
GHG emissions from waste collection and transport (t CO_2(eq))	-43
GHG emissions from waste treatment (t CO_2(eq))	1,119
GHG emissions from landfills (t CO_2(eq))	-10,943
GHG emissions avoided through recycling of materials recovered from waste (t CO_2(eq))	-8,213
GHG emissions avoided through recovery of energy from waste (t CO_2(eq))	
Total net GHG emissions (t CO_2(eq))	
TOTAL INCREMENTAL GHG EMISSIONS (t CO_2(eq))	***-18,079***


Incremental GHG emissions
-17,500
-17,600
-17,700
-17,800
-17,900
-18,000
-18,100
-18,200
-18,300
-18,400
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 2016 to 2046, from the present project which have been calculated by Jasper's calculation model.

Table 8--11: Project's Net GHG emissions

With Project Scenario	2016	2020	2025	2030	2035	2040	2045	2046
Net GHG emissions, t CO_2-eq	13,683	14,632	-3,604	-3,648	-3,637	-3,608	-3,654	-3,553

The percentage of the increase 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 6,93%, while a reduction is presented compared to 2025 and is 126%.

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.

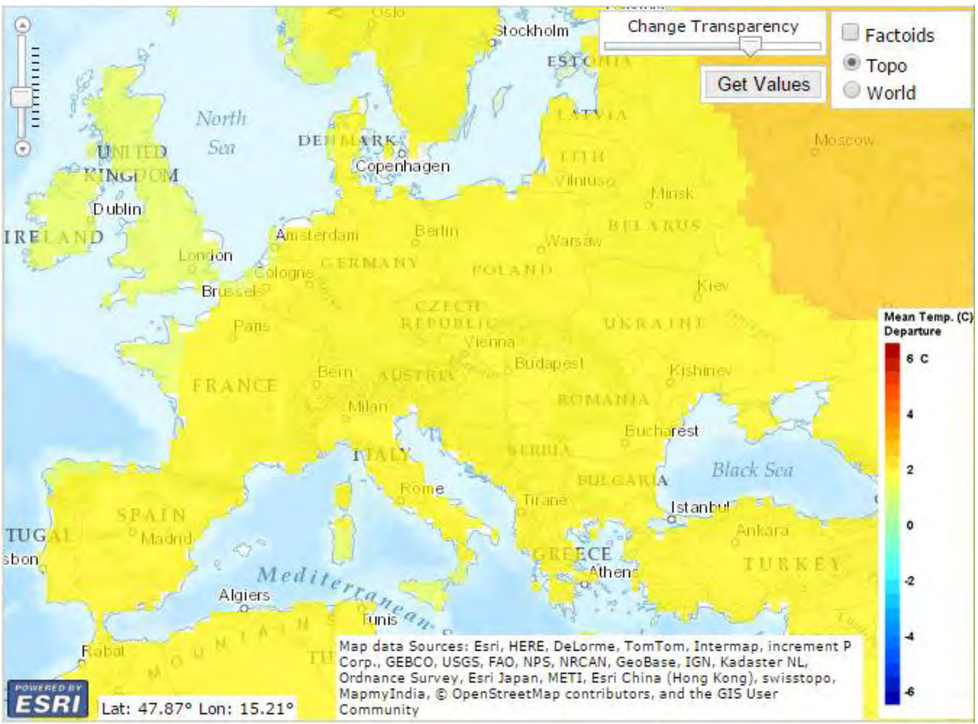


Figure 8-9: Temperature change projected by the middle model as compared to the 1961-1990 baseline average[2]

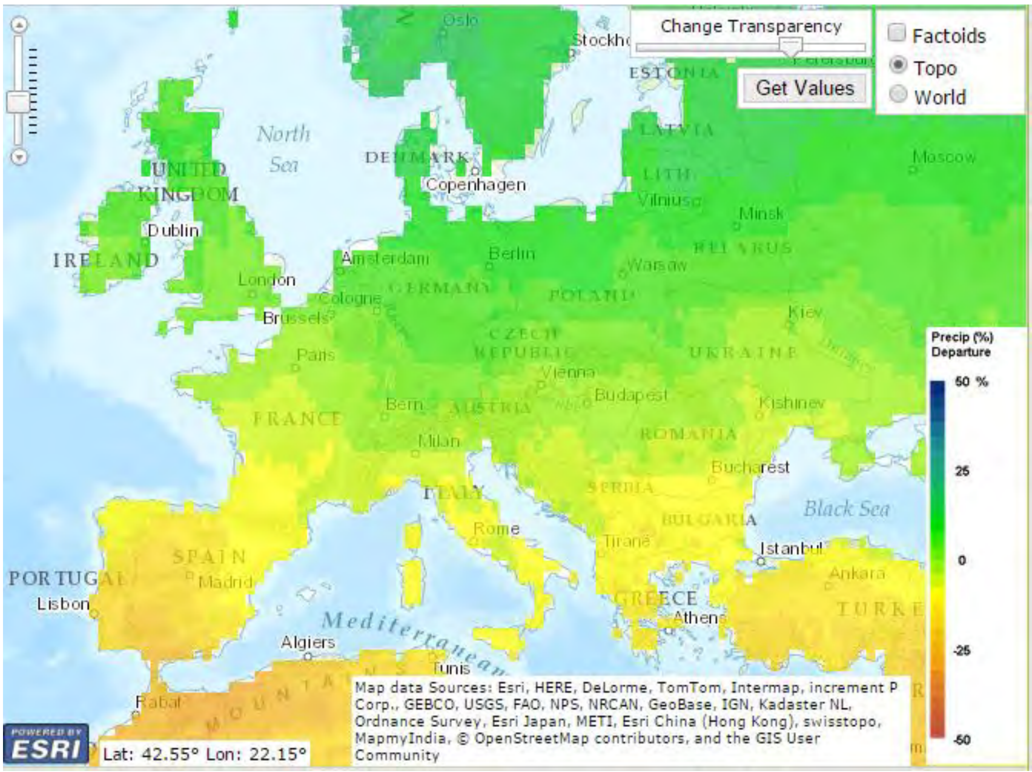


Figure 8-10: Precipitation change projected by the middle model as compared to the 1961-1990 baseline average

[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 8-12: 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, Stip 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 Stip 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 Stip 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 Stip, 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 Stip, 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 Stip, 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, Stip 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 Stip) as well as at November precipitation in the period from 1984 untill 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” (2014) 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.

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.

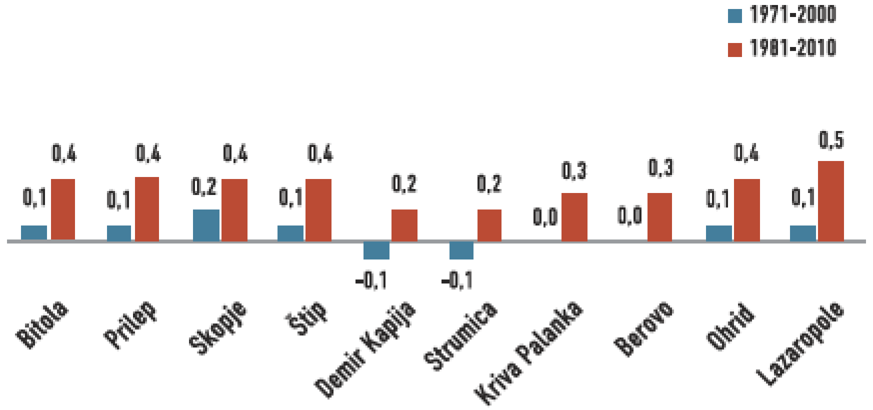
Table 8-13: Temperatures at various meteorological stations

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 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.

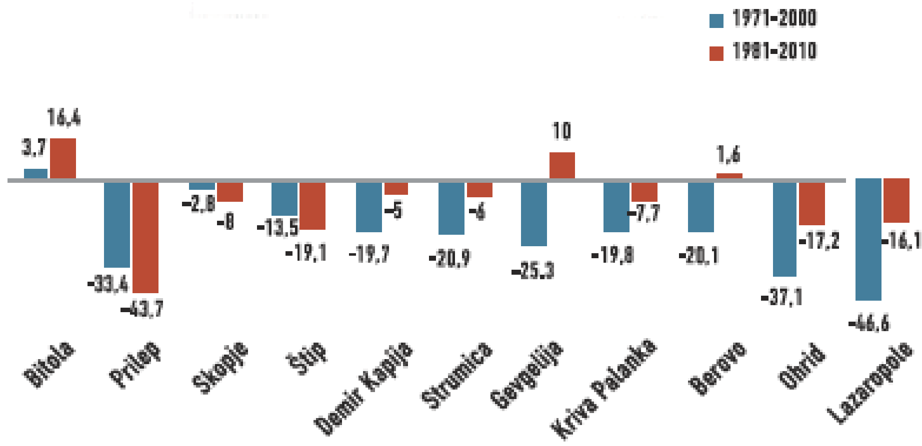
Figure 8-11: Average air temperature. Deviation of the average of two periods 1971-2000 and 1981-2010 from the 1961-1990 period



Precipitation

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 region 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 8-12: 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 are 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.

Extreme temperatures

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

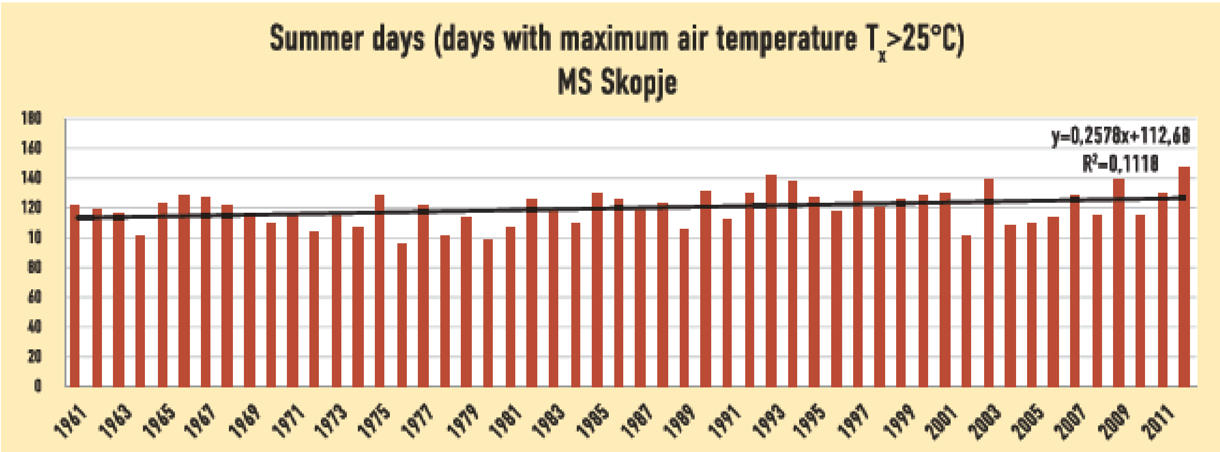
Skopje, Stip and Bitola (as the most representative stations for the main climate regions) and at (Strumica, Demir Kapija and Gevgelija (as representative stations for the southeast region, the most vulnerable to climate change).

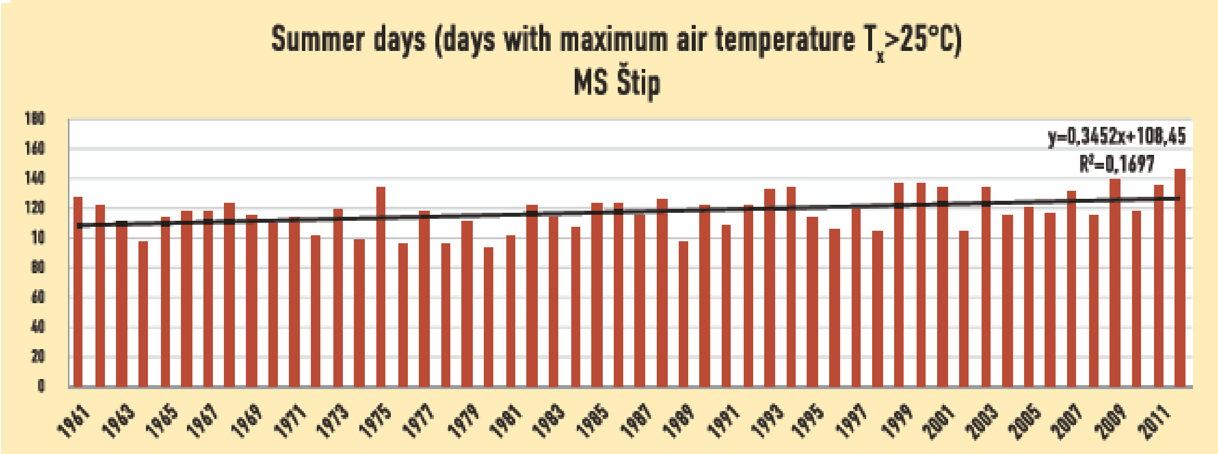
On the basis of maximum daily air temperature values, it was concluded that the frequency of heat waves decreases in correlation to the length of their duration, with the most frequently occurring heat waves being those of the shortest duration.

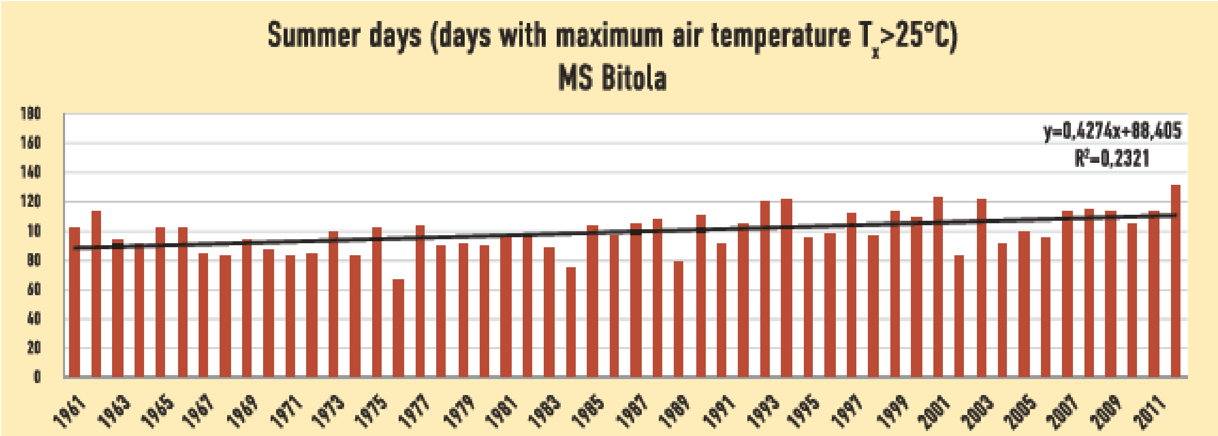
Researchers also found that the total number of recorded waves was unevenly distributed over time. Increases in frequency were also observed in various cities. In contrast to the period 1961-1987, a heat wave is recorded almost every year starting in 1987. It can also be noted that the greatest frequency 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, Stip, Lazaropole and Demir Kapija, 7 in Gevgelija and Berovo, 6 in Bitola, 5 in Strumica and Prilep and 3 in Ohrid.

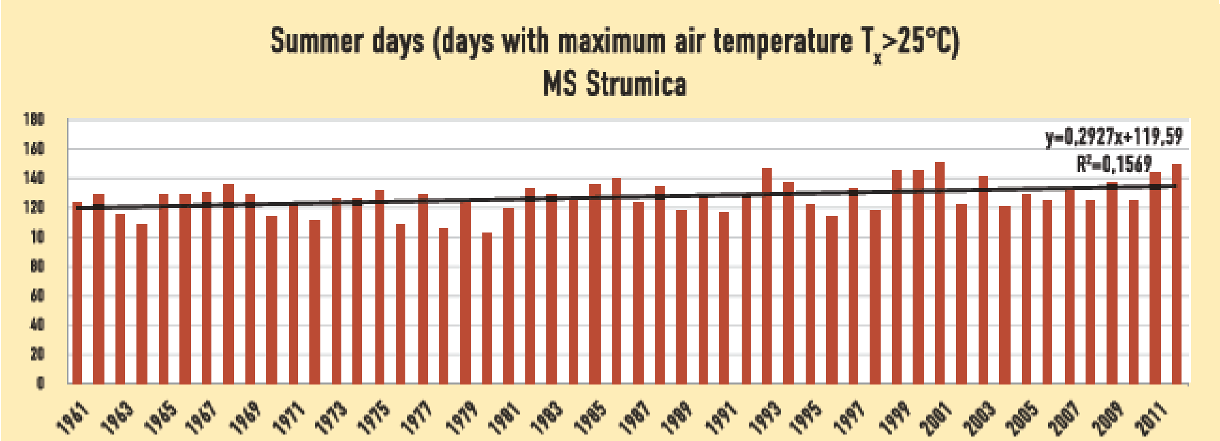
The following figure shows the number of summer days by years recorded the five main meteorological stations for the period 1961 to 2012 illustrating that the number of summer days has significantly increased in recent years as compared to the number at the beginning of the analysed period. Similarly there has been a significant increase in the number of tropical nights in recent years.

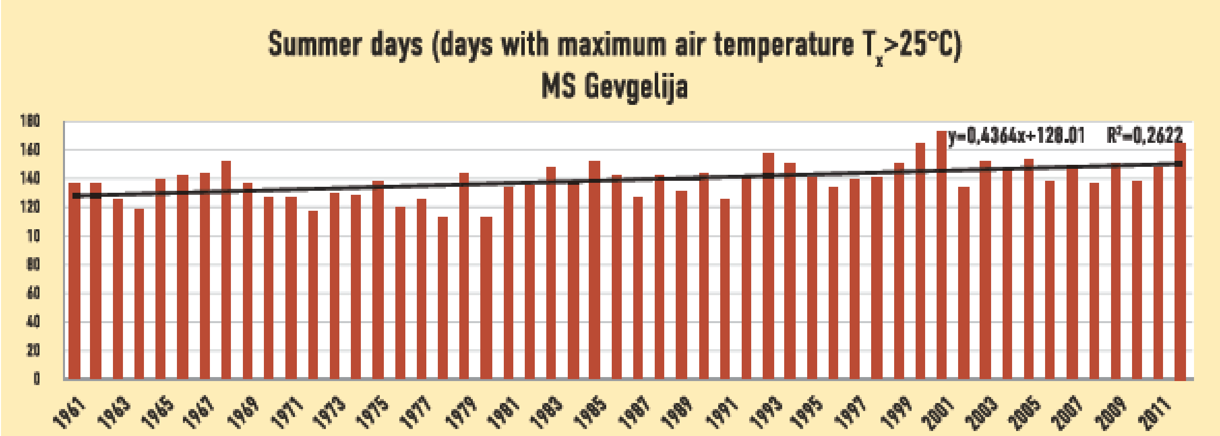
Figure 8-13: Summer days (days with a maximum air temperature of Tx>25°C in Selected areas for the period 1961 – 2012











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^{o} x 2.5^{o}. 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.

<u>Air temperature</u>

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 8-14: 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 8-15: 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

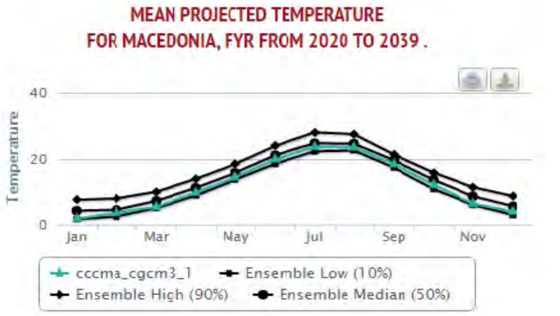
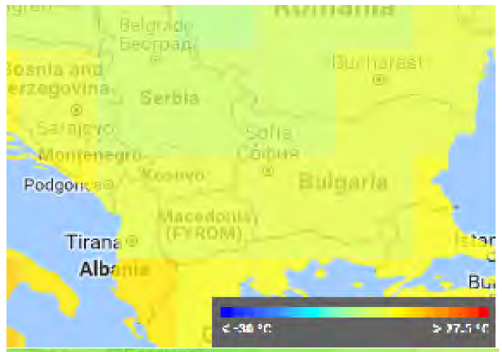
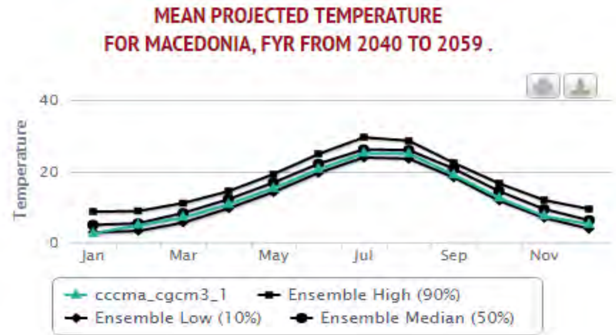
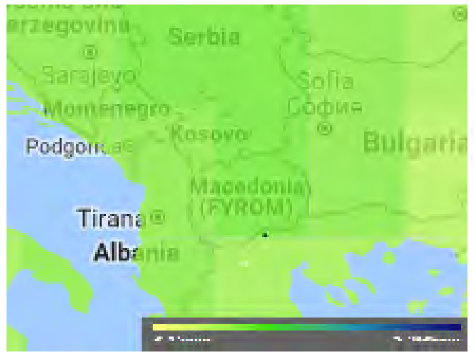
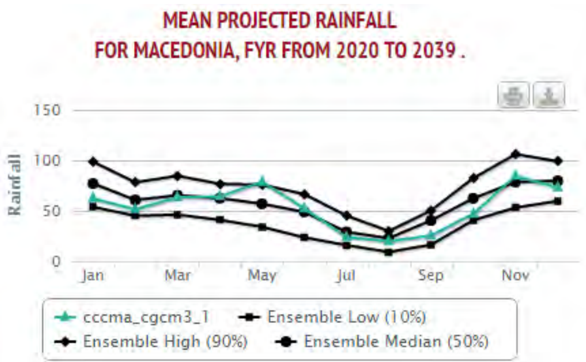
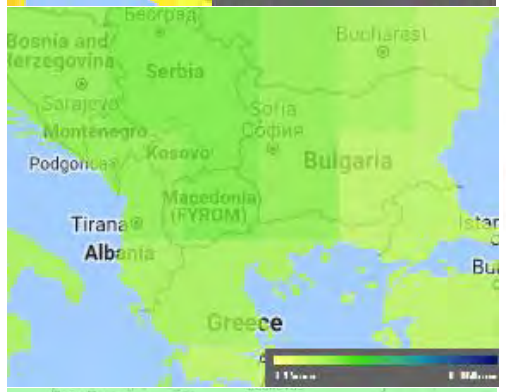
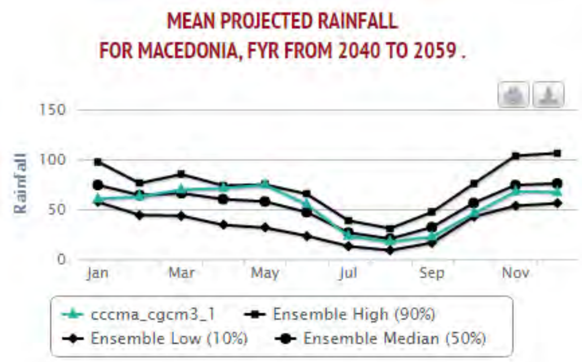
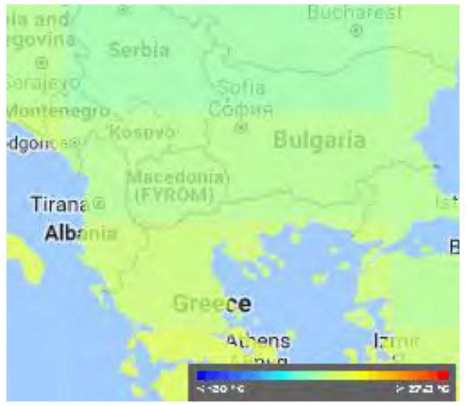
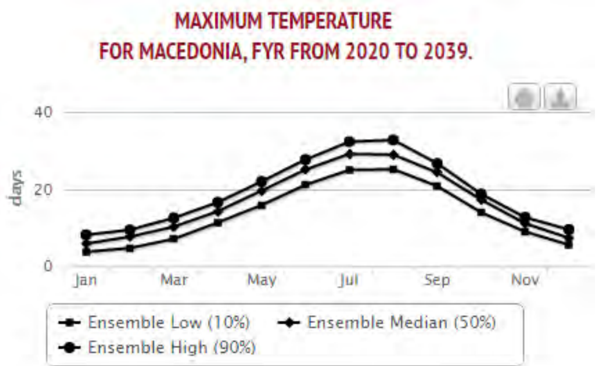
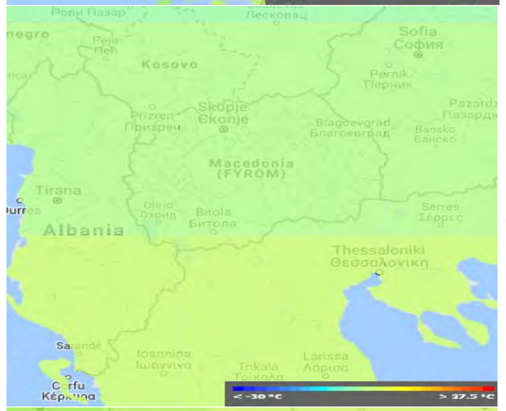
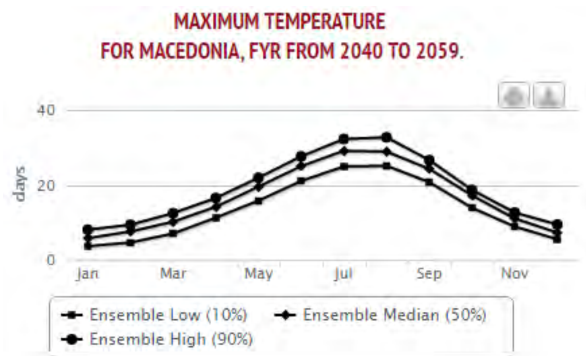
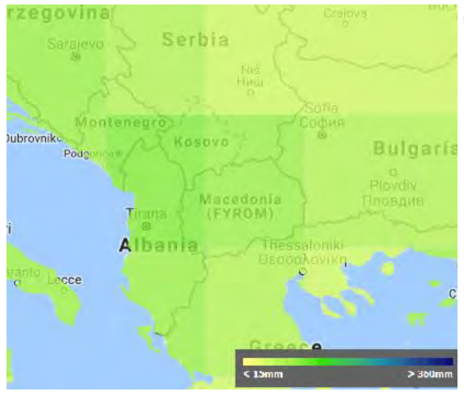
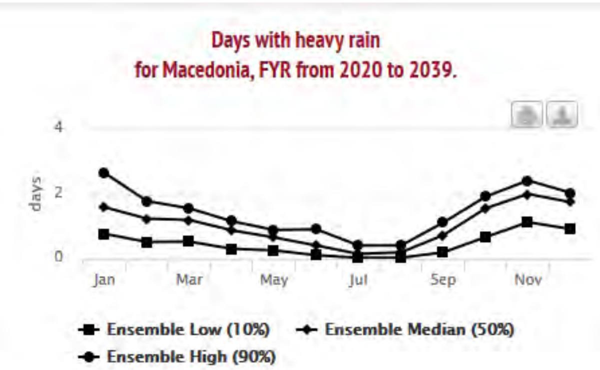
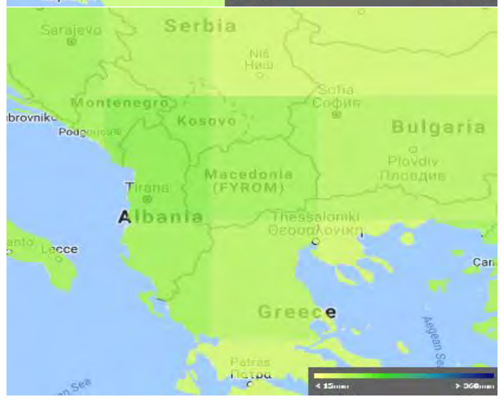
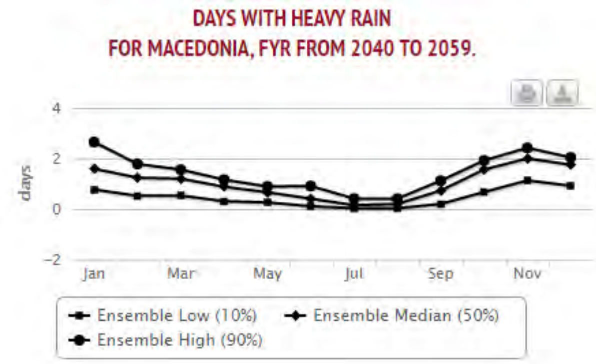
- It is likely that the spring and summer temperature changes (and therefore the average seasonal air temperatures in the eastern part of the country) will be higher compared to the rest of the country
- There will be a continual decrease in precipitation. The greatest changes, in the warm part of the 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 only 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.

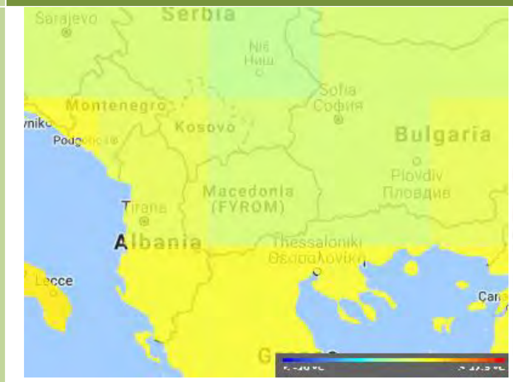
Table 8-16: Future climate change projections for the Beneficiary country

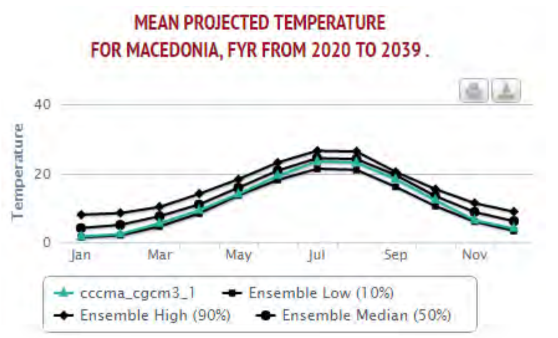
Scenario A2				
	2020-2039		2040-2059	
Temperature				
Rainfall				
Maximum Temperature				
Heavy Rain				

Scenario B1

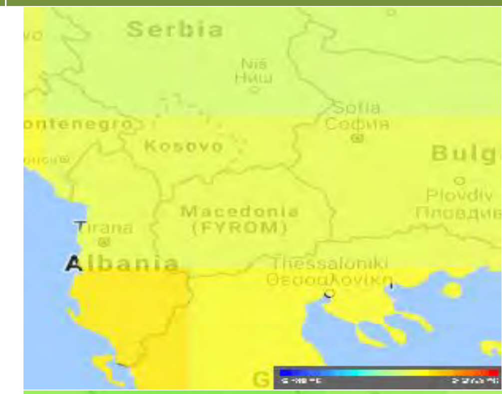
Temperature

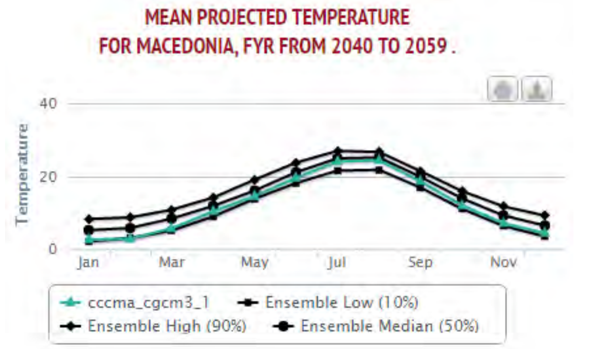
2020-2039





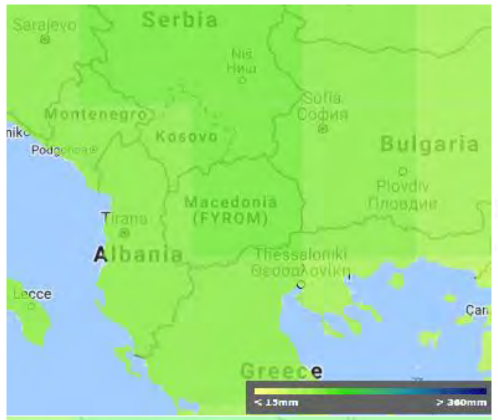
2040-2059

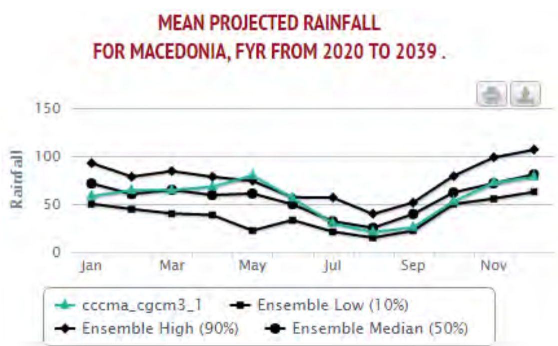




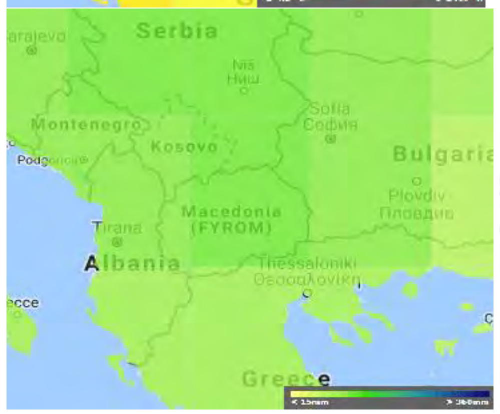
Rainfall

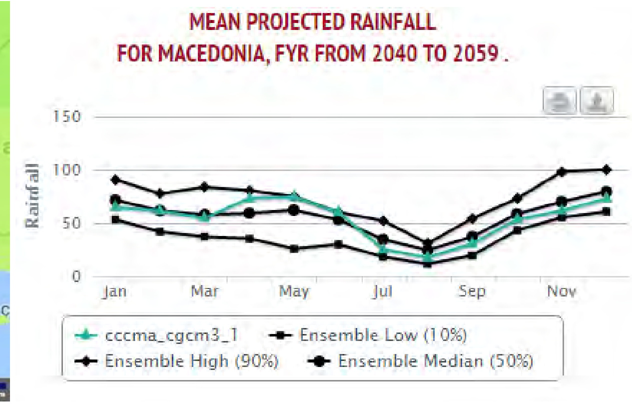
2020-2039





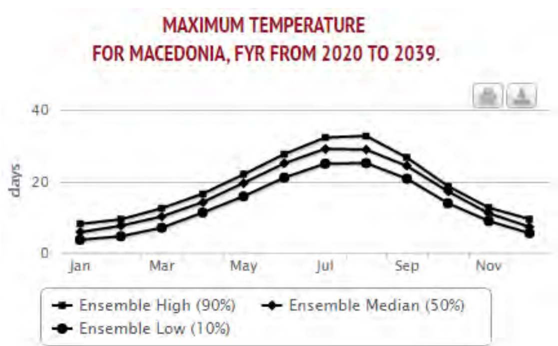
2040-2059



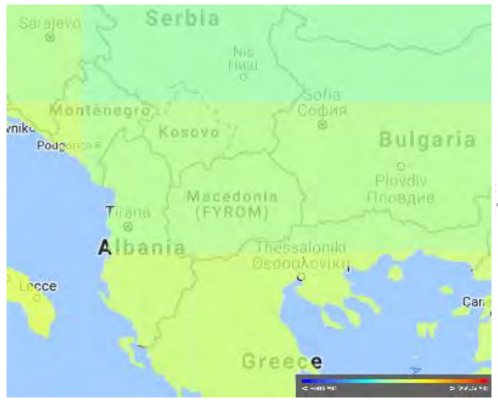


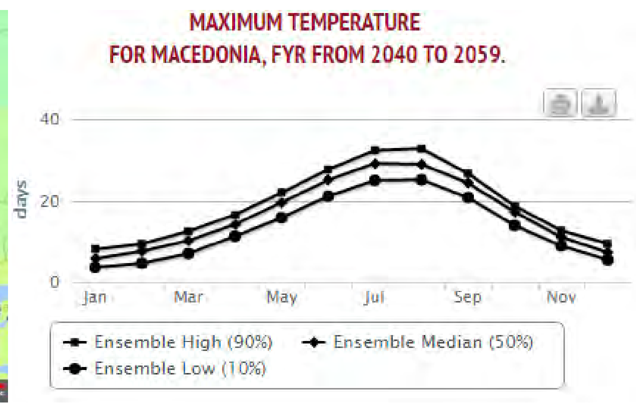
Maximum Temperature

2020-2039



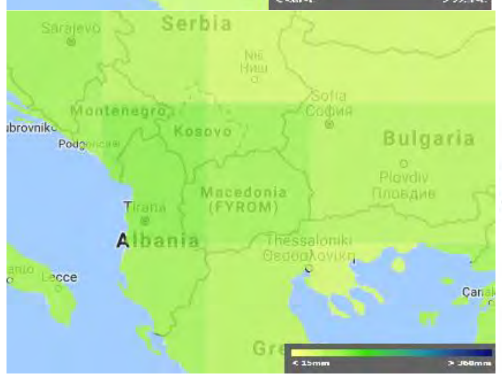
2040-2059

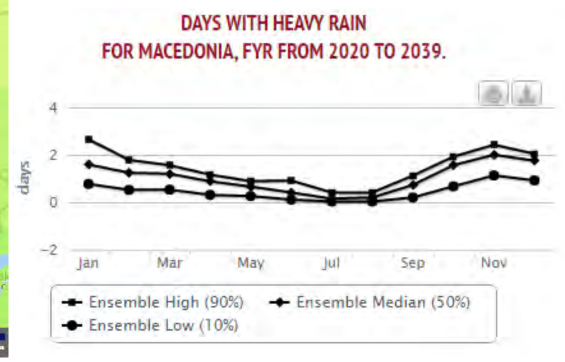




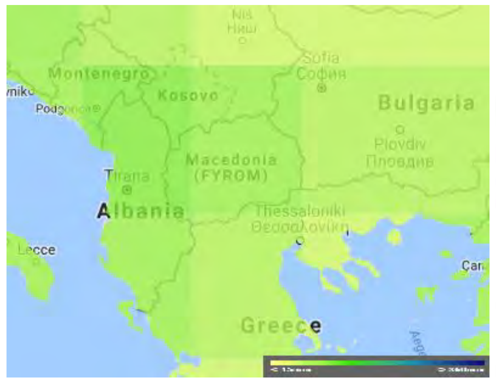
Heavy Rain

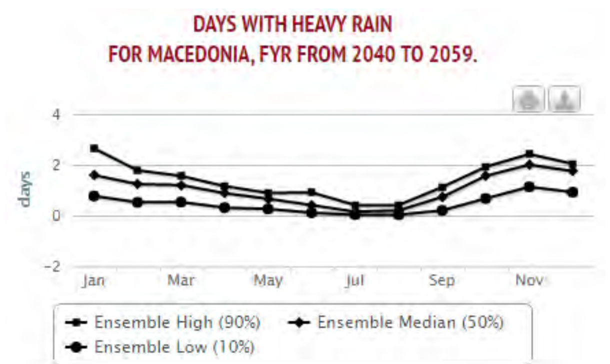
2020-2039





2040-2059





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.

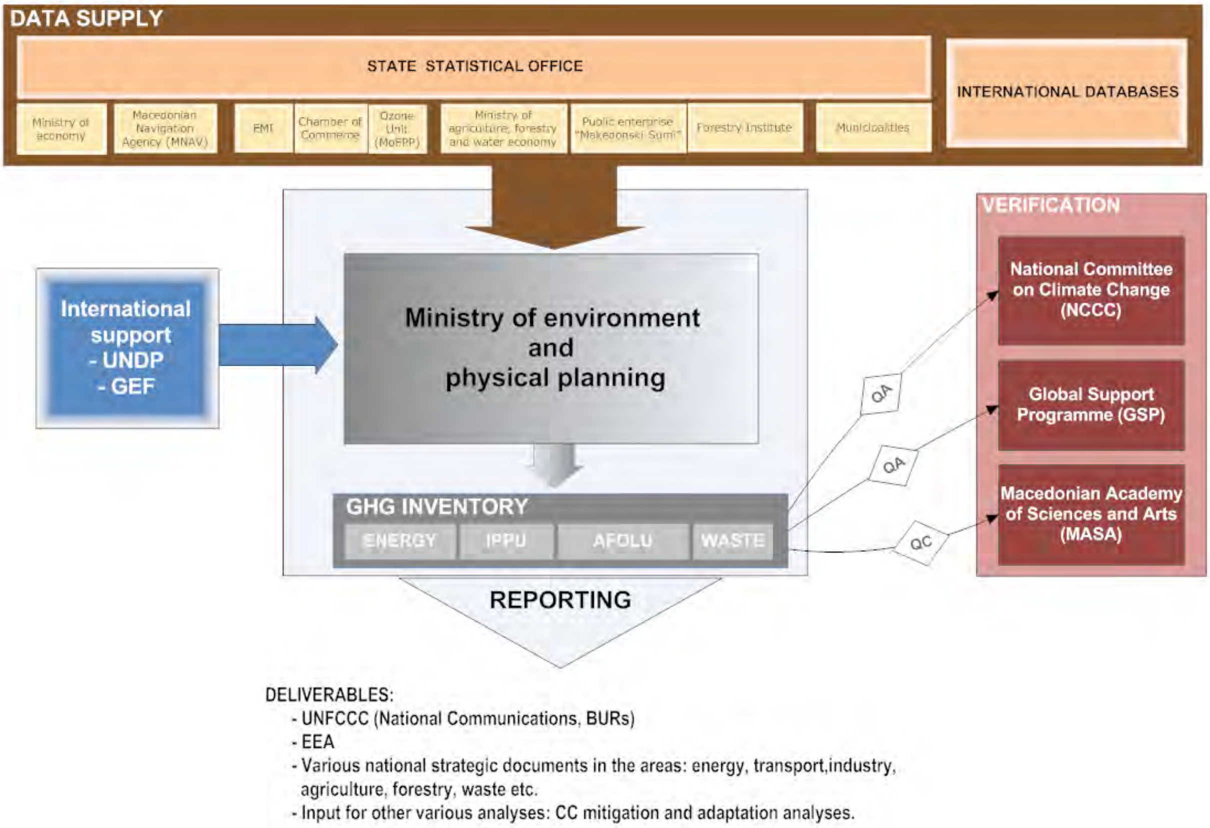
As part of this inventory, Country Specific Emission Factors for key source categories that contribute more than 95% to the total GHG emissions of the inventory have been updated. Most of the activity data were available from the State Statistical Office (MAKSTAT), Energy Balances, National Reports from 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 Figure 3-1 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 8-14: 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 8-17: Summary of emissions 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.

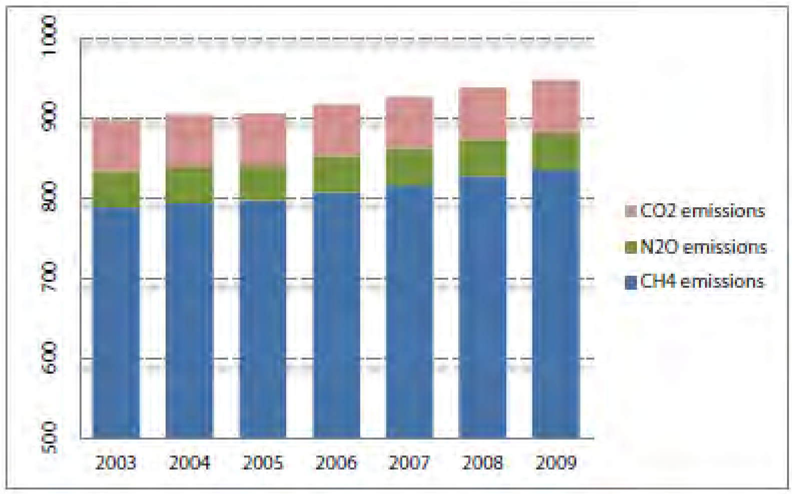


Figure 8-15: Summary of emissions from the Waste sector CO_2-eq. [kt]

Table 8-18: 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.

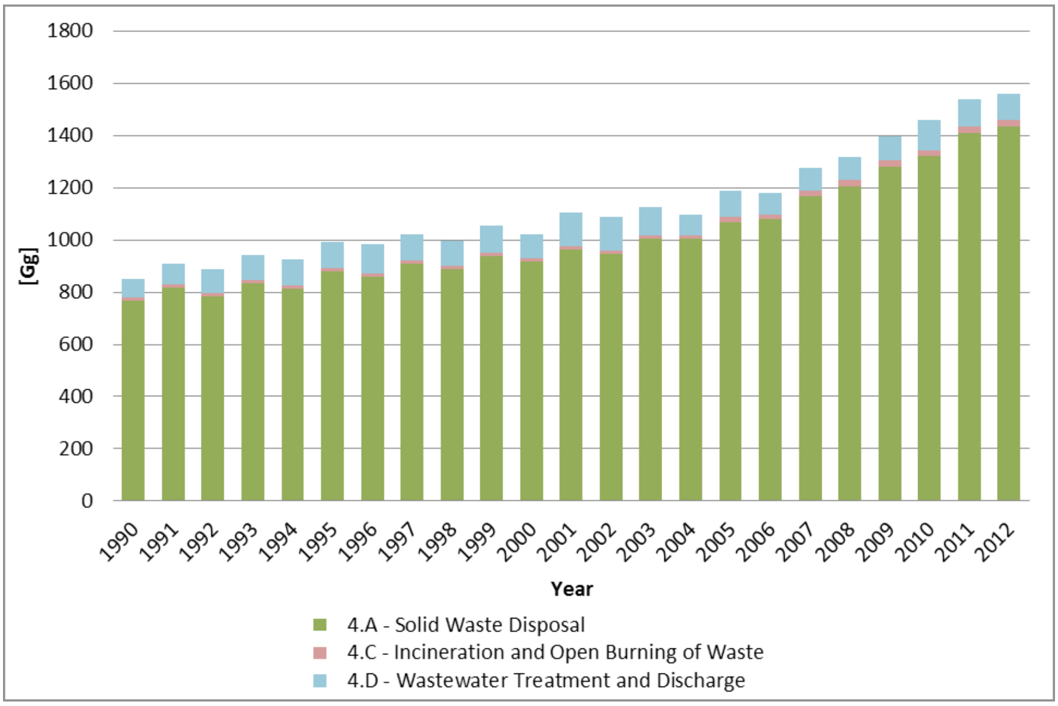


Figure 8-16: Waste Sector GHG emissions, 1990 – 2012 [Gg CO2-eq.]. (Source First Biennial update report on Climate Change, MOEPP, 2013)

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%).

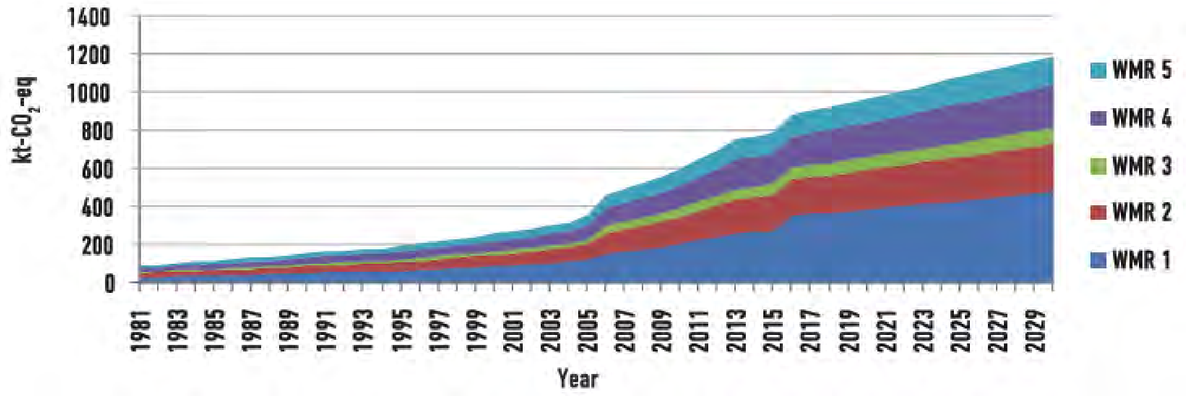
Similar to the other forms of waste, domestic wastewater treatment and discharge emissions have been in line with population growth. In contrast, as described in Section 3.4 on Industrial processes, emissions from the Industrial wastewater treatment and discharge have had a highly fluctuating trend; 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 I PCC 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 8-17: 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 of 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 CO_2 which has significantly lower global warming potential. Burning one ton of CH_4 results in an 87% reduction of CO_2-eq which is a significant GHG reduction. The RWMP and Integrated WMS which will apply in Vardar region include 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 or RDF development). The future CWMF will include Mechanical Biological treatment of mixed waste with sorting of metals and biostabilization of organic fraction, 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 Vardar region according national and EU regulations.

Measure 4: Anaerobic treatment of organic waste. This measures 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 CO_2 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 8-19: 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 CO_2-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 8-20: 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 8-21: 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

Actions	Description	Gases	Indicators	Projections	Methodology
					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).
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 8-22: 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 8-23: 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 Vardar 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 various components of the project and also how the project operated within the wider network or system. The assessment was undertaken separately for the various elements of the project, including the four sensitive themes which are presented in the table.

Table 8-24: Sensitivity matrix for CWMF&TSs

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 salility	Wild fire	Air quality	Ground instability/ landslides	Urban heat island	Growing season
		Climate variables / climate-related hazards																						
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

<u>Module 2:</u>
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 8-25: Assess exposure to baseline/observed climate for CWMF&TS

		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 salility	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 8-26: Assess exposure to future climate for CWMF&TSs

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		MEDIUM	MEDIUM	MEDIUM	HIGH	NO	MEDIUM	MEDIUM	MEDIUM	NO	NO	MEDIUM	HIGH	HIGH	NO	NO	NO	NO	NO	NO	NO	MEDIUM	NO	NO
Waste Management Center	On-site assets and processes	MEDIUM	HIGH	MEDIUM	HIGH	NO	HIGH	MEDIUM	MEDIUM	NO	NO	MEDIUM	HIGH	HIGH	NO	NO	NO	MEDIUM	NO	MEDIUM	NO	MEDIUM	NO	NO
	Inputs (water, energy, others)	HIGH	MEDIUM	HIGH	HIGH	NO	MEDIUM	MEDIUM	MEDIUM	NO	NO	MEDIUM	MEDIUM	MEDIUM	NO	NO	NO	MEDIUM	MEDIUM	NO	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	NO	NO	NO	NO	NO	HIGH	HIGH	NO	NO	NO	MEDIUM	MEDIUM	MEDIUM	NO	MEDIUM	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.

8.5.6.3 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.

<u>Module 3:</u>
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 8-27: Vulnerability classification matrix for each climate variable/hazard which could impact the project (baseline climate)

Sensitivity \ Exposure	No	Medium	High
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 8-28: Vulnerability classification matrix for each climate variable/hazard which could impact the project (future climate)

Sensitivity \ Exposure	No	Medium	High
No	5,9,10,14,15,16, 18,20,22,23		
Medium	17,19	1,2,3,7,8,11,21,6	
High			4,12,13

Vulnerability level

Green	No
Orange	Medium
Red	High

The numbers 1-23 represent 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 8-29: Risk Assessment Matrix (example)

		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	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.

Explanatory notes on the selection of the Severity and Probability for each issue are presented in the following table.

Table 8-30: 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

Probability			Severity		
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 Vardar 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 8-31: Risk Assessment Matrix Results

		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Rare				2, 21	
	Unlikely			6, 7, 8, 17,19	4, 12, 13	
	Moderate			1, 11	3	
	Likely					
	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.

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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 benefitsexceed 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). Without the project the regional waste management centre will not be build and the local PUCs would still have to dispose their waste at the local landfills/dumpsites.

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.

VAT is not eligible.

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 (5 years).

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 included), includes civil works, plant – machinery and mobile equipment;
- 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 plant – machinery and mobile equipment;
- Technical Assistance – Supervision& Publicity Measures during implementation;
- Public utilities (access road, connection of power supply network, water supply network etc);
- Land Acquisition.

Contingencies10% (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	0	150,000	0	0		0	0	0
	0	0	0	0		0	0	0
Total	**0**	**150,000**	**0**	**0**		**0**	**0**	**0**
Civil construction								
Mechanical Treatment		864,982	768,873	308,327	0	0	0	0
Biological treatment		285,525	85,658	263,318	0	0	0	0
Residual Landfill		805,510	241,653	742,859	0	0	0	0
Waste Water Treament Plant		54,325	24,446	192,853				
Windrow Composting for green waste		89,775	26,933	139,793	0	0	0	0
Infrastucture works		259,807	519,614	519,614	0	0	0	0
Transfer Station Veles		205,355	239,581	239,581	0	0	0	0
Transfer Station KAVARDATSI		174,223	203,260	203,260	0	0	0	0
Transfer Station NEGOTINO		162,933	190,088	190,088	0	0	0	0
Collection Equipment					0	0	0	0
Public Utilities (Access Roads)		25,000	50,000	225,000				
Total	**0**	**2,927,434**	**2,350,105**	**3,024,693**	**0**	**0**	**0**	**0**
Plant and machinery								
Mechanical Treatment		625,500	1,406,250	1,093,250	0	0	0	0
Biological treatment		306,000	554,400	371,600	0	0	0	0
Residual Landfill		14,520	43,560	38,720	0	0	0	0
Waste Water Treament Plant		34,865	209,190	453,245				
Windrow Composting for green waste		52,500	100,800	70,700	0	0	0	0
Infrastucture works		71,913	161,805	125,849	0	0	0	0

Initial project cost	Eligible				Non-eligible			
(in constant EUR)	2017	2018	2019	2020	2017	2018	2019	2020
Transfer Station Veles				80,000	0	0	0	0
Transfer Station KAVARDATSI				80,000	0	0	0	0
Transfer Station NEGOTINO				80,000	0	0	0	0
Collection Equipment				1,013,301	0	0	0	0
Public Utilities (Access Roads)	0				0	0	0	0
Total	**0**	**1,105,298**	**2,476,005**	**3,406,665**	**0**	**0**	**0**	**0**
Mobile equipment								
Mechanical Treatment				483,000	0	0	0	0
Biological treatment				116,000	0	0	0	0
Residual Landfill		0	0	505,000	0	0	0	0
Waste Water Treament Plant								
Windrow Composting for green waste				142,000	0	0	0	0
Infrastucture works					0	0	0	0
Transfer Station Veles				414,074	0	0	0	0
Transfer Station KAVARDATSI				257,580	0	0	0	0
Transfer Station NEGOTINO				234,205	0	0	0	0
Collection Equipment				2,109,356	0	0	0	0
Public Utilities (Access Roads)					0	0	0	0
Total	**0**	**0**	**0**	**4,261,215**	**0**	**0**	**0**	**0**
Contingencies								
Mechanical Treatment	0	74,524	108,756	70,079	0	0	0	0
Biological treatment	0	29,576	32,003	31,746	0	0	0	0
Residual Landfill	0	41,001	14,261	39,079	0	0	0	0
Waste Water Treament Plant		8,919	23,364	64,610				
Windrow Composting for green waste	0	7,114	6,387	10,525	0	0	0	0
Infrastucture works	0	33,172	68,142	64,546	0	0	0	0
Transfer Station Veles	0	20,535	23,958	31,958	0	0	0	0
Transfer Station KAVARDATSI	0	17,422	20,326	28,326	0	0	0	0
Transfer Station NEGOTINO	0	16,293	19,009	27,009	0	0	0	0
Collection Equipment	0	0	0	50,665	0	0	0	0
Public Utilities (Access Roads)	0	1,250	2,500	11,250	0	0	0	0
Total	**0**	**249,808**	**318,705**	**429,792**	**0**	**0**	**0**	**0**
Totals excluding intangibles								

Initial project cost	**Eligible**				**Non-eligible**			
(in constant EUR)	**2017**	**2018**	**2019**	**2020**	**2017**	**2018**	**2019**	**2020**
Mechanical Treatment	0	1,565,006	2,283,879	1,954,656	0	0	0	0
Biological treatment	0	621,101	672,060	782,663	0	0	0	0
Residual Landfill	0	861,031	299,474	1,325,658	0	0	0	0
Waste Water Treament Plant		98,109	257,000	710,708				
Windrow Composting for green waste	0	149,389	134,119	363,017	0	0	0	0
Infrastucture works	0	364,892	749,561	710,009	0	0	0	0
Transfer Station Veles	0	225,890	263,539	765,613	0	0	0	0
Transfer Station KAVARDATSI	0	191,645	223,586	569,166	0	0	0	0
Transfer Station NEGOTINO	0	179,226	209,097	531,302	0	0	0	0
Collection Equipment	0	0	0	3,173,322	0	0	0	0
Public Utilities (Access Roads)	0	26,250	52,500	236,250				
Total	**0**	**4,282,541**	**5,144,815**	**11,122,365**	**0**	**0**	**0**	**0**
Intangible components								
Technical Assistance, Supervision during implementation & Publicity	0	300,000	560,000	590,000				
Public Utilities(connection of power supply network, water supply network etc)	300,000	0	0	0				
Grand total	**300,000**	**4,732,541**	**5,704,815**	**11,712,365**	**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)

Subsequent project cost	**REINVESTMENT COST - Non Eligible Cost**				
(in constant EUR)	**2021-2026**	**2027**	**2028**	**2032**	**2033-2046**
Land acquisition	0	0	0	0	0
Acquisition of land	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**
Civil construction					
Mechanical Treatment					
Biostabilisation	0	0	0	0	0
Residual Landfill	0	631,321	631,321	0	0
Waste Water Treament Plant					
Windrow Composting for green waste					

Subsequent project cost	REINVESTMENT COST - Non Eligible Cost				
(in constant EUR)	2021-2026	2027	2028	2032	2033-2046
Infrastucture works	0	0	0	0	0
Transfer Station Veles	0	0	0	0	0
Transfer Station KAVARDATSI	0	0	0	0	0
Transfer Station NEGOTINO	0	0	0	0	0
Collection Equipment	0	0	0	0	0
Public Utilities (Access Roads)	0	0	0	0	0
Total	**0**	**631,321**	**631,321**	**0**	**0**
Plant and machinery					
Mechanical Treatment				1,250,000	
Biostabilisation	0	0	0	492,800	0
Residual Landfill	0	0	0	4,840	0
Waste Water Treament Plant			300,000	34,865	
Windrow Composting for green waste	0	0	0	89,600	0
Infrastucture works	0	0	0	143,827	0
Transfer Station Veles	0	0	0	32,000	0
Transfer Station KAVARDATSI	0	0	0	32,000	0
Transfer Station NEGOTINO	0	0	0	32,000	0
Collection Equipment				709,311	
Public Utilities (Access Roads)				0	
Total	**0**	**0**	**300,000**	**2,821,243**	**0**
Mobile equipment					
Mechanical Treatment				483,000	
Biostabilisation	0	0		116,000	0
Residual Landfill	0	0		505,000	0
Waste Water Treament Plant				0	
Windrow Composting for green waste	0	0		142,000	0
Infrastucture works	0	0		0	0
Transfer Station Veles	0	0		414,074	0
Transfer Station KAVARDATSI	0	0		257,580	0
Transfer Station NEGOTINO	0	0		234,205	0
Collection Equipment (incl. reinvestment of current trucks)				2,806,124	
Public Utilities (Access Roads)	0	0		0	0
Total	**0**	**0**	**0**	**4,957,983**	**0**
Contingencies					
Mechanical Treatment				62,500	
Biostabilisation	0	0	0	24,640	0
Residual Landfill	0	63,132	63,132	484	0
Waste Water Treament Plant		0	15,000	1,743	
Windrow Composting for green waste	0	0	0	4,480	0
Infrastucture works	0	0	0	14,383	0
Transfer Station Veles	0	0	0	3,200	0
Transfer Station KAVARDATSI	0	0	0	3,200	0
Transfer Station NEGOTINO	0	0	0	3,200	0
Collection Equipment				35,466	
Public Utilities (Access Roads)				0	

Subsequent project cost	**REINVESTMENT COST - Non Eligible Cost**				
(in constant EUR)	**2021-2026**	**2027**	**2028**	**2032**	**2033-2046**
Total	**0**	**63,132**	**78,132**	**153,295**	**0**
Totals excluding intangibles					
Mechanical Treatment				1,795,500	
Biostabilisation	0	0	0	633,440	0
Residual Landfill	0	694,453	694,453	510,324	0
Waste Water Treament Plant		0	315,000	36,608	
Windrow Composting for green waste	0	0	0	236,080	0
Infrastucture works	0	0	0	158,210	0
Transfer Station Veles	0	0	0	449,274	0
Transfer Station KAVARDATSI	0	0	0	292,780	0
Transfer Station NEGOTINO	0	0	0	269,405	0
Collection Equipment				3,550,900	
Public Utilities (Access Roads)				0	
Total	**0**	**694,453**	**1,009,453**	**7,932,521**	**0**
Intangible components					
Technical Assistance - Supervision during implementation&Publicity					
Public Utilities(connection of power supply network, water supply network etc)					
Grand total	**0**	**694,453**	**1,009,453**	**7,932,521**	**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: 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
b. Biological treatment (Biostabilization);
c. Landfill for residues (WWTP included);
d. Windrow Composting (for green waste);
e. Infrastructure Works;
f. Transfer stations;
g. Transportation costs direct to WMCor to Transfer Stations;

The O&M cost centres consist of fixed and variable costs. The basic assumptions of that distinguish is 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.

- Labour cost : (1 worker unskilled personnel, 1 driver / handler, 1 engineer / supervisor) 18,480€/year;
- Maintenancecost : 224,207€/year;
- Insurance and Monitoring costs: 43,851€/year;
- Administrative cost : 3,696Euros / Year.

The average quantity of sorted waste (avg. 28.503 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 39,904€/year and the cost of fuel 73,196 €/year.

In summary the table below illustrates the data mentioned above.

Table 9-3: Mechanical Treatment of Mixed Waste - Operating cost basic assumptions

Mechanical Treatment of Mixed Waste		
LABOUR		
CATEGORY	**No**	**EUR/year**
WORKER UNSKILLED	1	4,200
DRIVER / HANDLER	1	6,120
WORKER SKILLED	0	6,120
TECHNICIAN	0	7,200
SUPERVISOR	1	8,160
CHIEF ENGINEER	0	8,160
MAINTENANCE	**222,007**	**Euro/yr**
% of investment cost	4,0%	
ENERGY	10	KWh/t @ 0.140 EUR
FUEL	3.0	l/t @ 0.856 EUR
INSURANCE	38,851	Euro/yr
ADMIN. COST	3,696	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)		43,851
Labour (fixed)		18,480
Maintenance (fixed)		222,007
Energy for … t/year sorted waste		
waste (variable)	28,503	39,904
= EUR per t	1.40	
Fuel for … t/year sorted		
waste (variable)	28,503	73,196
= EUR per t	2.57	
Administrative cost (fixed)		3,696
Total EUR		**401,135**
Total Euro		401,135
Total EUR/t		**14.07**
Total Euro/t		14.07

9.1.3.1.2.Mechanical Treatment of Recyclables

The Mechanical Treatment of Recyclablescost center includes the following cost categories per year.

- Labor cost : (16 workers unskilled personnel, 2 drivers / handlers, 1skilled worker, 1engineer / supervisor) 93,720 Euros/year;
- Insurance and Monitoring costs: 25,000€/year;
- Administrative cost : 18,744€/year

The average quantity of shorted recyclables waste (avg. 8,556 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 23,956€/ year and the cost of fuel 21,971€ / year.

In summary the table below illustrates the data mentioned above.

Table 9-4: Mechanical Treatment of Recyclables - Operating cost basic assumptions

Mechanical Treatment of Recyclables		
LABOUR		
CATEGORY	**No**	**EUR/year**
WORKER UNSKILLED	16	4,200
DRIVER / HANDLER	2	6,120
WORKER SKILLED	1	6,120
TECHNICIAN	0	7,200
SUPERVISOR	0	8,160
CHIEF ENGINEER	1	8,160
MAINTENANCE	0	Euro/yr
% of investment cost	4.0%	
ENERGY	20	KWh/t @ 0.140 EUR
INSURANCE	0	Euro/yr
FUEL	3.0	l/t @ 0.856 EUR
ADMIN. COST	18,744	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)		25,000
Labour (fixed)		93,720
Maintenance (fixed)		0
Energy for … t/year sorted waste		
waste (variable)	8,556	23,956
= EUR per t	2.80	
Fuel for … t/year sorted waste		
waste (variable)	8,556	21,971
= EUR per t	2.57	
Administrative cost (fixed)		18,744
Total EUR		**183,391**
Total Euro		183,391
Total EUR/t		**21.44**
Total Euro/t		21.44

9.1.3.1.3. Biological Treatment (BiostabilizationPlant)

The Biological Treatment (Biostabilization Plant) cost center includes the following cost categories per year.

- Labor cost : (1 driver / handler) 6,120€/year;
- Maintenancecost : 79,300€ / Year;
- Insurance and Monitoring costs: 23,878€ / Year;
- Administrative cost : 1,224€/ Year.

The average quantity for composting (avg. 15,398 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 10,779€/year and the cost of fuel 26,362€/year.

In summary the table below illustrates the data mentioned above.

Table 9-5: Biological Treatment (Biostabilization Plant) -Operating cost basic assumptions

Biostabilization		
LABOUR		
CATEGORY	**No**	**EUR/year**
WORKER UNSKILLED	0	4,200
DRIVER / HANDLER	1	6,120
WORKER SKILLED	0	6,120
TECHNICIAN	0	7,200
SUPERVISOR	0	8,160
CHIEF ENGINEER	0	8,160
MAINTENANCE	79,300	Euro/yr
% of investment cost	4.0%	
ENERGY	5	KWh/t @ 0.140 EUR
FUEL	2.0	l/t @ 0.856 EUR
INSURANCE	13,878	Euro/yr
ADMIN. COST	1,224	Euro/yr
% of labour cost	20.0%	
MONITORING	10,000	Euro/yr

Calculation of average annual costs		
Cost category (fixed/variable)		**EUR/yr**
Insurance & Monitoring (fixed)		23,878
Labour (fixed)		6,120
Maintenance (fixed)		79,300
Energy for ... t/year composting waste (variable)	15,398	10,779
= EUR per t	0.70	
Fuel for ... t/year composting waste (variable)	15,398	26,362
= EUR per t	1.71	
Administrative cost (fixed)		1,224
Total EUR		**147,662**
Total Euro		147,662
Total EUR/t		**9.59**
Total Euro/t		9.59

9.1.3.1.4Residual Landfill(WWTP included)

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 : 64,945€/year;
- Monitoring and Aftercare costs: 36,196 Euros / Year;
- Insurance cost : 16,804Euros / Year;
- Administrative cost : 4,512Euros / Year.

The average quantity of Landfilled waste (avg. 23,349 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 16,344€/year and the cost of fuel 99,933€/year.

In summary the table below illustrates the data mentioned above.

Table 9-6: Landfill for residues - Operating cost basic assumptions

RESIDUAL LANDFILL		
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
MAINTENANCE	64,945	Euro/yr
% of investment cost	1.5%	
ENERGY	5	KWh/t @ 0.140 EUR
INSURANCE	16,804	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)		64,945
Energy for ... t/year landfilled waste (variable)	23,349	16,344
= EUR per t	0.70	
Fuel for ... t/year landfilled waste (variable)	23,349	99,933
= EUR per t	4.28	
Monitoring & Aftercare(fixed)		36,196
Insurance (fixed)		16,804
Administrative cost (fixed)		4,512
Total EUR		**261,294**
Total Euro		261,294
Total EUR/t		**11.19**
Total Euro/t		11.19

9.1.3.1.5. Windrow Composting for green waste

The Windrow composting for 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 : 24,900 Euros / Year;
- Monitoring and Aftercare costs: 5,000Euros / Year;
- Insurance cost : 4,358Euros / Year;
- Administrative cost : 2,064 Euros / Year.

The average quantity of Landfilled waste (avg. 2,301 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 1,611€/ year and the cost of fuel 3,939 € / 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 FOR GREEN WASTE		
LABOUR		
CATEGORY	**No**	**EUR/year**
WORKER UNSKILLED	1	4.200
DRIVER / HANDLER	1	6.120
WORKER SKILLED	0	6.120
TECHNICIAN	0	7.200
SUPERVISOR	0	8.160
CHIEF ENGINEER	0	8.160
MAINTENANCE	24,900	Euro/yr
% of investment cost	4,0%	
ENERGY	5	KWh/t @ 0.140 EUR
INSURANCE	4,358	Euro/yr
FUEL	2	l/t @ 0,856 EUR
MONITORING	5.000	Euro/yr
ADMIN. COST	2.064	
% of labour cost	20,0%	Euro/yr

Calculation of average annual costs		
Cost category (fixed/variable)		**EUR/yr**
Labour (fixed)		10,320
Maintenance (fixed)		24,900
Energy for … t/year landfilled waste (variable)	2,301	1,611
= EUR per t	0.70	
Fuel for … t/year landfilled waste (variable)	2,301	3,939
= EUR per t	1.71	
Monitoring & Aftercare(fixed)		5,000
Insurance (fixed)		4,358
Administrative cost (fixed)		2,064
Total EUR		**52,191**
Total Euro		52,191
Total EUR/t		**22.68**
Total Euro/t		22.68

9.1.3.1.6 Infrastructure works

The Infrastructures cost center includes the following cost categories per year.

- Labor cost : (1worker unskilled personnel), 4,200Euros/year;
- Maintenancecost : 16,586 Euros / Year;
- Chemicals cost : 5,000Euros / year;
- Insurance cost : 11,610Euros / Year;
- Administrative cost : 840 Euros / Year;
- Energy : 80,000 Euros / Year.
- Fuel : 5,000 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	16,586	Euro/yr
% of investment cost	1.0%	
ENERGY	80,000	KWh @ 0.140 EUR
INSURANCE	11,610	Euro/yr
FUEL	5,000	l @ 0.856 EUR
CHEMICALS	5,000	Euro/yr
ADMIN. COST	840	
% of Labour cost	20.0%	Euro/yr

Calculation of average annual costs	
Cost category (fixed/variable)	**EUR/yr**
Labour (fixed)	4,200
Chemical	5,000
Maintenance (fixed)	16,586
Energy (fixed)	11,200
Fuel (fixed)	4,280
Insurance (fixed)	11,610
Administrative cost (fixed)	840
Total EUR	**53,716**
Total Euro	53,716
Total EUR/t	**1.88**
Total Euro/t	1.88

9.1.3.1.7 Transfer stations

The three (3) transfer stations (Veles, Kavadartsi, Negotino) cost center includes the following cost categories per year

- Labor cost : 8 drivers and 7 unskilled workers 82,320 €/year;
- Maintenance and insurance cost : 118,129 € / year;
- Other costs (highway tolls, cost of tyres): 14,333 Euros/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): 27,000 € / year
- Fuel costs (average 2021-2046): 53,958 € / 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 are based on the assumptions which presented in chapter 6.

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 Veles	12,603	3,783	1,017	17,404	8.4	145,988
TS Kavadartsi	10,361	3,110	836	14,307	6.1	87,800
TS Negotino	4,439	1,333	358	6,130	12.8	78,416
			Total	**37,842**	**8.3**	**312,204**

9.1.3.1.8. Transportation 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 municipalities Gradsko and Rosoman) and transportation cost to transfer stations (for municipalities Veles, Demir Kapija, Kavadartsi, Lozovo, Negotino and Chashka).

Table 9-10: Transportation cost direct to WMC and Transportation cost to Transfer Stations

Waste categories	Waste quantities that must be transferred (t/a)	Unit Cost (€/t)	Total Cost (€/a)
Mixed Municipal Waste			
Gradsko Municipality	620	40.8	25,328
Rosoman Municipality	479	48.74	23,349
Veles Municipality	11,113	8.80	97,832
Demir Kapija Municipality	512	42.70	21,862
Kavadartsi Municipality	10,361	6.15	63,754
Lozovo Municipality	425	49.66	21,087
Negotino Municipality	3,927	10.65	41,810
Chashka Municipality	1,066	24.46	26,064
Recyclable Waste			
Gradsko, Rosoman, Kavadartsi	3,440	18.26	62,796
Demir Kapija & Negotino	1,333	15.94	21,242
Veles & Lozovo & Chashka	3,783	13.14	49,728
Green Waste			
Gradsko, Rosoman, Kavadartsi	925	61.74	57,114
Demir Kapija & Negotino	358	54.17	19,412
Veles & Lozovo & Chashka	1,017	44.86	45,641
TOTAL	**39,359**	**14.66**	**577,019**

9.1.3.1.9 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.

9.1.3.1.10 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 Vardar Region, 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 (different fleet will collect each type of bin (recyclables and residuals) thus labour and fuel cost are expected to be higher, compared to the current situation).

9.1.3.1.11Total 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 Treatment of Recyclables Waste	Mechanical Biological Treatment (for mixed waste)	Infrastructure works	Residual landfill	Windrow Composting for green waste	Administrative Cost	Total
2021	1,306,268	311,435	576,795	183,040	546,742	53,716	259,742	52,149	27,964	3,317,852
2022	1,325,583	311,590	576,860	183,154	547,166	53,716	260,068	52,162	28,700	3,338,998
2023	1,345,221	311,745	576,926	183,268	547,594	53,716	260,397	52,176	29,458	3,360,503
2024	1,365,189	311,903	576,994	183,385	548,029	53,716	260,731	52,190	30,237	3,382,374
2025	1,385,494	312,063	577,062	183,503	548,468	53,716	261,069	52,204	31,039	3,404,619
2026	1,405,318	312,197	577,113	183,590	548,832	53,716	261,347	52,215	31,855	3,426,183
2027	1,425,503	312,334	577,166	183,680	549,205	53,716	261,633	52,226	32,694	3,448,157
2028	1,446,056	312,474	577,221	183,773	549,587	53,716	261,925	52,237	33,558	3,470,548
2029	1,466,986	312,617	577,278	183,869	549,978	53,716	262,224	52,249	34,448	3,493,364
2030	1,488,299	312,763	577,335	183,967	550,378	53,716	262,530	52,261	35,364	3,516,614
2031	1,504,994	312,733	577,307	183,912	550,285	53,716	262,454	52,254	36,241	3,533,895
2032	1,521,965	312,705	577,280	183,860	550,200	53,716	262,385	52,248	37,142	3,551,500
2033	1,539,217	312,680	577,255	183,810	550,124	53,716	262,323	52,242	38,068	3,569,435
2034	1,556,754	312,659	577,231	183,764	550,056	53,716	262,267	52,236	39,020	3,587,703
2035	1,574,580	312,640	577,209	183,720	549,997	53,716	262,218	52,231	39,998	3,606,309

Year	Collection Cost (Residual, recyclables, green)	Transfer Stations	Transportation direct to WMC and to Transfer Station	Mechanical Treatment of Recyclables Waste	Mechanical Biological Treatment (for mixed waste)	Infrastructure works	Residual landfill	Windrow Composting for green waste	Administrative Cost	Total
2036	1,590,667	312,555	577,155	183,620	549,753	53,716	262,025	52,219	40,974	3,622,684
2037	1,607,006	312,473	577,103	183,523	549,518	53,716	261,839	52,207	41,977	3,639,361
2038	1,623,601	312,394	577,052	183,429	549,290	53,716	261,660	52,195	43,006	3,656,345
2039	1,640,457	312,317	577,003	183,338	549,071	53,716	261,487	52,184	44,063	3,673,638
2040	1,657,576	312,244	576,955	183,249	548,861	53,716	261,321	52,174	45,149	3,691,245
2041	1,673,121	312,114	576,881	183,114	548,493	53,716	261,033	52,157	46,236	3,706,864
2042	1,688,899	311,987	576,808	182,980	548,134	53,716	260,752	52,141	47,351	3,722,769
2043	1,704,915	311,864	576,737	182,850	547,783	53,716	260,477	52,126	48,496	3,738,963
2044	1,721,171	311,743	576,667	182,723	547,440	53,716	260,208	52,110	49,671	3,755,450
2045	1,737,669	311,625	576,599	182,599	547,105	53,716	259,946	52,095	50,877	3,772,232
2046	1,752,833	311,462	576,510	182,436	546,645	53,716	259,587	52,076	52,089	3,787,354

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:

- 24 Euros 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;
- 21Euros per ton for the treatment of recyclables for the year 2017 with average growth 1%;
- Administrative cost according the article 123 LoWM

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	Administration Cost	Total
2021	1,050,601	417,078	13,329	20,406	1,501,414
2022	1,065,846	418,112	13,496	20,228	1,517,683
2023	1,081,345	419,162	13,665	20,056	1,534,228

Year	Collection & transportation Cost (residual & recyclables)	Landfilling of residual waste	Treatment of recyclables	Administration Cost	Total
2024	1,097,101	420,227	13,837	20,054	1,551,219
2025	1,113,120	421,307	14,011	20,061	1,568,500
2026	1,128,613	422,106	14,178	20,062	1,584,959
2027	1,144,387	422,930	14,348	20,072	1,601,737
2028	1,160,448	423,780	14,520	20,090	1,618,839
2029	1,176,801	424,656	14,696	20,118	1,636,271
2030	1,193,452	425,558	14,874	20,154	1,654,039
2031	1,206,338	425,053	15,005	20,131	1,666,527
2032	1,219,440	424,574	15,138	20,116	1,679,269
2033	1,232,759	424,122	15,273	20,111	1,692,265
2034	1,246,300	423,696	15,411	20,113	1,705,520
2035	1,260,065	423,297	15,550	20,124	1,719,036
2036	1,272,433	422,383	15,672	20,118	1,730,606
2037	1,284,998	421,496	15,795	20,119	1,742,409
2038	1,297,763	420,635	15,921	20,129	1,754,447
2039	1,310,729	419,800	16,048	20,147	1,766,724
2040	1,323,900	418,991	16,177	20,172	1,779,240
2041	1,335,808	417,746	16,290	20,183	1,790,028
2042	1,347,898	416,529	16,405	20,201	1,801,034
2043	1,360,173	415,338	16,522	20,227	1,812,260
2044	1,372,634	414,173	16,640	20,260	1,823,708
2045	1,385,285	413,034	16,761	20,427	1,835,506
2046	1,396,867	411,549	16,867	20,578	1,845,861

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 Cost incl. 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	3,317,852	0	1,501,414	250,000	1,566,438
2022	3,338,998	0	1,517,683	250,000	1,571,314
2023	3,360,503	0	1,534,228	250,000	1,576,275
2024	3,382,374	0	1,551,219	250,000	1,581,155
2025	3,404,619	0	1,568,500	250,000	1,586,120

Year	Operating cost WITH PROJECT	With Project replacements	Operating cost WITHOUT	Without Project replacements	Incremental costs, incl. replacements
2026	3,426,183	0	1,584,959	250,000	1,591,224
2027	3,448,157	631,321	1,601,737	250,000	2,227,741
2028	3,470,548	931,321	1,618,839	250,000	2,533,029
2029	3,493,364	0	1,636,271	250,000	1,607,093
2030	3,516,614	0	1,654,039	250,000	1,612,576
2031	3,533,895	0	1,666,527	250,000	1,617,368
2032	3,551,500	7,779,226	1,679,269	250,000	9,401,457
2033	3,569,435	0	1,692,265	250,000	1,627,169
2034	3,587,703	0	1,705,520	250,000	1,632,183
2035	3,606,309	0	1,719,036	250,000	1,637,274
2036	3,622,684	0	1,730,606	250,000	1,642,079
2037	3,639,361	0	1,742,409	250,000	1,646,953
2038	3,656,345	0	1,754,447	250,000	1,651,897
2039	3,673,638	0	1,766,724	250,000	1,656,914
2040	3,691,245	0	1,779,240	250,000	1,662,006
2041	3,706,864	0	1,790,028	250,000	1,666,837
2042	3,722,769	0	1,801,034	250,000	1,671,735
2043	3,738,963	0	1,812,260	250,000	1,676,703
2044	3,755,450	0	1,823,708	250,000	1,681,741
2045	3,772,232	0	1,835,506	250,000	1,686,726
2046	3,787,354	0	1,845,861	250,000	1,691,493

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 and Compost

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

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

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 principle 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 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, 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.

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 9-16: LUC/DPC Calculation "With project"

LUC/DPC Calculation With Project	NPV	
Discount rate	4.0%	
Investment Cost Total (reinvestments included)	EUR	26,066,708
Operating Cost	EUR	50,118,662
Revenues	EUR	9,419,303
Total Cost	EUR	66,766,067
Total Waste input into the system	t/year	559,390
LUC, Investment	EUR/t.	47
LUC, O&M	EUR/t.	90
LUC, net O&M	EUR/t.	73
LUC, Total	EUR/t.	**119**

9.1.4.2.3. Affordability analysis

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 2042 will cover the Full LUC.

The value of affordability, for the residential users, is calculated as % of the average annual income.

Table 9-17: Waste tariffs and affordability issues in Vardar region (years 2017-2030)

User fees		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Residential User fees for Collection, transportation and treatment - disposal	EUR/t	32	38	44	50	51	53	55	57	58	60	62	64	69	72
Commercial User fees	EUR/t	124	121	119	118	119	119	119	119	119	119	119	119	119	119
Average HH income	EUR/HH/y	6.125	6.216	6.310	6.404	6.500	6.598	6.697	6.797	6.899	7.003	7.108	7.214	7.323	7.432
Collection,transportatio, treatment & disposal		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Waste per person	tonnes	0.23	0.23	0.24	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Waste per HH	tonnes	0.74	0.76	0.78	0.80	0.80	0.80	0.81	0.81	0.81	0.81	0.81	0.82	0.82	0.82
Tariffs per person	€ p.a.	7.42	8.94	10.64	12.42	12.78	13.23	13.69	14.17	14.66	15.18	15.71	16.27	17.60	18.22
Tariffs per HH	€ per HH	23.97	28.86	34.37	40.12	41.28	42.72	44.21	45.76	47.36	49.03	50.76	52.54	56.85	58.86
waste tariff as a % of average HH income	%	0.4%	0.5%	0.5%	0.6%	0.6%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%

Table 9-18: Waste tariffs and affordability issues in Vardar 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	74	76	79	81	84	87	91	96	100	105	111	119	119	119	119	119
Commercial User fees	EUR/t	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119
Average HH income	EUR/HH /y	7,544	7,657	7,772	7,888	8,007	8,127	8,249	8,373	8,498	8,626	8,755	8,886	9,020	9,155	9,292	9,432
Collection,transportation, treatment & disposal		**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**
Waste per person	tonnes	0.25	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Waste per HH	tonnes	0.82	0.82	0.82	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Tariffs per person	€ p.a.	18.83	19.45	20.10	20.77	21.46	22.17	23.34	24.55	25.80	27.09	28.43	30.73	30.76	30.79	30.81	30.84
Tariffs per HH	€ per HH	60.81	62.83	64.92	67.08	69.30	71.61	75.39	79.30	83.34	87.51	91.83	99.26	99.35	99.44	99.52	99.61
waste tariff as a % of average HH income	%	0.8%	0.8%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.0%	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%

Based on the above tables the total charges are set to reach gradually a peak value of 1.1% of the average disposable household income (starting from a current level 0.4%). 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 9-19: Revenues of "WITH PROJECT" scenario, prices in EUROS (constant price in 2017)

Year	Revenues - user fees	Revenues - sale of recyclables	Revenues - from Collective Schemes	Total Revenues
2021	2,618,033	553,232	103,640	3,274,905
2022	2,561,487	554,627	103,897	3,220,011
2023	2,622,877	556,042	104,158	3,283,076
2024	2,686,416	557,476	104,422	3,348,315
2025	2,752,184	558,931	104,691	3,415,806
2026	2,818,613	560,022	104,889	3,483,525
2027	2,887,428	561,148	105,094	3,553,670
2028	2,958,718	562,307	105,305	3,626,330
2029	3,129,114	563,500	105,523	3,798,138
2030	3,208,989	564,728	105,747	3,879,465
2031	3,280,826	564,092	105,621	3,950,539
2032	3,355,136	563,491	105,503	4,024,129
2033	3,432,004	562,925	105,390	4,100,319
2034	3,511,514	562,393	105,284	4,179,192
2035	3,593,756	561,896	105,185	4,260,837
2036	3,674,123	560,716	104,958	4,339,797
2037	3,811,660	559,571	104,738	4,475,968
2038	3,953,552	558,460	104,524	4,616,536
2039	4,099,949	557,383	104,316	4,761,649
2040	4,251,003	556,340	104,115	4,911,458
2041	4,402,026	554,719	103,806	5,060,550
2042	4,671,155	553,133	103,503	5,327,791
2043	4,659,537	551,582	103,207	5,314,326
2044	4,648,185	550,065	102,918	5,301,168
2045	4,637,094	548,582	102,635	5,288,311
2046	4,622,097	546,638	102,266	5,271,001

9.1.4.4. Revenues WITHOUT PROJECT

As for the present situation related to the “WITHOUT PROJECT” scenario, the following operational sources have been predicted which are the “collection revenues” and the revenues from source separated recyclables. Summarized data, are presented in the following table.

Table 9-20: Revenues for WITHOUT PROJECT scenario prices in EUROS (constant price in 2017)

Year	Revenues - user fees	Revenues - sale of recyclables	Revenues - from Collective Schemes	Total Revenues
2021	2,004,531	28,995	7,072	2,040,598
2022	1,986,684	29,067	7,090	2,022,841
2023	1,969,366	29,140	7,108	2,005,614
2024	1,969,100	29,214	7,126	2,005,440
2025	1,969,674	29,289	7,144	2,006,107
2026	1,969,699	29,344	7,158	2,006,201
2027	1,970,607	29,402	7,172	2,007,181
2028	1,972,395	29,461	7,186	2,009,042
2029	1,975,059	29,522	7,201	2,011,781
2030	1,978,594	29,584	7,216	2,015,394
2031	1,976,332	29,549	7,208	2,013,089
2032	1,974,934	29,516	7,199	2,011,650
2033	1,974,390	29,485	7,192	2,011,066
2034	1,974,688	29,455	7,185	2,011,328
2035	1,975,819	29,427	7,178	2,012,424
2036	1,975,251	29,364	7,162	2,011,777
2037	1,975,492	29,302	7,147	2,011,941
2038	1,976,532	29,242	7,133	2,012,907
2039	1,978,360	29,184	7,118	2,014,663
2040	1,980,966	29,128	7,105	2,017,199
2041	1,982,160	29,041	7,084	2,018,285
2042	1,984,107	28,957	7,063	2,020,127
2043	1,986,798	28,874	7,043	2,022,715
2044	1,990,222	28,793	7,023	2,026,038
2045	2,006,963	28,714	7,004	2,042,680
2046	2,022,214	28,611	6,979	2,057,803

9.1.4.5 Incremental Revenues

The table following present the result of incremental revenues, deriving from the comparison (abstract) between those two scenarios.

Table 9-21: Incremental Revenues prices in EUROS (constant price in 2017)

Year	With Project Revenues	Without Project Revenues	Incremental Revenues
2021	3,274,905	2,040,598	1,234,307
2022	3,220,011	2,022,841	1,197,170
2023	3,283,076	2,005,614	1,277,462
2024	3,348,315	2,005,440	1,342,875
2025	3,415,806	2,006,107	1,409,699
2026	3,483,525	2,006,201	1,477,324
2027	3,553,670	2,007,181	1,546,489
2028	3,626,330	2,009,042	1,617,288
2029	3,798,138	2,011,781	1,786,356
2030	3,879,465	2,015,394	1,864,071
2031	3,950,539	2,013,089	1,937,450
2032	4,024,129	2,011,650	2,012,480
2033	4,100,319	2,011,066	2,089,252
2034	4,179,192	2,011,328	2,167,864
2035	4,260,837	2,012,424	2,248,413
2036	4,339,797	2,011,777	2,328,020
2037	4,475,968	2,011,941	2,464,027
2038	4,616,536	2,012,907	2,603,629
2039	4,761,649	2,014,663	2,746,986
2040	4,911,458	2,017,199	2,894,259
2041	5,060,550	2,018,285	3,042,266
2042	5,327,791	2,020,127	3,307,664
2043	5,314,326	2,022,715	3,291,611
2044	5,301,168	2,026,038	3,275,130
2045	5,288,311	2,042,680	3,245,630
2046	5,271,001	2,057,803	3,213,198

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 9-22: Financial Return of the investment and FRR

FRR/C before EU assistance	NPV @ 4.0%
Investment cost (without contingencies)	-19,620,248
Revenues	28,611,149
O&M costs	-28,346,225
Residual value of investments	964,976
PROJECT CASH-FLOW before Community assistance FNPV/C	-18,390,348
FRR/C before Community assistance	**-2.7%**

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 9-23: 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)	22,449,721	
4	Total **considered** investment cost (in euro, discounted) (*)		19,620,248
5	Residual value (in euro, not discounted)	3,009,424	
6	Residual value (in euro, discounted)		964,976

	Main Elements and Parameters	Value Not discounted	Value Discounted (NPV)
7	Revenues (in euro, discounted)		28,611,149
8	Operating costs (in euro, discounted)		28,346,225
9	Net revenue (in euro, discounted) = (7) - (8) + (6)		1,229,900
10	Eligible expenditure [Art 55 (2)] (in euro, discounted) = (4) - (9)		18,390,348
11	Funding gap rate (%) = (10) / (4)	93.37%	

(*) Excluding contingencies

9.1.7. FINANCING PLAN FOR THE INVESTMENTS

After the funding gap estimation, on the eligible amount of **22,449,721Euros** applied the estimated grand of EU funding as illustrates the follow table.

Table 9-24: EU Contribution

	EU Community Contribution	Value
1.	Eligible costs (in Euro, not discounted) (Section H.1.12 (C))	22,449,721
2.	Funding gap rate (%) = (E.1.2.11)	93.73%
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)	21,042,455
4.	Co-financing rate of the priority axis (%)	85.0%
5.	EU contribution (in euro) = (3)*(4)	17,886,087

The EU grant corresponds to the 79.67% (85% * 93.73%) 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 9-25: Financing Plan prices in EUROS

Source of total investment costs (Euro)								
	Eligible cost			22,449,721	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)	e)	f)	g)	h)	i)
22,449,721	17,886,087	4,563,634			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 9-26: Financial Return of National Capital

FRR/C after EU assistance	NPV @ 4.0%
PROJECT CASH-FLOW before Community assistance FNPV/C	-18,390,348
Community Assistance	15,631,796
PROJECT CASH-FLOW after Community assistance FNPV/C	-2,758,552
FRR/C after Community assistance	**1.9%**

For the reason mentioned in above paragraph, the **FNPV/K and FRR/K have 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 9-27: Income Statement (Profit – Loss account) (years 2017-2030)

		istorical dat ►►►	Projection ►►►												
Vardar Solid Waste Project	**Unit**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
INCOME STATEMENT															
Income statement															
Operating revenues - user fees	*Th EUR*	1.801	2.046	2.374	2.746	2.809	2.803	2.928	3.059	3.196	3.339	3.489	3.646	3.934	4.115
Sale of recyclables and compost	*Th EUR*	0	0	0	0	594	607	621	635	649	663	678	693	708	724
Other revenues	*Th EUR*	0	0	0	0	111	114	116	119	122	124	127	130	133	136
TOTAL REVENUES	***Th EUR***	**1.801**	**2.046**	**2.374**	**2.746**	**3.514**	**3.524**	**3.665**	**3.812**	**3.967**	**4.126**	**4.294**	**4.469**	**4.775**	**4.974**
Operating costs - Collection Cost (Residual, recyclables, green)	*Th EUR*	-947	-987	-1.046	-1.111	-1.401	-1.451	-1.502	-1.554	-1.609	-1.665	-1.722	-1.782	-1.844	-1.908
Operating costs - Transfer Station VELES	*Th EUR*	0	0	0	0	-156	-160	-163	-166	-170	-173	-177	-180	-184	-188
Operating costs - Transfer Station KAVARDATSI	*Th EUR*	0	0	0	0	-94	-96	-98	-100	-102	-104	-106	-108	-110	-113
Operating costs - Transfer Station NEGOTINO	*Th EUR*	0	0	0	0	-84	-86	-88	-89	-91	-93	-95	-97	-99	-101
Operating costs - Transportation direct to WMC or to Transfer Station	*Th EUR*	0	0	0	0	-619	-631	-644	-657	-670	-684	-697	-711	-726	-740
Operating costs - Mechanical Treatment of recyclables	*Th EUR*	0	0	0	0	-196	-200	-205	-209	-213	-217	-222	-226	-231	-236
Operating costs - MBS	*Th EUR*	0	0	0	0	-587	-599	-611	-624	-637	-650	-664	-677	-691	-706
Operating costs - infrastructure works	*Th EUR*	0	0	0	0	-58	-59	-60	-61	-62	-64	-65	-66	-68	-69
Operating costs - Residual landfill	*Th EUR*	-704	-542	-425	-446	-279	-285	-291	-297	-303	-310	-316	-323	-330	-337
Operating costs - WINDROW COMPOSTING	*Th EUR*	0	0	0	0	-56	-57	-58	-59	-61	-62	-63	-64	-66	-67
ADMINISTRATIVE COST	*Th EUR*	0	0	0	0	-30	-31	-33	-34	-36	-38	-40	-41	-43	-45
TOTAL O&M COSTS	***Th EUR***	**-1.651**	**-1.528**	**-1.472**	**-1.557**	**-3.560**	**-3.654**	**-3.751**	**-3.851**	**-3.954**	**-4.059**	**-4.166**	**-4.277**	**-4.391**	**-4.509**
EBITDA	***Th EUR***	**150**	**518**	**902**	**1.188**	**-46**	**-130**	**-86**	**-39**	**13**	**68**	**127**	**192**	**383**	**465**
Depreciation	*Th EUR*	0	-12	-204	-439	-932	-932	-932	-932	-932	-932	-932	-963	-1.008	-1.008
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*		12	204	439	932	932	932	932	932	932	932	932	932	932
EBIT	***Th EUR***	**150**	**518**	**902**	**1.188**	**-46**	**-130**	**-86**	**-39**	**13**	**68**	**127**	**161**	**307**	**389**
Interests	*Th EUR*	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***	**150**	**518**	**902**	**1.188**	**-46**	**-130**	**-86**	**-39**	**13**	**68**	**127**	**161**	**307**	**389**
Income tax	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET INCOME	***Th EUR***	**150**	**518**	**902**	**1.188**	**-46**	**-130**	**-86**	**-39**	**13**	**68**	**127**	**161**	**307**	**389**
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 9-28: Income Statement (Profit – Loss account) (years 2031-2046)

Vardar 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*	4.291	4.476	4.670	4.874	5.088	5.305	5.614	5.939	6.283	6.644	7.018	7.596	7.729	7.864	8.002	8.136
Sale of recyclables and compost	*Th EUR*	738	752	766	781	795	810	824	839	854	870	884	899	915	931	947	962
Other revenues	*Th EUR*	138	141	143	146	149	152	154	157	160	163	165	168	171	174	177	180
TOTAL REVENUES	***Th EUR***	**5.167**	**5.368**	**5.579**	**5.800**	**6.032**	**6.267**	**6.592**	**6.936**	**7.297**	**7.677**	**8.068**	**8.664**	**8.815**	**8.969**	**9.126**	**9.278**
Operating costs - Collection Cost (Residual, recyclables, green)	*Th EUR*	-1.968	-2.030	-2.094	-2.161	-2.229	-2.297	-2.367	-2.439	-2.514	-2.591	-2.667	-2.746	-2.828	-2.912	-2.999	-3.085
Operating costs - Transfer Station VELES	*Th EUR*	-191	-195	-199	-203	-207	-211	-215	-219	-224	-228	-233	-237	-242	-246	-251	-256
Operating costs - Transfer Station KAVARDATSI	*Th EUR*	-115	-117	-120	-122	-125	-127	-130	-132	-135	-138	-140	-143	-146	-149	-152	-155
Operating costs - Transfer Station NEGOTINO	*Th EUR*	-103	-105	-107	-109	-111	-113	-115	-118	-120	-122	-125	-127	-130	-132	-135	-137
Operating costs - Transportation direct to WMC or to Transfer Station	*Th EUR*	-755	-770	-785	-801	-817	-833	-850	-867	-884	-902	-920	-938	-957	-976	-995	-1.015
Operating costs - Mechanical Treatment of recyclables	*Th EUR*	-241	-245	-250	-255	-260	-265	-270	-276	-281	-286	-292	-298	-303	-309	-315	-321
Operating costs - MBS	*Th EUR*	-720	-734	-749	-763	-779	-794	-809	-825	-841	-858	-874	-891	-909	-926	-944	-962
Operating costs - infrastructure works	*Th EUR*	-70	-72	-73	-75	-76	-78	-79	-81	-82	-84	-86	-87	-89	-91	-93	-95
Operating costs - Residual landfill	*Th EUR*	-343	-350	-357	-364	-371	-378	-386	-393	-401	-408	-416	-424	-432	-440	-449	-457
Operating costs - WINDROW COMPOSTING	*Th EUR*	-68	-70	-71	-72	-74	-75	-77	-78	-80	-82	-83	-85	-86	-88	-90	-92
ADMINISTRATIVE COST	*Th EUR*	-47	-50	-52	-54	-57	-59	-62	-65	-68	-71	-74	-77	-80	-84	-88	-92
TOTAL O&M COSTS	***Th EUR***	**-4.622**	**-4.738**	**-4.857**	**-4.979**	**-5.105**	**-5.231**	**-5.360**	**-5.493**	**-5.629**	**-5.769**	**-5.910**	**-6.054**	**-6.202**	**-6.354**	**-6.510**	**-6.667**
EBITDA	***Th EUR***	**545**	**630**	**722**	**821**	**927**	**1.035**	**1.443**	**1.443**	**1.667**	**1.907**	**2.158**	**2.610**	**2.613**	**2.615**	**2.616**	**2.612**
Depreciation	*Th EUR*	-1.008	-1.008	-1.424	-1.424	-1.424	-1.424	-1.424	-1.424	-1.424	-1.424	-1.424	-1.424	-1.424	-1.424	-768	-492
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*	932	932	932	932	932	932	932	932	932	932	932	932	932	932	277	0
EBIT	***Th EUR***	**468**	**554**	**231**	**329**	**435**	**544**	**951**	**951**	**1.176**	**1.416**	**1.667**	**2.118**	**2.121**	**2.124**	**2.125**	**2.120**
Interests	*Th EUR*	0	-450	-429	-407	-384	-360	-335	-308	-280	-251	-220	-188	-154	-118	-81	-41
Foreign exchange correction	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EBT	***Th EUR***	**468**	**104**	**-198**	**-78**	**51**	**184**	**616**	**643**	**895**	**1.165**	**1.447**	**1.931**	**1.968**	**2.006**	**2.044**	**2.079**
Income tax	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET INCOME	***Th EUR***	**468**	**104**	**-198**	**-78**	**51**	**184**	**616**	**643**	**895**	**1.165**	**1.447**	**1.931**	**1.968**	**2.006**	**2.044**	**2.079**
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 9-29: Cash - flow Statement (years 2017-2030)

		▼▼Historical data▼▼		►►► Projection ►►►													
Vardar 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***		**150**	**518**	**902**	**1,188**	**-46**	**-130**	**-86**	**-39**	**13**	**68**	**127**	**192**	**383**	**465**
Decrease / (Increase) in working capital	*Th EUR*		0	0	-98	-15	-32	0	-6	-6	-6	-7	-7	-7	-13	-8
FUNDS FROM OPERATIONS	***Th EUR***		**150**	**518**	**805**	**1,173**	**-78**	**-131**	**-92**	**-45**	**7**	**61**	**121**	**185**	**371**	**457**
Capital expenditures	*Th EUR*		-300	-4,799	-5,883	-12,320	0	0	0	0	0	0	-763	-1,148	0	0
FREE CASH-FLOW	***Th EUR***		**-150**	**-4,281**	**-5,078**	**-11,147**	**-78**	**-131**	**-92**	**-45**	**7**	**61**	**-642**	**-963**	**371**	**457**
Grants	*Th EUR*		300	4,799	5,883	12,320	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***		**150**	**518**	**805**	**1,173**	**-78**	**-131**	**-92**	**-45**	**7**	**61**	**-642**	**-963**	**371**	**457**
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***		**150**	**518**	**805**	**1,173**	**-78**	**-131**	**-92**	**-45**	**7**	**61**	**-642**	**-963**	**371**	**457**
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***		**150**	**518**	**805**	**1,173**	**-78**	**-131**	**-92**	**-45**	**7**	**61**	**-642**	**-963**	**371**	**457**
Cash in hand at the end of the year	*Th EUR*		150	668	1,473	2,646	2,568	2,437	2,345	2,300	2,307	2,368	1,726	763	1,134	1,591
				OK												

Table 9-30: Cash - flow Statement (years 2031-2046)

Vardar Solid Waste Project	Unit	istorical da	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***		**545**	**630**	**722**	**821**	**927**	**1,035**	**1,443**	**1,443**	**1,667**	**1,907**	**2,158**	**2,610**	**2,613**	**2,615**	**2,616**	**2,612**
Decrease / (Increase) in working capital	*Th EUR*		-8	-8	-9	-9	-10	-10	-13	-14	-15	-16	-16	-24	-6	-6	-6	-6
FUNDS FROM OPERATIONS	***Th EUR***		**537**	**622**	**714**	**812**	**917**	**1,026**	**1,429**	**1,428**	**1,652**	**1,892**	**2,142**	**2,586**	**2,607**	**2,609**	**2,610**	**2,605**
Capital expenditures	*Th EUR*		0	-10,378	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FREE CASH-FLOW	***Th EUR***		**537**	**-9,755**	**714**	**812**	**917**	**1,026**	**1,429**	**1,428**	**1,652**	**1,892**	**2,142**	**2,586**	**2,607**	**2,609**	**2,610**	**2,605**
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	9,000	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***		**537**	**-755**	**714**	**812**	**917**	**1,026**	**1,429**	**1,428**	**1,652**	**1,892**	**2,142**	**2,586**	**2,607**	**2,609**	**2,610**	**2,605**
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	-417	-438	-460	-483	-507	-532	-559	-587	-616	-647	-679	-713	-749	-786	-826
Interest payments other loans	*Th EUR*		0	-450	-429	-407	-384	-360	-335	-308	-280	-251	-220	-188	-154	-118	-81	-41
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***		**537**	**-1,622**	**-153**	**-55**	**50**	**159**	**562**	**561**	**785**	**1,025**	**1,275**	**1,718**	**1,740**	**1,742**	**1,743**	**1,738**
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***		**537**	**-1,622**	**-153**	**-55**	**50**	**159**	**562**	**561**	**785**	**1,025**	**1,275**	**1,718**	**1,740**	**1,742**	**1,743**	**1,738**
Cash in hand at the end of the year	*Th EUR*		2,128	505	352	297	347	506	1,068	1,629	2,414	3,439	4,714	6,432	8,172	9,914	11,656	13,395

Table 9-31: Balance Sheet (years 2017-2030)

		▼▼Historical data▼▼		►►► Projection ►►►												
Vardar 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	0
less depreciation (existing assets)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross fixet assets (project assets)	*Th EUR*	0	300	5,099	10,982	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302
less depreciation (project assets)	*Th EUR*	0	0	-12	-216	-655	-1,587	-2,519	-3,451	-4,383	-5,316	-6,248	-7,180	-8,112	-9,044	-9,976
Gross fixet assets (other CAPEX)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	763	1,911	1,911	1,911
less depreciation (other CAPEX)	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	-31	-107	-183
NET FIXED ASSETS	***Th EUR***	**0**	**300**	**5,087**	**10,766**	**22,646**	**21,714**	**20,782**	**19,850**	**18,918**	**17,986**	**17,054**	**16,885**	**17,070**	**16,061**	**15,053**
Stocks	*Th EUR*	0	0	0	195	226	289	290	301	313	326	339	353	367	392	409
Accounts receivable and other current assets	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash in hand	*Th EUR*	0	150	668	1,473	2,646	2,568	2,437	2,345	2,300	2,307	2,368	1,726	763	1,134	1,591
CURRENT ASSETS	***Th EUR***	**0**	**150**	**668**	**1,668**	**2,871**	**2,857**	**2,727**	**2,646**	**2,614**	**2,633**	**2,708**	**2,079**	**1,131**	**1,526**	**2,000**
TOTAL ASSETS	***Th EUR***	**0**	**450**	**5,755**	**12,434**	**25,518**	**24,571**	**23,509**	**22,497**	**21,532**	**20,619**	**19,762**	**18,964**	**18,201**	**17,588**	**17,053**
Shareholders' contributions	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained earnings	*Th EUR*	0	150	668	1,570	2,759	2,713	2,582	2,496	2,457	2,470	2,538	2,666	2,827	3,134	3,523
EQUITY	***Th EUR***	**0**	**150**	**668**	**1,570**	**2,759**	**2,713**	**2,582**	**2,496**	**2,457**	**2,470**	**2,538**	**2,666**	**2,827**	**3,134**	**3,523**
Investment grants	*Th EUR*	0	300	5,099	10,982	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302
less transfers to income statement	*Th EUR*	0	0	-12	-216	-655	-1,587	-2,519	-3,451	-4,383	-5,316	-6,248	-7,180	-8,112	-9,044	-9,976
	Th EUR		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loans	*Th EUR*	0	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	0
Accounts payable and other current liabilites	*Th EUR*	0	0	0	98	113	144	145	151	157	163	170	176	184	196	204
Taxes and dividends	*Th EUR*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIABILITIES	***Th EUR***	**0**	**300**	**5,087**	**10,863**	**22,759**	**21,859**	**20,927**	**20,001**	**19,075**	**18,149**	**17,224**	**16,298**	**15,374**	**14,454**	**13,530**
TOTAL EQUITY AND LIABILITIES	***Th EUR***	**0**	**450**	**5,755**	**12,434**	**25,518**	**24,571**	**23,509**	**22,497**	**21,532**	**20,619**	**19,762**	**18,964**	**18,201**	**17,588**	**17,053**

Table 9-32: Balance Sheet (years 2031-2046)

Vardar 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	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302
less depreciation (project assets)	Th EUR	-10,908	-11,840	-12,772	-13,704	-14,636	-15,568	-16,500	-17,432	-18,364	-19,297	-20,229	-21,161	-22,093	-23,025	-23,302	-23,302
Gross fixet assets (other CAPEX)	Th EUR	1,911	12,288	12,288	12,288	12,288	12,288	12,288	12,288	12,288	12,288	12,288	12,288	12,288	12,288	12,288	12,288
less depreciation (other CAPEX)	Th EUR	-260	-336	-828	-1,319	-1,811	-2,302	-2,794	-3,285	-3,777	-4,268	-4,760	-5,251	-5,743	-6,235	-6,726	-7,218
NET FIXED ASSETS	***Th EUR***	**14,044**	**23,414**	**21,990**	**20,566**	**19,143**	**17,719**	**16,296**	**14,872**	**13,448**	**12,025**	**10,601**	**9,178**	**7,754**	**6,330**	**5,562**	**5,071**
Stocks	Th EUR	425	441	459	477	496	515	542	570	600	631	663	712	725	737	750	763
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	2,128	505	352	297	347	506	1,068	1,629	2,414	3,439	4,714	6,432	8,172	9,914	11,656	13,395
CURRENT ASSETS	***Th EUR***	**2,553**	**947**	**811**	**774**	**843**	**1,021**	**1,609**	**2,199**	**3,014**	**4,070**	**5,377**	**7,144**	**8,896**	**10,651**	**12,406**	**14,157**
TOTAL ASSETS	***Th EUR***	**16,597**	**24,360**	**22,801**	**21,340**	**19,985**	**18,740**	**17,905**	**17,071**	**16,462**	**16,095**	**15,978**	**16,322**	**16,651**	**16,981**	**17,969**	**19,228**
Shareholders' contributions	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retained earnings	Th EUR	3,991	4,095	3,897	3,819	3,870	4,054	4,670	5,313	6,208	7,373	8,820	10,750	12,718	14,724	16,768	18,846
EQUITY	***Th EUR***	**3,991**	**4,095**	**3,897**	**3,819**	**3,870**	**4,054**	**4,670**	**5,313**	**6,208**	**7,373**	**8,820**	**10,750**	**12,718**	**14,724**	**16,768**	**18,846**
Investment grants	Th EUR	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302	23,302
less transfers to income statement	Th EUR	-10,908	-11,840	-12,772	-13,704	-14,636	-15,568	-16,500	-17,432	-18,364	-19,297	-20,229	-21,161	-22,093	-23,025	-23,302	-23,302
	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loans	Th EUR	0	8,583	8,145	7,685	7,202	6,695	6,163	5,604	5,017	4,401	3,754	3,075	2,361	1,612	826	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	212	221	229	238	248	258	271	285	300	315	332	356	362	369	375	381
Taxes and dividends	Th EUR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIABILITIES	***Th EUR***	**12,606**	**20,265**	**18,904**	**17,521**	**16,116**	**14,686**	**13,235**	**11,758**	**10,254**	**8,722**	**7,159**	**5,572**	**3,932**	**2,258**	**1,201**	**381**
TOTAL EQUITY AND LIABILITIES	***Th EUR***	**16,597**	**24,360**	**22,801**	**21,340**	**19,985**	**18,740**	**17,905**	**17,071**	**16,462**	**16,095**	**15,978**	**16,322**	**16,651**	**16,981**	**17,969**	**19,228**

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 9-33: 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	0.55
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 region was the recent year about 24.50%.

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 0.55**

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 in 2007-2013, 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 and the production of compost. 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;

   (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
   - Biological Treatment
   - 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 **1.80** 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 **23.154.969Euros** 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 9-34: Economic performance indicators

FLOWS - ECONOMIC ANALYSIS	NPV
Economic Inflows (Inc.)	**52,045,171**
Resource cost savings	33,385,121
Reduction of visual disamenities, odours and health risk	7,797,070
Reduction of greenhouse gas emissions	10,862,979
Total Economic Outflows (Inc.)	**-28,890,202**
Investments Economic cost	**-12,613,081**
Traded goods	-3,693,962
Non-traded goods	-1,662,284
Skilled Labour	-3,693,962
Unskilled Labour	-3,562,872
O&M economic costs	**-16,277,121**
Traded goods	-3,668,993
Non-traded goods	-1,100,698
Skilled Labour	-6,114,988
Unskilled Labour	-5,392,442
Economic Net Present Value	**23,154,969**
Economic Rate of Return	**17.2%**
B/C ratio	**1.80**

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) of Regulation (EU) No 1303/2013, a risk assessment must be included in the CBA. This is required to deal with the uncertainty that always permeates investment projects, including the risk that the adverse impacts of climate change may have on the project. The recommended steps for assessing the project risks are as follows:

- sensitivity analysis (identification of critical variables, elimination of deterministically dependent 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 9-35: 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%**	**-2.758.552**	**17,18%**	**23.154.969**				
Quantity of waste delivered to the plant								
Quantity of waste delivered to the plant	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				YES
	1,0%	-2.726.795	17,33%	23.491.804	-1,15%	1,45%	0,15%	
	-1,0%	-2.790.309	17,03%	22.818.130	1,15%	-1,45%	-0,15%	
Maintenance Cost								
Maintenance Cost	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				No
	1,0%	-2.773.684	17,15%	23.096.894	0,55%	-0,25%	-0,02%	
	-1,0%	-2.743.420	17,20%	23.213.042	-0,55%	0,25%	0,02%	
Price of Recyclables								
Price of Recyclables	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				NO
	1,0%	-2.746.471	17,21%	23.226.743	-0,44%	0,31%	0,03%	
	-1,0%	-2.770.634	17,15%	23.083.197	0,44%	-0,31%	-0,03%	
Price from Collection Schemes								
Price from Collection Schemes	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				NO
	1,0%	-2.756.296	17,19%	23.168.576	-0,08%	0,06%	0,01%	
	-1,0%	-2.760.809	17,17%	23.141.360	0,08%	-0,06%	-0,01%	
Tariff								
Tariff	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				YES
	1,0%	-2.715.638	17,18%	23.154.969	-1,56%	0,00%	0,00%	
	-1,0%	-2.801.467	17,18%	23.154.969	1,56%	0,00%	0,00%	
Energy cost								
Energy cost	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				NO
	1,0%	-2.760.965	17,18%	23.145.715	0,09%	-0,04%	0,00%	
	-1,0%	-2.756.141	17,18%	23.164.222	-0,09%	0,04%	0,00%	
Fuel cost								
Fuel cost	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				NO
	1,0%	-2.765.833	17,17%	23.127.038	0,26%	-0,12%	-0,01%	
	-1,0%	-2.751.271	17,19%	23.182.902	-0,26%	0,12%	0,01%	
Investment Cost								
Investment Cost	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				YES
	1,0%	-2.805.553	16,99%	22.957.461	1,70%	-1,1%	-0,85%	
	-1,0%	-2.711.552	17,37%	23.352.478	-1,70%	1,1%	0,85%	
Labour Cost								
Labour Cost	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				Yes
	1,0%	-2.773.911	17,15%	23.096.025	0,56%	-0,1%	-0,25%	
	-1,0%	-2.743.193	17,20%	23.213.914	-0,56%	0,1%	0,25%	

CATEGORIES OF VARIABLES	CHANGE	FNPV/K	ERR	ENPV	DIFFERENCE ON FNPV/K	DIFFERENCE ON ENPV	DIFFERENCE ON ERR	CRITICAL VARIABLE
Reduction of EU funds								
Reduction of EU funds	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				YES
	-1,0%	-2.914.870	17,18%	23.154.969	5,67%	0,00%	0,00%	
Shadow price of CO2								
Shadow price of CO2	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				NO
	1,0%	-2.758.552	17,2%	23.263.599	0,00%	0,47%	0,04%	
	-1,0%	-2.758.552	17,1%	23.046.339	0,00%	-0,47%	-0,04%	
Shadow price of landfill space								
Shadow price of landfill space	**0,0%**	**-2.758.552**	**17,18%**	**23.154.969**				YES
	1,0%	-2.758.552	17,29%	23.406.487	0,00%	1,09%	0,11%	
	-1,0%	-2.758.552	17,06%	22.903.450	0,00%	-1,09%	-0,12%	

The results of the sensitivity analysis and variables tested are given in the table below:

Table 9-36: Sensitivity analysis - switching values for critical variables

	Variable	Switching value	
1	Quantity of waste delivered to the plant	Maximum increase before the FNPV/K equals 0	86,86%
		Maximum decrease before the ENPV equals 0	-68,74%
2	Maintenance Cost	Maximum decrease before the FNPV/K equals 0	-182,30%
		Maximum increase before the ENPV equals 0	Always possitive
3	Price of Recyclables	Maximum increase before the FNPV/K equals 0	228,33%
		Maximum decrease before the ENPV equals 0	-322,61%
4	Price from Collection Schemes	Maximum increase before the FNPV/K equals 0	1222,30%
		Maximum decrease before the ENPV equals 0	-1701,49%
5	Tariff	Maximum increase before the FNPV/K equals 0	95,17%
		Maximum decrease before the ENPV equals 0	Not applicable
6	Energy cost	Maximum decrease before the FNPV/K equals 0	-1143,81%
		Maximum increase before the ENPV equals 0	Always possitive
7	Fuel cost	Maximum decrease before the FNPV/K equals 0	-378,86%
		Maximum increase before the ENPV equals 0	Always possitive
8	Investment Cost	Maximum decrease before the FNPV/K equals 0	-58,69%
		Maximum increase before the ENPV equals 0	Always possitive
9	Labour Cost	Maximum decrease before the FNPV/K equals 0	-179,61%
		Maximum increase before the ENPV equals 0	392,81%
10	Reduction of EU funds	Maximum increase before the FNPV/K equals 0	Nt applicable
		Maximum decrease before the ENPV equals 0	Not applicable
11	Shadow price of CO2	Maximum increase before the FNPV/K equals 0	Not applicable
		Maximum decrease before the ENPV equals 0	-213,15%
12	Shadow price of landfill space	Maximum increase before the FNPV/K equals 0	Not applicable
		Maximum decrease before the ENPV equals 0	-92,06%

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 9-37: 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 9-38: Risk analysis - results of the Monte Carlo analysis

	Variable	FNPV/K	ENPV
1	Expected value	-12.284.546	12.865.822
2	Standard deviation	2.606.874	3.286.336

The following figures illustrate the distribution of probabilities as estimated of the Monte Carlo Simulation:

Figure 9-1: Distribution of FNPV/k values

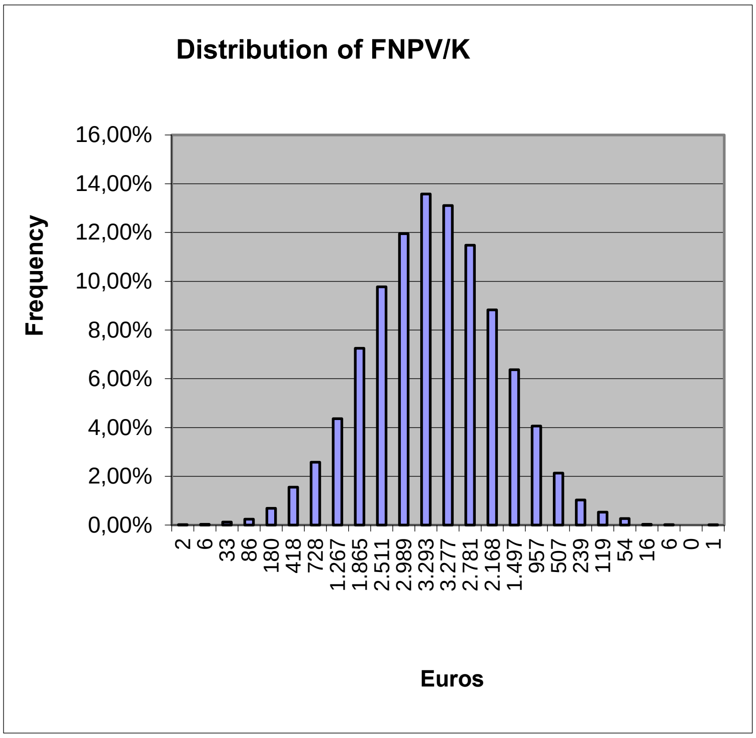
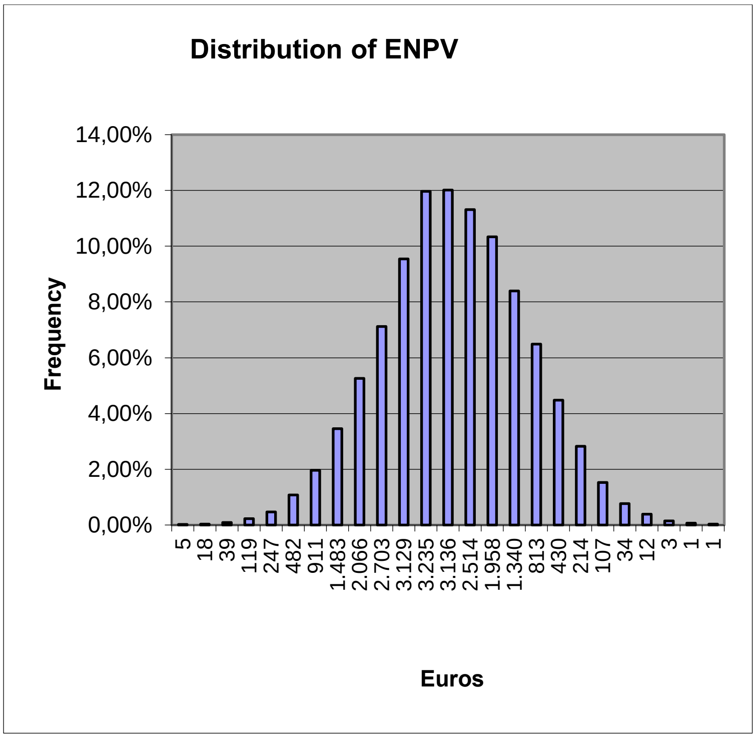


Figure 9-2: Distribution of ENPV values



Based on the above distribution there is a 95% probability that FNPV/K is between -17394018,9 and -7175072,6, with a 00% probability of FNPV/K >0 and there is a 95% probability that ENPV is between 6424603,7 and 19307040,2, 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 9-39: 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	
Moderate	
High	
Unacceptable	

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 9-40: 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 Vardar region.

Table 9-41: 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 councils or any other possible involved entity					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 entity should act accordingly	

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
	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

Risk description	Probability (P)	Severity (S)	Risk level (=P*S)	Risk prevention / mitigation measures	Residual risk after prevention /mitigation measures
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
Land acquisition risks					
Procedural delays	C	II	Moderate	Private parts of land are a small part of total area and it can be easily obtained.	Low
Land cost higher than predicted	B	I	Low	• Private parts of land are a small part of total area. • 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

Risk description	Probability (P)	Severity (S)	Risk level (=P*S)	Risk prevention / mitigation measures	Residual risk after prevention /mitigation measures
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 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.	Low
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	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.	Low

Risk description	Probability (P)	Severity (S)	Risk level (=P*S)	Risk prevention / mitigation measures	Residual risk after prevention /mitigation measures
unexpectedly large variations				• 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.	
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 included Eligibility Criteria for the tenderers and Performance Guarantee Forms for processes, in order to safeguard quality requirements.	Low
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.	Low

Risk description	Probability (P)	Severity (S)	Risk level (=P*S)	Risk prevention / mitigation measures	Residual risk after prevention /mitigation measures
				• Training programs will be provided to the personnel	
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 • Tariffs 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					
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	A	II	Low	• 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 have been presented with no objection • The CWMF location is included in existing operating non-compliant municipal landfill • During EIA consultation all needed clarifications will be provided.	Low

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Annex 10-I: Cost Breakdown Per Contract

10 PROCUREMENT AND IMPLEMENTATION

10.1 PROCUREMENT STRATEGY

10.1.1 Introduction

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.

10.1.2 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 reach, 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".

10.1.3 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;
- An inter-municipal waste management enterprise (IWME) should be established;
- 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.

10.1.4 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

10.1.5 Principal procurement options and procedures

The basic principle governing the award of contracts is competitive tendering. The purpose is two fold:

- 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 limits are 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
- Provision of 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 Tender Documents comprise:

(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 Tender Documents comprise:

  (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, Build and 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 an extended 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, 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.

- **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 a facility for a defined period, after which the facility reverts to the public sector.
  The facility is owned by the private sector for the contract period and it recovers costs through local authorities. In this type of contracts, the concessionaire will bring a financing structure, negotiated with equity investors and commercial lenders, as part of his tender. The rationale for using a PPP arrangement instead of conventional public procurement rests on the proposition that optimal 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 combination of 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 Vardar 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 Vardar Region**
Budget without VAT	**15,218,250€** 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 Vardar Region"

No. 1.2 Works contract	
SUBJECT	**Closure, rehabilitation and aftercare of non-compliant landfills and dumpsites in Vardar Region**
Budget without VAT	**10.436.721€**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 Vardar Region

10.3.2 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 Vardar 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 Vardar Region	
LOT 1 **Budget** without VAT	Bins and containers for temporary storage of waste (including bins for home-composting) **1,013,301€**without VAT
LOT 2 **Budget** without VAT	Trucks for collection of waste **2,109,356€** without VAT
LOT 3 **Budget** without VAT	Equipment for transfer stations **910,509€** without VAT
Procedure	International open tender procedure
Award	02/(n+2)
Construction Completion	06/(n+2)

10.3.3 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	**1,450,000 €**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	n	n+1	n+2	n+3	n+4	n+5
			J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A J J A O N D
WORKS	1.1	Construction of Waste Treatment and Disposal Facilities for Vardar Region						
	1.2	Closure, Rehabilitation and Aftercare of Non-Compliant Landfills and Dumpsites in Vardar Region						
SUPPLIES	2.1	Supply of equipment for waste collection and transferring of waste for Vardar Region						
	Lot 1	Bins for temporary storage of waste						
	Lot 2	Trucks for collection of waste						
	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