Preparation of Studies (FS, EIA, CBA), Design documentation and tender Dossiers for Waste Water Collection and Treatment Investment Projects in the Municipalities of Strumica, Bitola and Tetovo

ENVIRONMENTAL IMPACT ASSESSMENT STUDY

PROJECT FOR CONSTRUCTION OF A COLLECTION SYSTEM, REHABILITATIONS OF THE SEWERAGE NETWORK AND CONSTRUCTION OF WASTEWATER TREATMENT PLANT IN BITOLA

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This Project is funded by the European Union

A Project is implemented by NIRAS and its consortium partners
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The purpose of the Study is to assess the environmental impact of the project implementation in all of its stages and to provide for appropriate measures to prevent and control the potential impacts within the project documentation.

While drafting the Study, all of the important issues regarding the environment that are relevant to the project, media - air, water and soil, and the environmental areas – nature, waste, noise, odour, etc. were taken into account. The environmental impact assessment was based on the data obtained from the investor and the project activity designer, the actual situation established on site, additional specialised research, and on data from foreign and domestic expert books, and available national and international guidelines covering this topic.

The Study was drafted in accordance with the form and content prescribed in the Rulebook on the content for requirements that should be observed in a study for an environmental impact assessment of a project (Official Gazette no. 33/06).

Head of EIA consultant team responsible for preparation of the EIA study,

Marjan Mihajlov, M.Sc.

LIST OF ABBREVIATIONS

ASCI	Area of Special Conservation Interest
IPA	Important plant areas
IUCN	International Union for Conservation of Nature
PAHs	Polyaromatic Hydrocarbons
SPEC	Species of European Conservation Concern
UNDP	United Nations Development Programme
BOD_5	5-day Biological Oxygen Demand
TSS	Total Suspended Solids
LV	Limit Value
PE	Population Equivalent
EBA	Endemic Bird Area
EC	European Commission
EU	European Union
IBA	Important Bird Area
IPA	Important Plant Area
IPH	Institute of Public Health
VOC	Volatile Organic Compounds
PHI	Public Healthcare Institution
PE	Public Enterprise
kV	kiloVolts
CM	Cadastral Municipality
CP	Cadastral Parcel
CHP	Combined Heat and Power plant
LEAP	Local Environmental Action Plan
LUPD	Local Urban Planning Documentation
m.v.	site named
MEPP	Ministry of Environment and Physical Planning
MAFWE	Ministry of Agriculture, Forestry and Water Economy
m.a.s.l.	meters above sea level
MIS	Mercalli Intensity Scale
SME	Small and Medium Enterprises
MT	Margin of Tolerance
ICE	Internal Combustion Engines
BAT	Best Available Techniques
NEAP	National Environmental Action Plan
NPSWM	National Plan for Solid Waste Management

EIA	Environmental Impact Assessment
UN	United Nations
SIS	Spatial Information System
PM10	Suspended solids size ≤ 10 micrometers
TP	Treatment Plant
WWTP	Waste Water Treatment Plant
RM	Republic of Macedonia
SOP	Standard Operating Procedures
NM	Natural Monument
OHMA	Office of Hydro-Meteorological Affairs
FS	Feasibility Study
COD	Chemical Oxygen Demand

1. INTRODUCTION

The process of evaluation of the environmental impact and drafting a Study on the environment under the proposed project for the construction of the sewage collection system, rehabilitation of sewage network and construction of waste water treatment plant in Bitola represents a compulsory step in the process of obtaining construction approval. Its objective is assessment of the environmental impact from the project implementation as well as anticipation of appropriate measures to prevent and control the impact and achieve high degree of environmental protection.

The proposed project for construction of a collection system, rehabilitation of the sewerage network and construction of a wastewater treatment plant in Bitola is part of the activities provided in the Programme for water supply, drainage, collection and treatment of urban wastewater for the Bitola agglomeration which aims to solve infrastructural problems with water supply, collection and treatment of wastewater from the Bitola agglomeration. According to the legal obligations, the Programme itself as a planning document was a subject of a procedure for strategic environmental assessment, which ended with an approval from the competent authority. The Programme and the corresponding strategic environmental assessment report represent a part of the frame on which is prepared this Study.

In accordance with the Law on Environment (Official Gazette of RM no. 53/05, 81/05, 24/07, 159/08) the project on the construction of collection system, rehabilitation of the sewage network and construction of waste water treatment plant in Bitola is a type of project for whose implementation Assessment of the environmental impact of the project is required based on an appropriate Study.

The Study is designed in accordance with the requirements set out in the national legislation for environmental impact assessment (EIA), the Rulebook on the requirements to be met by the Study on the assessment of the environmental impact (Official Gazette of RM no. 33/2006) as well as the related guidelines.

The project on the construction of collection system rehabilitation of the sewage network as well as construction of waste water treatment plant in Bitola originates from a wider project and technical documentation developed within the project EuropeAid/133257/D/SER/MK - "Drafting of studies (FS, EIA, CBA), project documentation and bidding documents for the collection and treatment of waste waters, investment projects in the municipalities of Strumica, Bitola and Tetovo. It is in fact part of the overall national priority for reconstruction and modernization of the infrastructure of R. Macedonia, including the water management sector in accordance with the requirements and standards of the European Union (EU). This technical assistance for the project on waste waters for Bitola have been financed within the framework of the provisions of the Regulation (EC) no 1085/2006 of 2006/07/17 with the establishment of the Instrument for pre-accession (IPA).

The project envisions construction of collection system, rehabilitation of the sewage network and building a waste water treatment plant in Bitola. Activities connected with the building and rehabilitation of the sewage systems include:

- Reconstruction of the sewerage network in v. Gorno Orizari,
- Reconstruction of part of the sewerage network (collectors) in the City of Bitola,
- Construction of new collectors from the City of Bitola to Main feeding collector,
- Construction of pumping station and pressure pipe for v. Kravari to Main feeding collector at connection point with collector K1,
- Extension of the sewerage network of v. Dolno Orizari and construction of pumping station inclusive pressure pipe to the WWTP,
- Construction of Main feeding collector from connection of existing K0 to the WWTP.

The process of treatment of waste waters for the WWTP Bitola is "conventional process of treatment of active sludge" with secondary level of treatment of waste waters. The waste water treatment station/plant has been designed for 112 474 inhabitants.

WWTP will be designed and built in order to comply with the criteria for waste water release specified in the EU Directive for the treatment of urban waste waters (91/271/EEC), The legislation on the treatment of the urban waste waters (Official Gazette of 8 January 2006 and no. 26047) and by-law on the treatment of urban waste waters – Communication for sensitive and less sensitive water areas (Official Gazette of 27 June 2009 and no. 27.271). The sludge of the waste water treatment plant/station will be eliminated in accordance with the EU Directive on waste sludge (1986/278 / EEC).

The EIA study is prepared by a consultant team led by Mr. Marjan Mihajlov, graduated engineer in environmental studies, an EIA expert in charge of the preparation of the study.

The Ministry of Environment and Spatial Planning, and more specifically the Directorate for the environment is the competent body for the implementation of the procedure for EIA. After the submitted information on the intent for the above project, the Ministry of Environment and Spatial Planning informed the investor on the need for the implementation of the procedure EIA for the proposed project and specified the scope of the study. The study was based on the guidelines by the competent authority contained in the document on the defining the scope of the study, as well as in accordance with the existing national and international guidelines for this type of projects.

1.1 Goal of EIA

The procedure for environmental impact assessment of certain projects is a mandatory procedure by which a project is assessed in details in the development phase, or design in terms of the environment

The purpose of this procedure is to identify and predict any potential impacts of the project on the environment and human health. The procedure of assessment and identification of impacts is done on the basis of prior identification on baseline environmental conditions, and basic socio-economic conditions in the area where the project will be implemented. The EIA process should result with definying of measures to prevent, reduce or compensatation of the impacts where necessary.

The goal of the implementation of the EIA procedure is to harmonize the project with the environmental standards, to ensure that the technical project includes all necessary protection measures. In this context, the EIA procedure and obtaining a positive decision for its approval is a prerequisite for obtaining a construction permit for the project itself.

2 ADMINISTRATIVE AND LEGAL FRAMEWORK

This chapter outlines the administrative framework relating to the implementation of the project covered by this study, as well as outline of the relevant national legislation on the environment relevant for this project.

2.1 Administrative framework

According to the Law on environment, a competent institution for the implementation of the procedure for assessment of the environmental impact of projects is the Ministry of Environment and Spatial planning, that is the Department of environment under the Ministry.

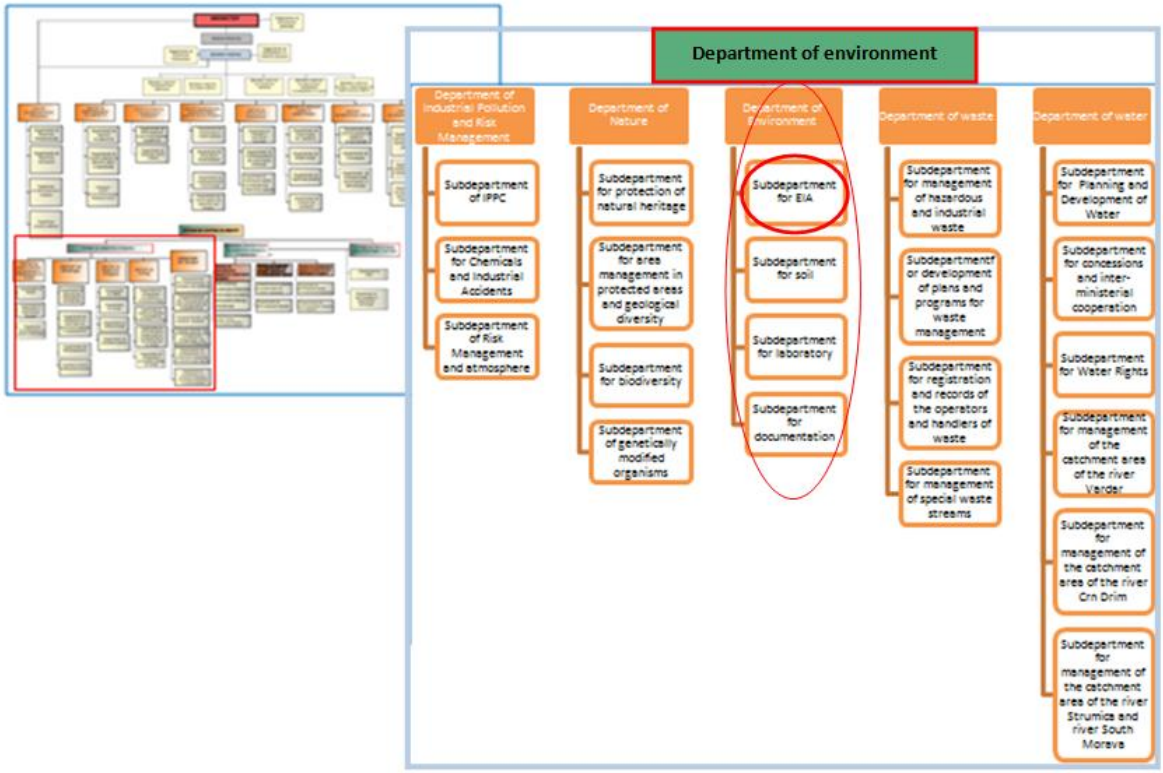


Figure 1 Institutional arrangement of MESP (left) and structure of the Department of environment (right)

The Department of the environment is in charge of the following responsibilities:

- Management of waste, air, chemical substances, noise and other areas of the environment;
- Expert tasks in the protection of the nature, waters and soil from pollution;
- Provides expert assistance and runs the procedure for the evaluation of the environmental impact and the procedure for issue of integrated environmental licenses;
- Manages the cadastre for the environment and the Registry of polluting materials and substances and their features;
- Executes the monitoring of the environment, and
- Provides other tasks defined by the regulations in the area of the environmental issues.

The Environment Sector consists of four departments, while the Department with its Unit for EIA is in charge of the implementation of the procedure for the environmental impact assessment. Additionally, the nature of the project necessitates the inclusion of other relevant sectors.

2.2 Legal framework

Following is the list of the relevant national legislation on the environmental impact assessment, considered in the drafting of the Study on EIA.

- Constitution of the Republic of Macedonia (Official Gazette of RM, no. 52/91, 01/92, 31/98, 91/01, 84/03 and 107/05) and the Constitutional law of R. Macedonia (Official gazette of RM no.52/91 и 4/92);
- Law on environment (Official Gazette of RM no. 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/13, 187/13, 42/14, 44/15, 39/16) and the relevant by-laws:
  - Regulation on defining the projects and criteria used to identify the need for implementation of the procedure for assessment of the environmental impact (Official Gazette of RM no. 74/05, 109,09, 164/12),
  - Rulebook on the information to be included in the letter of intent to implement a project and the procedure to identify the need for assessment of the environmental impact of the project (Official Gazette of RM, no. 33/2006),
  - Rulebook on the criteria required from a study on the environmental impact of a project (Official Gazette of RM, no. 33/2006),
  - Rulebook on the content of the information publicizing the intent for the project, decision regarding the need for the assessment of the environmental impact, the study for the environmental impact of the project, a report for the suitability of the study on the environmental impact assessment and the decision for the approval or rejection of the project implementation, as well as the method of consultation with the public (Official Gazette of RM no. 33/2006),
  - Rulebook on the form, content, procedure and manner of drafting the report on appropriateness/quality of the study for environmental impact assessment as well as the procedure for authorization of experts from the Official list of EIA experts in charge of the report (Official Gazette of RM, no. 33/2006),
- Law on quality of ambient air (Official Gazette of RM no. 67/04, 92/07, 35/10, 47/11, 51/11, 100/12, 163/13) and the related by-laws
- Law on waters (Official Gazette of RM no. 87/08, 6/09, 161/09, 51/11, 44/12, 163/13, 180/14) and the related by-laws,
- Law on waste management (Official Gazette of RM no. 68/04, 71/04, 107/07, 102/08, 134/08, 09/11, 51/11, 123/12, 163/13, 39/16) and the related by-laws,
- Law on protection from environmental noise (Official Gazette of RM no. 79/2007, 124/10, 47/11, 163/13) and the related by-laws,
- Law on nature protection (Official Gazette of RM no. 67/04, 14/06, 84/07, 47/11, 148/11, 163/13),
- Law on management of packaging and packaging waste (Official Gazette of RM no. 161/09, 17/11, 47/11, 6/12, 163/13, 197/2014, 39/16) and the related by-laws,
- Law on batteries and accumulators and waste batteries and accumulators (Official Gazette of RM no. 140/10, 47/11, 163/13, 39/16) and the related by-laws,
- Law on management of electrical and electronic equipment (Official Gazette of RM no. 06/12, 163/13, 39/16).

Additional relevant legislation:

- Law on construction (Official Gazette of RM no. 130/09) and related by-laws
- Law on local self-government (Official Gazette of RM no. 05/02) and the related by-laws
- Law on spatial and urban planning (Official Gazette of RM no. 24/08 and 91/09) and the related by-laws
- Law on conservation of cultural heritage (Official Gazette of RM no. 20/04 и 115/07) and the related by-laws

Relevant legislation connected with the procedure for EIA and its subject and scope:

- Law on environment (Official Gazette of RM no. 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/13, 187/13, 42/14, 44/15, 39/16).

This law regulates the rights and responsibilities of the Republic of Macedonia, the municipality, the city of Skopje and its municipalities, as well as the rights and responsibilities of the legal entities and individuals/natural persons in the enabling of conditions for the protection and improvement of the environment for the purposes of executing the rights of the citizens for a healthy environment.

The objectives of this law include: conservation, protection, renewal and improvement of the quality of the environment, protection of the life and health of the people; protection of the biological diversity; rational and sustainable use of natural resources and implementation and improvement of the measures aimed at overcoming the regional and global problems of the environment.

- Regulation on defining projects and criteria used to identify the need for the implementation of the procedure for environmental impact assessment „Official Gazette of RM no. 74/05 of 05.09.2005.
  This Regulation is used to identify projects for which it is essential to implement a procedure for the environmental impact assessment, before issuing a decision on the project implementation, generally identified projects that could have a significant environmental impact for which the need should be identified for implementation of a procedure for the environmental impact assessment, before issuing a decision for the project implementation, criteria used to define the need for a procedure on environmental impact assessment of new generally defined projects of line 2 of this article and criteria used to identify the need for implementation of the procedure for the environmental impact assessment in case of changed state of the existing facilities.
- Rulebook on the information required to be included in the notification on the intent/letter of intent to implement the proposed project and the procedure for identifying the need to assess the environmental impact, „ Official Gazette of RM no. 33/06 of 20.03.2006.
  This Rulebook specifies the information required to be included in the notification on the intent to implement the proposed project and the procedure for identifying the need to assess the environmental impact.
- Rulebook on the requirements to be met in the study on the environmental impact assessment , „Official Gazette of RM, no 33/06 of 20.03.2006
  This Rulebook specifies the content of the requirements to be met in the study on the environmental impact assessment.
- Rulebook on the form, content, procedure and method of drafting the report on the appropriateness of the study on the environmental impact, as well as the procedure

for authorization of individuals from the list of experts for environmental impact assessment to be in charge of the report, „Official Gazette of RM“ no. 33/06 dated 20.03.2006.
This Rulebook specifies the Rulebook on the form, content, procedure and method of drafting the report on the appropriateness of the study on the environmental impact, as well as the procedure for authorization of individuals from the list of experts for environmental impact assessment to be in charge of the report.

Rulebook on the content of the notification for the intent for project implementation, decision for the need of environmental impact assessment, study of the environmental impact assessment, report on the appropriateness of the study on environmental impact assessment, and the decision for approval or rejection of the project as well as methods of consultations of the public, „Official Gazette of RM“no. 33/06 dated 20.03.2006.

This Rulebook defines the content of the notification for the intent for project implementation, decision for the need of environmental impact assessment, study of the environmental impact assessment, report on the appropriateness of the study on environmental impact assessment, and the decision for approval or rejection of the project as well as methods of consultations of the public.

- Regulation for participation of the public in the drafting of the legislation and other by-laws, as well as plans and programmes related to environmental issues (Official Gazette of RM, no 147 dated 26.11.2008).
  This regulation regulates the conditions, method and procedure of participation of the public during the drafting of regulations and other acts, as well as plans and programmes in the area of the environmental issues, types of plans and programmes on environmental issues, method and procedure of participation of the public in the drafting, adoption, amendments and revision of plans and programmes, as well as the method and criteria used to define the public, including the non-governmental organizations.

Relevant legislation connected with the Project:

- Law on waters (Official Gazette of RM no.87/08, 6/09, 161/09, 51/11, 44/12, 163/13):

  This law regulates the issues relating to surface waters, including the existing water courses or water courses with no permanent / occasional water content, lakes, accumulations and sources, ground waters, coastal land and water habitats and their management, including distribution of waters, protection and conservation of waters, as well as protection against the hazardous effects of waters; water management facilities and services; organizational arrangement and financing the water management, as well as the conditions, method and procedures used for water release. Water management is an activity/area of public interest. All measures, standards and aims of the environment are applied as minimum requirements that should be met in the water management. The application of measures should not directly or indirectly lead to increased pollution of the media and areas of the environment or reduction of the existing quality of waters.

  - Regulation for the classification of surface waters (Official Gazette of RM no. 99/16):
    This Regulation is used for classification of surface waters (watercourses, lakes and accumulations).
  - Regulation for categorization of water courses, lakes, accumulations and ground waters (Official Gazette of RM, no 18/99 and 71/99):
    Natural and artificial watercourses, sections of the watercourses, lakes, accumulations and ground waters, whose waters based on their use and the degree of

clarity, are classified into classes following the Regulation on classification of waters, dividing them into 5 categories. The category I includes watercourses whose waters must comply with the criteria for I class, category II connected with the conditions for class II, category III with the conditions for class III, category IV with the conditions for class IV, while category V includes the watercourses whose waters must comply with the conditions of class V.

- Rulebook on the criteria for defining the zones sensitive to the issue of release of the urban waste waters (Official Gazette of RM, no. 130 dated 29.09.2011):
  The aim of this Rulebook is control of the emissions released in the bodies of water and protection of the environment from the hazardous impact of the released urban waste waters. Zones sensitive to the issue of release of urban waste waters can be sensitive and less sensitive, which is defined in accordance with the quality of the water body, the use of the water of that water body and its natural features and characteristics.
- The Rulebook of the conditions, method and limit values for the emission of the waste waters release after their treatment/purification, method of calculation/measurement, having into account the separate requirements for the protection of the protected zones (Official Gazette of RM, no 81 dated 15.06.2011):
  The aim of this Rulebook is control of the emissions and protection of the environment against the hazardous effect of the released waste waters.
- Rulebook of the method and procedure of the utilization of the sludge, maximum values of concentration of hard metals in the soil where sludge is used, values/quantities of concentration of hard metals in the sludge, considering its use and maximum annual quantities of hard metals that can be tolerated in the soil (Official Gazette of RM no. 73 of 31.05.2011):
  Provisions of this Rulebook refer to the sludge of the waste water treatment stations for the urban waste waters and other treatment/purification stations, treated waste waters whose structure is in compliance with the requirements of the urban waste waters; sludge from the septic tanks and other appropriate methods of purification of waste waters; the remaining sludge, that is layers, from other forms of waste water treatment.
- Rulebook on methodology, reference measurement methods, manner and parameters of monitoring of the waste waters, including the sludge from the treatment of the urban waste waters, Official Gazette of RM, no. 108 dated 12.8.2011
- Rulebook on the layout and content of the application form and the approval for use of sludge as well as the method of issue of the approval for the use of sludge, Official Gazette of RM, no. 60 dated 27.4.2011
- Rulebook on the form, content and manner of provision of the data and the type of information for use of the sludge after the treatment of the urban waste waters, depending on its use, treatment, structure and place of its use, Official gazette of RM, no. 60 of 27.4.2011
- Rulebook of the detailed requirements for the collection, transport and purification, method and conditions for project design, development and exploitation of systems and stations for the purification of the urban waste waters, as well as technical standards, parameters, standards of emission and norms for quality for pre-treatment, elimination and purification of waste waters, having into account the load/complexity and the method of purification of the urban waste waters which are released in the areas sensitive for release of urban waste waters (Official Gazette of RM no. 73 dated 31.05.2011):

The aim of this Rulebook is control of the emissions and protection of the environment from the hazardous effect of the released urban waste waters.

- Rulebook on the detailed conditions, manner and maximum accepted quantities and concentrations of parameters of the purified waste waters for their re-use (Official Gazette of RM, no 73 dated 31.05.2011):
- Rulebook on the hazardous materials and substances and their emission standards that can be released in the sewage or in a system for draining/outflow in surface or groundwater bodies, as well as coastal areas and water habitats (Official Gazette of RM 108 of 12.08.2011):
  The aim of this Rulebook is reduction and control of the emissions and environmental protection from the hazardous effects of the release dangerous and hazardous materials and substances in the waste waters, as well as prevent and / or stop and reduce the water pollution with the dangerous and hazardous materials.
- Rulebook on the method of transfer of information of the monitoring of the released waste waters and the form and content of the form used for the data submission (Official Gazette of RM, no108 dated 12.08.2011):
  The aim of this Rulebook is through transfer of information from legal entities and natural persons to gather information for the purposes of presenting the factual situation of the body of water - recipient of the waste waters. Transfer of information consists of a set of activities used for evidencing, provision and exchange of information based on processed and systematically presented data from the measurement of the quality and quantity of the waste waters and the reports from the measurements run in the form of a diary.
- Rulebook on the methodology, reference measurement methods, manner and parameters of monitoring of the waste waters, including the sludge from the cleaning of the urban waste waters (Official Gazette of RM, no. 108 of 12.08.2011):
  The aim of this Rulebook is control of the emissions and protection of the environment from the hazardous effects of the released waste waters.

❖ Law on the drinking water provision and discharge of urban waste waters (Official gazette of RM no. 68/2004, 28/2006 and 103/2008):
This Law regulates the conditions and the method of provision of drinking water, ceasing of the provision of the drinking water and discharge of urban waste waters in the recipient through the water supply and sewage system, the construction, maintenance, protection and connecting to water supply and sewage systems, relations between the provider and the user of the service, as well as supervision over the implementation of this law. The objectives of the Law include: availability of sufficient quantities of safe and clean water for drinking, for the needs of the service beneficiaries, in accordance with the requirements, standards and the values of water quality; supply of safe drinking water, and in cases of its contamination, prohibition or limiting it use; appropriate information dissemination regarding the quality of the drinking water and taking measures for provision of quality of the drinking water; appropriate treatment of the industrial waste waters before they are released into the recipient and through conducting away the urban waste waters, to enable protection from the negative effects of their release.

❖ Law on Water management / water economy (Official Gazette of RM no. 51 dated 31.03.2015):
This Law regulates the management, use, functioning and maintenance of the hydro systems, irrigation systems and draining systems. The aims of this law include: provision of economic management, utilization, functioning and maintenance of the hydro systems, irrigation and draining systems; defining of the scope of services

provided to the water recipients by the institution in charge of the water management; establishing conditions for normal and successful work of the institution in charge of the water supply activity and use of its services by the water beneficiaries and establishing a shareholding company with public ownership AD Vodostopanstvo, R. Makedonija.

- Law on quality of the ambient air (Official Gazette of RM. 67/04, 92/07, 35/10, 47/11, 51/11, 100/12,163/13):
  This Law regulates the measure for avoiding, prevention or reduction of the hazardous effects from the pollution of the ambient air on human health, as well as the environment as a whole, through defining borderline and target values for the quality of the ambient air and thresholds necessitating alarming and thresholds necessitating information, borderline and target values for emissions, formation of a sole system of monitoring and control of quality of the ambient air and monitoring of the sources f emission, a comprehensive system of monitoring with the quality of the ambient air and sources of emissions, information system, as well as other measures for protection against some activities of the legal entities and natural persons that have direct or indirect impact on the quality of the ambient air.

- Law on wastes management (Official Gazette of RM no. 68/04, 71/04, 107/07, 102/08, 134/08, 09/11, 51/11, 123/12, 163/13):
  Waste management is an activity of public interest. This law regulates the management of the waste; principles and aims for the waste management; plans and programmes for waste management; rights and responsibilities of the legal and natural persons regarding waste management; requirements and responsibilities of the legal and natural persons producing products and packages which after they have completed their life cycle represent a burden on the environment; method and conditions used for collection, transport, treatment, storage, processing and disposal of the wastes; import, export and transit of the wastes; monitoring; information system; financing and supervision over the waste management.

- Law on protection from the environmental noise (Official Gazette of RM, no. 79/2007, 124/10, 47/11, 163/13):
  This law regulates the rights and responsibilities of the Republic of Macedonia, the municipality and the city of Skopje, as well as the rights and responsibilities of the legal and natural persons in terms of the environmental noise management and protection against the environmental noise.

  - Decision for defining in what cases and under what conditions it is regarded that the peaceful environment of the citizens has been disturbed from a dangerous noise. (Official Gazette of RM, no. 1 dated 01.01.2009)
    This decision defines the cases and conditions where it is identified that the peaceful environment of the citizens has been disturbed from a dangerous noise.
  - Rulebook on the borderline values of the levels of noise in the environment (Official Gazette of RM, no. 147 dated 26.11.2008)
    This Rulebook defines the borderline values for the level of noise in the environment.

- Law on nature protection (Official Gazette of RM no. 67/04, 14/06, 84/07, 47/11, 148/11, 163/13):
  This law regulates the protection of the environment through the protection of the biological and geographic diversity and protection of the natural heritage, in the protected and outside the protected areas, as well as the protection of the natural rarities. Protection of the environment is an activity of public interest.

- Law on spatial and urban planning (Official Gazette of RM, no. 51/2005, 55/13, 163/13, 42/14)
  The spatial and urban planning is a continuing process covering drafting, adoption and implementation of a spatial plan and urban plans in order to enable and humanization of the area and protection and improvement of the environment and the nature. With the spatial and urban planning, basic principles are defined in the process of planning and space management.

2.3 EIA process

EIA for the proposed projects is applied in the Republic of Macedonia in accordance with Articles 76-94 from the Law on environment passed in June 2005 as well as its amendments (Official Gazette of RM no. 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/13, 187/13, 42/14, 44/15, 39/16). According to this Law, Project refers to e development document used to analyse and define the final decisions for use of the natural and created values, and it also includes construction of facilities and installations as well as implementation of other activities with impact on the environment, the area and the human health.

The types of projects necessitating EIA are identified in accordance with Article 77 of the Law and they are precisely defined by the Government of the Republic of Macedonia in the Regulation for identifying the projects and criteria used as a basis for identifying the need for the procedure for environmental impact assessment (Official Gazette of RM, no.89/05). Approval for project commencement in Republic of Macedonia is granted in a form of approval for construction and/or other required approvals (such as approval for waste management etc.).

In accordance with the Directive for EIA, projects are classified into two groups: for all the projects contained in Appendix I EIA is compulsory, while for each of the projects of Appendix II procedure will be implemented to identify the need for the EIA process. These appendixes of the Directive are transposed in the Macedonian legislation through the previously mentioned Regulation. The public and the relevant stakeholders/interested parties will be consulted for the EIA. These requirements i.e. conditions have been incorporated in the Law on environment.

The overall EIA process contains three specific stages:

1. Procedure for identifying the need for EIA of the proposed project ("screening")
2. Defining the scope of the EIA ("scoping"), and
3. Drafting a report on the appropriateness of the study on the environmental impact assessment to see whether the quality of the study is acceptable and whether it meets the legal requirements ("review").

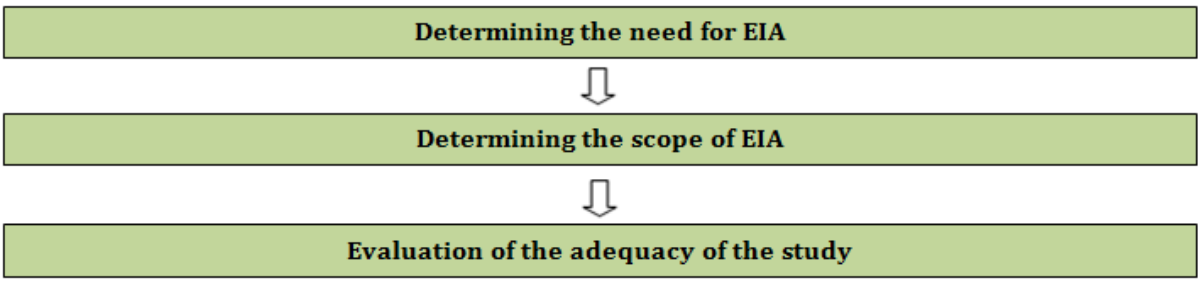


Figure 2 Procedure for identifying the need, scope and quality of the EIA

I phase Identifying the need for EIA

Identifying the need for EIA („screening“) is a stage from the process environmental impact assessment in the course of which the state administration authority in charge of the environmental issues in R. Macedonia identifies whether EIA is required for a proposed project after it obtained notification on the intent for project implementation. This identifying the need is a legal requirement in accordance with Article 80, item 5 of the Law on environment.

Identifying the need for EIA is in accordance with the provisions of the Law on environment prescribing the following requirements: Law on environment requiring the following: prior to the approval for the intent to realize a project, projects for which there is probability to cause significant impact on the environment as a result of their character, scope and location are subjected to assessment of their potential environmental impact.

The graph on figure 3 represents the basic elements of the required steps and contents of the procedure for identifying the need for EIA.

In accordance with the provisions, the investor submitted the notification on the intent for the project to the competent authority. The content of the notification is in accordance with Article 2 of the Rulebook of the information required in the notification on the intent for the project implementation and the procedure for identifying the need for environmental impact assessment.

The Project for the Construction of sewage collection system rehabilitation of the sewage network and waste water treatment plant in Bitola is contained in Appendix 1 of the Regulation for identifying the projects and criteria used to identify the need for implementation of the procedure for the environmental impact assessment (Official Gazette of R. Macedonia, no. 74/2005):

Appendix 1 Projects for which environmental impact assessment is compulsory

Item 11 Waste water treatment plant, with the capacity of over 10.000 inhabitants.

Considering the characteristics of the project and its coverage by the EIA Regulation, for the proposed project it is compulsory that the procedure should be executed for the environmental impact assessment and Study completed on the environmental impact assessment, for which Decision is obtained from the competent authority, which is used to identify the need for environmental impact assessment (Appendix 1).

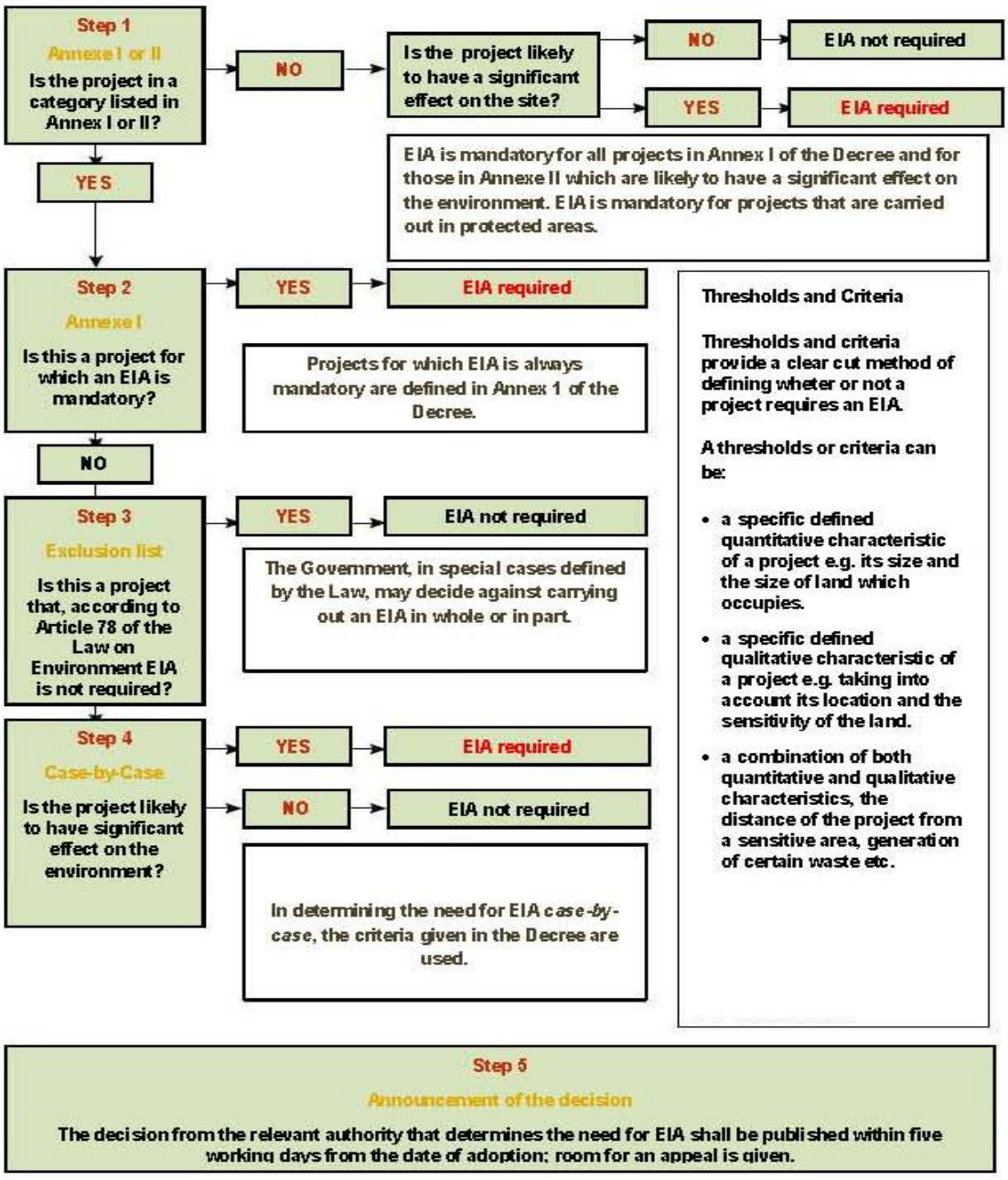


Figure 3 Basic procedural elements and content for the EIA procedure

Source: *Guidelines for implementation of the procedure for defining the need, scope and review of the environmental impact assessment in the Republic of Macedonia*

II phase Defining the EIA scope

The phase for identifying the scope of the EIA is a process in which the institution from the state administration in charge of the environmental issues defines the content and scope to be covered by the report for the study for the environmental impact assessment, in accordance with Article 8 of the regulation and the submitted letter of intent, and issues a decision for the scope of the EIA which is described to the investor. The aim of the phase on defining the scope

of the EIA and the opinion on the scope of the EIA is to inform the investor on issues that should be covered in the final report of the study of the EIA.

EIA is a process with the following requirements: before the decision for approval or rejection of implementation of a proposed project, projects envisioning activities with significant potential impact on the environment, as a result of their character, scope or location, should be subjected to assessment in terms of the influences.

Within this process, the phase in which problems to be assessed and the scope is a phase of „defining the scope of EIA".

In the reporting, the investor can also request opinion regarding the scope of the EIA study, for which the competent institution provides its opinion used as a basis for this study. Considering the fact that the Project is included in Appendix 1 of the EIA Regulation, together with the letter of intent a request was submitted for defining the scope of the EIA, as well as other issues connected with the characteristics of the project.

The scope of the project includes the activities for the construction of the sewage collection system, rehabilitation of the sewage network and construction of wastewater treatment plant in Bitola.

Defining the scope of the potential significant impact on the environment aims at answering three principal questions:

1. What is the possible environmental impact of this project?
2. What types of impact would be most significant and as such require special focus in the EIA study?
3. Which alternatives should be taken into consideration in the provision of proposals for the project?

The Decision defining the need for the EIA of the competent authority also includes the needed scope of the study, also defining the guidelines for the study.

2.3 Methodology of work

This Study has been completed in accordance with the guidelines and requirements of the relevant Macedonian legislation on environmental issues, national guidelines and the best international experience in this area, contained in the reference guidelines of different countries in the world.

The study of the environmental assessment has been prepared by a team of experts with relevant experience in environmental issues led by an expert in environmental impact assessment, in charge of the study. The team includes specialists in different areas relevant for the subject of this project:

- Expert in environmental impact assessment,
- Expert in hydrology,
- Expert in waste management,
- Expert in biological and geographic diversity,
- Expert in environmental odour management,
- Expert in environmental management,
- other external experts in environmental issues.

The Study covers all the environmental issues, focusing on the issues underlined in the decision obtained from the competent authority. Additionally, for the needs of the Study, specialized laboratory analyses and field research have been made in order to identify in detail and from

professional aspect part of the relevant issues of the Study (quality monitoring of the surface waters and ambient noise, observation and research of the area in question in terms of the biodiversity etc.)

In the process of drafting the Study, three stages of activities can generally be underlined:

- ***Data gathering and analysis - study on the basic state of the environment***

  During this stage relevant sources of data were identified on the environment, location and activities, previous studies and other documents, relevant national and local strategic documents on environmental issues and other issues connected with the subject matter of this project etc. Observation has been completed on the area in question by experts involved in the study regarding individual issues. Quality monitoring of surface waters and ambient noise has been completed. These methods have been used to assess the environmental quality and situation with the media and areas of the environment.

- ***Completion of the Study on environmental impact assessment***

  Having into account the basic state of the environment as a reference point, environmental impact assessment has been completed to assess the impact of the implementation of the proposed project for the Construction of the collection system, rehabilitation of the sewage network and construction of waste water treatment plant in Bitola. The Study was completed in accordance with the guidelines of the relevant by-law defining the content of the study (Rulebook on the content of the criteria to be met by the study for the environmental impact of the project (Official Gazette of RM no. 33/2006)). Based on the assessment, plan of proposed measures has been generated for prevention and control of the impact, as well as monitoring plan for the following of the implementation of measures and plan for monitoring the work of the landfill/garbage dump and its impact in course of the operational stage. During the drafting of the study, numerous national and international reference guidelines were used for this type of projects from relevant institutions for the environmental protection.

- ***Consultation and completion***

  During this phase, in accordance with the procedure requirements, intensive consultations will be made with the public. All the obtained relevant comments will be considered and incorporated in the study.

  Considering the opinion of the interested public, as well as the opinion of the organs included in the procedure, the competent authority will draft its opinion via report on appropriateness, which should result in a decision for approval of the study. The requirements for the decision issued by the competent authority are a compulsory responsibility to be implemented by the investor.

2.4 Participation of the public

Participation of the public in the procedure of the EIA is regulated with the Law on environment (Official gazette of RM 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11) and with the international conventions signed and ratified by the Government of the Republic of Macedonia. The practical participation of the public is executed through: a) publicizing the information to the general public; b) participation of the public, where the public can be actively involved in the public debates and invited to provide its opinion in the different stages of the procedures of EIA; c) through the mechanism of the accessibility to the justice system, when the public can influence the decision making through submission of complaints to the court or to the secondary commission of the government. There are several levels of involvement of the public, such as: information dissemination, consultation, participation and negotiation

(discussion with relevant arguments) and they are a part of the national legislation and practical daily work of assessment.

Following are the main objectives expected with the involvement of the public:

- To gain local and traditional knowledge that can be useful for the decision-making;
- To help in considering possible alternatives and measures for alleviation;
- To ensure that major impacts are not neglected, while the benefits are maximum;
- To reduce the conflict through early identification of the problematic issues;
- To enable the possibility for the public to be able to influence the design of the project in a positive manner (by creating the sense of ownership for the project);
- To improve the transparency of the overall process for EIA and increase the confidence among the public for the overall process.

During the procedure, the interested public is involved in the process in every stage in several ways. On the web page of the Ministry of environment and spatial planning and daily newspapers, the public is informed about the whole procedure while given an opportunity to express their opinion. Regarding the approved and publicized decisions, the public can submit complaints. It is compulsory that the public has an insight, and in that respect it has an entire insight into the whole study, and can provide its opinion or comments, suggestions, questions. In the public debate it is involved directly with questions and comments to the competent authority, investors and everyone involved in the procedure.

Participation of the public in the procedures for the EIA in cross-border context is regulated with the requirements of the national legislation on notification and participation of the public where the project or the plan-related document is planned to be implemented, or it is regulated with bilateral agreements between the countries providing the necessary details.

The notification on the intent for implementation of the project is publicized on the web page of the Ministry of the environment and spatial planning together with the decision for the need of EIA for the project (link).

The figure below represents a graph of the process of EIA and participation of the public within the individual phases of the process.

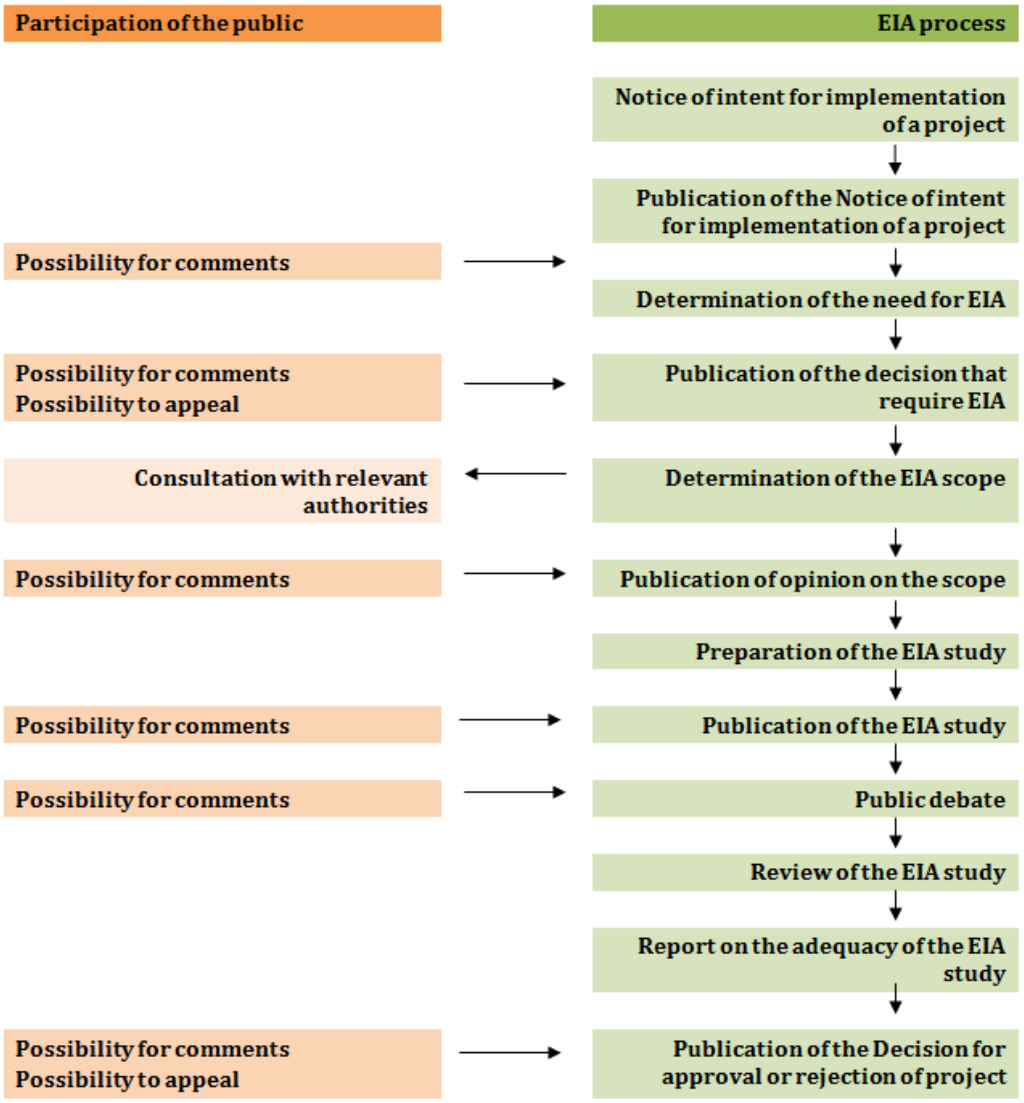


Figure 4 EIA process and participation of the public

2.5 Liability in case of damage

Chapter XVI from the Law on environment covers the responsibilities of the stakeholders of professional activities defined by individual by-laws[1] and their liability in cases of damage to the environment as a result of the activity implementation.

In accordance with this Rulebook, the activities for release of waste waters in surface waters from the waste water treatment plant, which represent a project component, are covered in this by-law:

> Item 3: Activities related to release of waste waters to surface waters, which are subject to license for release in accordance with the Law on waters.

[1] *Rulebook of the professional activities which during their execution might create a situation of liability for environmental damage, criteria for identifying environmental damage, as well cases that do not imply liability for environmental damage (Official Gazette of RM, no.31/11)*

Environmental damage is any damage affecting the following:

- Protected species and natural habitats, which has significant negative impact on the attainment and maintaining of the beneficial status for the conservation of these habitats and species.
- waters, which has significant negative effects on the ecological, chemical and/or quantitative status and /or ecological importance of the waters in accordance with the Law on waters and regulations approved thereof, and
- soil with its contamination, causing significant risk for the human health as a result of direct or indirect application of substances, preparations, organisms and microorganisms in, on or under the soil.

Restitution/Indemnification, including natural and monetary, in terms of liability for a damage to the environment, includes damages to waters, protected species and natural habitats, is return to the affected natural resource and its function in its normal/original state and in terms of damage to soil, it is elimination of every significant risk that can have negative impact on the human health.

Costs, in terms of liabilities for a damage to the environment, refers to all the costs needed for appropriate and effective coverage and indemnification for the overall damage, including the costs for assessment of the damage and the immediate threat of damage and other related activities, as well as the administrative, legal and other costs for implementation, costs for data collection, monitoring, supervision and other costs.

The aim of the concept of liability for a damage caused to the environment, based on the principle "the contaminator pays", is prevention and remediation of the overall damage caused to the environment and introduction of measures and practices to minimize the risk of the damage to the environment.

In view of these liabilities, if the environmental damage has not occurred yet, but there is immediate threat of damage, the operator is obliged immediately and without delay to take all the necessary measures for prevention of any environmental damage. If after the measures taken the operator failed to remove the immediate threat for environmental damage, he/she is obliged to immediately and without delay inform the organs of the state administration in charge of execution of the environment – related activities.

In case of an environmental damage, the operator is obliged:

- regarding the damage caused to inform the organ of the state administration in charge of the environmental issues,
- to provide restitution/indemnification for the entire damage caused, in accordance with the principle "the contaminator pays",
- to take all the necessary measures for control, retaining, elimination or other type of managing the factors that cause the environmental damage in order to limit or prevent further damage to the environment, negative impact on the life and health of people and negatively affecting the functioning of the natural resources, and
- to take all the necessary measures for remediation defined in accordance with appropriate by-laws[2].

Activities under this project include professional activity subjected to the above forms of liability from the Law on environment. The management and each possible damage of this activity will be regulated with the mechanism defined with the provisions for liability in case of environmental damage.

[2] *Rulebook on measures for remediation/indemnification in case of caused environmental damage (Official Gazette of RM no. 31/11)*

2.6 Further project activities in accordance with the legislation on environmental issues

Spatial and urban planning

To enable conditions for construction, it is necessary that the selected location for the future waste water treatment plant should be urbanized. For that purpose, the next step will be planning documentation for the urbanization of the land parcel, as a basis for the later construction approval.

Waste water discharge permit

For the purposes of realizing the public interest in use of waters, as well as for realization of the rights and responsibilities of the legal entities and natural persons to use and release waters, the right for utilization of waters from the water bodies and the right to release water in the water bodies, a water-use entitlement is provided for the legal and natural persons under conditions and in a manner set out in the Law on waters (Official Gazette of RM, no.87/08, 6/09, 161/09, 51/11, 44/12, 163/13, 180/14).

The holder of the water-use entitlement can be a national or foreign legal or natural person, including the organs of the state authorities and municipal authorities, in municipalities in the city of Skopje, under conditions and in a manner defined by Law.

A legal or natural person obtains the water-use entitlement on the basis of the approval to utilize waters and the approval to release water in other waters.

Activities related to release in waters and release and disposal of materials and substances in surface waters is an activity that affects and can affect the regime of waters and/or morphology of the water body.

For execution of the activities for release in waters and release and disposal of materials and substances in the surface waters, it is necessary to obtain an approval for release in the water.

The organ of state administration competent for the activities related to the environment issues the approval for release in water on previous request by a legal or natural person. The issue of the approval is in accordance with the provisions of the Law on waters.

In accordance with the above provisions, the operator of the future waste water treatment plant is obliged to obtain permit for discharge into waters.

3 DESCRIPTION OF ALTERNATIVE FORMS FOR PROJECT IMPLEMENTATION

The term „alternative forms“ refers to other methods which the investor can use to realize the project, in a way in which the environmental impact will be reduced. They are similar to the „measures for reduction of impact“, which represent alternative methods of implementation of the envisioned activities, where the significant negative environmental impact is avoided, reduced or remediated.

Alternative forms may vary ranging from a policy-making strategy to a detailed project design, or alternatives recommended in the Guidelines of the European commission for defining the scope, including:

- Alternative strategies (e.g. to manage the demand or reduce the loss, instead of developing a new resource);
- Alternative locations or routes for the entire project or part of the project (e.g. avoiding industrial vehicles through residential areas);
- Alternative technologies and raw materials (e.g. construction of power station, gas turbine with combined cycle instead of coal-based thermo station);
- Modified layout or plans (e.g. locating the noisy activities far from sensitive receptors or replacement of a large chimney with gas emissions with two smaller chimneys);
- Alternative measures for reduction of the environmental impact (these measures can be incorporated in the main design, for example, development of migratory paths for ensuring safe passage of wildlife through a highway, instead of creating a compensatory habitat).
- The Alternative „absence of project” or „zero” alternative must be regarded as factual (basic) state versus a state where the environmental impact of the proposed project should be further analysed. This may include changes regarding the current situation as a result of other activities in the neighborhood and changes in the conditions of the environment.

Types of available alternatives of one investor depend on the status of the investor (public operators/investors are provided with more alternatives) and on the type of activity. Generally and most often alternatives are considered on two levels, considering the location and technological aspects.

The project for construction of sewage collection system, rehabilitation of the sewage network and construction of waste water treatment plant in Bitola is a result of previously prepared extensive project and technical documentation on water management in the agglomeration Bitola. This documentation also considered the alternative forms, both in terms of location of the future waste water treatment plant, and the technical-technological characteristics of the process for the treatment and collection/sewage systems.

3.1 „Zero” alternative

“Business as usual”, “do nothing” and “do minimum” alternatives are fairly similar to one another. “Business as usual” refers to continuing the status quo situation. “Do nothing” alternative refers to taking no activity. When it comes to a new activity, the forms “business as usual” and “do nothing” are equal. When an activity already exists or is subject to modifications, “do nothing” alternative is possible. “Do minimum” option represents a situation of minimum maintenance of the existing resources.

“Do-nothing” scenario or null alternatives refers to the way in which the environmental conditions will change over time without implementation of the plan, i.e. like there is no project.

The aim is to identify the current state of the environment, against which the potential effects from the project implementation can be estimated. The environmental impact of the project can be estimated as a difference in the conditions of the environment with and without implementation of the project. "Do-nothing" scenario means continuation of the current trends without any changes or infrastructure improvements that would take place as proposed project activities. The situation without project implementation means future on the area of the project without implementation of the planned activities, i.e. continuation of the existing situation.

Situation like this can be viewed from several points. The most significant is the aspect of the environment implying:

- Continuing the situation of deteriorated quality of surface waters as recipients of communal waste waters, which lead to deteriorated quality of the ground waters connected with recipients,
- Continuing the situation of deteriorated living conditions for the total biodiversity and ecosystems in the surface waters of the recipient,
- Deterioration of the situation with the quality of surface waters and ground waters, as well as biodiversity of the recipient over time.

There are other equally significant aspects, such as economic aspects connected with the following expectations in a null alternative:

- Limited development of the municipality,
- Slowdown of the economic development of municipality,
- Reduced value of the farmers in the region,
- Region less attractive,
- Location and municipality less attractive,
- Stagnation in terms of attractiveness of location, leading to financial benefit for the municipality and the state.

As well as the social and health aspects:

- Non-hygienic conditions in non-existence of organized method of collection of waste waters,
- Continued probability for health problems connected with non-hygienic conditions
- Limited access to sewage,
- Old network and related problems,
- Lower quality of life in the region.

3.2 Location aspects

During the process of drafting the future WWTP and preparation of technical documentation, in cooperation with the representatives from the municipality several location options were considered and discussed in order to select the most suitable one. The selection of the most appropriate location for the future WWTP was based on the application of several selection criteria:

- Settled property and legal relations,
- Sufficient area on the location,
- Distance from sensitive zones (residential areas, medical and educational facilities etc.),
- Favorable communal and energy infrastructure,
- Proximity to the recipient for release of treated waters,
- Favorable status in terms of protected areas in accordance with the Law on nature protection,
- Favorable transport infrastructure.

The process of considering alternative locations resulted in a selection of three locations that were additionally analyzed in detail in terms of their advantages and disadvantages. The table below summarizes the selection of the most appropriate location.

Description of alternatives

Alternative 1:

Description of location	- East from Bitola, on the way to the village of Logovardi, in the proximity of the city
Advantages	- The majority of land is state-owned, - Good infrastructure connection - Close to the recipient
Disadvantages	- Insufficient area for construction (around 6 hectares) - Partly in ownership of natural persons

Alternative 2:

Description of location	- North of Bitola in the vicinity of the new cemetery, between the villages Dolno and Gorno Orizari (cadastre details KP 25, KO Bitola 5)
Advantages	- State-owned land - Sufficient area for construction (55 hectares) - Good infrastructure connection - Close to the recipient - Sufficient distance to the residential areas - Reduction of costs for construction of collectors
Disadvantages	

Alternative 3:

Description of location	- East from Bitola in the vicinity to the way to the village of Logovardi, cadastre details (КР 855/1 и 193)
Advantages	- State-owned land - Sufficient area for construction (25,8 hectares) - Good infrastructure connection - Sufficient distance with the residential facilities
Disadvantages	- Far from the point of release - Significant funds for construction of collectors

Table 1 Summary of the comparative analysis of the three alternative locations for all the envisioned selection criteria

Criterion	**Alternative 1**	**Alternative 2**	**Alternative 3**
Settled property and legal relations,	1	3	3
Sufficient area on the location	1	3	2
Distance from sensitive zones	2	3	2

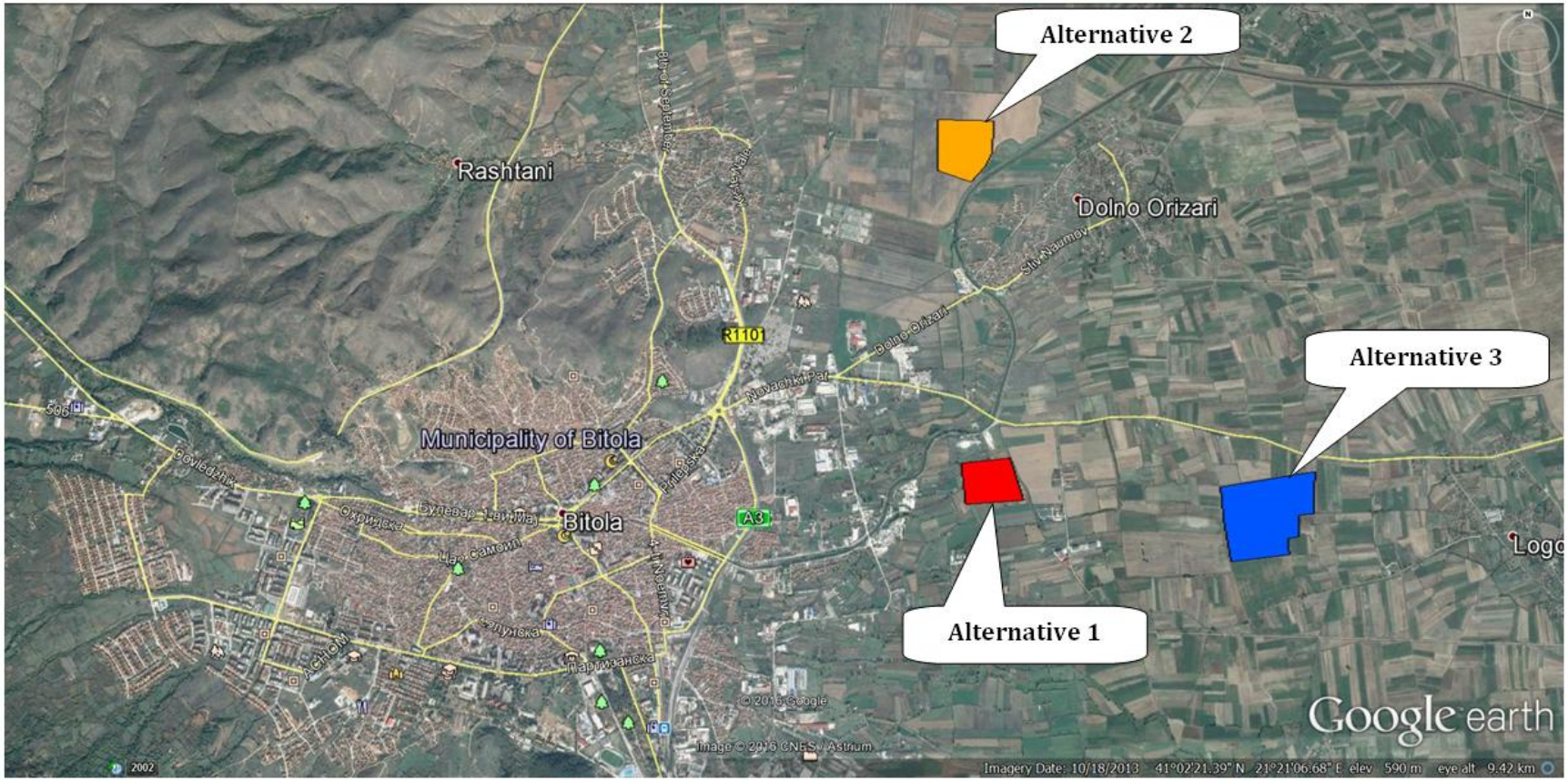
Criterion	Alternative 1	Alternative 2	Alternative 3
(residential areas, medical and educational facilities etc.)			
Favourable communal and energy infrastructure,	3	3	3
Proximity to the recipient	3	3	1
Favourable status in terms of protected areas in accordance with the Law on nature protection,	2	2	2
Favourable transport infrastructure	2	3	3
Average value	**2**	**2,86**	**2,29**
Rank	**3**	**1**	**2**

Table 2 Scoring system

3	2	1
Acceptable	Acceptable with reservation	Unacceptable

Based on the analyses, alternative 2 was selected as most eligible for the future WWTP.

Figure 5 Map of the locations considered for the project



3.3 Technological aspects

3.3.1 Alternatives considered

3.3.1.1 Alternatives for the collection and sewage networks

Water supply and sewage

In order to overcome the problems in the sector of water supply in the Bitola agglomeration / catchment area, the technical and project documentation assesses the key problems which if overcome will result in the quality improvement of the services in the water supply and sewage networks for the population. The requirements for the national legislation and the EU legislation have been analysed and varied forms of investment alternatives proposed. Different technical approaches were analysed referring to the measures and parameters for their implementation.

Following methods were used for the assessment of the alternatives:

- Different alternatives for the development of the water supply and sewage network in the agglomeration, depending on the level of development of the residential areas.
- Evaluation of different options for replacement of the old water supply and sewage networks – based on the available information on their state, leakage and other problems etc.
- Capacity of the municipality of Bitola, public enterprises JKP "Vodovod" and JKP "Niskogradba" for financing of the current significant investments in the water supply and sewage sector in Bitola. For that purpose analysis was made on the capacity of JKP "Vodovod" and JKP "Niskogradba" to generate income for the entire 25-year period.

The selection of alternatives of the identified major objective and the additional four objectives is aimed at:

- Complete coverage of the demand for high quality water, conservation of the current water resources through comprehensiveness of the water supply network, with projects for reconstruction/ replacement/ construction, which will result in the quality improvement of the supplied drinking water, reduction of the loss, improvement of the pressure in the water supply pipes.
- Connection of the entire population and businesses from the agglomeration with the sewage network, through implementation of projects for reconstruction / replacement / construction of sewage network and connection with the future WWTP which is expected to result in the highest level of protection of the soil and the ground waters.
- Treatment of the overall quantity of waste waters in the WWTP, in accordance with the requirements and conditions set out in the Macedonian and European legislation.
- Provision of better services to the beneficiaries with socially acceptable price, through measures taken by JKP "Vodovod" and JKP "Niskogradba" and in investments in the infrastructure and improvement of the efficiency and effectiveness of the services.

Alternatives for technical solutions of Main Collectors, the sewerage network directed to it and pumping stations

As aforementioned the main purpose of the present paper is to review and propose solution and alternatives for construction of a collector system which shall collect and direct the wastewater from the City of Bitola, v. Gorno Orizari, v. Dolno Orizari and v. Kravari to the future WWTP. At the same time the proposed technical solution provides for investment measures aimed at reconstruction (redirection) of part of the existing sewerage network to insure the best possible use of the existing sewer system to avoid flooding situations during rain. The aim is as such to redirect catchments areas or part of those from one existing main collector to the new

suggested collectors. That will reduce the storm water to parts of the existing collector system where flooding situations now occurs.

The main rule which applies in design of the collector system is directing of wastewater by gravity wherever possible and in the shortest possible route to the main collector and future WWTP. Where configuration of the terrain does not allow gravity flow, pump stations have been envisaged.

Separation of the existing combined sewer system into separate systems for wastewater and storm water collection in the city centre was preliminary analysed. However, due to the very narrow streets and the significant size of the existing system this option was abandoned as not feasible. Future extensions of the wastewater systems in the Bitola agglomeration will be designed as separate systems.

Selection of pipe material for the new sewer pipes is based on Consultant's vast experience in design, construction and operation of sewer systems. Two types of pipes are considered: GRP for pipe diameters from Ø700 and above and PVC pipes for the smaller dimensions. Justification of selection is elaborated further in the chapters below.

Manholes are foreseen to be made from sulphate-resistant reinforced concrete with a cast-in-situ manhole base and precast reinforced concrete elements (riser sections DN 1000, cone section DN 1000/800, grade rings, cover plate and manhole cover DN 800).

To avoid future damages to the revision manholes, construction of side connections shall also be foreseen, which shall allow later connection of the existing and future sewerage from households. At locations with paved surfaces, side connections for the dwellings shall be properly marked.

Selection of pipes

In the last two decades, plastic pipes have been broadly applied compared to other types of pipes. The main advantages of plastic pipes are low cost, small weight (for small diameters ≤630), easy assembly; they do not break easily and are easy to cut. The weakness of these pipes is that they require significant compaction of the backfilling in the area around the pipe.

The main types of plastic used to manufacture sewer pipes is un-plasticised polyvinyl chloride (PVC-U), polyethylene (PE) and polypropylene (PP).

In Western Europe PVC pipes are mostly used. They have smooth external and internal surface, which ensures excellent conditions for moving quantities of wastewater. Practice shows that these pipes when used in gravity sewerage are easier to assemble and at the same time better adapt to the geodesic slopes established in the design, compared to the plastic pipes with corrugated walls. According to observations from video surveillance after the construction these pipes usually have minimum deformations, there are no open fittings and they are less dependent on the compaction of the backfilling compared to the pipes with corrugated walls. The reduced deformations of PVC pipes give a better hydraulic profile and the closed fittings gives a system where infiltration is heavily reduced.

In Eastern Europe since the beginning of the 21st century there has been a massive use of corrugated plastic pipes and currently they are the most often used pipes. Their wall comprises a small internal layer and outside corrugated layer. The pipes are manufactured by extrusion. Because of the use of vacuum during the manufacturing process the internal wall has a wave like surface. It creates less favourable hydraulic conditions for conducing wastewater compared to pipes with smooth internal surface. As known in sewerage networks is needed a continuous flow of insoluble particles in order to prevent their deposition which hinders normal disposal of wastewater, so the internal wavelike surface of plastic corrugated pipes creates conditions for deposition of mineral insoluble dirt (most often sand) which is heavier than water. In order to

prevent this, the water is required to move faster through the pipes, which on the other hand can cause faster wearing out in equal conditions compared to smooth pipes.

Placing corrugated pipes is more difficult because they are more flexible in the longitudinal direction; they do not adjust easily to the geodesic slope determined in the design. During the backfilling and the compaction process care should be taken not to deform the pipe, especially at the initial backfilling and compaction. During surveillance after finishing construction it was detected that the corrugated pipes have greater deformations compared to the pipes with smooth internal and external surface. In some cases, due to improper backfilling and compaction infiltration of ground water is visible, especially at open fittings, which requires repair.

Taking into consideration the facts mentioned in this elaboration, the sewer pipes up to a diameter of Ø630, is planned to be pipes and fittings manufactured of one layered dense polyvinyl chloride (PVC) and they need to meet the requirements of the standard EN 1401 "Plastic piping systems for non-pressure underground drainage and sewerage, un-plasticized polyvinyl chloride (PVC-U). Specifications for pipes, fittings and the system".

The greater the diameter of the pipes, the greater the thickness of the walls leading to heavier pipes. This on one hand makes it more difficult to place the pipes, and on the other hand it makes their production price higher. This is the reason why during construction of plastic pipeline systems, especially for bigger diameters, pipes of glass-plastic fibres are used. The main advantages of these pipes are their high density and as such difficult to be deformed, hydraulic smoothness, persistence to corrosion, resistance to abrasion, lower relative weight and low coefficient of temperature extension. All above mentioned qualities are a result of the quality materials and technology used for their production, and also of combining unsaturated polyester resins fortified with glass fibres and filling (sand). All this is done by using the method of centrifugal wall construction in the process of centrifugal casting (CC-GRP - centrifugal casting-glass reinforced (thermosetting) plastics).

The glass fibre plastic pipes are manufactured in a wide range of nominal diameters and have smaller growing rate at diameters larger than ≥Ø700 (at each 100 mm) compared to plastic pipes. In this way, when establishing the dimensions of the sewerage, the pipes can be more easily adjusted to the exact qualities of wastewater and to the hydraulic conductivity of the pipes. This means that the dimensions (diameters) of the sewerage pipes in the network will be changed less and savings will be made not only because of the price of the pipe, but also because of the width of the cutting and refurbishment of asphalt, excavation, backfilling etc. A special production based on a specific static dimensioning of CC-GRP type glass fibre plastic pipes further allows the pipes to be situated even without a dig (micro tunnelling).

In relation to what has been said in this elaboration, the dimensioning and the construction of the sewerage with a diameter of ≥ Ø700 is proposed to be made with CC-GRP type glass fibre plastic pipes manufactured with centrifugal casting of fiberglass in accordance with the standard EN 14364 "Plastic piping systems for drainage and sewerage with or without pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) - Specifications for pipes, fittings and joints".

Description of main technical solution and alternatives

The technical solution and alternatives elaborated with this paper is based on extensive field surveys and data analyses performed by the Consultant as well as the hydraulic model developed during the study.

The model was developed for three options: Option 2. Option 1a and Option 1b which are further discussed in this paper.

Common for all three options are the technical solutions for the sewerage network and collectors for Dolno Orizari, Kravari, Bukovski livadi (existing collector K0), Industrialna (existing collector K1), existing Jani Male collector and Gorno Orizari (existing collector K5), as well as the solution for the main feeding collector to the WWTP.

Main feeding collector shall be located east of Bitola. It is designed to collect wastewaters from village of Kravari, City of Bitola, Dolno and Gorno Orizari and in the future, as well from the village Bukovo through the existing Collector K0 and from village Karamani through the suggested pumping station "Dolno Orizari".

Starting point of the collector shall be planned at an existing manhole on collector K0, from where it continues by gravity to the WWTP. Before each connection of the side collectors, overflows on the side connections have been designed to ensure, during storm weather that more than five times diluted wastewater will be overflowed to the recipient. The five times diluted wastewater will during rainy weather be transported to the WWTP. The main feeding collector is with total length of 4,870 m, divided in three sections:

- Southern Sector constructed from PVC pipe with diameter 630 mm, and length of approx. 470 m and GRP pipe with diameter 1,000 mm, and length of approx. 1,580 m.
- Middle section constructed from GRP pipe with diameter 1,200 mm, and length of approx. 1,800 m.
- Northern Section constructed from GRP pipe with diameter 1,400 mm, and length of approx. 1,020 m.

Village Kravari is located south of Bitola at a distance of approx. 5.5 km. The village is almost fully covered with sewerage network currently discharging in 5th Channel through a collector Ø 450 mm. The technical solution foresees collection of the wastewaters from the existing gravitational collector right prior the existing outlet in 5th Chanel. The alignment of the collector starts approximately 100 meters before the outlet with new designed manhole which will divert the wastewaters towards the new foreseen Pressure Pump Station – "Kravari". Detailed specification for PS Kravari is provided in Chapter 7.1. of this study. From PS Kravari, pressured pipeline is foreseen with HDPE Ø160mm towards the connection point of collector K1 to the Main Feeding Collector at a distance of 3.45 km. With the application of this type of pressure pipeline, deep excavations shall be avoided and thus the investment value will be decreased and better flexibility will be provided with defining of the pipeline alignment in horizontal as well as vertical direction.

Existing collector K0 ("Bukovski livadi"): conveys the wastewater from the settlement Bukovski Livadi, a residential area south of Bitola, with predominant individual housing.

As the catchment area is combined an overflow chamber is foreseen constructed on the existing collector K0 prior the connection point to the Main feeding collector.

Existing collector K1 ("Industrialna"): conveys the wastewater from the southern part of City of Bitola and the industrial zone of Bitola. On the existing collector K1 an overflow chamber will be constructed ensuring that only 1+5 times diluted wastewater to be conducted to the Main Feeding Collector. The additional diluted water will be discharged to the existing collector leading to outlet no 2 to 5th Channel.

All wastewater from existing K1 will as such be gravitated to the WWTP through the main feeding collector. Additional to the already existing catchment areas further ARM 1 and 2 and Borimechka areas (separate sewer residential area) are included according to the Urban Planning document (catchment area no 31 and 32).

New gravity collector Kurdeles is designed to accept the wastewater from the existing collector K2, existing collector Solunska and existing collector Ulica 16 in City of Bitola. As the

catchment areas of the referred collectors are combined an overflow chamber is foreseen on ensuring that only 1+5 times diluted wastewater to be conducted to the Main Feeding Collector.

Existing Jani Mali collector: This collector will be connected to the main feeding collector through an overflow chamber to avoid diluted water more than 1+5 to be lead to the WWTP

Existing collector K4: This collector that collect the wastewater from the major part of Bitola City north of the Dragor River will be connected to the main feeding collector through an overflow chamber to avoid diluted water more than 1+5 to be lead to the WWTP.

Village Gorno Orizari is located north of Bitola at a distance of 5.5 km. The sewerage network at the village is almost entirely constructed. Storm water network is not constructed and drainage is not solved due to which during rainfalls part of the storm water enters the sewer system causing functional problems of the system. The sewer is constructed from PE pipes with Ø250 and Ø300 and concrete pipes with Ø350 and Ø400 and reinforced concrete manholes. Wastewaters from the village are discharged to Dragor River through an existing AC collector Ø800 at outlet located east of the village. Thus, the technical solution foresees reconstruction of the main pipe section up to the connection manhole to collector K5 with approx. length of 1,600 m. One overflow has also been foreseen with purpose of relief of the current load of the system. With construction of the overflow the total wastewater quantities envisaged at Qoverflow = 110 l/s shall be discharged in Rashtanska River through newly designed pipeline with approx. length of 100 m. Wastewaters from the village shall be transferred through the existing collector K5 Ø800 to the future WWTP. On this collector, an overflow chamber will be constructed to avoid diluted water more than 1+5 to be lead to the WWTP. At this stage reconstruction of the main collector is not envisaged, although in the future it might be necessary to increase the pipe diameter.

Village Dolno Orizari is located north of Bitola at a distance of approx. 4 km. 90% of the sewerage network has been constructed in the village. Storm water network is not constructed at all. Wastewaters from the village are discharged in Dragor River through an existing collector Ø400 at outlet located east of the village, nearby the bridge over Dragor River, before village Karamani. The sewer is constructed from PE pipes with Ø250 and Ø300 and concrete pipes with Ø350 and Ø400 and reinforced concrete manholes in length of approx. 12,000 m. Due to the high level of the underground water, dwellings are without basements, thus the level of the ground floors allow connection to the newly designed sewer.

With the new technical solution extension of the sewer network shall be provided, by construction of 5 new pipe sections with approx. length of 1,600 m.

The proposed extension of the sewerage network in Dolno Orizari is shown on Drawing No. 13-7.

Wastewaters from the sewer system shall be collected with a new collector which begins at about 100 m. before the outlet where new manhole is foreseen to divert the wastewaters to a Pump Station Dolno Orizari. Detailed specification for PS Dolno Orizari is provided in Chapter 8.1. of this study. From PS Dolno Orizari the collector continues as pressure collector with Ø225 to the future WWTP located at a distance of 1.95 km. Similar to Kravari, the solution with Pump Station and pressure pipeline deep excavations shall be avoided and thus the investment value will be decreased and better flexibility will be provided with defining of the pipeline alignment in horizontal as well as vertical direction. In the future, the pumping station will also receive wastewater from Karamani.

City of Bitola sewerage network and collector system

As aforementioned many structural problems have been reported in the sewerage system of City of Bitola. The same has been confirmed with the development of the hydraulic model for the city sewer network. The main reason for this is the specificity of the system which is predominantly constructed as combined sewer and as such cannot take the load of the rain water during rainy weather causing overflows in some parts of the city. Irregular maintenance of the network as well as the age of the pipes are also reasons for frequent clogging of the sewer. Given the current situation the Consultant has provided three design alternatives which are referred to further below:

Alternative 1 - Option 2

Collector Milutinovich on the left bank of Dragor River and Collector Ulica 16-ta on the right bank are the main collectors for the sewerage water generated in Bitola - the collectors with the biggest catchment areas.

The major problem which shall be considered as priority for investment is ensuring hydraulic flow of collector Ulica 16-ta. One of the options was to reconstruct collector Ulica 16-ta and reduce its catchment area trough redirection of the flows from existing K2 and K3 collectors to Collector Solunska. The rest of the catchment area of Collector Ulica 16-ta should still be dewatered to the collector in accordance with the existing technical solution but the Ulica 16-ta Collector to be reconstructed to transfer the collected design wastewater flows from the catchment area.

At the first site survey of the trace of collector Ulica 16-ta it was found that in the stretch along Nikola Rusinski street, the existing collector goes to a very narrow street and the buildings are at the border of the street regulation. The conclusion was that construction of a new collector with larger diameter of the pipe is risky for the neighbouring buildings and as such not recommendable.

Based on our analysis and to avoid the risk for the buildings damages, the people living on Nikola Rusinski Street and the constructor, our proposal is to reduce the wastewater quantities flowing through collector Ulica 16-ta without reconstructing the existing collector.

With the current situation, the wastewaters from Shirok Sokak street continue through Dimitar Ilievski – Murato str. up to Collector Ulica 16-ta. Thus, the proposed option foresees the wastewaters directed to Shirok Sokak to be redirected to the collector on Solunska str. In other words, the direction of the wastewater flow in Shirok Sokak to be reversed. To achieve this, the option foresees the wastewater quantities collected from the crossroad of the streets Shirok Sokak and Pece Matichevski to be directed to the south from the above stated crossroad to the crossroad with Solunska Street and will be connected to the collector Solunska where reconstruction has been envisaged in order to accept the increased wastewater amounts. Reconstruction of Collector Solunska is foreseen with GRP pipes in length of 812 m approx. diameter range from Ø700 - Ø1200 as well as extension in order to connect to the future Main feeding collector with length of approx. 375 m with diameter Ø1400. The length of the collector to be reconstructed on Shirok Sokak Street is 221 m with Ø1200 GRP pipe.

The design solution shall comply with the Detailed Urban Plan (DUP) for the Central City Area part 3, Block 10 and 16, which regulates the area on street Boris Kidrich. and the part in front of the House of Culture. According to the DUP, it is foreseen that the str. Boris Kidrich passes in the future under Shirok Sokak.

Therefore, the sewer at the intersection of Boris Kidrich and Shirok Sokak street must be lower than road level of the newly designed underpass, which entails also a greater sewer depth at the junction of streets Shirok Sokak and Solunska (at place named Kamen Most).

Considering the great depth of more than 7 m and the high groundwater level, micro-tunnelling method is recommended for the construction of the entire section of Shirok Sokak street with approx. length of 221 m. plus branch of Solunska street with approx. length of 135 m. Using this method, excavations are only envisaged at the places of the new needed manholes. Since there are three existing sewerage collectors on Shirok Sokak, in which the wastewater flows in opposite direction of the newly suggested collector, the existing house connections will remain connected to the existing sewer and additional excavations on the street will be avoided.

Further extension of collector Ulica 16ta has been envisaged with length of approx. 912 m to connect to collector Kurdeles which further conveys the wastewaters to the Main feeding collector to WWTP.

Wastewater from the city shall through collector Solunska and collector Kurdeles, be further transferred and connected to the Main feeding collector to WWTP. Collector Kurdeles is foreseen with length of 1286 m with diameter range Ø700 - Ø1600 m with gravity flow. Overflow chambers have been envisaged before the connection point of the incoming collectors from the city to the main feeding collector to WWTP.

In addition to the above connection of the existing collector K2 to collector Solunska has been envisaged, starting at the crossroad of Nikola Tesla street with 4th November Street and continuing north-east as Ø1400 in length of 290 m to the connection point with Solunska before the railway.

Because of the extensive reconstruction activities of the main collectors envisaged with this option, connection of the secondary collectors and sewer networks has also been foreseen to ensure connection of the existing households to the new reconstructed street collectors. In line with this and to ensure proper function of the existing sewer system during the construction works, pumping of the wastewater has been envisaged during replacement of pipes.

Collector K1 will continue to gravitate as it does today and will be connected to the Main feeding collector to WWTP.

Proposed new collectors and overflows as recommended in Option 2 were analysed by means of the hydraulic model.

Alterative 2 – Option 1a

Alternatively, the proposed solution for the collector system in Option 1A foresees the wastewater from collector Ulica 16-ta and Dimitar Ilievski - Murato to be redirected to the collector at Solunska street through 4th of November street.

The new section of the collector is foreseen from the junction between Nikola Tesla str. and Dimitar Ilievski Murato str. The new collector is led along Dimitar Ilievski - Murato Street with length of approx. 388 m with GRP pipe Ø1000. At the junction between Dimitar Ilievski str. And 4th of November str. the new collector continues along 4th of November str. with a length of approx. 462m with GRP pipe Ø 1600 to the junction with the collector at Solunska str. With this solution at the junction between Dimitar Ilievski – Murato str. and Poeshevo str. through an overflow manhole (redirection chamber), part of the wastewaters continues into the existing collector Ulica 16-ta along Poeševo Str. and Karposh str. and part to collector Solunska. With the new sewer section, hydraulic flow of the existing collector Ulica 16-ta will be ensured, bringing the total length of the new collector to 850 m. The collector section is envisaged with GRP pipes fr0m Ø1000 - Ø1600. Connection of the wastewater from the new section will result in change of diameter of collector Solunska where the existing pipe Ø800 shall be changed to Ø1600 with length of 227 m to the connection with K2 Collector. The total investment costs for Option 1a were estimated to be 4% higher (454,460 Euro) than the investment costs of Option 2 or 11,815,945 Euro.

Alterative 3 – Option 1b

Proposed solution for the collector system in Option 1b foresees the wastewater from collector Ulica 16-ta and Dimitar Ilievski - Murato to be redirected to the collector on Solunska str. through Nicola Tesla str. The new section of the collector is foreseen along Nikola Tesla str. with length of 517m from the junction between Nikola Tesla str. and Dimitar Ilievski Murato street to Solunska street.

With this solution, only part of the wastewater from the combined sewer system through an overflow manhole (redirection chamber) shall be transferred to Ulica 16-ta collector ensuring partial relief of the flow of this collector.

The new section at Nikola Tesla Street is envisaged from GRP pipes with Ø1000 - Ø1400. After joining of wastewater from Nikola Tesla will come to change the size of the anticipated collector Solunska with diameter of Ø800 increases to Ø1400mm of length L = 370 m to the junction with collector K2.

The total investment costs for Option 1b were estimated to be 2% higher (227,230 Euro) than the investment costs of Option 2 or 11,588,716 Euro.

Recommended Alternative

The aim of this paper is to investigate and recommend the best feasible technical, financial and operational option. On the bases of the description of the 3 alternatives in the previous chapter, the Consultant recommends **Alternative 1 – Option 2** which provides for smallest investment and best hydraulic profile and without re-distribution chambers needed at the time being.

The advantage of this technical solution is the shortest length of the collector to be reconstructed compared to Option 1a and 1b. To obtain the same effect in Option 1a, reconstruction of 859 m collector shall be envisaged and 517 m in option 1b. As such the transferring of a considerable part of the wastewater coming from the western part of the town now dewatering to Collector Ulica 16-ta which is overloaded during storm weather will be transferred to collector Solunska. In Option 2 the water will be directed to the Solunska Collector at the closest possible western point. In option 1a and 1b the connection points to collector Solunska are further to the east leaving the transit water in longer secondary collectors. Establishing of those longer secondary collectors (1a or 1b) will lead to longer time disturbances of the existing infrastructure in relatively narrow streets during construction. The wastewater from the western part of the town will partly be transferred to the Solunska collector. As the Solunska Street is much wider than any of the above-mentioned streets it is important for the minimal disturbance of the traffic etc. to reach Solunska Street at the first possible point as well as the construction works is faster in a wide street. Again, here the Option 2 is the preferable.

Finally, distribution chambers function as overflow chambers with a resistance section with relative smaller diameter outlet pipe. This will increase the risk for blockings and for exceeded maintenance. For both options 1a and 1b it is necessary to establish such a chamber to reduce the flow to Ulica 16-ta collector.

Conclusion is as such that from a technical, financial and a time and infrastructure point of view option 2 is the most feasible. Finally, it should be underlined that a collector (smaller diameter) already exists in Shirok Sokak. Excavations have as such been performed in the past.

3.3.1.2 Process alternatives considered

In order to achieve the best option for the design of the Bitola WWTP, it is necessary to evaluate the treatment process technologies available in terms of various monetary as well as nonmonetary parameters. According to the evaluation procedure the selected options can then be attributed a rank. These options comprise:

- Primary sedimentation, which is the most efficient mechanism for the removal of floating and suspended solids, both fine and coarse, from raw sewage. Thus, the foul wastewater is treated by a physical and/or chemical process involving settlement of suspended solids, or other processes in which the BOD5 of the incoming wastewater is reduced by at least 20% before discharge and the total suspended solids of the incoming wastewater are reduced by at least 50%;
- Secondary biological processes, which are efficient in the removal of organic substances that are either in the colloidal size range or soluble. Secondary biological processes essentially provide for the removal of 85% of the conventional pollutants (materials which deplete oxygen from the water: biochemical oxygen demand and suspended solids), and provide acidity control (pH).
- Sludge treatment and disposal - a product of the wastewater treatment process is waste sludge, which can be utilized in different forms depending on the unit treatment process. In considering sludge characteristics required it is then necessary to examine the treatment technologies which are available with the respect to their performance, reliability, standard of maintenance, capital costs and operating costs.

Some processes, however, such as aerated lagoons, stabilization ponds, and extended aeration systems, are designed to operate without primary sedimentation.

The Programme for water supply, drainage, collection and treatment of urban wastewater for the Bitola agglomeration, as part of the overall project and technical documentation, considers several technology alternatives. They are given below.

Preliminary Treatment

Municipal wastewater contains pieces of wood, plastic, rags and other large objects which if not removed can clog intake pipes, flow measurement devices or pumps and can cause many operational problems. The objective of preliminary treatment is to remove coarse impurities, sand and grease from wastewater. In general preliminary treatment involves treatment units including:

- Screening and screening's washing/compaction
- Grit removal
- Grease and oil separation

Primary Treatment

Primary clarifiers are generally used to reduce the solids and organic loading on subsequent treatment units. The main objective of primary treatment is the removal of organic or inorganic settleable solids by settlement for a specific period of time in sedimentation tanks after preliminary treatment. Primary clarifiers reduces load to subsequent units, but increase load for sludge treatment (require sludge digestion).

Secondary Treatment

Biological treatment comprises the removal of the soluble and colloidal organic matter. The removal can be accomplished by chemical or biological means. In case of mainly domestic sewages, biological treatment is the preferred process.

Removal of carbonaceous compounds is accomplished by biological processes, which are used to convert the finely divided and dissolved organic matter in sewage into settleable biological solids that can be removed in settling tanks (or other alternatives like membranes).

To achieve the required quality targets for the planned WWTP in Bitola, it is considered that only biological processes are appropriate to convert the finely divided and dissolved organic matter of the mostly urban wastewater into flocculent, settleable biological and inorganic solids,

which can subsequently be removed by sedimentation. These "secondary biological processes" are employed in conjunction with the physical and chemical processes that are used for preliminary and primary treatment of wastewater; i.e. screening and grit removal.

The most commonly used biological processes which are relevant to the Bitola influent characteristics are listed and described below.

Conventional Activated Sludge

This treatment process essentially involves the aeration of settled sewage mixed with return activated sludge in an aeration tank. Aeration is normally via fine bubble diffused aeration with diffusers fixed in a grid array on the tank floor or alternatively via surface aerators.

Activated sludge process is a unit process comprising a biological reactor (activated sludge tank) with associated aeration equipment and a secondary settling tank, both connected by a return sludge recirculation pipeline. The biomass generated in the aeration process is removed via settling in the secondary settlement tank, with a percentage of the settled sludge being re-circulated to the inlet of the aeration tank as return activated sludge to maintain the biomass concentration in the aeration tank.

Depending on treatment targets different zones with different conditions are established inside Aeration Tank. These zones are mainly categorized according to their oxygen and nitrate content. Anoxic and anaerobic zones are usually equipped with mixers to keep the MLSS in suspension.

What all conventional activated sludge processes have in common, is a need for separate sludge stabilization. This is sometimes done aerobically, which is costly but relatively simple. Hence, the typical solution for sludge stabilization is mesophilic anaerobic digestion. This process is more risky due to the handling of explosive biogas. But the biogas can be used for heating of the digester and operation buildings, in parallel to the production of electric energy.

Extended aeration

The extended aeration tank is a special type of the activated sludge process. In this process the volume of aeration tank is increased such that the sludge is already stabilized inside the tanks. There is no need for further stabilization. The essential difference between an extended aeration plant and a conventional activated sludge plant is the retention time and the profile and variety of the micro-organisms which inhabit the aeration stages of each process.

The extended aeration process produces a relatively small amount of sludge which is stable and relatively easy to dewater.

The advantages of this process are lower overall investment cost, lesser requirements to number and skills of operators, very robust process in case of strong influent and small toxic shocks, due to large volume. The disadvantages are somewhat higher O&M cost.

Activated sludge with alternating denitrification

This method is a special type of the activated sludge process. The period of aeration is equivalent to the aeration phase, while the period of aeration stoppage is the equivalent of the anaerobic phase. Thus, nitrification and denitrification stages are maintained at different times in the aeration tank and are repeated in a continuous loop. Unless there are extreme fluctuations in influent sewage quality, the system can provide a very stable good quality effluent which has a very high efficiency in ammonia reduction.

Aerated lagoons

Aerated Lagoons come in many variations. In general, they can be grouped into:

- Aerated Lagoons with sludge recycle.

- Aerated Lagoons without sludge recycle.

The first group is basically the same as the activated sludge process, just with the Aeration Tank (AT) being implemented as lagoon instead of a concrete tank. Such an approach makes particular sense for large WWTPs, where it sometimes turns out to be more cost effective constructing dams instead of concrete walls.

The second group does away with Final Sedimentation Tanks. Depending on project specifics, sometimes the final zone of such lagoons is not aerated any more, to reduce solids being flushed out into the effluent. What all such units have in common though, is very low MLSS concentrations. This makes these systems very large, yet still implicating relatively inferior effluent quality to other systems. Consequently, such systems are not being newly constructed nowadays any more, apart from the odd exception somewhere.

Trickling Filter (TF)

Trickling Filters (TFs) consist of a media bed over which pre-settled wastewater is continuously distributed. It trickles through the filter and is then collected in an underdrain system. As the wastewater is flowing over the filter media (sometimes also called "packing") a microbial slime layer develops on this media. The organics of the wastewater are adsorbed and absorbed to be degraded by the micro-organisms present in this slime layer. With growing thickness of the slime layer the micro-organisms nearest to the filter media receive less and less oxygen, and eventually die off. Thus they lose their ability to cling to the media, and are subsequently washed out. This phenomenon of losing the biological slime is called "sloughing". The higher the organic loading on a filter, the higher the growth rate of the micro-organisms, and the higher is the hydraulic load to provide a sufficient sloughing effect and to avoid clogging. Too much slime within the voids of the filter media would hamper wastewater flow and air circulation.

Since influent hydraulic load can be insufficient, it is common practice to introduce a recirculation of treated effluent to have an operating means to increase the hydraulic load on the TF. This recirculation is mostly only operated during periods when the influent flow rate falls below a defined minimum value.

TFs do not need artificial aeration, which is why they feature low energy/operation cost. They used for carbon remove only.

The effluent of TFs contains the sloughed slimy sludge particles. These are diverted into a sedimentation tank, wherein the biological sludge is separated from the clear effluent. Generally this sludge has better settling properties as activated sludge.

The sludge has to be stabilized separately as explained in the chapter on activated sludge process.

Rotating Biological Contactor (RBC)

RBCs - just like Trickling Filters - are also based on the principle of attached growth of micro-organisms. The only difference being the technical implementation.

RBCs consist of a large horizontal shaft with mounted plastic media that are partially (mostly about 40%) submerged, and the rest being above water level. The shaft is rotated slowly (1-2 rpm) by means of an electric motor. The plastic media typically features circular plastic disks with very small open spacing between the individual disks, which are mounted perpendicular to the shaft. A standard RBC unit may have a surface area of several thousand m^2. Submerged RBCs with about 70-90 % submergence have not proven successful, particularly due to insufficient oxygen supply.

Aeration is accomplished by the exposure of the biofilm to the atmosphere. Biofilm sloughing is achieved by the wastewater flowing along the disk surfaces back into the holding tank.

A sedimentation unit after the RBC is required to separate the sloughed sludge from the clear effluent. RBCs suffer particularly from problems with bearings and shaft failure. Generally, their application is mostly limited to small units.

Tertiary Treatment

Tertiary treatment is the advanced treatment process, following secondary treatment of waste water, that produces high-quality water. Tertiary treatment includes removal of nutrients such as phosphorus and nitrogen and practically all suspended and organic matter from waste water. Removal of nitrogen compounds may be accomplished by physical, chemical or biological methods.

Physical methods include air stripping of ammonia or ion exchange and are generally applied in freshwater (groundwater) treatment. Physical methods are not considered for wastewater treatment.

Chemical methods include breakpoint chlorination, where chlorine is added to sewage to oxidize the ammonia in solution to nitrogen gas and other compounds. This process has a lot of disadvantages such as requiring high chlorine dosages, high operating cost due to chemical requirement and requires high skilled operators. Generally the efficiency of these methods will not yield an effluent that meets the effluent quality criteria and consequently will not be considered.

Biological methods for the removal of nitrogen are involves two step process Nitrification/Denitrification. Two configurations can be applied, separate nitrification/denitrification and combined nitrification/denitrification systems.

Phosphorous may be present in wastewater as organic or inorganic, In general it is present as orthophosphate, polyphosphate, pyrophosphate or organic phosphate. Orthophosphate is the dominating compound. Phosphorus compounds may be removed by means of chemical or biological processes.

Sludge Treatment

All sewage treatment plants produce sludge as a by-product. The quantity and quality of this sludge is dependent upon the method of sewage treatment and therefore sludge treatment and disposal must be considered as an important part of the sewage treatment process.

Raw sewage sludge can rarely be disposed of without additional treatment, enabling environmentally acceptable disposal. Sludge has high water content and contains harmful bacteria, consequently sludge has to undergo a series of processes prior to final disposal or re-use. The most common processes of sludge treatment comprise thickening, digestion and dewatering.

The first step on sludge handling is the thickening process which aims at increasing the solid fraction in the sludge by removing a significant portion of the liquid mass. Thickening can be accomplished by gravity or mechanical means. Gravity thickening is similar to settling tanks. Mechanical thickening systems include Gravity Belt Thickeners, Rotary Drums, Dissolved Air Flotation and centrifuges.

The second step in sludge handling is the stabilization of sludge. The most common system used for medium size to large municipal wastewater treatment facilities is sludge digestion which converts the organic solids to a stabilized material that can be easily handled and processed for further treatment. Digestion is the process whereby complex organic matter in the sewage sludge is broken down, by the action of bacteria and microorganisms, either aerobically or anaerobically, into simpler and more stable compounds. Anaerobic digestion takes place without the addition of oxygen, and produces methane gas, carbon dioxide and water as by-

products.

The last step in sludge handling is sludge dewatering that reduces the water content of the sludge increasing the dried solids content of approximately 4% DS from the conditioning system to approximately 25% DS after pressing. Polymers have to be added that condition the sludge and drastically improve the dewater ability characteristics. Sludge dewatering may be accomplished by three means of equipment: centrifuges, belt filter presses and chamber filter presses.

3.3.2 Analysis of alternatives

The analysis of the above mentioned alternatives is made on the basic level, where the proposed options are assessed in terms of the technique and, where possible, of the environmental benefits. The selection of the most appropriate treatment process is generally based on the following general requirements:

- Process reliability: Processes with high reliability and least sensitive to shock loading, operator errors, power failure and inadequate maintenance are to be preferred.
- Requirements for discharges: as per UWWTD 91/271/EEC.
- Energy requirements: The process option with lower energy consumption is preferred, not only due to lower operational costs but also in terms of lower environmental impact on air pollution (CO_2, NOx emissions etc.).
- Sludge handling: While sludge may sometimes be a useful by-product in the form of fertilizer or soil conditioner, there is no doubt that treatment and disposal of sludge are often the most difficult and costly aspects of treatment plants. Therefore, processes that produce predictable, stable sludge and have a low production rate are to be preferred.
- The Plant shall be designed in modules for flexibility of construction in phases as needed and to facilitate maintenance and repair works.
- Layout of treatment facilities to achieve economy, efficiency and effectiveness in operation and performance.
- To have easily accessible equipment and facilities to facilitate maintenance and replacement.

The following table summarizes the technical arguments for the different treatment processes and gives an evaluation of the operation under general conditions.

Table 3 Summary of the technical arguments for various treatment processes

Alternative	**Advantages and disadvantages**
Conventional Activated Sludge	Advantages: Flexible operation. Relatively small footprint (0.4 m^2/PE_{60}). Subsequently: less heavy metal introduction into sludge through precipitant, less overall sludge production than with option, no increase of salinity of recipient water, higher pH in effluent and thus more stable nitrification. Disadvantages: Requires separate sludge stabilization. Requires skilled operators. Relatively high cost for Electro-Mechanical (EM) equipment. Not economic below a certain threshold size (20,000 - 30,000 PE_{60}). Justification for selection: Well-known and well-proven technology. Capable to meet discharge standards. Most widely used wastewater treatment for domestic purposes, process well documented.
Extended aeration	Advantages: Flexible and simple operation. Does not requires separate sludge stabilization. Relatively low requirements as to operator's skills. Lower overall investment cost. Very robust process in case of strong influent and small toxic

Alternative	**Advantages and disadvantages**
	shocks. Relatively small footprint (0.4 m^2/PE_{60}). Disadvantages: Requires large tank volumes. Relatively high O&M cost. Justification for selection: Flexible and simple operation, little requirements to operator's skills.
Activated sludge with alternating denitrification	Advantages: Flexible operation. Capable to meet discharge standards. Disadvantages: Requires separate sludge stabilization. Justification for selection: Flexible operation. Most widely used wastewater treatment for domestic purposes, process well documented.
Aerated lagoons	Advantages: Basically the same concept as conventional activated sludge process, but implemented in lagoons instead of concrete tanks. Disadvantages: Requires large lagoon volumes and much land due to low MLSS concentrations. Economically not attractive. Justification for non-selection: Inefficient and expensive
Trickling Filter (TF)	Advantages: Well-suited process for carbon removal only. Reduced energy needs. Relatively small footprint (0.4 m^2/PE_{60}). Disadvantages: Requires separate sludge stabilization. Generally not well suited neither for enhanced nitrogen nor phosphorus removal. Complicated process, if later upgrading to N and P removal may be required. Not very flexible operation mode. Justification for non-selection: Not well suited for WWTPs that require enhanced nutrient removal. This also matters for those WWTPs below 10,000 PE_{60}, which do not require such treatment level yet, but might require upgrading in future.
Rotating Biological Contactor (RBC)	Advantages: Simple. Well-suited process for carbon removal only. Reduced energy needs. Similarly small footprint (0.4 m^2/PE_{60}). Disadvantages: Requires separate sludge stabilization. Generally not well suited neither for enhanced nitrogen nor phosphorus removal. Complicated process, if later upgrading to N and P removal may be required. Problems with bearings and shafts cannot be safely excluded. Usually not applied to WWTPs of the size in discussion. Justification for non-selection: Not well suited for WWTPs that require enhanced nutrient removal. This also matters for those WWTPs below 10,000 PE_{60}, which do not require such treatment level yet, but might require upgrading in future.
Aerobic sludge stabilization	Advantages: Stable process. Odour generation. Reduces total sludge amount by approx. 25 %. Disadvantages: Relatively high sludge production. High energy consumption. limited treatability in dewatering units
Anaerobic sludge stabilization	Advantages: Stable process. Low energy consumption for mixing and heating Reduces total sludge amount by approx. 35 %. Disadvantages: High investment cost requires specific training of the operator. Safety measures for biogas handling required Potential occupational hazards in relation to biogas handling

The selection of the most appropriate treatment process is generally based on the following

general requirements:

- Collected wastewater shall be treated to produce an effluent with quality, suitable for discharge in natural waters.
- Effectively operating mechanical stage.
- Pneumatic aeration with air supply in bioreactors in the form of fine bubbles.
- Effective secondary sedimentation.
- Sludge stabilization (aerobic or anaerobic).
- Mechanical dewatering of treated sludge.
- The Plant shall be designed in modules for flexibility of construction in phases as needed and to facilitate maintenance and repair works.
- Layout of treatment facilities to achieve economy, efficiency and effectiveness in operation and performance.
- To have easily accessible equipment and facilities to facilitate maintenance and replacement.

As a result of the screening, the following wastewater and sludge treatment options have been selected for further evaluation in the Feasibility Study depending of the status of the receiving waters (less sensitive with carbon and nitrogen removal) and hence the effluent standards to be fulfilled:

- Option 1 - Activated sludge plant with primary clarifiers and anaerobic sludge stabilization in sludge digester.
- Option 2 – Activated sludge plant with aerobic sludge stabilization in separate tank.
- Option 3 - Extended activated sludge plant (aerobic sludge stabilization in the activated sludge tanks).

The three options are based on well-known and well-proven technologies and implemented at other wastewater treatment plants in Europe. In the following chapter the selected options for the Bitola wastewater treatment plant are described in more details.

Option 1 - Activated sludge plant with primary clarifiers and anaerobic sludge stabilization in sludge digester.

Preliminary treatment

The objective of preliminary treatment is to remove large contents from the waste water stream. Preliminary treatment including: Pumping station with coarse screens. Pumps for raw waste water are necessary for lifting the wastewater in order it can gravity through the WWTP and discharge into the river. Pumps for diluted waste water in wet weather are necessary for lifting the storm water and discharge it into the river.

Fine screens building, combined with washed screening compactor. Grit and Grease removal, including dewatering with grit classifier and girt washing. Primary Settling Tanks for reducing the solids and organic load.

Biological treatment, Including: Selector for mixing of preliminary treated water and Activated Sludge Recirculation. Distribution chamber for each Aeration tank is provided. Aeration tank for carbon compounds reduction. Aeration for nitrification process is provided using Fine Bubble Diffused Aeration (FBDA). FBDA is recommended because of the higher energy efficiency. Biological processes are controlled by maintaining process control parameters, such as sludge

age, Return Activated Sludge (RAS) rate, Mixed Liquor Suspended Solids (MLSS) concentration, Surplus Activated Sludge (SAS) and oxygen demand.

Space for future extension for biological phosphorous removal in anaerobic zone and further chemical phosphorous removal if needed.

Secondary Settling Tanks for separating the biomass from the effluent. The Secondary Settling Tanks will achieve the effluent quality required and sufficient activated sludge for re-circulation to the bioreactor.

Sludge treatment

Sludge has high water content and contains harmful bacteria, so a series of processes prior to final disposal or re-use is needed. The first step on sludge treatment is the thickening process which aims is increasing the solid fraction by removing a portion of the water. In this option is proposed:

- Gravity thickening of Primary Sludge
- Mechanical thickening of Surplus Activated Sludge
- Mixed sludge tank

The second step in sludge treatment is the stabilization of sludge. Stabilization is the process whereby organic matter in the sludge is broken down into more stable compounds. In this option we propose anaerobic sludge digestion in closed, heated tanks (digesters), where methane and carbon dioxide are produced during the digestion (stabilization) of the raw sludge. The produced biogas may be used for heating the digesters and for building's heating.

The last step in sludge treatment is sludge dewatering that reduces the water content of the sludge by mechanical pressing. For WWTP Bitola we proposed:

- Sludge holding tank for homogenization
- Sludge dewatering by centrifuges
- Sludge storage area for dewatered stabilized sludge

Option 2 – Activated sludge plant with aerobic sludge stabilization in separate tank.

Preliminary treatment. Pumping station with coarse screens. Pumps for raw waste water are necessary for lifting the wastewater in order it can gravity through the WWTP and discharge into the river. Pumps for diluted waste water in wet weather are necessary for lifting the storm water and discharge it into the river.

Fine screens building, combined with washed screening compactor. Grit and Grease removal, including dewatering with grit classifier and girt washing.

Biological treatment, Including: Selector for mixing of preliminary treated water and Activated Sludge Recirculation (RAS). Distribution chamber for each Aeration tank is provided. Aeration tank for carbon compounds reduction. Aeration is pneumatic with fine bubbles. Biological processes are controlled by maintaining process control parameters.

Space for future extension for biological phosphorous removal in anaerobic zone and further chemical phosphorous removal if needed.

Secondary Settling Tanks for separating the biomass from the effluent. The Secondary Settling Tanks will achieve the effluent quality required and sufficient activated sludge for re-circulation to the bioreactor.

Sludge treatment. To increase the solid concentration in Surplus Activated Sludge before stabilization we propose mechanical thickening. Sludge stabilization will take place in a separate

reactor with addition of oxygen (atmospheric air). Aerobic sludge stabilization is similar to activated sludge process.

The dewatering process is like Option1: Stabilized sludge holding tank for homogenization, Sludge dewatering by centrifuges, Sludge storage area for dewatered stabilized sludge.

Option 3 - Extended activated sludge plant (aerobic sludge stabilization in the activated sludge tanks).

Preliminary treatment. Pumping station with coarse screens. Pumps for raw waste water are necessary for lifting the wastewater in order it can gravity through the WWTP and discharge into the river. Pumps for diluted waste water in wet weather are necessary for lifting the storm water and discharge it into the river.

Fine screens building, combined with washed screening compactor. Grit and Grease removal, including dewatering with grit classifier and girt washing.

Biological treatment, Including: Selector for mixing of preliminary treated water and Activated Sludge Recirculation (RAS). Distribution chamber for each Aeration tank is provided. Extended aeration process, which means carbon compounds reduction and aerobic sludge stabilization in the aeration tank. Aeration is pneumatic with fine bubbles. Biological processes are controlled by maintaining process control parameters.

Space for future extension for biological phosphorous removal in anaerobic zone and further chemical phosphorous removal if needed.

Secondary Settling Tanks for separating the biomass from the effluent. The Secondary Settling Tanks will achieve the effluent quality required and sufficient activated sludge for re-circulation to the bioreactor.

Pump station for Return Activated Sludge (RAS)

Sludge treatment

In this option the sludge is stabilized in the biological reactor. The thickening and dewatering processes includes:

- Gravity thickening for stabilized sludge
- Sludge holding tank for homogenization
- Sludge dewatering by centrifuges
- Sludge storage area for dewatered stabilized sludge

Technical evaluation of options

The following table summarizes the technical arguments for the different treatment processes and gives an evaluation of the operation under general conditions.

Table 4 Technical analyses of options

Options		Advantages	Disadvantages
Option 1	Pretreatment Primary sedimentations Aeration tank	• Well-known and well-proven technology • Capable to meet discharge standards. • Most widely used wastewater treatment for domestic purposes, process well documented. • Operation parameters well characterized. • Relatively low energy consumption • Widely used for large wastewater treatment plants • Relatively low land requirement • High operation flexibility.	• Moderate capital and investment costs. • Two different sludge types will be handled/treated • Relatively high number of staff required • Risk of odour problems from primary clarifiers
	Sludge anaerobic digestion	• Stable process • Low energy consumption because of energy production from biogas • Reduces total sludge amount by approx. 25 %. • Widely used for large wastewater treatment plants • Expected solid's content in dewatered sludge – 25-30%SS • Small footprint	• High investment cost • requires specific training of the operator • Safety measures for biogas handling required • Potential occupational hazards in relation to biogas handling
Option 2	Pre-treatment Aeration tank	• Well-known and well-proven technology • Capable to meet discharge standards. • Most widely used wastewater treatment for domestic purposes, process well documented. • Operation parameters well characterized. • Effective in a wide range of applications • High operation flexibility.	• Moderate capital and investment costs. • Moderate sludge settles ability. • Requires continuous aeration, increased energy consumption.
	Sludge aerobic digestion in separate reactor	• Stable process • Low odour generation • Reduces total sludge amount by approx. 18 %.	• Relatively high sludge production • limited treat ability in dewatering units – 18-22%SS • Relatively high energy

Options		Advantages	Disadvantages
Option 3	Pre-treatment Aeration tank with extended aeration	• Well-known and well-proven technology • Capable to meet discharge standards. • Most widely used wastewater treatment for domestic purposes, process well documented. • Operation parameters well characterized. • Mechanical simple construction • Easy to operate. • Less electro-mechanical equipment than • Simple plant configuration • Low risk of odour problems	• Relatively big investment costs. • Moderate sludge settles ability. • Requires interrupted aeration with bigger blowers, increased energy consumption. • Relatively high energy consumption • Widely used for small wastewater treatment plants • Relatively high land requirement
	Sludge aerobic digestion in aeration tank (extended aeration)	• Low energy consumption • Only one sludge type to be handled • Low investment cost • Stable process • Low odour generation	• Relatively high sludge production • limited treat ability in dewatering units – 18-22%SS • Reduces total sludge amount by approx. 15 %.

The main benefits of Option 1 - *Activated sludge plant with primary clarifiers and anaerobic sludge stabilization in sludge digester*, compared with the Option 2 and Option 3 are:

- Most widely used wastewater treatment for domestic purposes. Widely used for large wastewater treatment plants;
- Well-known process and well documented;
- Relatively low land requirement;
- Low energy consumption because of energy production from biogas;
- Reduces total sludge amount by approx. 25 %;
- High treat ability in dewatering units – 25-30%SS in dewatered sludge.

Factors, apart from construction and operating and maintenance costs, which need to be taken into account in selecting the most appropriate wastewater treatment plant option include:

- Energy requirements: The process option with lower energy consumption is preferred, not only due to lower operational costs but also in terms of lower environmental impact on air pollution (CO_2, NOx emissions etc.).
- Sludge handling: While sludge may sometimes be a useful by-product in the form of fertilizer or soil conditioner, there is no doubt that treatment and disposal of sludge are often the most difficult and costly aspects of treatment plants. Therefore, processes that produce predictable, stable sludge and have a low production rate are to be preferred.

The Feasibility study further discusses the sludge disposal and reuse in separate chapter (5.5)in regards to:

- Methods for disposal and utilization of sludge from wastewater treatment
  - Agricultural usage
  - Land reclamation
  - Landfilling
  - Co-incineration

It also discusses options for Sludge Management in Bitola summarizing it in summarized in table below.

Table Disposal/reuse options

Disposal/reuse strategy	Disposal/reuse option
Agricultural reuse	Applicable but limited
Land reclamation	Applicable but limited
Landfilling	Applicable
Co-incineration	Applicable

Conclusion

In view of all the factors above, it is recommended that Option 1 - Activated sludge plant with primary clarifiers and anaerobic sludge stabilization in sludge digester be adopted for Bitola wastewater treatment plant.

The Average Incremental Cost for Option 1 is EUR 0.140 per m^3 and is lower than that of Option 2 and Option 3.

Furthermore Option 1 has the advantages of being a widely used for large wastewater treatment plants. The conventional activated sludge process is most widely used wastewater treatment process for domestic purposes and it is very well known from other cities in Europe and has high process reliability. For WWTP with more than 90,000 PE, anaerobic digestion is recommended, because of the operation costs benefits. Anaerobic digestion takes place without the addition of oxygen, and produces methane gas. In relation to this Option 1 has low energy consumption because of energy production from biogas. Anaerobic sludge treatment reduces total sludge amount at the highest level and produces the lowest volume dewatered sludge because of high dewatering ability.

In regards to sludge disposal and reuse, the feasibility study concludes the following.

> At present, there are too many unknown factors, lack of information and absence of regulations and monitoring to recommend application of sludge from the Bitola WWTP to agricultural land.
>
> Application of sludge to agricultural land is currently not an option until all the above are adequately addressed. Thus, until all the recommendations outlined herein are addressed, application of sewage sludge to agricultural land should not be considered a viable option in the short-term. Several viable options are available to the management of the proposed facility and the Municipality. These options primarily include re-cultivation of landfills and rehabilitation of quarries and other land area with damaged soil profile.
>
> An EU funded project “Development of national water study” started in the beginning of 2016. One of the tasks under this project is developing of “Strategic Framework for Sludge

Management". Depending on the results of this Sludge Strategy, additional sludge management options for Bitola agglomeration might become relevant for the medium and long-term (e.g. sludge incineration).

The short-term solution for sludge management is landfilling. The Municipality of Bitola is using the Landfill Meglenci located approximately 20 km north-east from City of Bitola on the hillside of Gradiste-Brajinac mountains. The nearest settlement Meglenci is situated on 1.5 km distance from the landfill. The company in charge of waste collection in Bitola is JKP Komunalec.

The Macedonian Ministry of Environment and Physical Planning has issued a permit for disposing stabilized excess sludge on the existing municipal solid waste landfills until the projects for regional landfills will be implemented. It is expected that sludge can be reused for agricultural purposes or for land reclamation in the long-term. According to the MoEPP, all legislation related to the reuse of sludge for agricultural purpose is in place in Macedonia and is in accordance to the EC Sludge Directive.

3.4 Do nothing alternative

This so-called do nothing alternative is a case is not favourable for the investor, or the authorities, or for the overall users of this type of project, given that there is no complete and effective wastewater collection and treatment plant for the Bitola agglomeration.

The situation without implementation of the planning document involves the future area of the planning document without implementation of planned activities in the planning document, that is, continuation of the current situation as it currently is.

The situation without the implementation of the planning document can be reviewed by three aspects:

- Impacts associated with the environment,
- Economic impacts,
- Social impacts.

Given the nature of the planning document, perhaps the most significant impacts would be related to the environment which would be expected with the failure thereof. They include:

- Extension of the state of impaired quality of surface waters that are recipients of municipal wastewater, and thus degrading the quality of groundwater associated with recipients,
- Extension of the state of disrupted living conditions for the overall biodiversity and ecosystems in the surface water.

From an economic perspective, this scenario would not have a significant effect, but it contributes to a limited development of the municipality and weaker attractiveness of the region and the municipality.

From a social perspective, the project, given its nature, would have a limited impact, which would be comprised of the following:

- Old sewage system,
- Insufficient sewerage coverage,
- Lack of sewerage network in rural areas,
- Lack of waste water treatment
- Opportunities for infection and development of disease due to lack of proper waste water management,
- Improving the quality of life in the region.

2. PROJECT DESCRIPITON AND PROJECT FEATURES

4.1 Description of the project site

4.1.1 Project scope

The area covered by the project for construction of a collection system, rehabilitation of the sewage network system and construction of a waste water treatment plant in Bitola includes the town of Bitola and Gorno Orizari, Dolno Orizari and Kravari settlements.

- Bitola – 72,400;
- Gorno Orizari - 4,193;
- Dolno Orizari - 2,684;
- Kravari - 1,492.

Figure 7 is a map of the scope of the project.

4.1.2 Project duration

The description of the project duration of the proposed WWTP covering all life cycles ranging from planning, construction until the period of work commencement, and also includes any changes in the project.

Construction Phase

Construction phase as envisaged in the project for a collector system, rehabilitation of sewerage network system and construction of wastewater treatment plant in Bitola includes:

- Construction works for construction of the collection system and rehabilitation of sewerage network for a period of 18 months,
- Construction works for construction of wastewater treatment plant for a period of 20 months.

One of these activities is planned to be carried out in urban areas - rehabilitation of sewage system, and others in rural areas (construction of WWTP). The activities will include clearing, excavation, concreting and paving etc.

Work phases

This phase includes the start and operation of networks and WWTP including test period, along with their normal operation. This period will also include maintenance, rehabilitation and upgrading activities in order to prolong the lifespan.

Decommissioning

WWTP usually operate for several years and during those years some parts thereof may be converted and adapted to other uses. Thus changed, these parts can be used for multiple purposes, such as recreation, agriculture or construction of other facilities. After completing the work on wastewater treatment plants typically the rehabilitation of the site is required.

WWTP authority prescribes the conditions which will ensure the phases and the rehabilitation of the site.

4.1.3 Description of the WWTP macro location

The location of the WWTP is planned to be located in Bitola, at the northern part of the city. The location is near the new cemetery, between the villages of Dolno and Gorno Orizari CP 25 KM 5 Bitola, Municipality of Bitola. About 1 km southwest of the project site, the industrial zone Bitola

is located in Bitola that houses a number of industrial facilities in various fields. Figure 8 is a map with the location of the project site.

4.1.4 Description of the WWTP micro location

The location of future WWTP is about 4 km away from the city center. Distance from the nearest settlement Dolno Orizari village is about 0,6 km that is about 1,5 km from Gorno Orizari village. Photos attached provide a visual description of the planned location for the project.

Figure 6 View over the larger location (above), western (left) and eastern (right) side

The land which is planned to be the project side is the cadastral parcel 25 and it is state-owned land occupying a total area of 51 ha. Construction area of the treatment plant is planned to cover an area of about 10 ha. At the moment the general location is agricultural land which will be urbanized for the purpose of this project in order to provide conditions for construction thereof.

The location with its southern side borders the Dragor riverbed, while the other three site sides border with other agricultural plots. Figure 9 shows the map with micro location of the project.

Figure 7 Project scope

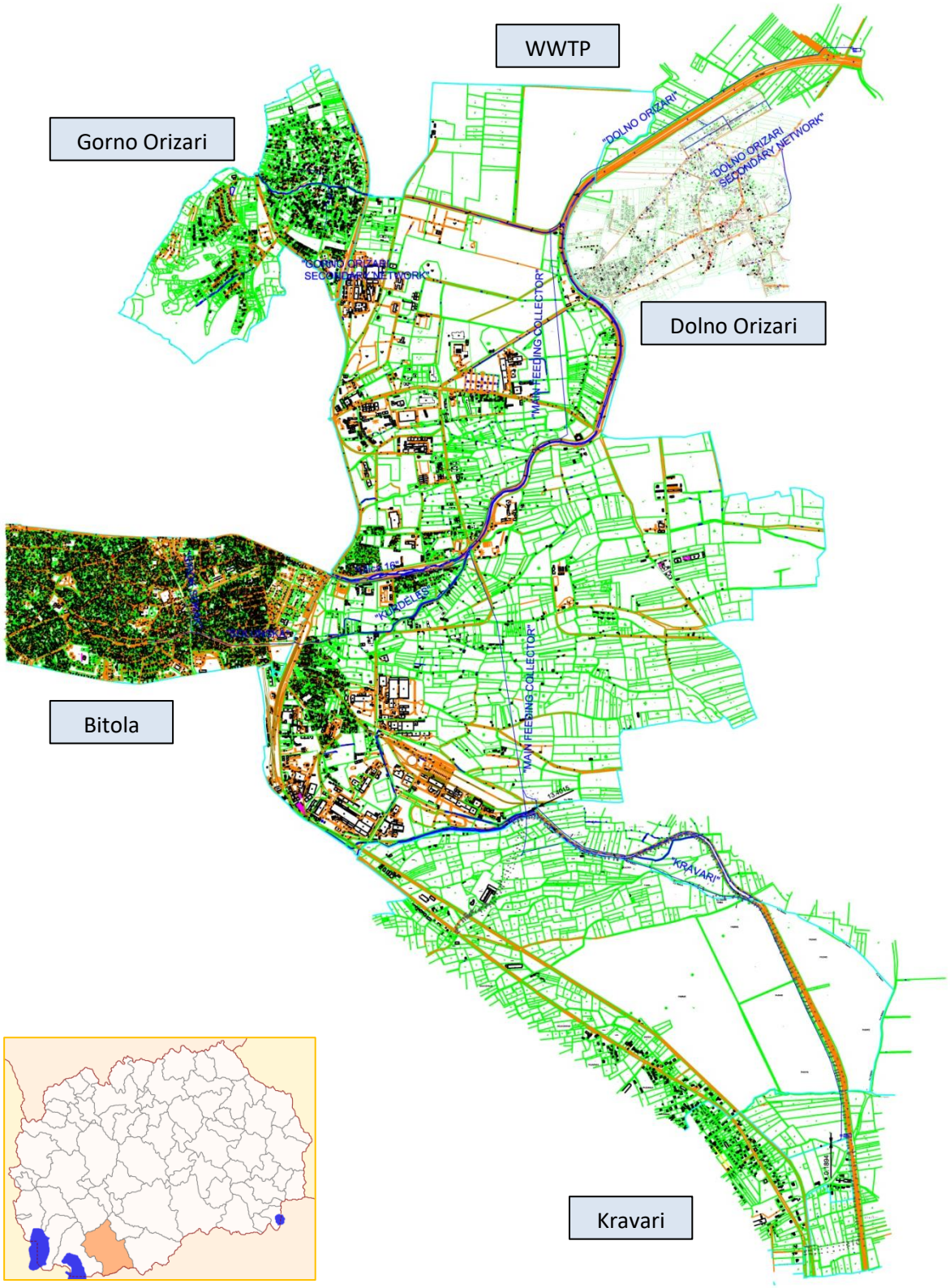


Figure 8 Project macro location

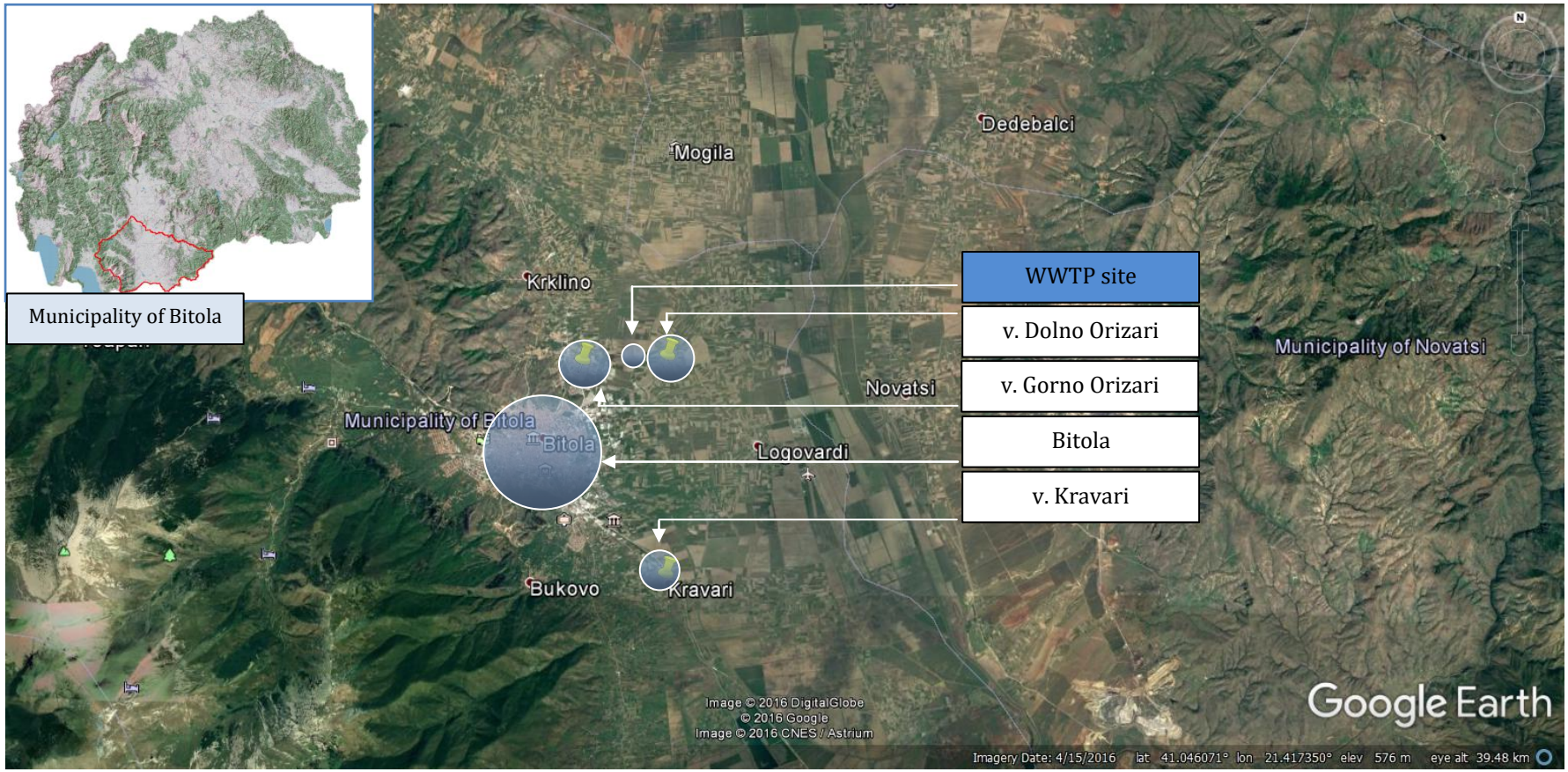
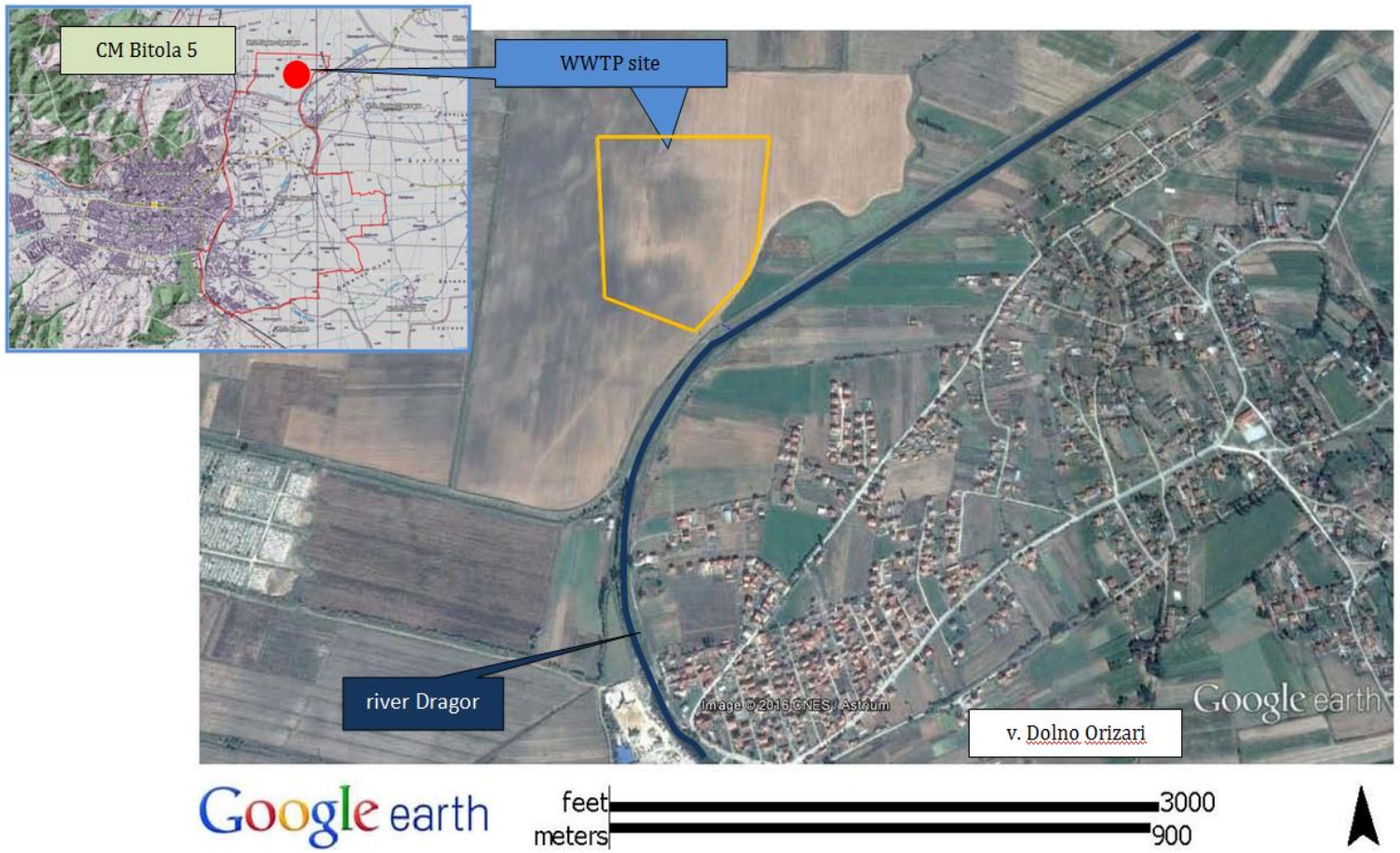


Figure 9 WWTP Bitola micro location



4.2 Technical description of the project

4.2.1 Description of the sewerage system solutions

Activities related to the construction and rehabilitation of sewerage systems include:

- Reconstruction of the sewerage network in v. Gorno Orizari,
- Reconstruction of part of the sewerage network (collectors) in the City of Bitola,
- Construction of new collectors from the City of Bitola to Main feeding collector,
- Construction of pumping station and pressure pipe for v. Kravari to Main feeding collector at connection point with collector K1,
- Extension of the sewerage network of v. Dolno Orizari and construction of pumping station inclusive pressure pipe to the WWTP,
- Construction of Main feeding collector from connection of existing K0 to the WWTP.

Technical specifications for the sewerage system

The technical specifications for the activities are described below.

Table 5 Specification of "Reconstruction of sewerage network in v. Gorno Orizari"

№	Diameter	Extension Length (m)	Reconstruction Length (m)	Total length (m)
1	Ø400	-	1,150	1,150
2	Ø500	-	450	450
3	Overflow chamber Pipe Ø500	100		100
Total Length (m)		**100**	**1,600**	**1,700**

Table 6 Specification of "Reconstruction of sewerage network in city of Bitola"

№	Diameter	Extension Length (m)	Reconstruction Length (m)	Total length (m)
I	Collector Kurdeles (from existing outlet 3 to new Main feeding collector)			
1	Ø700	217	-	217
2	Ø800	39	-	39
3	Ø1700	1030	-	1030
II	Collector Solunska			
4	Ø700	-	300	300
5	Ø1200	155	377	532
6	Ø1400	120	-	120
III	Collector Ulica 16-ta			
7	Ø630	847	-	847
8	Ø1600	65	-	65
IV	K2 with Collector Solunska			
9	Ø1400	-	290	290
V	Collector Shirok Sokak + branch to Solunska			
10	Ø1200	-	356	356
VI	Connection of the secondary collectors and sewer network in City of Bitola			

№	Diameter	Extension Length (m)	Reconstruction Length (m)	Total length (m)
11	Ø200	-	10,100	10,100
Ø300				
13	Ø400			
14	Ø500			
Total Length (m)		**2,473**	**11,423**	**13,896**

Table 7 Specification of "Main Pressure Collector from Kravari to Main Feeding Collector start at connection point with Collector K1"

№	Diameter	Extension Length (m)	Reconstruction Length (m)	Total length (m)
1	Ø160 PEHD	3,450	-	3,450
2	Ø315	100	-	100
Total Length (m)		**3,550**	**-**	**3,550**

Table 8 Specification *of* "Extension of the sewerage network of v. Dolno Orizari and Main Pressure Collector to the WWTP"

№	Diameter	Extension Length (m)	Reconstruction Length (m)	Total length (m)
I	Main collector from v. Dolno Orizari to WWT			
1	Ø225 PEHD	1,950	-	1,950
2	Ø400	100	-	100
II	Secondary sewer network v. Dolno Orizari			
3	Ø315	1,600	-	1,600
Total Length (m)		**3,650**	**-**	**3,650**

Table 9 Specification of "Main feeding collector from K0 to WWTP Bitola"

№	Diameter	Extension Length (m)	Reconstruction Length (m)	Total length (m)
1	630	470	-	470
2	Ø1000	1,580	-	1,580
3	Ø1200	1,800	-	1,800
4	Ø1400	1,020	-	1,020
Total Length (m)		**4,870**	**-**	**4,870**

Technical specifications for overflows

Given that Bitola is served by a Combined Sewerage Network, rainwater flows are the determining design values for the contributing urban areas. As weir overflow level as a minimum (1+5) Q_{DWF} has been envisaged, overflow chambers are dimensioned for each of the pipes connecting to the Main feeding collector, to ensure this flow volume to enter into the Main feeding collector to the WWTP before overflowing to the recipient.

Characteristic data of each of the overflows is provided in the table below.

Table 10 Storm water overflows dimensioning data

№	Overflow	Wastewater quantites			Inlet Collector	Resistant section	Overflow characteristics			Overflow pipe	Type
		$Q_{dim.}$	Q_{d2}	$Q_{overflowing}$	D	D	$h_{ov.}$	L_d	$b_{ov.}$	D	
		[l/s]	[l/s]	[l/s]	[mm]	[mm]	[m]		[m]	mm	
OPTION 2											
1	Kidrich	2,582	459	2,123	1600	450	0.80	21.88	6.83	1200	overflow with raised edge
2	Solunska	7,363	683	6,680	2200	450	1.59	18.61	11.03	2x1500	
3	K0*	802	197	606	1000	350	0.51	19.52	4.26	800	
4	K1	2,066	387	1,679	1400	400	0.94	17.10	7.58	1400	
5	Jani Maale	1,331	45	1,286	1200	150	0.39	4.71	4.17	1000	
6	K4	8,036	485	7,552	2000	400	1.08	16.42	11.79	2x1500	
7	K5**	1,115	258	857	1200	350	0.73	15.07	3.96	1000	

Sewage pumping stations

In the present feasibility study and due to the terrain configuration, the Consultant foresees two wastewater pumping stations.

Table Technical characteristics of the pump stations

№	WWPS	Qmax.h	Head	Hydraulic pump data				Pumps	
				Q	H	N	n	working	reserve
		[l/s]	[м]	[l/s]	[m]	[kW]	r/min.	(num.)	(num.)
1	WWPS "Kravari"	13.82	30.50	14.00	30.50	11.00	2900	1	1
2	WWPS "Dolno Orizari"	23.14	17.50	24.00	17.50	11.00	2900	1	1

The pumping stations are planned to be equipped with a mixer, smooth grille with vertical lifting, electric conveyor belt, i.e. floods door for protection from floods and diesel generator (25 KW) in the event of a power failure.

Description of activities

Activities related to reconstruction of the sewage network systems and construction of the collection system, herein including the WWTP envisage standard construction activities including land, concrete and asphalt works:

- Site cleaning,
- Shallow pits,
- Removing existing sewer installation and replacement with new one,
- Installation of a new sewage installation,
- Concrete works wherever necessary,
- Paving wherever necessary.

Given the location, construction activities associated with Shirok Sokak are planned to be underground, designed as micro tunnelling. In this way will be enabled smooth functioning of the businesses on this street and will be avoided impacts from standard surface construction activities.

4.2.2 Description of the WWTP

For Bitola agglomeration Activated Sludge Process with full nitrification along with the removal of carbon and sludge stabilization in anaerobic digester is foreseen as the most adequate wastewater treatment process.

The design of the WWTP for the proposed site takes into consideration the possibility for future additional extension to allow tertiary treatment. The project design and layout provides sufficient flexibility and an adequate amount of free site footprint for such purpose.

The treatment plant for wastewater treatment is designed for 112 474 population equivalent.

Hydraulic and pollutant loads

The design of the wastewater treatment plant is based on the wastewater flows and pollutant loads listed in the table below.

Table 11 Hydraulic and pollutant loads

Description	Unit	Value	Dimension
Population equivalent	PE	**112,474**	PE
Wastewater flow			
Average wastewater flow -	Qav	**27,090**	m^3/d
		1,129	m^3/h
		314	l/s
Design maximum wastewater flow in dry weather –	Qmdf	1,842	m^3/h
		512	l/s
Design maximum wastewater flow in wet weather -	Qmwf	2,794	m^3/h
		776	l/s
Total wastewater flow in wet weather conducted to the WWTP	Qtwf	9,075	m^3/h
		2,521	l/s
Diluted wastewater flow in wet weather to be discharged to the river	Qdwf	6,281	m^3/h
		1,745	l/s
Pollution load			
Biochemical Oxygen Demand	BOD5	6748	kg/d
		249	mg/l
Chemical Oxygen Demand	COD	13497	kg/d
		498	mg/l
Total Suspended Solids	SS	7873	kg/d
		291	mg/l
Total Nitrogen	Nt	1237	kg/d
		46	mg/l
Ammonium Nitrogen	$N\text{-}NH_4$	990	kg/d
		37	mg/l
Total Phosphorus	Pt	202	kg/d
		7	mg/l

Hydraulic profile

The hydraulic profile of the wastewater treatment system is designed to allow minimum heat loss and energy consumption. Pumping station for elevation of the wastewater will be located at the inlet of the treatment plant. The aligned terrain level of the treatment plant should correspond as much as possible of the existing terrain, taking into account the limitations of the pipeline process, hydraulic profile, etc.

Effluent standards

The wastewater treatment plant is designed and will constructed to comply with the discharge effluent criteria set out in the EU Urban Wastewater Treatment Directive (91/271/EEC), Urban Wastewater Treatment Regulation (Official Gazette dated 8 January 2006 and no 26047) and the "Urban Wastewater Treatment Regulation Sensitive and Less Sensitive Water Areas Communiqué" (Official Gazette, dated 27 June 2009 and no 27271). The sludge from the wastewater treatment plant will be disposed of in compliance with the EU Sewage Sludge Directive (1986/278/EEC).

The following treated wastewater quality standards are to be met.

Table 12 Treated wastewater quality standards

Parameter	Design concentration from WWTP Bitola
Biochemical Oxygen Demand (BOD5)	25 mgBOD5/l
Chemical Oxygen Demand (COD)	125 mgCOD/l
Total suspended solids (SS)	35 mgSS/l
Total nitrogen (N)	10 mgN/l (future option)
Total phosphorous (P)	1 mgP/l (future option)

Description of the treatment technology – water line

Coarse Screens

Coarse screens are required to protect the inlet pumps and treatment facilities from large debris such as rocks, leaves, paper rags etc. They capture all particles having a size larger than the distance between the bars (30mm bar spacing). They are located in parallel channels. The input and output of the channel has a control gate, which serves to isolate them as needed.

Captured waste is transported by the transport mechanism to closed containers.

The building, which housed the bars is equipped with a ventilation system so air pass through a filter before being released into the atmosphere.

Inlet Pumping Station

The inlet pump system shall be designed to provide a gravity flow through the works under all conditions. Four (4) wet well variable speed pumps shall be configured as 1 duty + 2 assist + 1 standby with a capacity for maximum flow to treatment in WWTP.

Four (4) wet-well pumps shall be configured as 1 duty + 2 assist + 1 standby with a capacity for diluted wastewater flow in wet weather for discharging to the river.

Fine Screens

They capture all particles having a size larger than the distance between the bars – 5mm. They are located in parallel channels. The input and output of the channel has a control gate, which serves to isolate them as needed.

Captured waste from the fine screens shall be discharged, via conveyors into a screenings washer/compactor press and then into skips for subsequent collection and disposal to the municipal solid waste landfill.

Aerated Grit and Grease Removal Tank

The wastewater shall be pumped into a combined aerated grit and grease removal tanks. A minimum of two grit and grease removal tanks shall be constructed, each capable of handling 50 % of the maximum design flow in wet weather.

Grit shall be removed in order to reduce the risk of damage to the mechanical equipment in the following treatment units, and grease shall be removed to avoid non-aesthetic conditions caused by the volatile organics and malodorous floating sludge.

The grit shall be pumped from the grit hoppers by submersible pumps to a common grit classifier with washing system. A screw conveyor will transport the settled grit from the grit classifier to containers with a capacity for approximately one week's grit production.

The aeration system of the grit chambers shall comprise horizontally installed tube aerators, blowers and air distribution pipework. The blowers shall to be installed in a separate blower room.

Distribution Chamber to PST

A distribution chamber shall be provided between the aerated grit chamber and the primary settling tanks. The chamber shall be designed to give an equal hydraulic split under all flow conditions to the settlement tanks.

Primary Settling Tanks (PST)

Primary Settling Tanks are the main facilities in mechanical wastewater treatment. Their main purpose is to separate the larger suspended solids from wastewater and to settle the sludge while grease and oils rise to the surface and are skimmed off.

Primary settling tanks are usually equipped with mechanically driven scrapers that continually drive the collected sludge towards a hopper in the base of the tank where it is pumped to sludge treatment facilities. The scum shall be transported to the digesters.

Mixing and Distribution Chamber (for Influent and Return Activated Sludge)

To ensure that the influent is efficiently mixed with the return sludge and also to accurately distribute the flow to each process stream a tank with minimum 10-minute retention time based on peak dry flow to treatment plus RAS flow shall be provide ahead of the aeration tanks. The chamber is to be designed to give an equal hydraulic split to each aeration lane under all flow conditions and have a continuously operating submerged mixer.

Aeration Tank

Removal of the organic loads shall take place in accordance to the activated sludge system for effluent standards as specified in this Document. Construction of advanced wastewater treatment (additional BNR) is not a scope of works of this Stage (it will be part of future Stage 2).

Nitrification is the sequential conversion of ammonia to nitrite and ultimately nitrate. Ammonia in wastewater could originate from a variety of sources, including: proteins (meat and blood),

urea, amino acid products, casein, corrosion inhibitors, process chemicals and raw materials or cleaning chemicals containing quaternary ammonium compounds.

In this option we propose a minimum of two aeration tank streams. Aeration tank streams shall be of the same size, volume and configuration. The volume of aeration tank shall be based on a minimum design temperature of 12°C for design purposes, since the requirement of the EU discharge standard refers.

Mixers shall be provided and a minimum velocity of 0.3 m/sec must be ensured. Fine bubble aeration is required. The variable speed blowers are to be housed in a soundproofed building. The design of the aeration equipment shall be such as to optimize the supply of air to the process and shall be controlled by the use of suitably positioned dissolved oxygen monitors.

Distribution Chamber to SST

A distribution chamber shall be provided between the aeration tanks and the secondary settling tanks. The chamber shall be designed to give an equal hydraulic split under all flow conditions to the settlement tanks.

Secondary Settling Tanks (SST)

Secondary Settling Tanks achieve the effluent quality required on the one hand and to achieve sufficient mixed liquor thickening for recirculation to the Aeration tanks.

Commonly secondary settling tanks are provided to separate the biomass form the effluent by means of a controlled density flow pattern driven by gravity. Circular tanks with flat bottom and suction scrappers are provided.

At least three final settlement tanks shall be provided. All SST's, including the allowance for the future construction of the additional SST, shall be of the same size, volume and configuration.

The hydraulic surface loading rate shall not exceed 1.3 $m^3/m^2.h$ based on design peak wet flow.

A system for floating sludge from each clarifier shall be included. Floating sludge shall be transferred to the sludge dewatering.

Disinfection

Disinfection of effluent is only required as an emergency treatment in case of epidemic and after requirements of the hygienic authorities.

UV irradiation is proposed to disinfect effluent for WWTP. UV provides rapid, effective inactivation of microorganisms through a physical process. UV light has demonstrated efficacy against pathogenic organisms, including those responsible for cholera, polio, typhoid, hepatitis and other bacterial, viral and parasitic diseases.

Treated effluent discharge main and outfall structure

The treated effluent from the secondary clarifiers' collection chamber shall be discharged to the Dragor River. The outfall structure at the outlet of the discharge main shall be designed to protect the river banks and base from erosion and caving at the discharge point. Energy dissipaters shall be used in case the effluent velocity is high enough to cause erosion.

Pumping Station for Return Activated Sludge (RAS) and Surplus Activated Sludge (SAS)

The return activated sludge (RAS) pumps shall be capable of returning sludge to the distribution and mixing chamber at between 0.5 and 1.5 times the dry weather flow to the plant. This shall be achieved by using a number of fixed speed pumps or a single variable speed pump. Standby pump(s) shall be provided.

The pumps for excess sludge shall be submersible pumps. The pumps shall be speed controlled by means of frequency-converters. Excess sludge shall be transferred to the sludge thickening. The pumping of the sludge shall be controlled by a timer. One stand-by pump shall be provided besides the duty pumps.

Supernatant Pumping Station

Supernatant from the sludge treatment processes shall be collected in a balancing tank and returned to the inlet works at a point downstream of the flow measurement and sampling point.

Submerged pumps (1 in duty +1 spare) should be installed with automatic change over. The balancing tank shall be of sufficient capacity to retain the sludge liquors so that they can be returned to the works inlet overnight.

Description of the treatment technology – sludge treatment

Pumping Station for Primary Sludge

A pumping station for primary sludge shall be configured as duty/ standby variable speed pumps. The primary sludge will be pumped from Primary Settling Tanks to Sludge Thickener.

Sludge Thickener for Primary Sludge

The aim of thickening process is increasing the solid fraction in the sludge by removing a significant portion of the liquid mass. The primary sludge will be pumped from Primary Settling Tanks to Sludge Thickener and will be thickened by gravity in a circular tank. The retention time shall be a minimum of 1 day. The tank shall be fitted with a picket fence mechanism.

Mechanical Thickener for Surplus Activated Sludge

The surplus activated sludge will be thickened by mechanical thickeners. Polymer preparation units and polymer dosing pumps shall be provided. Minimum number of mechanical thickener is 2 (working time 8 hours).

The content of solids in the thickened sludge shall be increased from approximately 1 % to approximately 5 - 6 %. Excess water shall be delivered back to the system.

Reception Station for Septic Sludge

Reception station for sludge from septic tanks shall be provided. Equipment to the station necessary for the adoption of septic sludge should include: fine screen with space between the rods 6mm, screw conveyor, standard containers and measurement device. The coupler has to be with dimensions equal to the couplers of mobile septic tanks. Adopted sludge will be pumped to the mixed sludge tank.

Raw sludge tank

The primary and secondary sludge are different in composition and moisture content. Before submitting them to the anaerobic digester, they shall be mixed in a tank for homogenization together with the septic sludge. Retention time in raw sludge tank shall be at least 1 day, and there will be suction chamber for the corresponding pumping systems for feeding the digester. At least one submerged mixer shall be installed in the tank.

Anaerobic digester

Raw sludge stabilization shall be accomplished by mesophilic anaerobic digestion process - digestion takes place optimally around 30 to 38 °C.

Many microorganisms affect anaerobic digestion, who promotes a number of chemical processes in converting the biomass to biogas. The overall process can be described by the chemical reaction, where organic materials such as proteins, fats and carbohydrates are

biochemically digested into carbon dioxide (CO_2) and methane (CH_4) by the anaerobic microorganisms. The stabilization is performed in two phases. In the first phase (sour rot) complex organic substances, involving water is degraded to intermediate products: organic acids, alcohols, gases, and other amino acids. The process is accompanied by unpleasant odours. In the second phase (alkaline or methane rotting) the intermediate product from the first phase is degraded to end products: methane and carbon dioxide.

For dimensioning the digesters, a minimum treatment time of 20 d shall be observed.

An additional effect of the anaerobic stabilization is the production of gas methane, which will produce energy for the sludge heat exchanger. It is arranged as a double pipe heat exchanger. The heating process can be achieved in the CHP units (co-generators) or/and the additional heater (boiler) either by using biogas or natural gas.

The digester is arranged as flow-through reactor. At the top of the digester, a gas hood with observation window, measurement systems and pressure safeguard should be provided. The required equipment shall be installed in the gas building. In order to protect the digester against excess pressure (over 0,05 bar) or sub-pressure, a protection device for gas excess pressure and sub-pressure shall be installed into the gas hood.

For homogenization and mixing of the sludge in the digester a central mixer is intended. The digester will also have a heating system for maintaining the process temperature at around 35-37^{o}C. In order to maintain free ammonia levels below 80 mg/l a pH-control system with the option to dose HCl in order to decrease the pH value shall be foreseen.

A gas building is considered near to digester. The structure should provide room for all equipment and appurtenances, including control panels, required for a sound operation of gas system and heating system for the plant, including recirculation pumps and their connections or interfaces.

For utilization of the produced biogas a one combined heating and power (CHP) – unit shall be installed in the building. In addition, one boiler shall be installed next to the CHP as a redundant unit for the heat supply. The CHP and boiler will be used for heating the digester contents and for producing hot water and electricity. Produced excess heat shall also be used for space heating in adjacent buildings.

The building shall be adequately ventilated and air monitored for CH_4 and H_2S.

Gasholder

The digester gas generated from the anaerobic process is stored in a low pressure double membrane gas holder. The gas holder shall be installed in order to provide a constant gas flow to the consumer and to decouple the generation of biogas in the digester and the gas utilization. The usable volume should be able to storage up to 8 h of the gas production.

Flare

An enclosed waste-gas torch or flare shall be used with a vertical, cylindrical, and self-supported refractory lined stack. The flame is completely hidden inside the combustion chamber. The design shall be based on a single burner or array of burners enclosed within a cylindrical enclosure lined with refractory material.

The torch or flare shall be readily accessible and should be located at least 12 m away from the gas holder. The output capacity should be of 200 percent rated flow and shall be visual and wind screened.

Digested Sludge Tank

The tank for digested sludge shall be constructed in front of the sludge dewatering equipment and shall be designed and construct for one-day retention time. The tank shall be equipped with mixer for homogenization.

Sludge Dewatering

The last step in sludge treatment is sludge dewatering that reduces the water content of the sludge increasing the dried solids content of approximately 5% DS from the conditioning system to approximately 25-30% DS after pressing. Polymers have to be added that condition the sludge and drastically improve the dewater ability characteristics.

The stabilized thickened sludge shall be dewatered in two centrifuges. The sludge flow and SS concentration to the mechanical dewatering units shall be measured. Sludge shall be transported in a closed system to a container for transport to the landfill. Reject water from both dewatering units shall run through a flow-monitoring device and back to the plant inlet. All signals from flow monitoring, alarms control and regulation facilities shall be transferred to the SCADA system.

An automatic polymer dosing station must be provided. Dosing should take place before the dewatering unit. The polymer product will be purchased as liquid product, and thus the polymer station does not need to include dilution of a solid product to liquid phase.

Sludge Storage Area

An uncovered concrete hard standing shall be provided for storage of the sludge cake for period of 4 months.

Out of Specification Sludge Storage Area

Along with the standard sludge storage area, it is provided also area for storage of the sludge cake that does not comply with the sludge parameters suitable for reuse (i.e. heavy metal content, other pollutants, low dry solids content etc.). The minimum size of the area shall be sufficient to store one month of average production of "out of specification" sludge cake.

Service water system

A wash water supply system shall be provided that is compatible with the process equipment being provided. Source water shall be the final effluent taken after the flow measurement point or bore hall system.

Service water shall be used for washing the screens, screen presses, grit classifiers, pipe cleaning, polymer preparation and dilution, mechanical thickening and sludge dewatering plant wash water requirements, indoor and outdoor cleaning purpose and any other process wise water requirements. In addition, an automatic filtration system shall be obligatory to use for the above-mentioned purposes.

Odour Treatment

The principal odour sources shall be covered and ducted to odour control plant via a forced air ventilation system. Areas without normal access shall also be ventilated to avoid corrosion of concrete and metal parts. In this case, ventilation rates may be lower than for accessible areas. The concrete used for such areas shall be resistant to H_2S.

The areas considered as principal odour sources that are to be provided with odour treatment are:

- Coarse screen house / Inlet pumping station;
- Fine screen buildings;
- Sludge dewatering building.

Waste material storage

In accordance with requirements, with particular consideration being given to the Health and Safety and Environmental regulations, shall be provided all necessary storage facilities for operational waste materials which shall include as a minimum the following:

- Waste oil/lubricants
- Waste chemicals and contaminated materials (packaging/containers etc.)
- Household waste - area required for containers provided by Municipal Solid Waste Collection Company.

Water Lowering System

The high level of ground water necessitates design of water lowering system around deep founded facilities, such as Aeration Tank, Primary and Secondary Tanks, etc. The system will lower the level of ground water by pumping it out during the execution period, as well in case of need structures to be empty for repairs during the operation period.

Buildings

The following buildings have to be designed and constructed:

- Treatment Process Buildings:
  - Coarse screen house / Inlet pumping station
  - Fine screen house
  - Blower station
  - Service building to anaerobic digester
  - Building for sludge dewatering
- Power substation
- Administration building
- Workshop, storage and garage building
- Gate house

External Connections to the WWTP

Access to the following communal infrastructure will be provided for the proposed WWTP location:

- Main collector – DN1400; L=280 m
- Access Road from WWTP to national road - B=6+2 m; L=1,650 m
- High Voltage electricity supply from Transformer station “Bitola 3” to WWTP site – L=4,000 m
- Potable water supply to WWTP Site – DN 110; L=790 m

5 BASELINE ENVIRONMENTAL CONDITION IN THE PROJECT AREA

5.1 Geographic location

Construction of a collector system, rehabilitation of sewerage network and construction of wastewater treatment plant in Bitola is implemented in the Bitola Municipality. Bitola is the second largest city in Macedonia. It is situated on the river Dragor, in the end southwest part of the Republic of Macedonia in the bottom of the Baba Mountain, 13 kilometres away from the Greek border, in the biggest Macedonian valley Pelagonija. The town occupies a surface of 15 square kilometres for the narrower area and over 24 square kilometres for the wider area. The Bitola terrain leans from west to east that is from the mountain pick Pelister and mountain Baba to the Pelagonija Valley or from 710 meters to 590 meters height above the sea level, and the town's average height above the sea level is 650 meters.

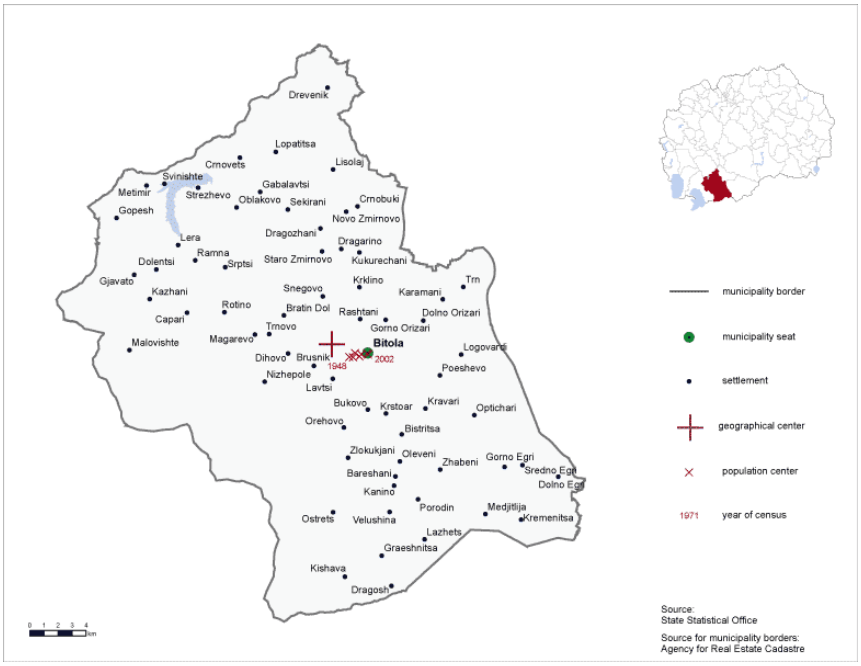


Figure 10 Bitola Municipality

As per the new territorial division of the Republic of Macedonia from 2004, the area of Bitola Municipality covers 65 villages, among which: Baresani, Bistrica, Bratin Dol, Brusnik, Bukovo, Velusina, Gabalavci, Gopes, Gorno Egri, Gorno Orizari, Graesnica, Dihovo, Dolenci, Dolno Egri, Dolno Orizari, Dragarino, Dragozani, Dragos, Drevenik, Gjavato, Zabeni, Zlokukani, Kazani, Kanino, Karamani, Kisava, Kravari, Krklino, Kremenica, Krstoar, Kukurecani, Lavci, Lazec, Lera, Lisolaj, Logovardi, Lopatica, Magarevo, Maloviste, Metimir, Medzitlija, Nizepole, Novo Zmirnevo, Oblakovo Oleveni, Opticari, Orehovo, Ostroec, Poeshevo, Porodin, Ramna, Rashtani, Rotino, Svinishte, Sekirani, Snegovo, Sredno Ergi, Srpci, Staro Zmirnevo, Streževo, Trn, Trnovo, Capari, Crnobuki, Crnovec. Population density is 788 inhabitants/km^2. Although Bitola is placed on the peripheral part of R. Macedonia, it is the second largest economic center right after Skopje as well as an important administrative and commercial center.

Generally speaking, although Bitola is set at the peripheral part of the Republic of Macedonia, it is second largest economic centre after Skopje, as well as an important administrative and commercial centre. Bitola is set in a region of intensively developed agriculture and is important agro-industrial centre, not only for the Pelagonija Valley, but also in the wider south-western region of the Republic of Macedonia. Many of the largest companies in the country are based in Bitola.

The planned location for construction of the treatment plant is shown in the following figure.

Figure 11 Location of newly envisaged WWTP

5.2 Climatic features

Climate elements (temperature, humidity, insolation, cloudiness, precipitation, wind, etc.) and climatic factors influence the development and survival of wildlife, all human activities and certain processes in nature, as an important element in the biosphere.

Bitola region, as well as the whole Pelagonija Valley is rather southern positioned and due to the altitude should have a modified Mediterranean climate like Tikvesh, Valandovo, Gevgelija and Strumica. But, although Pelagonija Valley is at a distance of 155 kilometres from the Adriatic Sea, and at about 130 kilometres from the Aegean Sea, still the Mediterranean climate influence isn't much felt, because of the high mountainous surrounding of the valley, and its own height above the sea level (it is between 571 and 770 meters) due to which temperate-continental, continental and mountainous climate are predominant..

Generally speaking, according to the characteristics and the appearance of the climate phenomena during a year, Bitola region belongs to a warm continental area. The climate in Bitola has moderate – continental characteristics with an emphasized continental component, because of the closeness of the mountainous relief, the height above the sea level, the near-by valley etc., and these facts make the climate in Bitola and Pelagonija very dynamic and unstable. According to the Kepen's climateclassification, the climate in Bitola can be marked with CSW "ax" – a specific variant of the etezic climate with dry and very warm summer, and a rainy winter period, divided into a shorter cold and dry period, with the first maximum rainfall in autumn and the second one in spring. This variant is called Macedonian variant of the etezic climate because it is typical for Macedonia, especially for the regions at 500-600 meters height above sea level. Bitola is a typical representative of this variant with dry and very hot summers, and winters and springs with abundant rainfall.

The average annual temperature is 11.0°C with the highest average monthly temperature of 21.0°C in July and August and lowest of -1.0 °C in January. The temperature amplitude is 21.6 °C while the difference between the maximum absolute of 40.5°C and the absolute minimum temperature of -30.4°C is 71,6°C, it is specific to areas with a continental climate. The temperature has specificity of continental climate and the rainfalls resemble dry modified Mediterranean or steppe-like climate which, with flashes of hot air masses penetrating from North Africa - Sahara.

In the winter months the average percentage of sunny days was 12.3%, and in the spring months it was 28.3%, in summer months 43% and 24.3% in the autumn months.

Table 13 Average monthly and annual air temperature in Bitola region

Average monthly and annual air temperature in °C													
Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Temperature	-1.0	2.0	6.0	11.0	15.0	19.0	21.0	21.0	17.0	12.0	5.0	2.1	11.0

In Bitola, July and August are the months with the longest insolation, and December and January – the shortest. The average year sum of insolation for the 1951-1990 period is 2,325.6 hours, which is about 6.3 hours a day.

Fog usually appears during autumn, winter and spring, that is from September to May, and most foggy months are December, January, November and February. Thick fogs with only about ten meters of visibility are most common. Such thick fogs are common for the winter period, and sometimes in late autumn (November). The average number of foggy days is 22.77. This number can vary from 9 to 48 days in some years.

The relative humidity is: in winter 81.3%, in spring 67%, in summer 57.7% and in the autumn months 71.7% or 69.42% annually. Due to the special orographic conditions, Bitola and the surrounding area have less rainfall, which are not evenly distributed. The average annual quantity is 598 mm and not more than 800 mm, with 119 rainy days a year. There are some dry periods, but usually with a short duration of 10-15 days, and the longest being 60 days.

Table 14 Average monthly and annual precipitation in the Bitola region

Average monthly and annual quantities of rainfall in mm													
Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annually
Quantity	41.0	38.0	35.0	53.0	48.0	29.0	31.0	29.0	39.0	53.0	66.0	73.0	535.0

The snow cover occurs from October to April. The annual average is 34-36 days under snow cover, and the maximum reached in January. The maximum height of snow is 60-65 cm.

North wind is prevailing in Bitola with average annual frequency of 189 ‰, average annual speed of 2,2 m/s and maximum speed of 15,5 m/s. The second frequent is the southern wind with an average of 134 ‰, average annual speed of 3,7 m/s and maximum speed of 18,9 m/s. Northwest wind is also frequent with an average of 83 ‰, average speed of 2,4 m/s and maximum speed of 18,9 m/s. Northwest wind has an average of 83 ‰, with an average speed of 2,4 m/s and maximum speed of 18,9 m/s. Northwest wind has an average of 63 ‰, with an average speed of 2,7 m/s and maximum speed of 18,9 m/s. Northeast wind has an average of 63 ‰, with an average speed of 2,2 m/s and maximum speed of 15,5 m/s. West wind has an average of 61 ‰, with an average speed of 3,5 m/s and maximum speed of 22,6 m/s. Southwest wind has an average of 41 ‰, with an average speed of 2,4 m/s and maximum speed of 15,5 m/s. The least frequent is the eastern wind with an average of 22 ‰, average annual speed of 1,7 m/s and maximum speed of 15,5 m/s. Frequent winds and relatively low temperatures allow for increase of evaporation conditions of the free- and soil water, that is, there are conditions for increasing the potential evaporation. The average evaporation is 855 l/m^2.

Pelagonija also features with local currents which are rather refreshing in the summer months.

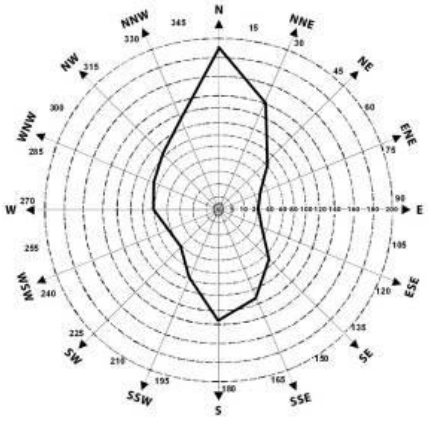


Figure 12 Rose of the Winds in the Bitola valley

Climate changes

Climate changes predictions[3] for the main climatic elements (temperature and precipitations) have been developed until 2100, that is to say, for the periods 1996-2025 (labelled as 2025), 2021-2050 (labelled as 2050), 2050-2075 (labelled as 2075) and 2071-2100 (labelled as 2100) in comparison to 1961-1990 (labelled as for the reference period 1990). The results from the four global circular models (GCMs) were used in parallel to the NCEP/NCAR for repeated data analysis (Kalnay et al., 1996; Kistler et al., 2001). Based upon this, local climate scenarios have been developed for the first time in accordance with the national climatc sub-regions.

As per the results, the average rise in temperature is between 1,0°C in 2025, 1,9°C in 2050, 2,9°C in 2075 and 3,8°C in 2100, while the average reduction of precipitation in the range of 3% in 2025, 5% in 2050, 8% in 2075 to 13% in 2010 compared to the reference period.

The largest increases in temperature in R. Macedonia are expected in the summer season, along with substantial decrease in precipitation. There will be almost no change in precipitation in winter, but changes are expected in other seasons.

According to the empirical scale and direct GCM results, local forecasts show much more intensive increases in temperatures in winter and spring. In addition, local forecasts show less reductions in rainfall in summer. The predicted temperature changes are intensive in the three climate sub-types in the northwestern part of the country under Alpine climatic influence, given by the meteorological stations in Lazaropole, Popova Shapka and Solunska Glava.

5.3 Geological features

Bitola basin is located in the southern part of the Republic of Macedonia.

As a geological structure is located in the northern part of the Pelagonian Basin, which is an elongated intermountain graben system situated in NNW-SSE direction. The total length of the basin is over than 250 km, and it extends from Prilep and Bitola to Serbia in the north and to Greece in the south. The depression fill comprises a succession of predominantly lacustrine sediments with intercalated lignite seams and fluvial deposits.

The Pelagonian Basin is bordered by two fault systems, which correspond to the two main episodes in its evolution: late Miocene and Pliocene ones. Pleistocene extension of the basin resulted in the development of several sub-basins, one of which is the Bitola Basin. Neogene sediments of the Bitola Basin were divided into four informal lithostratigraphic units corresponding with two sedimentation cycles. On the basis of the mammal fauna found in the

[3] Third national communication on climate change, Vulnerability and adaptation to climate change

upper part of the sediments of the second cycle, these were dated as Pontian/Lower Pliocene. Many authors for the corresponding deposits reported the same age from the Greek part of the basin based on palynological and macropalaeobotanical data.

The Pelagonian graben was initiated first during late Miocene time. The N-S–trending Pelagonian graben is ~100 km long (including a part in the Northern Greece) and up to 25 km wide. It is a complex graben developed on Precambrian gneiss and schist and Paleozoic schist and granite of the Pelegonian tectonic unit. Within the graben there are small horsts and one intragraben horst that divides the main graben into northern and southern parts containing 450–500m and 700–800m, respectively, of sedimentary fill. The graben is bounded on all sides by normal faults. Along the eastern side of the graben the youngest sedimentary layers are displaced up to 70m. The basal units in Pelagonian basin are proluvial-alluvial sediments based on borehole data. Seismic studies indicate that these sediments were deposited in narrow river valleys rather than with a fault controlled graben.

Paleontological data from higher stratigraphic levels indicate the graben was initiated in late Miocene time and contained a lacustrine environment from late Miocene to the end of the end of Pliocene and Pleistocene time locally. Considering that there is probably more than 1000m of section in the southern part of the graben, it can be suggested that this part of the graben may has been initiated during middle Miocene (Badenian-Sarmatian) time. The Miocene-Pliocene section is covered by 5–15m of Pleistocene alluvial-proluvial sediments, except in the southeaster part of the graben, where upper Miocene strata are exposed by uplift and erosion. In this area, the section has been well studied in the Suvodol open pit coalmine and in drill holes in numerous water wells. The sequence is divided into two formations and undifferentiated Quaternary strata.

The basic facts that can be pointed out for the geo-chronological development of the wider region are:

- The oldest rocks in the Western Macedonian zone have Precambrian age and they are in the frames of the magmatic complex composed from granodiorite, shale granodiorite, syenite rocks and granite;
- For today look of terrain the current geological processes during the Quarter period are important, when the deluvial cover is created over the basic rocks, the glaciofluvial sediment are noted in the foothill of mountain Baba in form of wreath wide several kilometres and alluvial sediments in the foothills of the biggest rivers but mostly they are formed in Pelagonija valley.

All periods of the geological development had big impact over the creation of today condition of the terrain which is manifested with current relief and conditions.

From geo-morphological aspect the wider area characterizes with sharp slopes created from tectonic and erosion processes. On hills it is noted presence of tranches during the contact between different lithological elements i.e. in the contact between the diluvium and glaciofluvial sediments as well viogrus and granites.

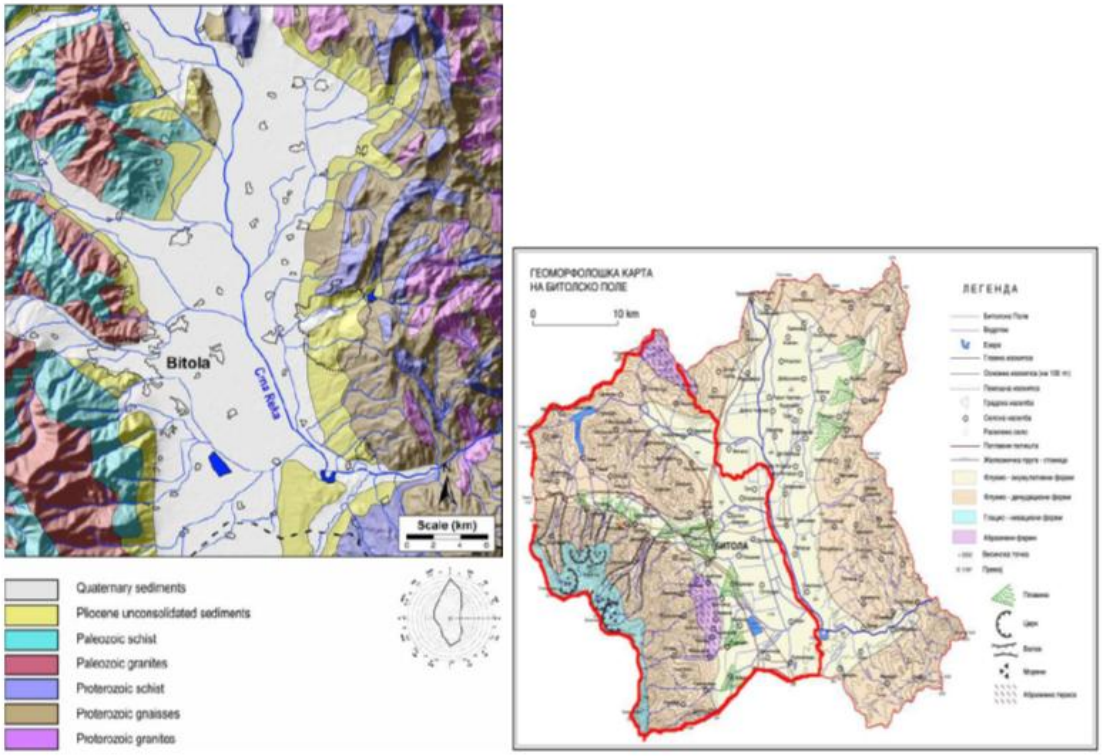


Figure 13 Fragment of geological map of Macedonia – Bitola valley and surrounding

The terrain is mostly flat with a minimum height of 585m/ km 10 + 426.50 and mountainous area with an altitude of 769m/km 3 + 034.10. The area around the electricity line tower AZ3 is slightly rounded. The slope of the terrain on the northeast side is relatively sharp. Current trenches - valleys in geological terms are in the stage of medium activity. Due to the relatively sharp bow across them from time to time they are becoming deeper and therefore filled in by proluvial material in the zone of connection with intermittent streams.

5.4 Seismic features

From regional seismological tectonic terms the area belongs to the Western-Macedonian zone, characterized with minor plicate structures and radial tectonics. Extension of the structures in the Western-Macedonian zone is a NW-SE to NNW-SSE. Tectonic development is associated with two major orthogenesis: Hercine and Alpine orogenesis. With Hercine orthogenesis, Paleozoic sediments were regionally metamorphic and corrugated in soft synclinal and anti-synclinal structures. Alpine orthogenesis conditioned strong dynamo-metamorphism, intensive crimping of the terrain and for the most part, processing of the hercine structures. In the later stages of the Alpine orthogenesis (at the end of the Lower or early Middle Pliocene), the terrain was captured with very intensive radial tectonics that formed more tectonic cliffs. Paleozoic metamorphic rocks are intensively corrugated in lenient synclinal and anticline structures. Synclinals are larger, well expressed, while anticlines are less expressed, narrow and open structures. During the Middle Pliocene, certain parts of the terrain were taken by intensive radial tectonics (neotectonics) and as a result, more tectonic ridges were created. As the most remarkable is the Ohrid ridge, oriented in the N-S direction, between the mountain chains Galicica-Karaorman and JablanicaMokra and from N. is limited to the southern slopes of Karaorman. During the formation of the Pliocene ridges, the terrain became very labile with intense manifestation of radial tectonics. It has been active through the whole Middle and Upper Pliocene and acts in the Quarter, with tendency of conciliation.

The area of the city by its seismological characteristics belongs to the zone of high extent seismic activity and expected intensity of 5.7° by Richter. The planned range is between 7 and 8 degrees by Mercali‟s scale of expected earthquakes. Earthquakes in the region are mostly shallow (h ≤ 60 km), whereupon most of them have hypocenters to 40 km, and often up to 20 km.

5.5 Hydrological features

The project area belongs to the Crna River basin. It covers the Semnica River (in the norther part of the municipality), Dragor River, Krstvoska River, rivers Belishka and Graeshka. Dragor river runs through Bitola in the length of 4,5 km, and its spring is on the slopes of Pelister in the length of 4,5 km. The total length of the Dragor river is 25,123 km with a watershed size of 67 km, drainage-basin of 188 km^2 and average slope of 17,0 ‰. The quantity of water in the river depends on precipitation and groundwater on Mount Baba. Dragor river average flow through the city for the period November to June is 2-3 m^3/s. Dragor river is formed by several small rivers as follows: Duhovski Dragor (in the length of 12 km, whose spring is formed from waterflows originating from the slopes of Pelister: Sapuncica, Lak potok, Crvena reka and Klisurica) and Bratindolski Dragor or Boroica. The amount of water in the river depends solely on rainfall and groundwater from Baba and Pelister.

On the top of Baba Mountain-Pelister there are two glacial lakes, known as "Pelister Eyes" - Large and Small Lake. Baba Mountain is rich with springs, streams and rivers. Most sources are located in the higher parts of the mountain, at an altitude between 2.000 and 2.200 m. The rivers in their upper part have mountain characteristics, full of plenty clear and cold water. Some of them flow into Lake Prespa (belonging to the Adriatic basin). There are plenty of streams, which extends to the area as: Smilevska river, and its tributory Kindjirka, Kristoar river and its tributaries Stara reka and Slovjanska river, Bistrica and its tributary Petkovica, Vilushka river and its tributary Ostrechka river, Graeska river with its tributary Kisevska river and Negochanska river (formed by Mala river and Bachilo and including Dragor river), Shiva river, Ksiropotamos etc.

From a hydrogeological point of view the existing groundwater in the irrigation area can be classified into two groups: ground waters under the free water level of debt of 1,5-2m and groundwater under pressure (artesian and subartesian waters) at a debth under 50m with a capacity of 0,5 I/s - 9 I/s. Hydrogeological thickness of the collector is different and usually it is about 3,0 m. The direction of movement of groundwater is compliant with the slope towards Pelagonija basin - Crna River. Filling-in the aquifer is carried by vertical infiltration of precipitation, and partly from surface waters with rivers that cover the surrounding terrain.

Artificial reservoir lake "Streževo" is an important hydrographic facility for Bitola and the region is located at some 22 km from Bitola. This lake occupies a volume of 112.000.000 m^3 water, with 72 m depth dam, an area of 7 km^2, and an average width of about 1 km and a length of 7 km. Construction of "Streževo" hydro system allowed for provision of the necessary irrigation water for one part of Pelagonija, additional quantities of untreated waters for PE “Vodovod” Bitola, provision of the needed untreated water for one part of the industry (thermal plant „Bitola”, Sugar Plant „4th of November”, yeast and spirit factory, fruit and vegetable processing plant, textile factory „Pelister” etc.), electricity – energy use of the hydropotential of the water from the hydro system watershed, flood protection for Pelagonija etc. Water catchment of Baba Mountain rivers and their inclusion in the river basin Semnica happens with the alimentation canal with a total length of 61.5 km and a throughput of 5 m^3/s. The detailed pipeline network of hydro system is designed to irrigate part of Pelagonija is a network of main, distribution and segmented pipelines with a total length of 534 km.

The water management area "Pelagonija" has registered a total of 660 sources, 4 of which are registered as sources with significant yield. The highest yield has the source of Crna River – Crna Dupka with capacity of 1170 l/s.

The example below shows the hydrographic network on the ground.

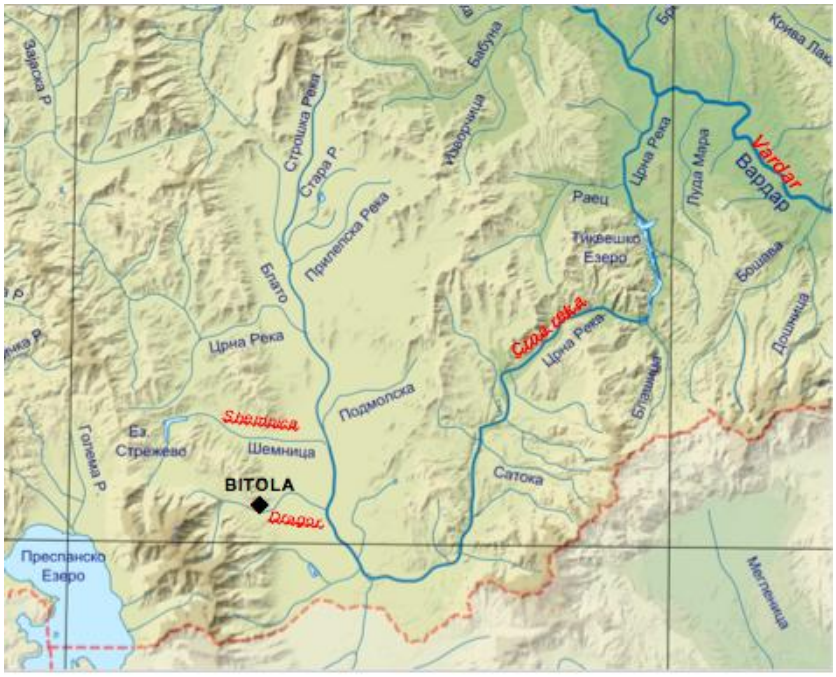


Figure 14 Crna River basin area

For the purposes of this study, an analysis[4] of the hydrological aspects of Dragor river at elevation of K-581 m.a.s.l as a recipient regarding the project for construction of WWTP Bitola was prepared.

Dragor river is the right tributary of Crna River which flows into this river close to Novaci village at an elevation of 576.7m.a.s.l. The basin of Dragor river has hand-fan shape and stretching from the west towards the south and has the following physical and geographical characteristics:

- The basin extends from the highest elevation of the Pelister peak on Baba Mountain at the elevation of K-2602 m.a.s.l., to the elevation at the estuary in Crna River K=576.7m.a.s.l
- Total catchment area to the river flow of Crna River ..... F = 188km^2
- Length of watershed .....O =56km
- Average height of the watershed.....Jsr=1750 m.a.s.l.
- Length of watershed .....L =22 km

Dragor River watershed is separated from the Prespa Lake water catchment at the western part of Baba Mountain, at the southern part it borders the neighbouring watersheds formed by Baba Mountain and Macedonian-Greek border, Crna River at the eastern side and Šemnica river water catchment at the northern part formed by Baba Mountain.

[4] Analysis of hydrological aspects regarding the project "WWTP Bitola" profile - treatment plant "Bitola" k 581.00 MNM Joseph Milevski, Maneko Solutions, 2016

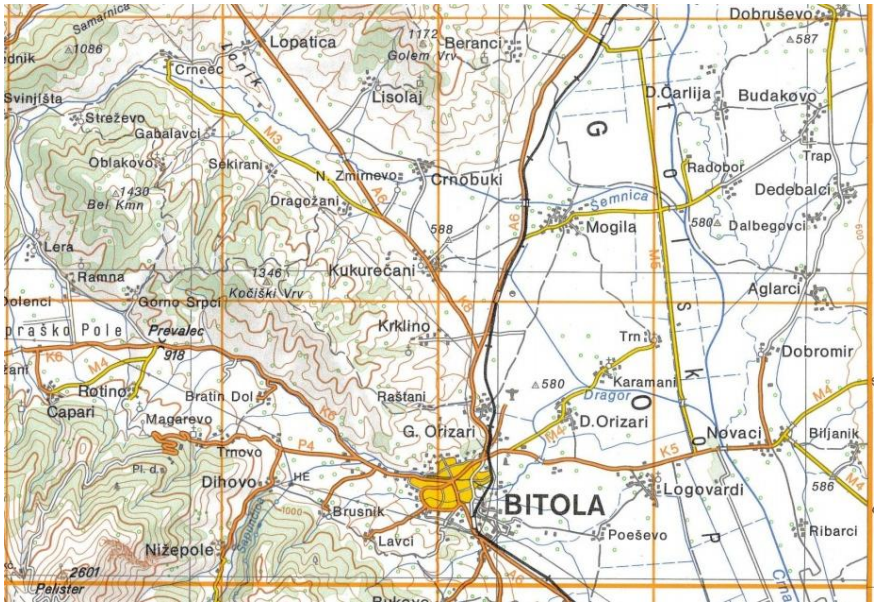


Figure 15 Dragor River basin area

Dragor River Basin has developed hydrographic network at its source part at the foot of Baba mountain, and number of smaller streams are formed at the same spot and join at elevation 1250 m.a.s.l. Dragor river is one of those watercourses which is called Sapunchica at the elevation of 1250m.a.s.l. It is formed at the foot of Baba Mountain from a large group of sources in the zone between 2200-1550m.a.s.l., and flowes from west to east up until Crn Kamen, and it takes northern direction up to Dihovo village. As we mentioned earlier, downstream from Nizepole at 1250 m.a.s.l., it meets two left tributaries also formed at Baba Mountain foot under Large Lake, Stara Buka river and Crvena Reka is formed under Small Lake under Baba Mountain. River Sapuncica meets these two rivers compiling collection pool located above Nizepole and starting from this place until the Crna River it is called Dragor. Dragor river close to Dihovo village changes its direction eastwise and continues east up to Crna river at Novaci village. At the beginning when entering the town of Bitola it receives Bratindolska river and right above the envisaged WWTP site at 582 m.a.s.l., it receives the last left trubutory of Golema river formed above Rashtani village and under the mountain massif Snegovski Pat at 950 m.a.s.l. On the right-hand side there are several smaller streams formed from the mountains above Brusnik and Lavci villages that are fully regulated and introduced into Dragor in the locality Kurdelec at the very entrance in Bitola.

In the past few years from a national, hydrological and meteorological monitoring, throughout Dragor river catchment there is only one main meteorological station run by professional personnel, several precipitation measuring stations and a few groundwater stations in the Pelagonija part. By 1982 there was a hydrological station "Bitola" which ceased operations after the construction of the HMS "Streževo" when an increased anthropogenic impact on the water upstream of the hydrological station was detected. After establishing a separate network of hydrological stations on all catchments with collection channel, the HMS “Streževo” professionals have started permanent measures of the water quantities in the water flows included in the system amongst which Dragor river in Dihovo village. All of these measurements, although not continuous for a long time, make it possible to define the oscillations of water resources in some parts of the Dragor river basin. However, undoubtedly it is necessary to make a new Hydrological Overview of the Dragor river basin and other basins formed from Baba Mountain, taking into account the need to use the water quantities on the upper part of the basin which may cause critical decrease of the water capacity in certain parts of the basin areas.

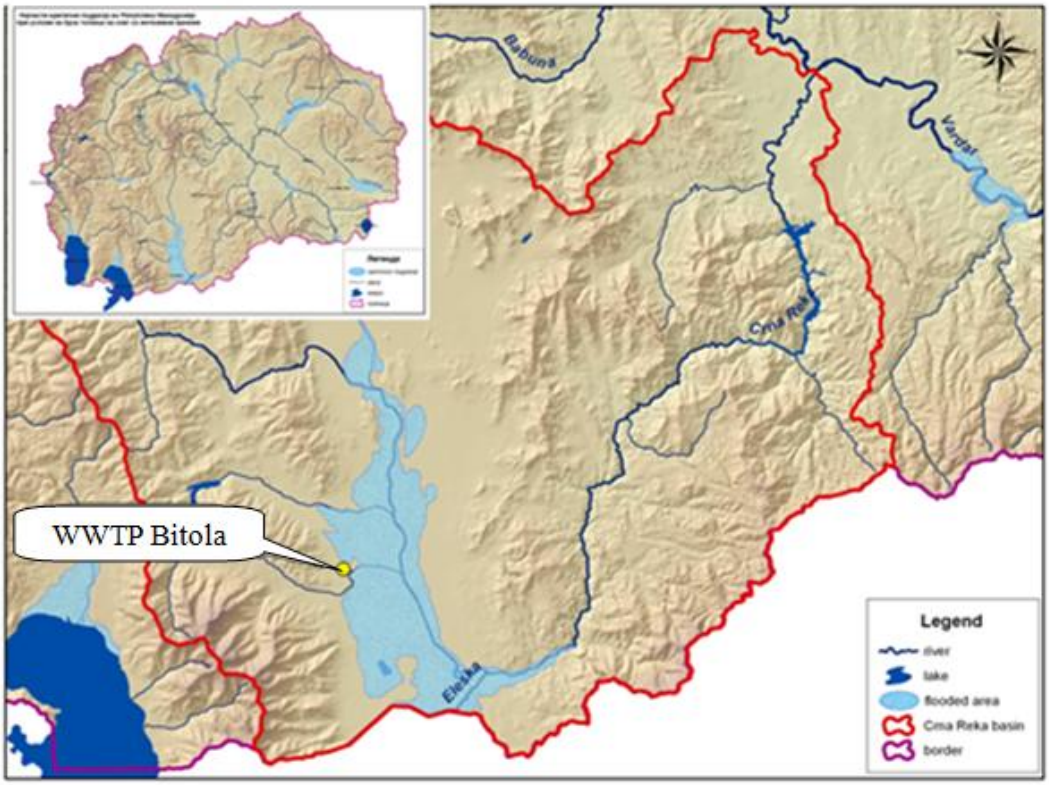


Figure 16 Critical areas in Macedonia in conditions of rapid snowmelt and intense rainfall[5]

There are no direct and permanent measures of the river Dragor quantities for the WWTP "Bitola" at K-581 m.a.s.l, and when implementing the method, analysis has defined the average waterflow, the basin area to the hydrological station "Bitola", large waters for a recurrent period of T=10, 50, 100 years calculate the total quantities of the basin. The analysis includes the regime of groundwater in the area and analyse the phenomena of flooding in the Crna river basin. Based on the above, the analysis finally brings conclusions and recommendations which are given in this study.

Because of its geomorphology and climate, R. Macedonia is susceptible to floods. There are regional and local flooding. Almost all the rivers in R. Macedonia cause flooding. Over 102,000 hectares of land could be flooded given a one-year recurrent period. As a result of natural conditions and coverage under especially low forest species, rare, short but intense rainfall, unbalanced water regime are factors leading to many floods. These floods threaten infrastructure facilities and agricultural land that gets covered with sterile sediment.

Many measures to control the river basins have been implemented in the R. of Macedonia to improve the protection against floods, local regulation of the riverbeds in the urban areas, systematic regulation of rivers in larger segments and control beds and flood-gates. Maintaining the channel of the Crna River has been implemented in Pelagonija. The channel of the river Semnica has been severely degraded due to gravel. Bitola, Prilep and Bucin are settlements often susceptible to flooding.

[5] Presentation – Floods in large drainage basins, Causes, effects and their relation with climate changes, Josif Milevski, 2011

Large systems for flood control were built in Skopje, Pelagonija, Strumica and Struga regions. There 32,7 km in the Skopje region, 82,3 km Pelagonija, 79,3 km in Strumica and 10,9 km in the region of Struga, protected in case of flood. The total length of rivers treated in Pelagonija is:

- Crna reka River - 58,1 km,
- Dragor - 10,7 km,
- Šemnica - 12,2 km,
- Elashka - 1,3 km.

Lines of flood protection are usually built in combination with irrigation and/or drainage systems. Insufficient maintenance on the flood protection lines is one of the main problems in the Pelagonija Region. Regulated river-banks overgrown with riparian vegetation reduces the transferability of the channel, which consequently causes flooding. In 2014, 10.000 ha were flooded in the Pelagonija Valley.

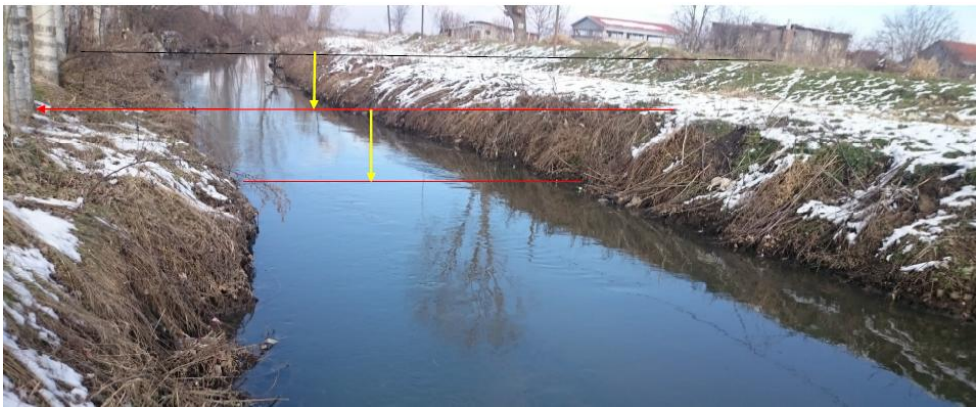


Figure 17 Regulated riverbed of the river Dragor

5.6 Topography, soils and land

Topography

The landscape of the municipality of Bitola is characterized by mountainous and plains. Baba Mountain is located on the west side and on the east side, the municipality occupies the central part of the Pelagonija valley floor.

Terrain of Bitola is sloping from 715 to 585 m, from west to east side, from Pelister and Baba Mountain to Pelagonija valley, from 710 meters to 590 meters height above the sea level, and the town's average height above the sea level is 650 meters. These differences in heights significantly influence the city's appearance and structure of the city landscape. On the one hand the city is situated on the flat area, and on the other side on the hilly and mountainous land. Bitola is located in the area where two different agricultural units meet, cereal and vegetable production in the east, northeast and southeast and orchards, vegetable production and livestock breeding area in the west and southwest.

Landscape features allow expansion of the city towards the territory i.e. towards west, southwest and north, which was very intensively used in the last decade of the last century.

The general decline of the terrain is very suitable for construction as well as for efficient drainage of storm and wastewater. The average decline on the ground in the direction south - north is around 2-4%.

Soils

Predominant type of genetic land in Pelagonija is “smolnitsa” (resin-like soil), which developed from the lake silt after the expiry of the former Pelagonija Lake. The amount of humus ranges from 2 to 4.5%. These soils are used for cultivation of cereals, industrial and horticultural crops.

Deposits of alluvial soils ranging from ten centimeters to several meters. Humus contained is 0.42 to 3.62%. The alluvial soils are eligible for production of horticultural and industrial crops. Delluvial soils are located on the outskirts of the city. These are young soil types with a small percentage of humus 1-2% that require fertilizing. “Crvenica” are widespread in the periphery and towards villages Brusnik Lavci, Bukovo, Krstoar and less to Dihovo and Bratindol. The content of humus ranges from 1.18 to 3.96% and are characterized by lower fertility.

Decreased use of agro-technical measures in agriculture in the municipality of Bitola, as a consequence of the economic conditions is regarded as positive factor to preserve that is decrease the soil pollution from mineral fertilizers and pesticides.

In Municipality of Bitola there are no documented data on the soil quality, but taking into account the close REK Bitola alongside with the irrigation of part of the agricultural areas with polluted waters from the Fifth channel, one may conclude that large parts of the soil have deteriorated quality.

Pelagonija valley, especially in the area of Bitola faces the problem of erosion. It manifests itself in the form of surface spills on land and deepening of torrential basins, gullies, ditches, furrows and the like. Pelagonija as a Lake Valley and lateral lake valleys are favorable grounds for harmful effects of erosion and floods. At the turn of the slopes and the valley there are lake and river terraces, which are eligible to floods, taking the surface coating which encumber the fertile land.

Bitola has a very big problem with surface erosion. The slopes are steep and their plant cover is degraded or destroyed. The area of Bitola shows large temperature differences -35˚C to +45˚C, which also influence the erosion process. In order to protect the area from erosion processes in the period from 1960 to 1975, afforestation was carried out as a measure to protect against erosion. Also, the area of Bitola near the regional road Prilep - Bitola - Resen in the area called ”Bajro"show signs of erosion.

Land use

For the purpose of optimal land use alongside with all conditions harmonised with the Spatial Plan of the Republic of Macedonia up to 2020, we propose use of zoning and based upon this Republic of Macedonia is devided into 6 agricultural-economic zones and 54 microzones.

The rocomendations from the Spatial Plan are directed towards considerations for the land rating when planning the space and preferring land clasess of lower rating (above IV category), in cases when urban plans are developed, that is when land adaptation from agricultural to constructional purpose is planned. Priority is the protection of agricultural land and limit the transformation of the land of I-IV class in non-agricultural land[6]. The land purpose is given in the following figure.

[6] Definition for use and protection of farmin land, exerpt from the RM Spatioal Plan

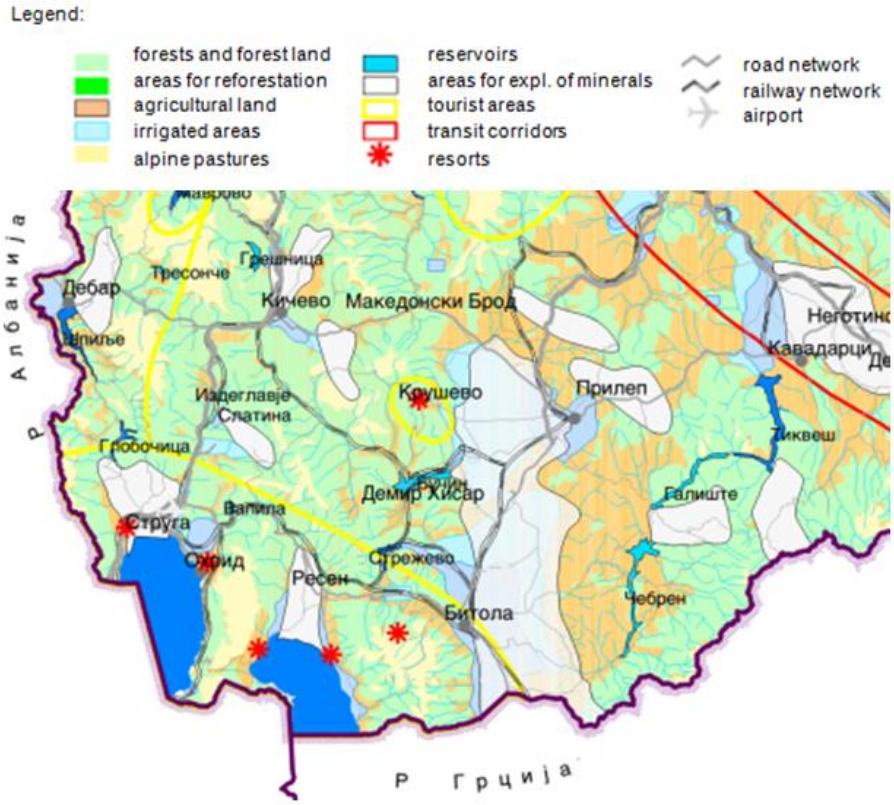


Figure 18 Land use in the present scope of the agglomeration Bitola[7]

Data on agricultural land, method of use and types of crops in terms of land use is given in Chapter 5:13:13, Agriculture.

5.7 Waste Management

Waste management in the town of Bitola is mandated to the communal PE "Komunalec" responsible for the collection, transport and depositing the communal waste from individual users and legal entities on the territory of the Municipality of Bitola.

Collection and transportation of municipal and other types of non-hazardous waste in the Municipality of Bitola is carried out in total 16 districts with 18 special vehicles for collection and transportation of waste. Household communal waste is collected from 13 districts, combined collection of communal waste from household and non-hazardous waste is collected at 1 district, industrial non-hazardous waste is collected from 1 district and selective collection of waste paper and waste plastic (PET) is collected at 1 district. Communal waste from the Municipality of Bitola is collected from the town of Bitola and from the 14 villages surrounding the town of Bitola (Logovardi, Lopatica, Kukurechani, Kravari, Dihovo, Trnovo, Magarevo, Dolno Orizari, Bistrica, Nizo Pole, Zabeni, Bukovo, Lavci and Karamani). The serice is planned to extend by 5 vilalbes annually, to reach 5% increase of the collected amount of waste.

The system for collection of municipal waste conducted by the PE Komunalec in the Municipality of Bitola is conducted through 1) Removal System and 2) Trasportation system.

[7] Spatial Plan of RM

Removal System

After the removal system, the waste is collected from certain places and at certain times, previously disposed by possessors in containers for the intended purpose. After the removal system, the waste is collected from individuals or households and commercial waste from legal entities. Municipal waste is collected from appropriate containers for collection of municipal waste sized 1,1m^3 and 5m^3, plastic containers of 120-240 litres and an undetermined number of improvised containers. The containers are emptied on working days from Monday to Friday from 7 to 14 pm.

Containers for collection of municipal waste from the downtown area are collected twice a day with a daily route combined with night-duty vehicle with a precisely specified route. Emptying containers with communal waste by night-duty vehicle is carried out in the following terms:

- In the period between April 1 to October 1 from 19:00 to 02:00 am;
- In the period between October 1 to April 1 from 17:00 to 24:00 pm;

During the weekend, that is on Saturday and Sunday, the collection of municipal waste is carried out by emergency vehicles with a specificly defined route.

Collection of communal waste from individual residential facilities is organised once a week, that is from collective residential facilities is performed twice a week under the following schedule Monday – Thursday, Tuesday – Friday. Removal System is also implemented for collection of industrial non-hazardous waste. The collection is carried out in containers of 1,1m^3, in containers of 5m^3.

Transportation System

Transportation system is used for collection of selected waste, paper and plastic, bulk (large items) household waste such as old furniture (arm-chairs, couches, mattresses, old beds, old cabinets etc.) electricity and electronic waste (old kithen devices, stoves, refrigerators, washing machines, old TV sets, old computers), various car parts (internal and external tyres) from legal nad natural entities. Selected waste (paper and plastic PET) is collected in separate specialized containers (baskets). Collected amounts are processed using hydraulic presses in the form of bales and are handed over to authorised processors.

Based on the analysis made by the PE Komunalec, in 2013 from Bitola municipality they have collected 571.364 tons of waste per week, or about 29710 tons annually. Out of the total quantities of collected waste 25,759.44 tons/year is municipal waste collected from individuals, and 3951.48 tons/year is a commercial and industrial non-hazardous waste. Town of Bitola has collected 23486 tons/year of municipal waste, while in the rural areas there are 2273.44 tons/year collected waste.

Based upon the previous defined quantities of communal waste, collected annually on the territory of the town of Bitola and based upon the structure of waste fractions identified within the National Plan for Solid Waste Management, the assessed quantities of waste fractions are given in the following table.

Table 15 Communal waste fractions

Type of waste	Proportion (%)
Biodegradable	26
Paper and cardboard	11.9
Plastic	9.6
Wood	2.7
Glass	3.5
Textile	2.9

Type of waste	Proportion (%)
Metals	2.6
Other waste (inert, complex)	7.5
Hazardous waste from households	0.2
Mixed fine particles (<10 mm)	30.9
Mixed packing	2.2
Total	**100**

The table gives quantities of generated municipal waste and industrial waste for the entire municipality according to the records of the PE Komunalec for 2013.

Table 16 Generated municipal waste in urban and rural areas and non-hazardous industrial waste 2013.

Municipality of Bitola	Municipal waste (weekly - in tones)	Municipal waste (anually - in tones)
Town of Bitola - urban environment	451.65	23.563
65 villages - rural areas (21.5% of the population of 14 villages)	43.72	2.281
Total municipal waste	495.37	25.844
	Industrial non-hazardous waste (per week - tons)	Industrial non-hazardous waste (per year - tons)
Total industrial non-hazardous waste	75.99	3.964
A total of	571.36	29.808

Collection of communal and other types of non-hazardous waste from the territory of Municipality of Bitola is performed with special vehicles that provide safe and secure waste transportation from the collection spot to its final delivery, that is to say, disposal. The transport of waste in Bitola includes: 360 streets, 2720 legal entities and 24,313 individuals. For the collection of municipal and other types of non-hazardous waste in the municipality of Bitola specialized vessels for collection are placed such as: 1450 containers of 1,1 m^3, 22 containers of 5 m^3, plastic cans of 120-240l and improvised containers. In the neighbouring villages a total of 67 containers of 1,1m^3 and 1760 cans of 120 l were placed.

For the purpose of collection and transportation of municipal and non-hazardous waste the PE Komunalec Bitola has engaged total of 18 special vehicles owned by the company.

Disposal

Municipal waste is collected in an organized way from Bitola and taken to Meglenci landfill located 16 km northeast of Bitola near the REK in Novaci. This location meets the criteria for the disposal of municipal waste for a period of over 15 years. The municipal waste is disposed on the landfill as per the surface method and the specified location has sufficient area for disposal for the next 15 years. The landfill is equiped with all necessary equipment. The landfill is recording the deposited amounts of waste. The average weekly amount of landfilled waste amounts to about 575 tons.

Landfill is covered with an inert material and there is a side channel for collection of rainwater from the site. There are swabbed roads for the movement of vehicles with municipal waste. The landfill Maglenci is recording the municipal waste according to the legislation of the Republic of Macedonia.

Despite this landfill, the municipality has registered many wild, unregulated landfills, both in rural areas and in the vicinity of Bitola and throughout the municipality. Smaller places are not covered by organised waste collection, so the local population mainly uses the river beds or

other places for waste disposal so during rainfalls or larger river flows major part of this waste ends up in the rivers through small local springs. The landfill is regularly eradicated by Centre for Public Health Bitola twice a year covering an eradication area of 1500m^2.

There is no modern installation for processing of municipal and other types of non-hazardous waste. Collected selected amounts of waste paper and waste plastics by the PE Komunlaec and legal entities that carry out purchase of waste paper and waste plastic are pressed with hydraulic presses. Only one legal entity performs mechanical treatment of PET plastic (performs its cutting). The collected amount of paper and plastic are passed on to further treatment to entities authorized to conduct and manage this type of waste. The collected amount of waste are deposited in the landfill Meglenci managed by the PE Komunalec Bitola.

In the selection process for collecting waste paper up until October 2013 205.5 tons of waste paper were collected. By the end of the year it is expected that about 265 tons of waste paper will be collected. For the next year it is envisaged that there will be 5% increased quantities of collected paper. The quantities of collected plastics are minor due to the problem of illegal collectors of PET plastic. For 2015 it is expected that 2200 tons of waste paper will be collected, while the quantities of collected plastics are above 10 tons.

PE Komunalec has the capacity for mechanical treatment of paper and plastic and capacity for waste disposal. Mechanical waste treatment is performed only on paper and cardboard. For this purpose we used two hydraulic presses for treatment with pressing. The average daily baled paper is around 800 kg. The pressed paper is handed over to legal entities for further treatment. For selective collection of waste (paper and plastic) on the territory of Bitola many specialized plastic containers of 1,1 m^3 are placed and some grid containers.

The municipality of Bitola keeps accurate data on biodegradable waste. Organised collection of biodegradable waste is partly performed by PE Komunalec from Bitola, that is PE Javno zelenilo (Public greenery) mandated for maintenance of public green areas to collect grass, branches and leaves.

Medical waste management in the municipality started in 2012 by the private company Eco Club Dooel Bitola. Generated waste are collected from the designated institutions in accordance with the regulations for hazardous waste, than separately stored in containers of 1,1m^3, plastic bins of 120 litres and specialized boxes. According to the capacity of the institution the collection is organised differently, for example the larger health-care institutions have organized a central location for storage of hazardous waste from the separate departments. The treatment of this waste by incineration in a mobile furnace - incinerator at a temperature of 1300-1500°C with a capacity of 50kg/hour. The furnace has a primary and secondary chamber for further combustion of gases. Clinical Hospital Bitola monthly generates and disposes 4-5 t, and Gynecological hospital (Fertility) some 100 kg/ month. Waste from the remaining private practices is collected in 50 special containers of 5 kg.

Measures and activities for supporting composting of biodegradable waste shall commence with the implementation of the pilot-project by the PE Komunalec for composting biodegradable waste which will be the basis for a public campaign for the process of individual household composting.

Currently, management of sludge from the sewage system does not exist in the territory of this agglomeration. Emptying septic tanks is usually performed by pumping in case of failures, this hydraulic system is ineffective. According to information from PCE Niskogradba, the sludge is discharged into the existing sewer system without prior treatment.

According to the decision of the Council of the Municipality of Bitola, landfill Meglenci will be used for final disposal of the entire amount of sludge generated from the WWTP.

5.8 Air Quality

To monitor the air quality monitor of pollutants will be performed and they will be identify qualitatively and quantitatively. Monitoring has an essential task in managing the environment - it is the basis for taking measures for protection against pollution and improve air quality.

The monitoring of the air quality in the Republic of Macedonia is performed by the Ministry of Environment and Physical Planning responsible for the management of the National automatic system for air quality, and the Institute for Public Health with the Centres for public health in Skopje and Veles.

Ministry of Environment and Physical Planning manages the National Automatic Monitoring System for Air Quality, which consists of 15 monitoring stations, one of which is located in Kavadarci.

The automatic monitoring stations for measuring air quality are recording environmental and meteorological parameters arriving through a modem at the central station every hour. Measured environmental parameters are as follows:

- CO - carbon monoxide expressed in mg/m^3,
- SO_2 - sulfur dioxide expressed in µg/ m^3,
- Nitrogen oxides, expressed in µg/ m^3,
- O_3 - ozone, expressed in µg/ m^3,
- PM_{10} - suspended particles smaller than 10 micrometers, expressed in µg/ m^3,
- benzene, toluene, ethyl-benzene, ortho- and para-xylene (BTX).

These monitoring stations measure the following meteorological parameters:

- wind speed expressed in m/s,
- wind direction, expressed in degrees,
- temperature, expressed in degrees Celsius,
- humidity expressed in%,
- pressure, expressed in hPa,
- global radiation, expressed in W/m^2.

The limit levels and types of pollutants in ambient air are given in the following tables.

Table 17 Limit values for the protection of ecosystems and vegetation

Pollutants	Protection	Average period	Limit values
Sulfur dioxide - SO_2	Ecosystems	Year winter period	20 µg/m^3
Nitrogen oxides (NO + NO_2)	Vegetation	Year	30 µg/m^3

Source: annual report of processed data on Environmental Quality - 2010; MEPP

Table 18 Limit values for human health protection

Pollutants	Average period	Limit value to be reached in 2012.	Allowed number of exceedances during the year	2015 Limit
Sulfur dioxide - SO_2	1 hour	350 µg/m^3	24	350 µg/m^3
	24 hour	125 µg/m^3	3	125 µg/m^3
Nitrogen dioxide	1 hour	200 µg/m^3	18	200 µg/m^3
	1 hour	40 µg/m^3	0	40 µg/m^3
PM_{10}	24 hours	50 µg/m^3	35	50 µg/m^3

	1 year	40 µg/m^3	0	40 µg/m^3
Carbon monoxide	Maximum daily 8 – hours average	10 mg/m^3	0	10 mg/m^3
Lead	1 year	0,5 µg/m^3	0	0,5 µg/m^3
C_6H_6	1 year	5 µg/m^3	0	5 µg/m^3

Source: annual report of processed data on Environmental Quality - 2010; MEPP

Air quality in Bitola Municipality

The main sources of air pollution in Bitola are stationary and mobile sources of pollution such as: production and transformation of energy, fuel combustion, heat for industry and heating individual homes and administrative facilities.

Production of energy from the power plants (REK Bitola produces about 75% of the total electricity consumption on a national level) is a sector that threatens the air quality.

The monitoring of air quality in Bitola is done through two fixed monitoring stations by the National monitoring network set up in the town on two locations (2004) and one UHMR station. The stations monitor environmental and meteorological parameters: Carbon monoxide CO (mg/m^3), sulfur dioxide CO_2 (µg/m^3), ozone O_3 (µg/m^3), suspended particles with particle size of 10 microns PM10 (µg/m^3), speed and direction of the wind, temperature, pressure, air humidity, global radiation and other parameters.

One of the stations is located in the central town area in the vicinity of Clock tower, in the Streževo management headquarters yard, and the other station is located in the backyard of the Meteorological station of the Office for Hydro-Meteorological Affairs. According to the schedule of both stations in Bitola one can note that one station is set in an urban environment, and the other in sub-urban environment.

The station located in the Streževo management headquarters yard monitors the traffic pollution and heating from the administrative institutions and houses, along side with the effects from the industrial facility emissions, and the other one located at the very entrance of the town, in the backyard of the Meteorological station of the Office for Hydro-Meteorological Affairs is monitoring the industrial pollution.

The most important data when analysing the values of the air pollutant is actually the fact weather the one-hour and 24-hours limit values for protection of human health have been overstepped, how many times during the month/year (given in the table below).

Table 19 limit values for human health overstepped annually in Bitola (Bitola1 and Bitola 2) for 2014.

Limit values	SO_2 µg/m^3	NO_2 µg/m^3	PM_{10} µg/m^3	CO mg/m^3	O_3 µg/m^3
Alert threshold	500	400			240
1h limit value for protection of human health	350	200	-	-	-
How many times has 1h limit value been exceeded in 2014	0	0	-	-	-
24h limit value for protection of human health in 2014	125		50	10 eight-hour	
How many times has 24h limit value been exceeded in 2014	0		136 (Bitola 1)	0 eight-hour	
Target value for human health					120
How many times has the limit value been exceeded in 2014					8

Collected data show exceeded limit values for protection of human health in Bitola in 2014 regarding concentration of suspended particles sized 10 microns (136 times over during 2014) however there is np exceeding regarding other substances.

According to the latest annual report on the quality of environment in the Republic of Macedonia for 2013[8], prepared by the MEPP, one can see the corresponding air quality in Bitola:

- The average annual concentration of nitrogen dioxide compared to the limit value to protect human health (40 mg/m^3) was not exceeded at any measuring point in the country. Relatively low levels of NOx in 2013 (6 mg/m^3) have been measured in the measuring station Bitola 1.
- Maximum 8-hour CO mean values per calendar year have also shown lower values (7 mg/m^3) at measuring point Bitola in relation to the limit value for protection of human health (10 mg/m^3).
- The long-term goal of protecting human health for ozone in 2013 has shown exceeding at the majority of measuring stations and the station Bitola 1 as well.
- Observed exceeding the limit on PM10 particles concentrations in 2013 with annual average concentration of 70 mg/m^3).

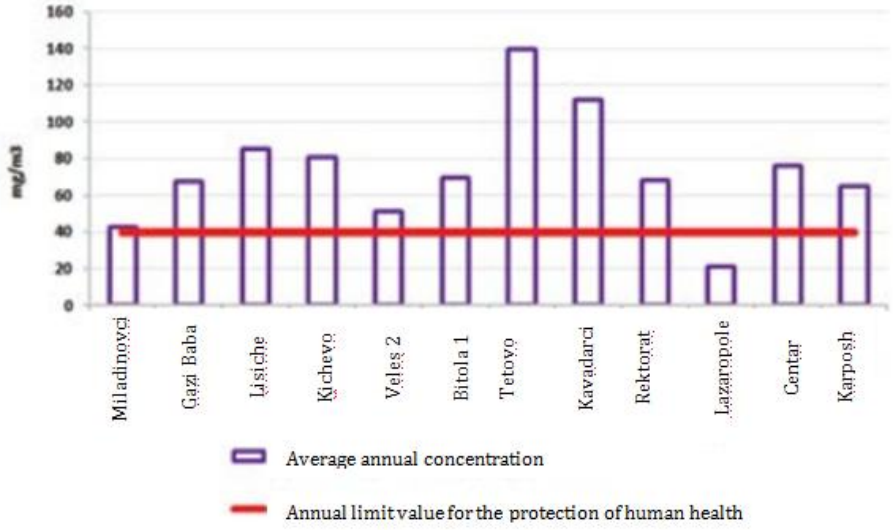


Figure 19 Average annual concentrations of PM10 for 2013

The measured concentrations of PM10, SO_2, CO and O_3 in accordance with the available monthly reports from the State automatic monitoring system for air quality in the Republic Macedonia for the last 5 months (October 2015 - February 2016) are given in the following table:

	PM10 AV 50 µg/m^3	**SO_2** AV 120 µg/m^3	**CO** AV 10 mg/m^3	**O_3** AV 120 µg/m^3
October 2015	0-110 µg/m^3	0-15 µg/m^3	0-2 mg/m^3	40-90 µg/m^3
November 2015	0-210 µg/m^3	0-20 µg/m^3	1-6 mg/m^3	30-90 µg/m^3
December 2015	30-330 µg/m^3	0-10 µg/m^3	1-7 mg/m^3	20-80 µg/m^3
January 2016	0- 300 µg/m^3	0-20 µg/m^3	1-8 mg/m^3	20-90 µg/m^3
February 2016	10-140 µg/m^3	0-20 µg/m^3	1-4 mg/m^3	40-100 µg/m^3

[8] Due to problems in regular maintenance of the monitoring stations, that is due to irregular purchase of spare parts, in 2014, there is lower collection of SO_2 data. The measuring stations in Municipality of Bitola are not covered with the analysis, since there is no data for them in them in the 2014 Annual report on the quality of environment.

The table shows that the only exceeded limit values are for the PM10 with daily concentrations drastically exceeding the limit values in most of the days. High concentrations of this pollutant resulting from combustion of vehicle fuels, industrial production facilities and central heating stations. This condition is especially emphasized during winter when the increase in the concentration of these particles affected by domestic heating alongside the climatological and meteorological conditions. The impact of weather conditions is particularly noticeable in valleys with heavy fog, insufficient air circulation to air the pollution and a temperature inversion also has been noticed.

Unfavourable situation with air quality in the town of Bitola was also determined in the Programme for the improvement of air quality in Bitola. The programme mentions higher SO_2 concentrations in Bitola 1 station in comparison with the Bitola 2 station due to the emissions from the near thermo-electrical plant; NO_x concentrations are higher in Bitola 2 stations in comparison to Bitola 1 due to the emissions mainly originating from traffic. The variation in PM10 concentrations between stations is also present, indicating that the same sources of emissions and the same factors influence the concentrations of PM10 in both stations. Concentrations are higher during the winter months.

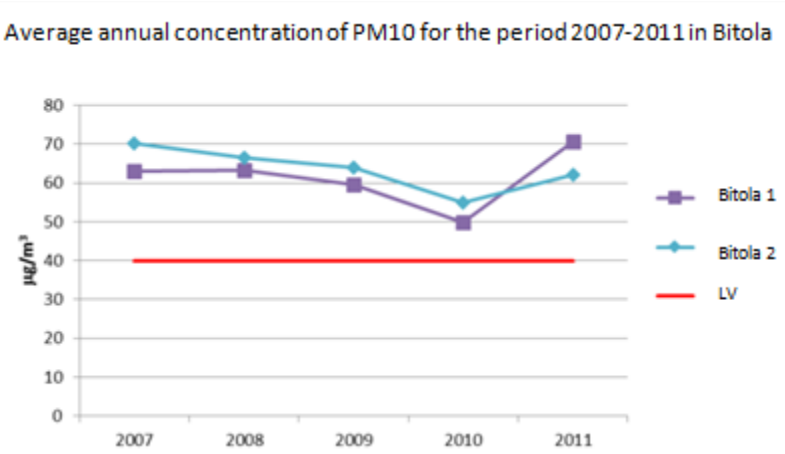


Figure 20 Average annual concentration of PM10 for the period 2007-2011 in Bitola

Measurements of air quality at both monitoring stations in Bitola indicate that the concentrations of pollutants in both stations do not differ too much. This suggests that in many cases, air quality in the town can be affected by common sources of emission. Based upon this, one may assume that the whole Bitola population is affected by the same level of pollutants and exceeded limit values, especially for PM10 throughout the whole town area. The most critical pollutant in Bitola are the suspended particle sized 10 micrometers - PM10 that exceed the daily and annual limit values at the two measuring stations.

Odour

In accordance with the Law on environment, odour is defined as an area of the environment (Article 5). Odour is regarded as unpleasant feature and it has not been regulated in any way with the current environmental legislation which means that there are no limit values for the odour, nor emissions, nor manner and methodology to assess the odour impact.

5.9 Noise

Environmental noise is increasing steadily, particularly difficult to control in densely populated conurbations and residential areas near highways, railways and airports. It is among top negative effects on the environment and it represents noise from unwanted or harmful external sound generated from human activities causing unpleasant effect and disturbance. The biggest

sources of environmental noise are vehicles in the road, rail and air traffic, industrial activity, neighbourhood noise and particularly significant and specific for the R. Macedonia is the noise from construction activities. The impacts of noise on humans are summarized in the following figure.

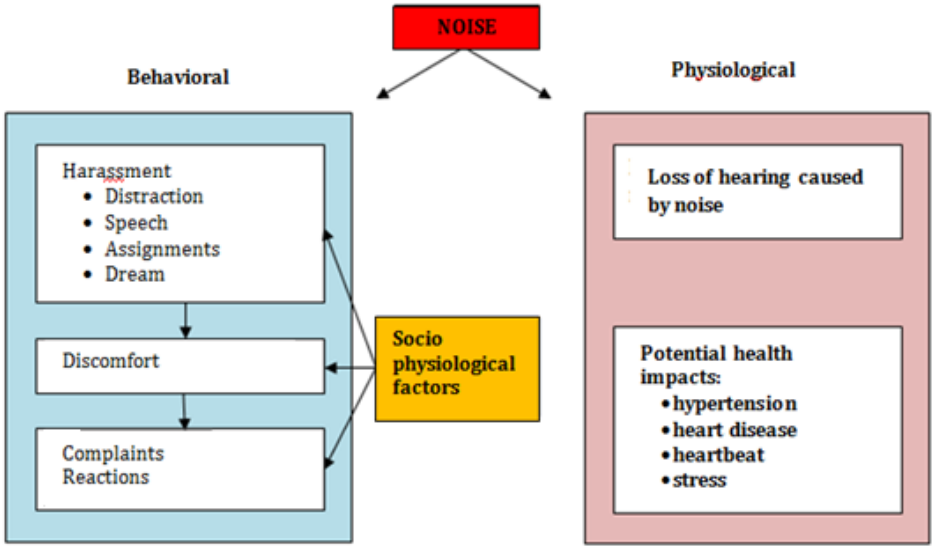


Figure 21 Link between causes and impacts associated with noise

Measuring and monitoring noise is necessary in order to achieve and maintain the environmental noise within the limit values, defined in four areas based upon the level of protection against noise with ultimate goal protection of human health and wellbeing. In accordance with the current legislation, measurement and monitoring data on noise levels are submitted to the Ministry of Environment and Physical Planning, Macedonian Environmental Information Centre.

The law defines the primary duty bearers in protection from environmental noise, namely:

- The bodies of state administration;
- Municipalities, City of Skopje and municipalities in Skopje;
- Legal and natural persons.

In accordance with the Law on protection against environmental noise, environmental noise is caused by unwanted or harmful sound caused by human activities imposed by the close environment and causes unpleasant feeling or disturbance, including noise emitted by means of transportation, road, rail or air traffic and from industrial activities. Noise disturbance means anxiety caused by noise emissions of noise either frequent and/or long-term, caused in defined time and place, which interrupts or affects regular activities and work, concentration, human rest or sleep. Noise anxiety is defined by the level of anxiety of the population caused by noise determined by means of field surveys or inspections.

Limit values for basic noise indicators in the environment are set out in the Regulations for limits on noise levels. According to the degree of protection against noise, limit values for basic indicators of environmental noise caused by different sources should not be higher than:

Area differentiated according to the level of noise protection	**Noise level expressed in dB**		
	Ld	**Le**	**Ln**
Area of first degree	50	50	40
Area of second degree	55	55	45

Area differentiated according to the level of noise protection	Noise level expressed in dB		
	Ld	Le	Ln
Area of third degree	60	60	55
Area of forth degree	70	70	60

Le - day (period from 07:00 to 19:00), Le - evening (period from 19:00 to 23:00 hrs) Ln - night (period from 23:00 to 07:00 hrs)

Areas according to the level of noise protection are specified in the Regulations for the locations of measuring stations and measuring points (2008).

- Area of I degree noise protection is an area intended for tourism and recreational area in the vicinity of medical facilities and hospitals, national parks and nature reserves.
- Area II of noise protection is area primarily intended for accommodation, especially residential area, areas intended for educational activities and up-bringing, social protection facilities intended for accommodation of children and elderly persons and facilities for primary health-care protection, playground areas and parks, public green spaces and recreational areas and local parks.
- Area III of noise protection is area where environmental activity is allowed where the noise will not cause large disturbance, that is trade – business – residential area intended both for accommodation, that is facilities with protected spaces such as craftsmen's or similar production (mixed area), area intended for farming activities and public centres to perform managerial, service and hospitality-related activities.
- Area IV of noise protection is area where environmental activities are allowed, activities which may cause noise disturbance, area free of apartments, intended for industrial, craftsmen or other production activities, transport activities, storage and service activities and communal activities that generate noise.

Decision for identifying the cases and conditions when harmful noise disturb citizens' peace (2009) identifies the activities that cause noise exceeding limit values are regarded as peace disturbing.

Institutions that currently perform measuring the levels of ambient noise in R. Macedonia are:

- Central Environmental Laboratory within the Ministry of Environment and Physical Planning which performs only incidental measurements mostly upon a request from legal and natural entities.
- Republic Institute for Health Protection within the Ministry of Health. Health care institutions in Skopje and Bitola that assess the harmful effects of environmental noise on the population exposed.

The project includes a larger range that includes urban and rural areas, according to the area covered by this project mainly could be categorized as areas of III to IV degree of noise protection.

Measurement of noise in Bitola

The most common major sources of noise in Bitola are all kinds of vehicles, equipment and machinery used in industrial facilities and agricultural machines. The measuring the environmental noise on the population exposed in Bitola is covered by the network of the Institute for Public Health - Bitola.

Department of Hygiene and environmental health at IPH "Institute for Public Health - Bitola" performs measurements of the level of noise pollution in April and October. In the period between 2010 and 2014, according to the Regulation on the locations of measuring stations and

measuring points, the noise levels were measured at nine measuring points shown in the figure below.

Noise intensity is shown through the basic noise indicators during Ld day, during Le evening-time and during night-time Ln, expressed in dB (A) defined in accordance with the Rulebook for application of noise indicators, additional noise indicators, manner of noise measurement and measuring methods and environmental noise indicators. On four occasions 50 measurements were taken at each measuring point around the clock.

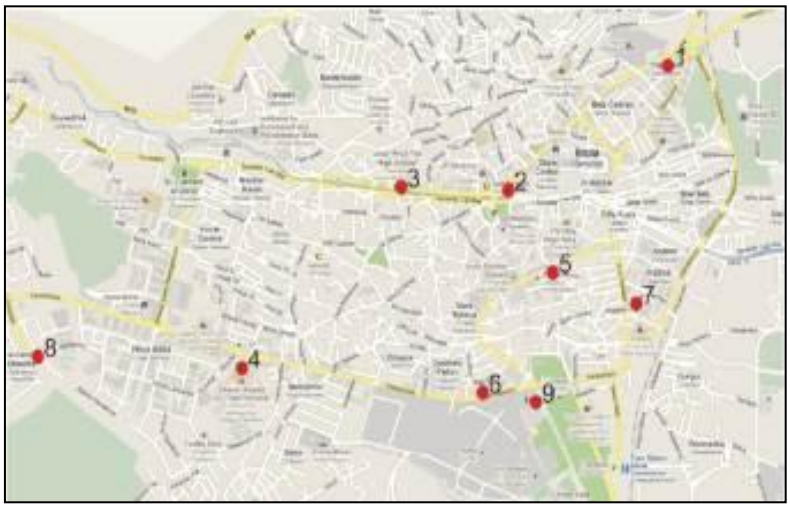


Figure 22 Disposition of measuring points in Bitola in the period between 2010 and 2014

The received data on basic indicators Ld and Le, show exceeding values at the measuring point 3, where the noise level exceeds LV and at all other measuring points the noise level did not exceed the LV for that measuring point.

For the purposes of this study and setting the basic condition for ambient noise at the location where the WWTP is planned to be built the level of noise was measured[9]. The measurement is done on 01.26.2016 at one measuring point within the WWTP site, 15 meters away from the riverbed of Dragor in the direction towards Dolno Orizari.

Table Results measuring the ambient noise at the location of the WWTP Bitola

Main source of noise	Noise level L_{Aeq}
CNL Communal noise	45 dB (A)
Permissible noise level in the range of IV degree of protection against noise over day / evening	70 dB (A)
Permissible noise level in the range of IV degree of protection against noise over night	60 dB (A)

5.10 Landscape, biodiversity and natural heritage

5.10.1 Landscape features

The analysis of the landscape features of a region or one of its comprising parts, takes into account the key elements of the landscape image such as geological-tectonic features and

[9] Report on noise level testings in the environment and water analysis, 01 February, 2016, Pharmahem environmental laboratory

alterations of the wider region that affected global landscape changes jointly affecting the climate. This affected changes in flora and fauna that are inevitably always, followed by anthropogenic influences.

Pelagonija is the largest valley in the Republic Macedonia, which is a special landscape unit within the Rhodope group of landscapes. It consists of Bitola and Prilep Field including the Black River river basin and Lerin Field in Greece but also some smaller fields as natural units, surrounded by high mountains. West of Baba Mountain and Mountain Busheva and in continuation with Ilinska Mountain and Bigla facing it with its eastern exposures. Mount Dautica is located on the northern side, Babuna at northeast and Selechka Mountain and Nidze from east and southeast, respectively whose ridge reaches to the west and merges with the southern slopes of Baba Mountain near Lerin, and some parts of Neredska Mountain.

The types of natural habitats, as indicators of the life factors of habitats determine the representatives of biocenoses present in this specific area. For easier distinction thay are grouped into groups named by the climate features or according to the dominant species or landscape features of the treated area. For example:

- forests and bushes,
- open space with grass and pastures,
- agricultural land,
- urban and industrial areas,
- aquatic ecosystems,
- stony and rocky terrains, etc.

Pelagonic plateau can be grouped in two-parts units. The first part belongs to the hillsides and hills that penetrate into its interior, especially on the upper part of the plateau and because of the slopes thay are not used, but are left as pastures. Covered with indigenous steppe vegetation, the tree species are pre-dominant - Christ's thorn (Paliurus spina-christi), almond-leaved pear (Pirus amygdaliformis), common hornbeam (Carpinus orientalis), black clear (Fraxinus ornus), brier (Rosa canina). On higher hills, especially with northern, northeastern and northwestern exposures one may find pubescent oak (*Quercus pubescens*), prickly juniper (*Juniperus oxycedrus*), blackthorn (*Prunus spinosa*) which alike all larger trees are heavily affected by the cattle and the local population. Moreover tamaris and woody species inhabit the valleys, especially with northern and north-eastern exposure and they can only be used for nesting of small birds. The rest is mostly overgrown with grass (*Agropyron repens*) and other rare species characteristic of sub-Mediterranean region. Ground vegetation is present, but after the wet spring period they are burned by the summer sun.

Figure 23 Hilly area of Pelagonija

The second part of the Pelagonija plain is flat land with arable land planted with seasonal agricultural crops, so throughout the year they are mainly ploughed, without any vegetation or with scattered cereal crops in different growing phases. Acacia (Robinia pseudoacacia), poplar (Populus nigra pyramidalis) are present by the rivers, but in extremely small numbers and in short rows. This enables maximum use of heavy agricultural machinery, however most of the natural habitats are reduced. For these reasons hiding places, nesting places, knighting places, feed diversity are completely degraded throughout the year, causing a dramatic change for all members of the biocenosis. Marsh flora is extinct, and fauna left.

In the current circumstances, very few species of previous biocenosis can find opportunities for normal life and reproduction, but also perform the function of flora protectors in the field from insects and other pests. Different pesticides are used for agricultural production in Pelagonija to destroy weeds, which further reduces the chance for hiding and nutrition of the resident fauna.

Figure 24 Plain region of Pelagonija

On the other hand, such terrain condition has many unfavourable consequences on the soil micro-climate due to the maximum possibilities for the wind to freeze the soil in the winter and with it to block the water infiltration in te soil and dry the soil in the summer months. Thus the water regime in the soil is disturbed, which has negative impact on yields despite the existence of irrigation system. Living factors in this lower plain part of Pelagonija are limited and there is a possibility only for limited biocenosis that have been generated in the past 60 years under the influence of the antropogenic factor. The characteristics of the biotope are uniformed and limited for many fauna and flora species and this habitat provides for limited opportunities for survival of a richer biocenosis. The rest of Pelagonija is an urban part composed of larger and smaller more or less urbanized areas.

Landscape features

Landscape characteristics of the micro location of the planned treatment plant are characterized by the abovementioned features. Dolno Orizari village is located on the lower part of Pelagonija just 2-km north-east of Bitola connected to Bitola with the industrial zone Bitola, French and Christian cemetery. The terrain surrounding the village is almost completely flat with a very slight slope towards the northeast and then east.

Not much different are the landscape characteristics for the other project components, speaking about the rural areas.

Figure 25 Location of the WWTP Dolno Orizari (left) and Landscape east of the WWTP (right)

The east area consists of completely flat land, divided into numerous arable land used exclusively for annual agricultural crops. It is characteristic that surfaces are larger, adjusted for heavy agricultural machinery, and almost no boundaries with distinctive wood and shrubby vegetation. The villages of Novaci, Dobromir, Binjanik are located in this direction, power plants REK Bitola are 7-8 km away, behind them lies the coal mine Suvodol and Bitola landfill. Selechka Mountain or Bitola part of Mariovo with its central village Staravina starts from here and goes eastward.

In the middle of this area Crna River runs keeping its north-south direction, receiving the Šemnica river waters right under Mogila village, and east of the village Dolno Orizari accepting the waters from Dragor river. Dragor is the largest tributary of the Crna River in Pelagonija. On the ground, towards east some asphalt roads have been constructed connecting the mentioned villages and among them the terrain is intertwined with tractor tracks.

The ground is almost completely naked, divided into numerous fields, some of which are arable, others are fallow, and some fully abandoned. The terrain has very few trees, growing individually or in small groups or alleys, which are of anthropogenic origin as remains of the field protective zones. Trees are small in diameter with visible traces of periodical cutting and recovery with new buds and scions. Because the terrain is very slight sloped, there are almost no traces of erosion, not even surface erosion. Pedological layer is alluvial of chernozem-type, which are characteristic of this part of Pelagonija, somewhere thicker than 50 cm.

Towards the south the situation is identical, full plain, fields, occasional tree and several villages as Logovardi, Kravari, Žabeni and Egri and Bukri further down. Furthermore the plane goes up the mountainside of Nidze or up to Macedonian-Greek border. Crna River reaches the end and the lowest point of Pelagonija entering the Skochivir gorge towards Tikvesh.

Apart from the usual rural roads just west, a railway line and an asphalted road goes up to the border towards the Greek border. The monotonous landscape is shatter in the distance by the pond near the village of Žabeni and larger pool near the village of Bukri.

Figure 26 Landscape South of the WWTP (left) and area West of the WWTP (right)

Town of Bitola is placed on the west and southwest and the closest village is Dolno Orizari village, Industrial zone, WWI French cemetery, Jewish cemetery, Orthodox cemetery - St. Nedela, Farming school and Gorno Orizari village. From the east side which is the lowest part of Bitola flows the Dragor River curving towards north and heads towards Dolno Orizari village.

The northern entrance in Bitola is near Gorno Orizari village facing north when arriving from Prilep. This shows that two thirds of the Dolno village surroundings, that is waste water treatment plant site belongs to the town of Bitola, more precisely its lowest eastern parts i.e. the urban, densely populated area. It reaches the slopes of Dautica Mountain, stretching itself through the Pelagonija plain and going north from Dolno Orizari village. In the distance, the monotonous plain is intervened by low, rounded hills that descend from the northwest from the mountain and penetrate the plains. They too have steppe characteristics and do not change the environment, i.e. the steppe character of the landscape and habitats.

5.10.2 Biodiversity of the WWTP surroundings

Biodiversity in the WWTP vicinity is identical to the biodiversity previously described for lower and plain area of Pelagonija. That space was the bottom of the former Lake Pelagonija or Crnsko Blato, which in the sixties through a land development of the Black River has been turned into arable land for cultivation of maize, sunflower and sugar beet. These are crops that cover the ground only for a few months during the year and provide shelters and feeding ground for the floor fauna. In this interval nesting birds use this terrain for nesting, so they accommodate here to stay, feed and nest. Most of the year, these stripped areas are limitation factor for all species whose existence is conditioned by permanent vegetation, trees, shrubs, tall annual plants used for nesting, sleeping and feeding.

This goes for the waterfowl which used to be present in the past, especially in the winter during migration and in summer during nesting periods. Now when the swamp has been dried and meliorated they are completely absent, except during migration season. Other examples pointing out the degradation of the environmental factors of one habitat is the small and rare population of the common buzzard (Buteo buteo) and the common kastrel (Falco tinnunculus) although the cereal crop cultivated in this area are abundant with a large population of rodents and insects which are their main prays. The reason for their absence is the lack of trees and shrubs suitable for nighting, nesting, hiding, resting.

Species that live, feed and nest on the ground such as Kawi Polish partridge (Perdix perdix) and quail (Coturnix coturnix), absence of higher vegetation it is not a limiting factor. More than a third of the surrounding space in the WWTP site belong to the eastern and the western periphery of the town of Bitola and their infrastructural facilities that are limitation factor for the site biodiversity throughout the year.

Due to the large variations in the presence and size of the vegetation, quality values of the habitats are changing alongside the presence and the population of the zoocenosis.

The village houses are modernised, old barns are torn apart decreasing the nesting possibilities which is one factor for certain deteroriation of the habitat, especially for the lasser kestrel (Falco naumanni) and the barn owl (Tyto alba) alongside with the changing population of the insects, lizzards, mice in the fields decreasing thier prays.

5.10.3 Important habitats and species

Field uniformity and numerous limitation values of the habitat features surrounding WWTP prove that the WWTP site does not have any characteristic feature that may be regarded as SIGNIFICANT HABITATS that would be recommended for special treatment as a natural rarity or value. The sole point is the existing forest with anthropologic origin located 3-4 kilometres away close to Rashatni hills that requires special protection but as PARK FOREST or as BITOLA LUNGS to preserve the nesting location of the rich ortofauna which is under the town management.

5.10.4 Areas in the wider WWTP environment

The project location[10]) is not located within the areas of importance for nature conservation. The project location in near to 1) identified prime butterfly area Baba mountain, 2) Emerald area Pelister and 3) national Park IPA Pelister and and 4) identified important bird area Pelagonija (Figure 27). On its west side, the project location nearly borders with the wider area of prime butterfly area Baba mountain. On the same west side, the project location is near to an Emerald area Pelister, with a closest distance of about 2,5 km. Also, on the same side, the projec location is near to national park and IPA Pelister, with ea closest distance of about 3 km. On the east side, the project location (i.e. WWTP location and the area of village of Kravari) is near to an identified important bird area (IBA) Pelagonija, with closest distance of about 0,5 - 1 km.

The important Bird Area Pelagonija is one of the 24 sites (according to the criteria of BirdLife International) that are most important bird areas in the Republic of Macedonia and covers an area 1136 km^2. Regarding the distribution of birds R. Macedonia, the location of future WWTP capita is the White Stork (Ciconia ciconia), classified as LC (last concern), or at least threatened by IUCN (International Union for Conservation of Nature) Red List of threatened species. The White Stork can be threatened by the destruction of wetlands that are its favourite residence. Wetlands may be destroyed by the construction of dams and pump stations, as well as the industrialization of the locations where they are created. Serious threat to the survival of the white stork was his collision with overhead power lines. White Stork is known as migratory species in R. of Macedonia.

[10] Project location = includes location of WWTP, sewerage and collection systems.

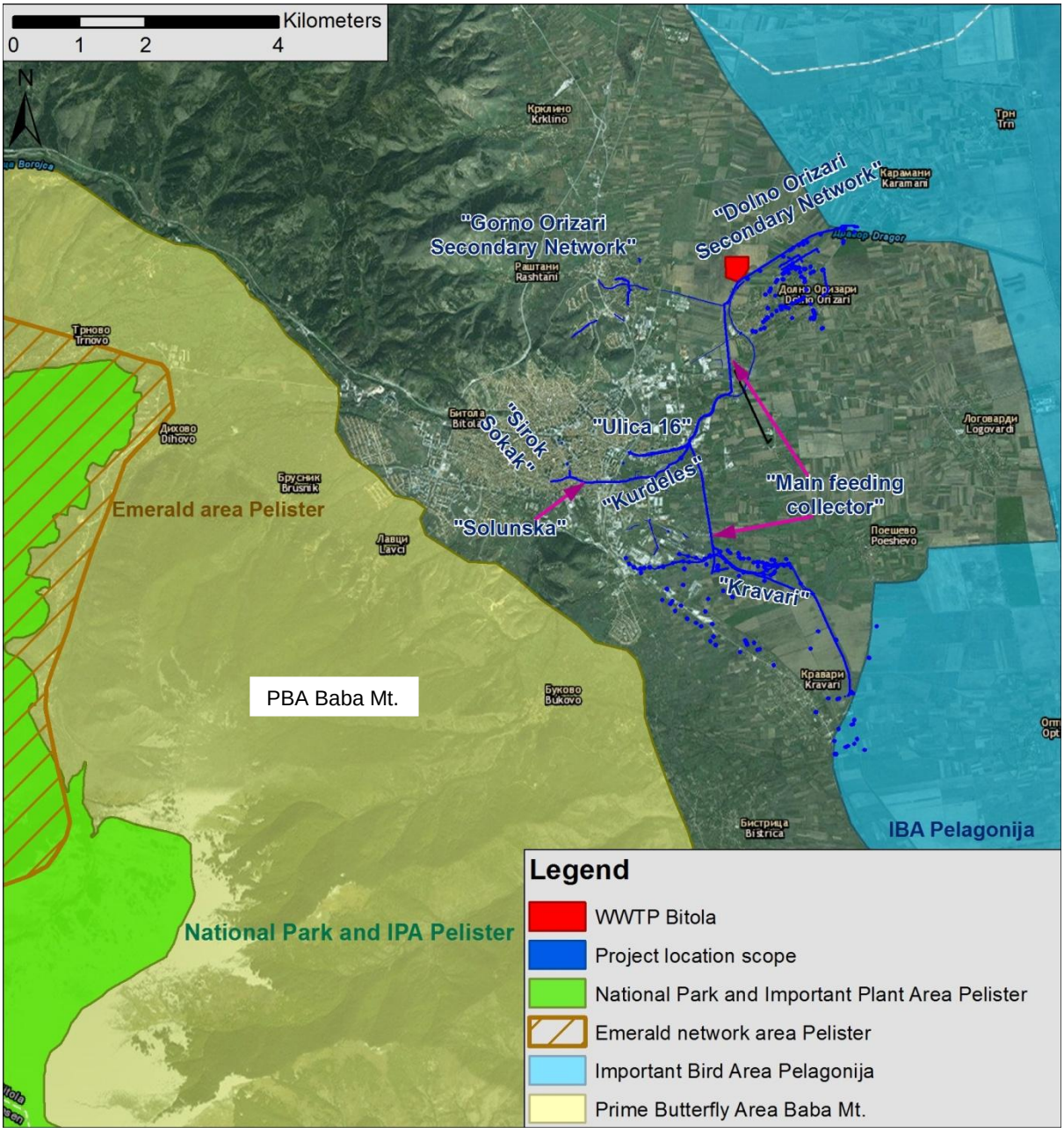
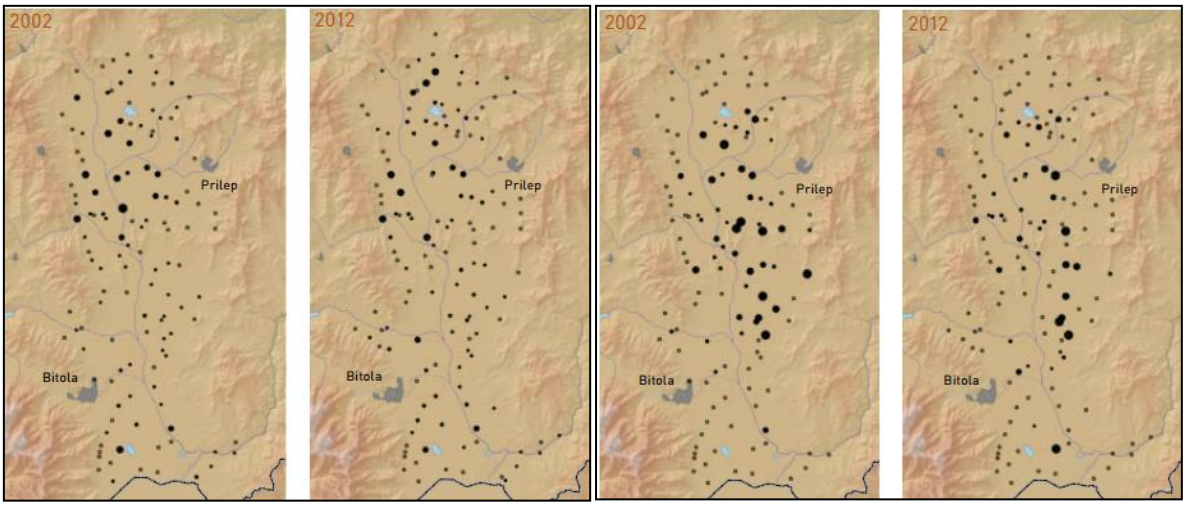


Figure 27 Project location in regards to protected and important areas (1:100000)

The population of white storks (Ciconia ciconia) in Macedonia has seen a slight increase, if one can judge by increasing the number of its largest sub-populations (Pelagonija) in the period 2002-2012. The number of nested couples increased from 220 to 320 (an increase of 31%), which are mainly concentrated around the wet meadows in the north and central part of the Pelagonija Valley.[11]

[11] 2012 Situation with birds in Macedonia, Metodija Velevski and others, Macedonian ecologicaln society

Figure 28 White Stork (left) and steppe kestrel (right)



Source: Status of Birds in Macedonia 2012

Figure 29 population of white storks (left) and steppe kestrels in Pelagonija

some 9 km north of the future WWTP site, Pelagonija region is located which is an Emerald site[12], and at some 10 km to the west there is another Emerald site - Pelister.

[12] Emerald network is ecological network of areas of special conservation interest (ASCI – Areas of Special Conservation Interest) which is developed on the territory of member-states of Bern Convention (Convention for conservation of wild life and their natural habitats in Europe).

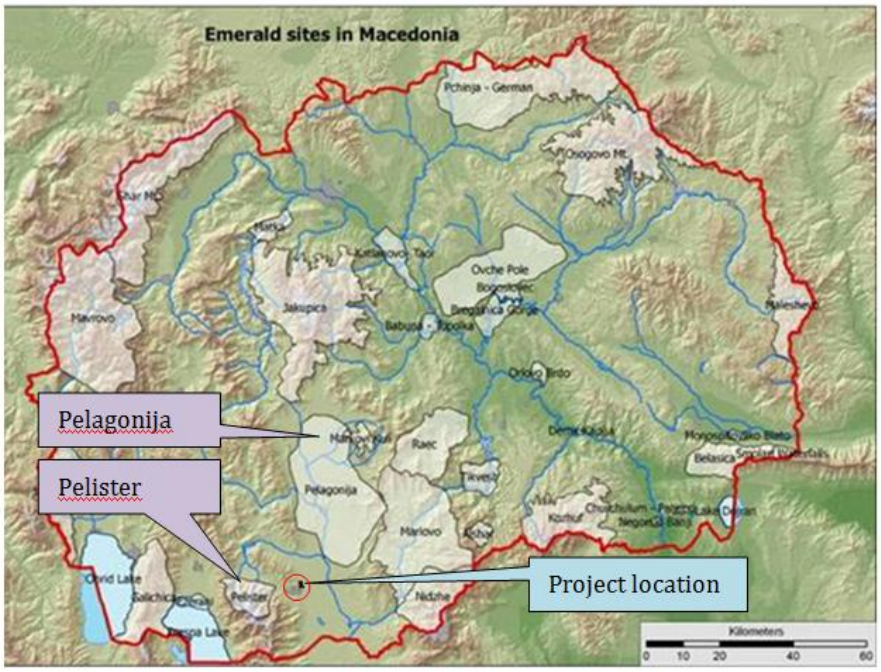


Figure 30 Emerald areas in the R. Macedonia vs project location

At some 3 km west of the project location one can find the representative area and protected area (no change in category of protection or borders) - NP Pelister. Pelister is identified as Important Plant Area[13] Pelister.

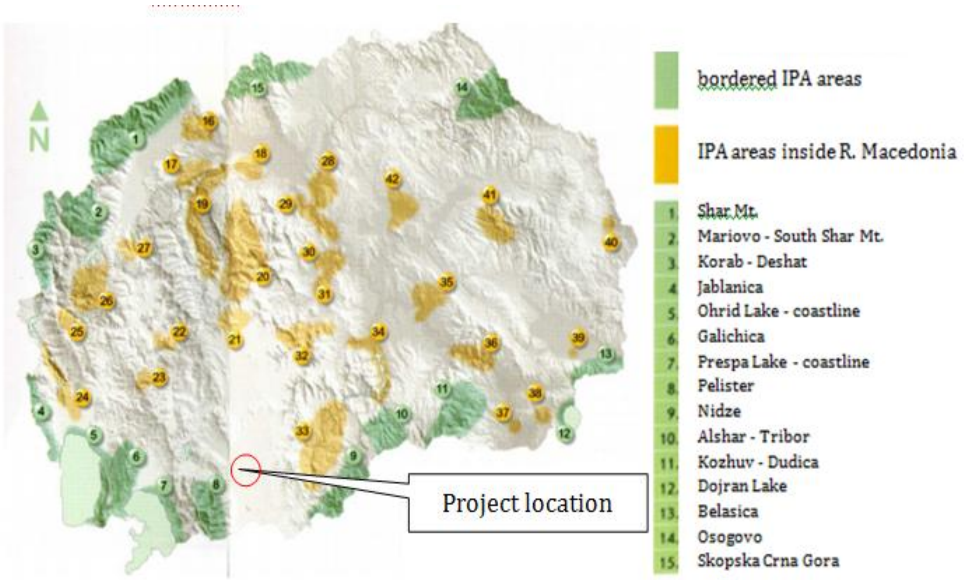


Figure 31 Important Plant Areas in the R. of Macedonia (Source image: MES)

At some 10 km west of the project location can find the Area proposed for protection under the NR of the RM, proposed for proclamation as a natural rarity - Sycamore - Magarevo.

[13] Significant plant areas are spaces characterised by specially wealth of significant (endemic, threatened and relict) wild plant species. They are defined due to proper definition of national systems for protected territories in order to achieve more efficient protection of wild flora. This, at the same time, is a deteremination of the European strategy for plant conservation.

- Sycamore trees in the village Magarevo grow just up the road towards Pelister. Both trunks have similar dimensions - height of 23 m.

At some 7 km north of the project location one can find the area important for conservation/management of species[14] - Pelagonija.

- It is particularly significant for the mosaic of habitats of arable land, meadows, pastures and boundaries, enabling the survival of one of the largest European colonies of the steppe kestrels and significant population of White Stork. Yet many other species of birds inhabit this space, including European roller, Eurasian stone curlew, pallid harrier and others. The implementation of agri-environment measures will maintain the habitat diversity.

Non-representable protected areas and areas proposed for protection as NR in the RM (areas included in other protected and proposed areas, non-representative or areas with lost values) identified in the near vicinity of WWTP are:

- 15 km southwest of the location - Kolojzana (Beech reserve site ((Fagus moesiaca)). The association Calamintho grandiflorae – Fagetum stands out. This forest in terms of its taxonic elements, composition and space vibrancy is a rare example of Balkan beech in our country.).
- 15 km southwest of the location Neprtka (Birch reserve ((Betula verrucosa)). The reserve is comprised of two stands which by their location occupy the southern area in Macedonia. Although some of the oldest trunks have begun to rotten in their mid parts the general wooden mass is in good condition.).
- 18 km south of the site - Rupa (this site is distinctive for the association Fago-Abietetum meridionale). Taxonic elements, altitude and vividness of the environment are the elements that characterize this forest. Another feature of this area is the presence of fir (Abies borissi-regis).
- 10 km west of site - Pelister 1 (in the forest belt and by the springs one can see the presense of a thicket of alder (Alnus glutinosa) but with an unusual floristic composition: *Telekia speciosa, Silene asterias, Geum coccineum, Adenostyles orientalis, Caltha leta, Ranunculus serbicus, Laserpitium latifolium and others.* This area is characterized by the association Silene asterias - Alnetum glurinosae. This type of alder forests are not seen elsewhere in Macedonia. These waters must not be diverted nor used. The most beautiful wooden mass was destroyed due to the construction of the lower station of the Begova Cheshma elevator.).
- 15 km southwest form the site - Pelister 2 (in the Alpine belt between 2200-2500 m.a.s.l., at places where snow remains for a longer period (for example above Large and Small lake) special type of vegetation is developed among which one may see the endemic species of *Dianthus myrtinervius*, and *Festuca kajmakcalana, Geum montanum, Festuka picta, Potentilla chrysocraspeda, Veronica bellidifolia* and others. Characteristic association is Diantho myrtinervii Festucetum.).
- 15 km southwest of the location - Pelister 3 (the highest peak Pelister has represented the association Caricetum curvulae, stony ridges exposed to strong winds encountered boreal species of: *Carex curvula, Jumcus trifidus, Festuca supina, Cetraria islndica,*

[14] Areas proposed for conservation/management with species are not proposed for any if the six conservation categories, however proper protection measures for the species need to be included in the documents for spatial planning or sectorial startegies for land use, such as forest management plans, water management plans, agro-ecological programmes, rural development programmes, transport startegies, etc.

Gaphalium supnum and others. On Pelister these are probably glacial relicts.).

- 10 km west of site - Pelister 4 (Here the association of Gentiano luteae - Pinetum piucis is found. In the subalpine zone over 1600 m.a.s.l., one may see the scattered blocks of granite rocks. Among cavities in these blocks Molika pine (Pinus peuce) grow, with some rare trees of Juniperus nana, Gentiana lutea, vacinium myrtillus, Zuzula luzulina, Daphne mezereum and others. These are the primary habitats of Molika, i.e. without competition from other forest trees.).

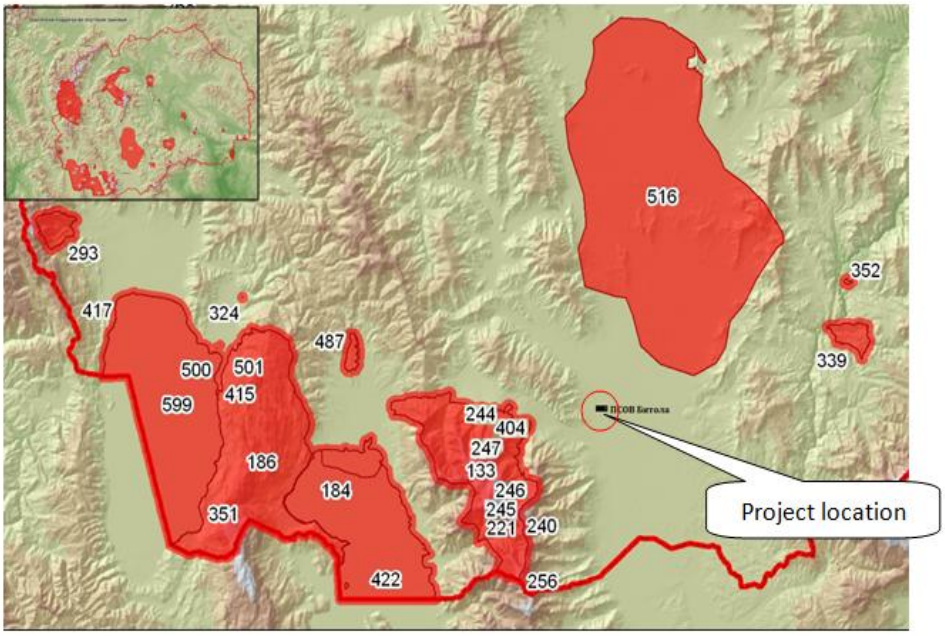


Figure 32 Protected Areas in the wider vicinity of the project location

133 - Protected area Pelister, 404 - Sycamore – Magarevo, 516 – Pelagonija, 244 - Pelister 1, 245 - Pelister 2, 246 - Pelister 3, 247 - Pelister 4, 256 – Rupa, 240 - Neprtka, 221 - Kalojzana

5.11 Water quality

The quality of the ground waters in the Republic of Macedonia is monitored by the Hydrological Directorate via RIMSYS(River Monitoring System) a programme that analysis the hydrological parameters, physical and organoleptic indicators, mineralisation, oxygen indicators, eutrofication indicators and harmful matters. Within this programme, Crna River is also monitored for its hydrological parameters in the Nogaevci station and other parameters that define the water quality and its classification as per the Decree for the categorisation of rivers, lakes, accumulations and underground waters (Official Gazette of RM No. 18/99 and 71/99) are monitored from the Skochivir station indicated in the following figure, listing all the measuring stations included in the program.

Figure 33 Overview of monitoring stations for monitoring the quality of surface waters

Decree on water classification, and according to the purpose and level of purity, the surface water (rivers, lakes and accumulations) surface water are classified into classes.

Table 20 Classes of water

Class	Usage of water
I	This is very clean, oligotrophic water, which in its natural state, with eventual disinfection, can be used for drinking as well as production and processing of food products and is suitable for mating and cultivation of salmonide fish spices. It is constantly saturated with oxygen, with low content of nutrients and bacteria, contains very slight, occasional anthropogenic pollution with organic matters (but not with inorganic matters).
II	This is a less polluted, mesotrophic water, which in its natural state can be used for bathing and recreation, water sports, cultivation of other fish spices (cyprinids), or which after the usual methods of purification / conditioning (coagulation, filtration, disinfection etc.) can be used for drinking and production and processing of food products. The buffering capacity and oxygen saturation throughout the year are good.
III	That is moderately eutrophic water, which in its natural state can be used for irrigation, and after usual purification methods (conditioning) for industries, which do not need drinking water quality. Buffering capacity of the water is low, but it maintains the pH value at a level still suitable for breeding of most fish. Occasionally oxygen insufficiency occurs. The level of primary production is considerable, and some changes in community structure, including fish species can be observed. The load of harmful substances is evident as well as microbiological pollution. The concentration of the harmful substances varies from natural levels to levels of chronic toxicity for the aquatic life.
IV	Class of highly eutrophic, polluted water, which in its natural state may be used for other purposes, but only after specific treatment. The buffering capacity has been exceeded, leading to greater levels of acidity, which affects the development of offspring. There is saturation with Oxygen in the epilimnion, and Oxygen deficiency in the hypolimnion. There is proliferation of algae.

In accordance with their intended use and purity levels, natural and artificial waterflows, waterflow segments, lakes, accumulations and underground waters whose waters are divided into 5 classes based upon Decree on water categorization. Waterflows whose waters are meeting criteria listed in the category I are Category I waters, those meeting criteria of category II are listed in second category, ones meeting criteria of category III are listed in third category, waters meeting criteria of category IV are listed in forth category and those meeting criteria of category V are listed in fifth category, respectively.

Database of quality and quantity of water flows was established within the Macedonian Information Centre for Environment. This database is established based upon proper collection, processing, analysis and presentation of water monitoring data performed by the Office for Hydro-Meteorological Affairs, Hydrobiological Institute Ohrid, Institute of Public Health, Central Laboratory for Environment, PE Vodovod and Kanalizacija – Skopje and from all other entities involved in the water monitoring mandated to submit data to the Macedonian Information Centre on Environment.

On the territory of Municipality of Bitola, the water quality of the Crna River is monitored at measuring point Skochivir.

Based upon data from the last three Annual reports from the processed data on environment quality for the period 2012-2014, one may conclude that values of the measured parameters are standard in the course of 3 annual periods, with an exception of COD with drastic increase of measured values.

Parameter	2012	2013	2014
R-ren oxygen (mg/l)	2-3.99	2-3.99	2-3.99
BOD5 (mg/l)	2.01-4	4-5.99	4-5.99
COD (mg/l)	10.1-20	-	20.1-25
Nitrates (μg/l)	<10.000	<10.000	<10.000
Nitrites (μg/l)	10-500	10-500	10-500

For this period the above mentioned measurements show that in accordance with the Saprobic index, Crna River belongs to Class II, with a measured index of 2.1.

Based upon sanitary hygienic condition the main recipient of Dragor river, Dragor river waters belong to second class waters before entering the town of Bitola and forth class when exiting the town based upon the Decree on waters categorisation and this difference is due to the large organic pollution from the households and the industry.

Dragor River when exiting Bitola up to the mouth in the Crna River is completely dead river, without any wildlife. In the recent years Dragor river suffers from heavy water pollution polluting every living thing in it. The main polluter is the poultry farm "Jonche Georgievski" which almost uncontrollable realises large quantities of faeces from the manufacturing process. Other river contaminants are villages whose population throw their garbage into the river. Bitola Prison, Textile industry facility "Pelister" also discharges faeces in the Dragor River. Formerly, Dragor River got polluted by Boris Kidrich tannery which is now closed down and from other sources of pollution. Worst polluters are: Sugar plant, textile factories, "Bitola brewery", "Transkop" "Lozar" and others. Pollution of Dragor River is in III, that is IV and V group or outside any class with it receiving the epithet "dead river". The river is transformed into open channel taking away the waste communal waters including physiological waste (faeces and urine), waste waters with household trash and waste waters from industrial facilities. Polluted and untreated water Dragor river waters flow into the Crna river and pollute it. These waters belong to the fourth and fifth class of polluted waters thus being the most polluted waters.

In accordance with the Decree on waters classification in the Dragor river part in Bitola up to its mouth in the Crna River and in the part from the fifth Bitola channel up to the mouth of Crna River and Crna River up to the mouth in Prilep River to Tikvesh Lake belong to III class waters.

For the purposes of this study and setting the basic condition for the quality of surface waters of the recipient (Dragor River). Physical and chemical analysis was performed on the composite

sample of waters taken from the spot of the planned discharge channel of the treated communal waters of WWTP Bitola[15].

Table Analysis results of water sample from Dragor river

Parameter	Determination method	Unit	MM1	MPC III
BOD_5	MKC EN 1899-1:2007, non-accredited	mg/L O_2	34	4,01 - 7,00
COD_{KMnO4}	MKC EN ISO 8467:2007, non-accredited	mg/L O_2	22,6	5,01 - 10,00
Total nitrogen	Merck Spectroquant NO_3- N test; 1.09713; analogous to DIN 38405D9 and pretreatment with Crack Set 20 1.14963; Analogous to MKC ISO 11905-1:2007	mg/L N	9,9 (±0,7)	0,326 - 0,450
Total phosphorous	Merck Spectroquant PO4-P 1.14848 and pretreatment with Merck Crack Set 10 1.14687; Analogous to MKC ISO 6878:2007	mg/L P	1,03 (±0,10)	0,071 - 0,010
Suspended solids	MKC EN 11923:2007 non-accredited	mg/L	26	30 - 60

Based upon the analysis results of the given parameters, surface waters of Dragor river at discharge spot belong to class V waters.

Waste water discharge environmental standards

The discharge of waste water into a surface recipient is regulated in the national legislation by Rulebook of the conditions, method and upper critical values for the emission of the waste waters release after their treatment/purification, method of calculation/measurement, having into account the separate requirements for the protection of the protected zones (Official gazette 81/11).

This Rulebook defines the conditions, the manner and the limit values for discharge of waste waters upon its treatment, the manner of its calculation, bearing in mind the particular requirements for protection of protected zones. The goal of this Rulebook is a control of the emissions (discharges) and protection of the environment from the impact of the dicharges waste waters.

The following table gives an overview of discharge limit values for some characteristic parameters, according to the Rulebook.

Parameters and units	Limit values for discharge into a surface recipient
pH	6.5 - 9.0
T (°C)	30
Color	/
Odour	/

[15] Report from the examination of the environmental noise analysis and analysis of water, February 1, 2016, Pharmachem Environmental Laboratory

Parameters and units	Limit values for discharge into a surface recipient
Suspended mater mg/l	35
BPK mgO_2/l	25
HPK mgO_2/l	125
Mineral oils mg/l	10
Total phosphorus mgP/l	2 (1 Lakes)
Total nitrogen mgN/l	10
Ammonium mgN/l	10
Nitrites mgN/l	1
Niitrates mgN/l	2

5.12 Social situation and social circumstances

5.12.1 Demographic properties

Municipality of Bitola covers an area of 794,53 km2. According to the last Census of 2002, 86 408 people live in the Municipality, of which 74 550 people in the city of Bitola, which is the centre of the Municipality, and 11 858 in 18 settlements. 26 387 households were registered in the 2002 Census, and the average number of members per household was 3.27.

Table 21 Distribution of the population of Bitola according to the territorial distribution of 2004.

	Total population	Households	Residences (all types of residences)
Municipality of Bitola	**95,385**	**28,942**	**37,225**
city of Bitola	74,550	23,010	28,155
65 settlements	20,835	5,932	9,070

With the new territorial division of the R. of Macedonia, since 2004, the area of the Municipality of Bitola covers 65 villages: Barešani, Bistrica, Bratin Dol, Brusnik, Bukovo, Velušina, Gabalavci, Gopeš, Gorno Egri, Gorno Orizari, Graešnica, Dihovo, Dolenci, Dolno Egri, Dolno Orizari, Dragarino, Dragožani, Dragoš, Drevenik, Ѓavato, Žabeni, Zlokućani, Kažani, Kanino, Karamani, Kišava, Kravari, Krklino, Kremenica, Krstoar, Kukurečani, Lavci, Lažec, Lera, Lisolaj, Logovardi, Lopatica, Magarevo, Malovište, Metimir, Medžitlija, Nižepole, Novo Zmirnevo, Oblakovo, Oleveni, Optičari, Orehovo, Ostrec, Poeševo, Porodin, Ramna, Raštani, Rotino, Svinište, Sekirani, Snegovo, Sredno Egri, Srpci, Staro Zmirnevo, Streževo, Trn, Trnovo, Capari, Crnobuki and Crnovec. Population density is 788 inhabitants/km^2.

The share of urban population in Bitola Municipality is relatively stable during the period 2002-2013, and is 78.15% in 2013. Natural growth has been negative at around -3.3‰ annually. Net migration has been positive during the last years- average 45 persons per year.

Table 22 Population dynamics in Butola Municipality

Items	2002	2009	2010	2011	2012	2013
Population - total	95,385	93,643	93,524	93,236	92,905	92,647
Urban population %	78.16	79.35	78.97	78.74	78.54	78,15
Rural population %	21.84	20.65	21.03	21.26	21.46	21.85
Births	914	989	976	880	881	844
Deaths	1,180	1,134	1,171	1,177	1,262	1,154
Natural growth	-266	-145	-195	-297	-381	- 310

Net Migration	45	39	76	9	50	52

Source: http://www.stat.gov.mk/Publikacii/PDFSG2014/03-Naselenie-Population.pdf

Life expectancy in Macedonia is 74.83 years, according to Statistical Yearbook 2014 and the average age of population is 38 years. For Pelagonija region the average age of population is 40.3 years. The region has the most unfavourable age structure - share of the population aged 65+ is 15.3 % whereas share of population aged 0-14 is 15.4 %. Population density of Macedonia is 80.3 and 49.3 for the Pelagonija Region.

Age distribution in the Bitola municipality is similar to the Pelagonija Region average; there is a continuous process of ageing with 15.0% of the population being over 65 years old and only 14.5% of the population being below 15 years of age.

Table 23 Age distribution of the population

Items	0-14 years	15-64 years	Over 65 years	Age dependency ratio	Coefficient of demographic replacement
Bitola Municipality	14.5%	70.5%	15.0%	41.9%	0.81
Bitola Municipality	15.4%	69.3%	15.3%	44.3%	0.9
Macedonia	16.9%	70.9%	12.2%	41.1%	1.19

Source: Regions of the Republic of Macedonia, 2014 and own calculations

The process of population ageing (decreasing relative share of the kids below the age of 15 and increasing share of the population over the age of 65) will keep mortality at a constant degree. Deaths per 1,000 inhabitants in recent years are more than 12 and this is the highest compared to all other regions in Macedonia. The minor positive net migration will be mostly influenced by the likely economic development of the region and will not be a decisive factor of the population forecast.

The gender structure of the population shows an evident trend of reducing the share of male population. Very unfavourable are the circumstances in terms of the natural movement of the population characterized by below-average birth rate, above-average mortality rate and natural growth rate of negative 0.16. The total fertility rate in the Municipality in 2008 was 1.48 and does not provide for population replacement. This situation is primarily determined by the extensive migratory movements abroad in the last four decades, which caused significant narrowing of the fertility basis of the population within the Agglomeration. According to data on external migration, it is realistic to assume that today, at least one third of the total population of this region is abroad. As regards the internal migration intern-municipal migrations are predominant.

The unfavourable trends in natural and mechanical movement of the population have reflected in the changes of the age structure, expressed in an intensive process of demographic aging. The Municipality stands out as one of the areas with the oldest population in the country.

This Municipality has a smaller increase in the number of households than that of the country. The share of single households and the population living therein are higher than the country's average in all municipalities. The total number of households is 37 225, of which 23 010 are in the city and 5 932 in the villages. The growth of households is 1.7%.

The educational structure of the population in the Agglomeration shows that, despite the unfavourable demographic trends, the Municipality as a whole has at its disposal quality human resources. The existing educational structure of the population can be estimated as unfavourable because of the large share (over 40%) of the population with low level of

education. The educational level of the population older than 15 is as follows: 41.8% elementary, 43% high school, and 15,2% with higher education.

The Employment Agency of the Republic of Macedonia in 2014, registered 6 699 unemployed persons actively seeking work in Bitola. According to the place of residence of the unemployed, of the total number of unemployed, 5 244 are unemployed coming from the City, whereas 1 455 persons from the villages have registered as unemployed. Of the total number or registered unemployed, 51% or 3 412 persons are male, compared to the 49% or 3,287 of females. The age structure analysis of the unemployed registered in the Employment Agency of Republic of Macedonia shows that the large share of unemployed are those 60 years of age or older, followed by the 25-29, and 50-59 age groups.

The age dependency ratio (ratio of younger and older dependents - people younger than 15 and people older than 65 - to the working age population – those aged 15 - 64) is 41.9% - lower than the regional average but slightly higher than the national average. The coefficient of demographic replacement (people aged 15-19 years, entering active working age versus the people aged 60-64 years, leaving active working age) is 0.81 i.e. each 100 persons leaving the working age group in 2013 are replaced by 81 persons entering the same group.

5.12.2 Water resources

Water supply

Coverage of the city of Bitola by sewerage network is 99%, whereas the coverage in the Municipality is 82%. However, the sewerage network has not yet been completed, since the Municipality of Bitola faces the problem of wastewater treatment (from residential areas and industrial wastewater). It is necessary to complete the collection system, construct collector stations, resolve the issue with the fifth canal that is open, and build wastewater treatment plants.

The main sources of water in Bitola are rivers, groundwater, reservoirs and mineral waters. The largest water reservoir in the region is the artificial lake Streževo, which is part of the Hydro System Streževo. It is located about 22 km from the city of Bitola and has a capacity of 680 l/s. The Hydro System Streževo included all water from the rivers Šemnica and Dragor with their tributaries and the watercourses of the Mountain Baba: Kišavska, Graeška, Ostrečka, Zlokućanska, Stara Reka and Kinderka. The lake covers an area of 7 km^2 and has a capacity of 112 million m^3 of water.

The Hydro System Streževo is used for irrigation, water supply and generation of electricity in the Municipality of Bitola. The raw water is processed in the potable water chlorination station "Dihovo". The total quantity of delivered raw water to the potable water chlorination plan "Dihovo", in 2014, was 5 127 000 m^3. The water is treated (before chlorination, flocculation, and coagulation, filtration and disinfection by chlorine) and transported to sterile water reservoirs with a total capacity of 11 200 m^3. There are five reservoirs placed at various elevations, and with various capacities, ranging between 100 m^3 and 5 000 m^3. From these reservoirs, the water is transferred via the distribution water supply network to the inhabited areas in the Municipality of Bitola.

The configuration of the terrain in the city of Bitola requires separation of the water supply system in three different pressure zones in order to align the pressures to each consumer.

Zone 1 - is the largest by volume. This zone encompasses the highest buildings in the city, most of the industrial facilities and about 25 villages that are part of the regional water supply network.

Zone 2 - is supplied with water through standstill chamber in the Brusnichko-lavchanski area, V = 100m^3, with water level at 725 masl. Part of the settlement Bair, settlement Bukovski Livadi as well as the city hospital are supplied through this zone.

Zone 3 - is supplied with water directly from the filter station at elevation 765 masl. The highest point in this zone is at 730 masl and the lowest is at 695 masl. This is the smallest of the three zones, where relatively newer residential areas are located, a significant portion of which are individual houses

Reservoir 1 in chlorination station "Dihovo" supplies Reservoir 2 in the old filtering station, Reservoir 5 - Epinal and High zone in the city of Bitola. High zone in Bitola supplies with water the Reservoir 4 in Bukovski Livadi, which in turn supplies water to the settlement Bukovski Livadi. Middle zone is supplied with water from Reservoir 5 at Epinal, whereas Reservoir 2 is supplied with water from the Middle zone. Low zone is supplied with water from Reservoir 2, whereas Reservoir 3 is supplied with water from the Low zone, and then supplies the settlements within the Municipality of Bitola. The remaining settlements are supplied from the Low zone.

Within the JKP “Vodovod” (Public Utility Company “Water supply network”), or more precisely at the filtering station Dihovo, there is a service unit for sanitary control and protection of potable water. Within the city network of Bitola there are 25 control points for controlling water quality. Samples from 7 points are taken on daily level. According to the water consumption by inhabitant, the Municipality of Bitola is ranked first in R. of Macedonia. JKP “Vodovod” Bitola e is responsible for collection, treatment and supply of potable water to the population and the industrial facilities in the city of Bitola, and the 19 settlements within the Municipality. City of Bitola and four inhabited settlements covered by the Programme are connected to the overall water supply network Karamani, Dolno Orizari, Gorno Orizari and Kravari, with a total population between 84 064 and 86 671 inhabitants users of the services of JKP "Vodovod" Bitola in a period of 4 years.

The total length of the primary water supply network in the city of Bitola is 17,1km, whereas the remaining settlements are supplied via 123,7km-long distribution network. Households, industrial facilities, commercial facilities, and public institutions, such as schools, hospitals, hotels, and the like are connected to the water supply network. The daily water consumption in 2013 was 147 l per inhabitant. This figure does not include water consumption by industrial and commercial facilities.

According to the data from JKP "Vodovod" Bitola, industrial companies are the second major consumer of water in Bitola. Nowadays, most developed industry in Bitola is the food industry for production of milk and dairy products, production of sugar, production of yeast and brewing. The quantity of water consumed by households and other consumers in 2014 are presented in the following table.

Table 24 Data about the invoiced potable water for domestic consumption

Item	Year				
	2009	2010	2011	2012	2013
Domestic Water consumption, m^3/year	4.945.543	4.454.689	4.412.540	4.740.261	4.530.071
Per capita consumption for domestic customers, l/c/day	156	141	140	151	147

According to the data of JKP "Vodovod" Bitola, it may be stated that the total consumption of water in the Agglomeration is about 70% by households, 23% by industrial facilities and 7% by public institutions and commercial facilities.

The main disadvantages of the water supply network are the pipes that are old and are causing defects in the distribution network, which is confirmed by the fact that in the period between 2010 and 2013, 3 246 pipe defects have been reported. This also contributes to the loss of water. About 55 km of the pipes are made of asbestos and should be replaced.

Within the JKP "Vodovod", that is to say at the filtering station Dihovo, there is a service unit for sanitary control and protection of potable water, which is operational 24/7. Within the city network of Bitola there are 25 control points for controlling water quality. Samples from 7 points are taken on daily level. According to the water consumption by inhabitant, the Municipality of Bitola is ranked first in R. of Macedonia.

The consumption of potable water by households is shown in the following table. Brusnik Lavci and Bukovo, which are also part of the Programme, and are not covered with the water supply network, are supplied with water from their own sources.

Table 25 Data on potable water bills

Subject matter	Year				
	2009	2010	2011	2012	2013
Consumption of potable water by households (m^3/year).	4.945.543	4.454.689	4.412.540	4.740.261	4.530.071
Consumption of drinking water per capita (l/day)	156	141	140	151	147

The current state of the water supply network within the Agglomeration Bitola is shown on the following figure.

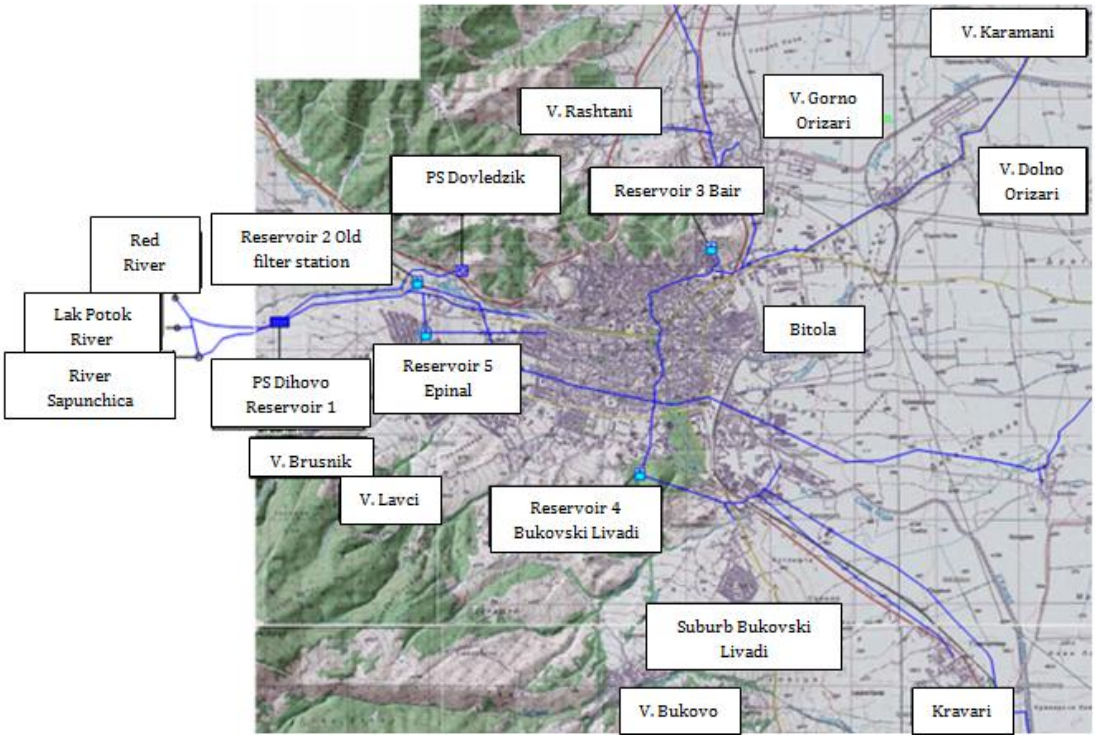


Figure 34 Current situation of the water supply network in the Bitola Agglomeration

Generated volume of wastewater

Pollution of surface waters in the municipality of Bitola is the result of generated industrial and municipal wastewater. Use of contaminated surface water for irrigation causes long-term contamination of the soil and groundwater, resulting in penetration of pollutants in the food chain.

Sewage water from the city flows into the Dragor River, at the exit of the city, and the fifth canal collects the untreated wastewater from the industry. These waters flow into Crna River and pollute it, and then into Lake Tikveš. Past studies have shown that the amount of sewage water in Dragor is twice the amount of clean water. In accordance with the physical, chemical and microbiological analysis of the water quality of Dragor River by the Public Health Institute Bitola, it has been determined that the water quality varies between category II and V at the entrance and the exit of the city of Bitola.

As a result of the lack of treatment plant, there are no real data on wastewater generated in the Bitola Agglomeration. According to previous experience, it is estimated that about 90% of the water consumption ends up in the sewerage system.

Wastewater from industrial plants ends up in the Dragor River without any treatment. The table below shows the volume of water consumption, as well as the quantities of wastewater created by type of consumer.

Although there is no information in the current environment of high water losses, infiltration of 0,12 l/s/ha has been assumed.

Table 26 Quantities of water consumption and wastewater generated

Type of consumer	Unit	Value
Water consumption and wastewater generated by households		
Population in the Agglomeration connected to the distribution network of JKP "Vodovod" Bitola		77.750,00
Billed water consumption by households	m^3/year	1.817.702,00
Total population in the Agglomeration		81.714
Population in the Agglomerations connected to a sewerage system	80.136%	65.482
Population in the Agglomerations not connected to a sewerage system	19.864%	16.232
Water consumption per capita	l/capita/day	150.59
Wasterwater generated per capita	l/capita/day	135.53
Household wastewater generated in the sewerage system	m^3/daily	8.875
Water consumption and wastewater generated by other facilities		
Water consumption by other facilities	m3/year	436.608,00
Water consumption by other facilities – 250 work days	m3/daily	1,746
Water consumption by other facilities—100%	m3/daily	1,746
Total wastewater generated by facilities connected to the sewerage	m3/daily	10.621
Infiltration – 0,12 l/ha	m3/daily	3.826,00

The sewerage network has not yet been completed, hence the Municipality of Bitola faces the problem of wastewater treatment (from residential areas and industrial wastewater). Construction of the collection system for drainage and wastewater treatment, and the construction of the treatment plant will solve the problem of uncontrolled discharge of wastewater into the water courses and environmental pollution.

Main sources of wastewater are households and commercial facilities, but also wastewater is discharged from a large number of industrial facilities and public institutions, such as schools, hospitals, kindergartens, administrative buildings, and the like. There is a sewerage system for waste water only in Bitola, Gorno Orizari Dolno Orizari and Kravari. According to JKP "Niskogradba", the responsible entity for the sewerage and collection of wastewater from

households and industrial facilities in the Municipality of Bitola, about 84% of the city of Bitola is covered by a sewerage network, 100% coverage with a sewerage network in the settlements Gorno Orizari and Kravari, and 80% coverage with a sewerage network in the settlement Dolno Orizari. The settlement Lavci is close to the city of Bitola, and half of the main collector, which will be connected to the city sewerage network, has been built. The settlement Brusnik is also close to Bitola, and it is envisaged to be connected to the city sewerage in the future, whereas for the settlements of Bukovo and Karamani there is only a project for constructing a sewerage. For these locations without sewerage infrastructure, either septic tanks are used, or the wastewater is directly discharged to the nearest water source. The overall coverage with a sewerage network in the Bitola Agglomeration is 80.136%. The following table presents data on the population with sewerage network access in the Bitola Agglomeration compared to the total population of the Agglomeration.

Table 27 Overview of sewerage network access in the Bitola Agglomeration in 2014

Settlement	Total population	Sewerage access (%)	Population with sewerage access	Population without sewerage access
Bitola	72.400	84%	60.816	9.778
Gorno Orizari	2.385	100%	2385	0
Dolno Orizari	1.782	80%	1426	356
Kravari	855	100%	855	0
Bukovo	3.395	0	0	3.395
Karamani	327	0	0	327
Lavci	328	0	0	328
Brusnik	242	0	0	242
Total	81.714	80.136%	65.482	16.427

The graphic overview of the sewerage network access in the city of Bitola compared to no sewerage network access and the whole Bitola Agglomeration is shown on the following graphs.

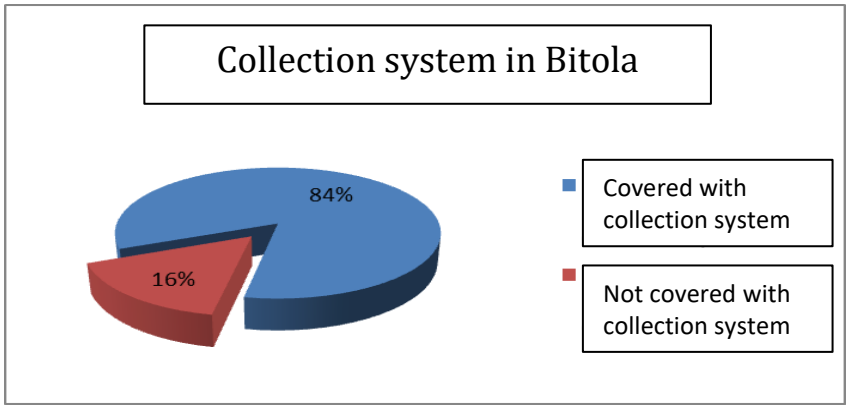


Figure 35 Sewerage network coverage of the city of Bitola

The main disadvantages of the current sewerage system arise from the fact that sewerage and the storm sewers are combined and cause flooding. The problem arises because the outlets were built at a lower level and with heavy rainfall the river water level rises, which prevents the discharge of waste water into the river and it goes back to the sewerage system, thus createing a lot of sediment. Sewage pipes are old and need to be replaced, and a separate system for storm water for certain parts of the city has to be built, which will reduce the burden on the sewerage system.

Wastewater management

About 30% of the city of Bitola has a separate system for storm water and sewage effluents, the rest of the sewerage system is combined.

The sewerage system in the Municipality of Bitola is comprised of 13 collectors along 21 km to which the secondary sewerage network is connected. The total length of the sewerage network is 180 km. Collectors and pipes in the sewerage network are made of concrete, reinforced concrete, or asbestos cement and have a diameter ranging between 500 and 1 500 mm. Wastewater from the collectors is not subject to any treatment, and over ten outlets are directly discharged into the Dragor River and the Fifth canal. Eight of the ten outlets serve to receive the wastewater from the city of Bitola and one outlet each for receiving wastewater from the settlements Gorno Orizari and Kukurečani. Wastewater from the settlements Lavci, Brusnik, Bukovo, and Karamani is collected in septic tanks or directly discharged into the nearest water courses.

Detailed overview of the outlets, their location, pipe diameter, recipient and similar are shown in the table provided bellow.

Table 28 Main Outlets in Bitola

Outlet No.	Collector	diameter (mm)	recipient	Remark
1	Collector K0	800	5th Channel, river Crna	
2	Collector K1	1.200	5th Channel, river Crna	
3	Collector K2	1.000	River Dragor, River Crna	
4	Collector K3	1.000	River Dragor, River Crna	
5	Collector K4	2F 1.200	River Dragor, River Crna	
6	Collector v. Dolno Orizari	400	River Dragor, River Crna	combined sewerage network from v. Dolno Orizari
7	Collector K5	600	River Dragor, River Crna	
8	Collector v. Kukurechani	300	River Dragor, River Crna	
9	Collector for storm water at V. Karangelevski street	1.000	River Dragor, River Crna	faecal sewerage network of Village Kukurechani
10	Collector Jeni Maale 2del	1.000	River Dragor, River Crna	

Sludge from sedimentation mostly contains 2-5% of suspended solids. The bubbling water from rapid gravity filter mainly contains 0,5-1,0% of suspended solids. Treatment of sludge will reduce the volume of waste materials that are removed. An effective method of the treatment is to reduce the water content in the sludge. A sure way to achieve this is by incorporating additional sedimentation step. Using a separator plate combined with chemical dosage will result in reducing the water content to 90%.

5.12.3 Economic development

The population of the rural part of Bitola municipality is mainly engaged in agriculture, while in the town industrial and commercial businesses and services are predominant.

Bitola field occupies the largest part of the Pelagonija valley, with a total cultivable area of about 70.000 ha. Most of it is comprised of arable land, garden areas, orchards, vineyards and meadows.

The forest fund of the municipality is also a good basis for more dynamic development of the whole Bitola economy since the surrounding Baba Mountain - Pelister, Kajmakchalan and other forest areas possess large forest complexes of fire and industrial wood.

Bitola and its wider surroundings are rich with diverse mineral wealth, especially lignite and other non-metals. The largest electricity facility in Macedonia, the mining and energy plant REK - "Bitola" operates utilising these natural resources. This plant employs 2,500 people who dispose 30 million cubic meters of tailings, extract 6-7 million tons of lignite and produce 4.2 GWh of electricity.

Another significant facility with wider social importance is the hydro-meliorative plant Streževo serving Bitola and other settlements with potable water and at the same time providing industrial water for Bitola industrial plants amongst which REK 'Bitola'. This system irrigates more than 20200ha of Pelagonija land. Besides this activity, "Streževo" is used for production of electricity at its hydropower plants, fish and mushroom farming, catering activities and more. "Streževo" also serves as protection against flooding part of Pelagonija.

As a result of this favorable natural features, in the recent decades the egsisting raw materials and resources begun to be valorized in the area of: metal, textile, food, tobacco, printing industry, production of milk and dairy products, alcoholic and non-alcoholic beverages, sugar, yeast, spirits and others.

The main industrial facilities in the Municipality of Bitola are: Agro plant AC "Pelagonija," "Factory for yeast and alcohol", "Lozar Pelisterka ", "Mill Stojchev" and dairies: "IMB Mlekara" Bitola, "Ideal Sipka", “Sugar factory "4th November", "Sinpeks" - Bitola, "Cermat", Tobacco factory "Soko Mac", JSC "Metalec", "Enigma "printing houses: “Kiro Dandaro", "Mikena" CC "Pelister" and others. Among apparel manufacturers: "Rodon", "Sat Moda", "Konignton", "Karevski" and others.

If comparing the number of economic entities in Bitola and ones established throughout the country one may see that Bitola is residence place of 6.31% of the total number of such entities in the country. The local economy of Bitola is in post privatization cycle sharing the similar trends of the national economy.

No less important for the Bitola economy are craftsman activities, especially the old crafts that are dying out. The Register of artisans enrols 114 craftsmen and another 49 (old) with different profiles which need to re-register making it a total of 163 artisans.

The industrial structure of the municipality is determined by commercial enterprises, working in the areas of: Industry and mining - 195 companies, agriculture and fishing - 47 companies, forestry - 17 companies, water economy - 7 companies, trade - 857, transport - 180, processing - 357, construction - 40, catering and tourism - 109, banking and uinsurance - 46, housing - 10, and others.

Natural conditions enabled development of different enterprises in the municipality such as REK Bitola and PE Streževo. REK Bitola is a plant whose primary function is production of electricity and coal maiking it the biggest company in the Macedonian system of energy supply, consisting of two production units: “Suvodol” Mine and Thermal Power and operational unit. REK Bitola has a share of over 72% in total energy production in the Macedonian energy

system. By opening a new coal mine Brod-Gnietino, located at the confluence of Pelagonija, the estimated lifetime of this energy generator will be extended for at least 15 years.

Giant in irrigation engineering is PE Streževo is of important public interest. PE Streževo manages with irrigation water, water protection and flood control. As additional activities PE Streževo engages in the production of electricity from hydropower plants, as well as breeding fish and mushrooms.

Industrial zone "Žabeni" (established by the Council of Bitola in 2008) aims to be a major factor and contributor to local economic development around Pelagonija. Currently the total number of companies who have purchased plots in this area is 29. The total number of issued building permits 5 and another 5 are awaiting the issuance of the authorization. In 2013 the new factory "Kromberg & Schubert" has begun production of cable installations for cars and it is expected that this company will employ 2,500 people after fully adopting the operational capacity. Another plant for production of PVC and aluminum windows and doors in the construction phase.

Since 31 December 2013 the total number of active businesses in the Municipality of Bitola was 3.957. Their structure includes almost all sectors of the economy. Most active entities are micro enterprises - 71.7%. The groups of large and medium enterprises make up less than 1%.

Agriculture

Pelagonija region is the largest agricultural producer in the Republic of Macedonia. As such, by the nature of agricultural production the prevailing product in the region are: cereals (wheat, barley, ray, oat and maize), industrial (sunflower, rapeseed, tobacco, sugar beet, etc.) forage (maize silage, alfa-alfa, beans, false grass, etc.) crops (potato, watermelon, beans) vegetable (tomatoes, pepper, onion, cabbage etc.), grape production (wine and table wine), mushrooms, natural meadows and pastures.

More than 35% of farms in Bitola are combined farms with arable land and livestock production. There are only a few farms (approx. 15%) for cattle breeding. Most farms are mixed ones, with agriculture is a major activity, but also generate income from other sources. The average size of the farm is about 2 ha.

Table 29 Agricultural land in the region of Bitola

	Total area	**Land size**	**Arable agricultural land ha**					Pastures	forests	Idle land
			Total	Arable land and gardens	Orchards	Vineyards	Meadows			
	179,495	**121,660**	**63,776**	**55,766**	**1,222**	**1,313**	**5,475**	**57,884**	**47,516**	**10,319**
Registered enterprises	129,352	78,164	27,941	26,748	326	599	268	50,223	45,193	5,995
Registered individual farmers	44,378	41,254	34,462	28,608	761	680	4413	6,792	1,436	1,688

Available natural resources are an important precondition for rapid progress of Bitola in the next period. Thus, potential opportunities to promote local development related primarily to: agriculture and arable land, forest potential, mineral wealth and so on.

5.13 Cultural heritage

Bitola has rich cultural and natural heritage. The town of Bitola belongs to the category of towns with visible layers of old building experiences with all elements of various modern influences. Preserved profane architecture from the late 19th and early 20th century remains an impressive reflection of the urban image of Bitola. Buildings in Bitola dated from periods that maintains the Macedonian renaissance throughout its style features and sublimates the local building ideas and influences of the western European architecture.

The broader area of Bitola region is identified by the following cultural heritage:

- Shirok sokak (which means "Wide Street") is a long pedestrian street that runs from Magnolia Square to the City Park.
- Covered Market - built in the 15th century
- Old Bazaar in downtown area
- Heraklea Lyncestis

There are few hundred of monuments of cultures in the city of Bitola. In 2015, a Law on the old city kernel was adopted, bringing more rigorousregime of protection. Shirok sokak has a status of national protected monument of culture and also is one of the complexes included with the new regime.

Heraklea Lyncestis was old Greek town in Macedonia which was decided later by the Romans. Its ruins are located 2 km south of the modern city of Bitola. It was founded by Philip II of Macedonia in the middle of the 4th century BC, after having conquered the surrounding region and incorporated it into his kingdom of Macedon. The town was named in honor of the mythological Greek hero Heracles. The name Lyncestis derives from the name of the ancient kingdom, conquered by Philip, where he built the city.

After the strong earthquake that struck the city in the early VI century BC, its inhabitants gradually left. It was around the time when the region was attacked by the Slavs.

The most famous cultural monuments in Bitola: Clock tower is the most recognisable monument of Bitola; Bezisten (covered market) is one of the most valuable and best preserved old buildings with recognisable architectural – aesthetic and other values; churches "St. Dimitrija", "Holy Mary" and "St. Nedela"; "Isak Mosque", "Jeni Mosque", "Zandan Kule", archaeological site "Tumba", archaeological site "Gurgur Tumba" and the remains of the ancient city Heraklea Lyncestis rich with monumental luxurious building, theatre, basilicas, wonderful mosaics, episcopal residency, court portico, city fountain from the Justinijan time and other buildings that enchant with their beauty and show the lives of our ancestors in the ancient period.

a) The Clock Tower

b) Bezisten Bitola

c) The remains of the ancient city Heraclea Lyncestis

Figure 36 Part of the cultural heritage in Bitola

The Archaeological map of Macedonia studies pre-historic and historic layers of human existence from the oldest time to the late middle-ages of the analysed area, the following sites are:

- St. Trinity – Heraklea, old Christian basilica is located approximately 500 m southwest of the downtown area; Heraclea - Heraclea Lyncestis, urban settlement from the Hellenic period to the Middle Ages;
- Cadastral municipality Bukovo – Bukovski monastery, old Christian basilica; Kutlishte, settlement from Roman time; Neoljani, middle age settlement located in the Twelve springs area, Crkvishte, middle age church and necropolis located 2 km away from the village near Mishea Livada area;
- v. Dolno Orizari – Geramidnica, a settlement from the Bronze and late antique period, about 800 m south of the village of D. Orizari.

6 POTENTIAL IMPACT AND CONTROL MEASURES

6.1 Introduction

As is the case with all other infrastructure facilities, wastewater treatment plant construction projects may exert certain impact on the environment. This impact may range from insignificant to very significant, from short-term to long-term, and certain impact cannot be fully assessed until the wastewater treatment plant has been constructed and commissioned. However, almost all impact can be mitigated by way of implementing effective improvement measures.

Effective improvement or mitigation measures are measures that serve the purpose to mitigate the actual or predicted impact by specific activities. Mitigation measures can be efficient only if they are fully implemented and if periodic monitoring is carried out upon their implementation so as to verify if these measures yield the desired effects.

In many cases, mitigation measures cannot completely prevent the impact. However, such measures are necessary to ensure the construction and operation of the wastewater treatment plant with minimum environmental impact.

In general, the major forms of impact deriving from this project are the following:

- Waste generation,
- Odour,
- Emissions in water,
- Emissions in air,
- Noise.

The objective of this Study is to determine what, if anything at all, would change in the recipient environment surrounding the Project, as the result from the implementation of the Project itself, and also to assess the significance of those changes. In order to define the possible changes, the existing or the baseline situation has been identified and described for the environment that may be affected by the Project (Chapter 5).

Approach

The environmental impact assessment comprises the following steps:

- Description and characterization of the situation with the impact recipient environment,
- Assessment of the changes (impact) to the environment that would result from the project implementation,
- Evaluation of the significance of the impact, and
- Definition of prevention and/or control measures.

An important segment of the assessment is the evaluation of the significance of the impact, which is a function of the sensitivity of the recipient (ecological value) and the magnitude of the impact. The assessment is composed of:

- Evaluation of the **sensitivity** of the recipient,
- Evaluation of the **magnitude** of the impact,
- Evaluation of the **significance**,
- **Cumulative** impact.

The recipient **sensitivity** is defined by the following criteria.

Table 30 Criteria defining the sensitivity of the recipient

Sensitivity	Description
Very high	Very high significance and rarity, international importance, very limited potential for replacement

Sensitivity	Description
High	High significance and rarity, national importance, very limited potential for replacement
Medium	High or medium significance and rarity, regional importance, limited potential for replacement
Low	Medium or low significance and rarity, local importance, limited potential for replacement
Negligible	Very low significance and rarity, local importance

The impact **magnitude** is defined by the following criteria.

Table 31 Criteria defining the magnitude of the impact

Magnitude	Description
Great	Loss of resources or resources' quality and integrity; great damage to the key characteristics and elements (Negative)
	High level or great improvement of resources; voluminous restoration or great improvement of their quality (Positive)
Medium	Loss of resources, but without affecting their integrity; partial loss/damage to the key characteristics and elements (Negative)
	Benefit for the key characteristics or elements; improvement of quality (Positive)
Small	Certain measurable changes to the characteristics, quality and vulnerability; smaller losses or changes to one (or several) key characteristics or elements (Negative)
	Lesser benefit for one (or several) key characteristics or elements; certain beneficial impact or reduced risk from occurrence of negative impact (Positive)
Negligible	Very small losses or adverse changes to one or several characteristics or elements (Negative)
	Very small benefit or positive changes to one or several characteristics or elements (Positive)
No changes	No losses or changes to the characteristics or elements; no noticeable impact in any way

It should be underlined that the greater the sensitivity of the recipient and the greater magnitude of the impact, the greater significance of the impact. For example, a highly sensitive recipient affected by a highly adverse impact will result in a highly significant negative impact. Impact significance can be evaluated by way of a matrix given in the table below.

Table 32 Matrix determining the significance of an impact as a function from the recipient sensitivity and impact magnitude

		Magnitude of an impact				
		No changes	**Negligible**	**Small**	**Medium**	**Great**
Recipient sensitivity	**Very high**	Neutral	Minor	Minor or medium	Major or profound	Profound
	High	Neutral	Minor	Minor or medium	Medium or major	Major or profound
	Medium	Neutral	Neutral or minor	Minor	Medium	Major
	Low	Neutral	Neutral or minor	Neutral or minor	Minor	Minor or medium
	Negligible	Neutral	Neutral	Neutral or minor	Neutral or minor	Minor

Evaluation of the impact significance

The evaluation of impact significance relies on reasonable argument, expert decision and consideration of relevant stakeholders' opinion and advice. Certain forms of impact may be assessed and their significance may be determined relying on particular quantitative thresholds and increments. The following table describes five categories of impact significance.

Table 33 Categories of significance of impact and their importance in decision-making

Significance	Description
Profound	This category of significance is normally applied to only negative impact, and it represents a key factor in the decision-making process. This impact is generally, though not exclusively, linked to sites or characteristics of international, national or regional importance that are likely to sustain the greatest damage or loss of integrity. This category may include great changes to sites or characteristics of local importance.
Major	This category applies to positive or negative impact, and is considered to be a very important factor. It may be relevant for the decision-making process.
Medium	This category applies to positive or negative impact that may be important, but which would not be considered in the decision-making process. The cumulative effect from these factors may affect the decision-making process if they contribute to an increased overall negative impact to a particular resource or recipient.
Minor	This category applies to positive or negative impact of local importance. It bears no key importance in the decision-making process, but is important for the improvement of the quality of the project's technical documentation.

Significance	Description
Neutral	No impact below the level of perception, within the normal limits of variation or within the margin of the foreseeable error.

Evaluation of the significance of the cumulative impact

When a single recipient is evaluated in isolation from other things, the impact may not be significant, but when individual impacts are considered in combination, the cumulative effect may become significant. The following factors should be considered when determining the significance of the cumulative impact.

- Which recipients are affected?
- How will the situation of the recipient be affected?
- Which is the probability of the impact taking place?
- The ability of the recipient to absorb the impact before the changes become irreversible.

Five categories of significance of cumulative impact can be determined.

Table 34 Categories of significance of cumulative impact

Significance	Impact
Profound	The recipient is irreversibly affected. It has to be taken into consideration in the decision-making process.
Major	May become an issue that needs to be taken into consideration in the decision-making process.
Medium	Unlikely to become an issue that needs to be taken into consideration in the decision-making process, but may require improvements.
Minor	Local importance.
Insignificant	Outside the current possibilities for prediction or within the possibility for the recipient to absorb the change.

Measures

Based on the identified potential impacts, we have proposed prevention and control measures as per individual issues.

Moreover, a high level of environmental protection and full compliance with the environmental legislation will be achieved through the following:

- Setting up and implementation of an environmental management system,
- Implementation of audit measures,
- Adoption of environmental policy,
- Continuous training and organization of the staff,
- Setting up an operational control (set of documented practices, procedures and systems).

6.2 Air

Transport of pollutants due to atmospheric movements may trigger adverse impact to great distances. On regional level, air pollution gives rise to such negative effects as acidification of forest ecosystems, lakes and waterways, as well as eutrophication of water bodies. The link between pollutant emissions from the sources of pollution, such as the traffic and the industry,

their transport to great distances and their impact on the air quality, also affects the vegetation, animals and people. According to the Law on Ambient Air, a source of emission is a place or an area that releases pollutants into the ambient air.

In general, sources of air emissions may be categorized as:

- Point (stationary) sources – stationary site or immobile installation that releases pollutant matters and substances, that is, a single identifiable source such as a pipe, a channel, a mine, a chimney, etc.
- Diffuse sources – several smaller or dispersed sources that releases the pollutants into the air, water or soil, and whose combined impact on the environment may become significant.
- Mobile sources – internal combustion engines integrated inside vehicles.

Emissions may be divided into:

- *Directed emissions.* These emissions are released in the air from individual point sources, such as chimneys, ventilation outlets, exhaust system outlets.
- *Fugitive emissions.* These emissions are not released from chimneys, pipes, ventilation outlets or exhaust systems, rather, they present uncontrollable emissions. An example of fugitive emissions are wastewater evaporations, dust emissions from fill dirt, emissions from handling construction and other materials, evaporations from open vessels / containers / tanks or from incidental leaks. Emissions from building openings (doors and windows) are also considered fugitive emissions.
- *Mobile source emissions.* Emissions from internal combustion engines in vehicles and machines.

In accordance with the given categorization, below follows the definition and the description of potential sources of air emissions during the construction phase and the operational phase of the project.

6.2.1 Construction phase impact

Emissions

The implementation of the project in this phase covers a bulk of construction work related to the undertaking of such activities as the construction of a collection system, rehabilitation of the sewerage system, and the construction of a wastewater treatment plant.

Construction activities will consist of groundwork and concrete work, circulation of transport vehicles and heavy equipment, handling of grain materials, etc. At the same time, these activities are the major sources of air emissions in this phase of the project. The former ones predominantly release dust, whereas the latter ones generate emissions from fuel combustion. Moreover, for the purposes of the WWTP, an 1100 m long access road will be built, with relating construction activities, too, constituting potential source of air emissions.

The main air emissions during the construction work will compose of the mechanically generated dust coming from clearing the ground of vegetation, excavation, transportation of the soil, movement of the vehicles and heavy equipment on the dirt road, disposal of earth and fine-grain materials, etc.

In most cases fugitive air emissions can be estimated using emission factors. One common approach is based on the size of the affected area estimating overall emissions from construction scattered throughout a geographical area[16].

[16] EPA Air Emissions Factors and Quantification, Compilation of Air Pollutant Emission Factors (AP-42), Chapter 13: Miscellaneous Sources, 13.2.3 Heavy Construction Operations

Table Area affected with construction works

	Total length (m)	Affected surface land area (ha)
Sewerage and collection system	27616	5,52
WWTP site		10
Total		15,52

The abovementioned manual suggests an approximate emission factor for construction activity operations:

- E = 2.69 megagrams (Mg)/hectare/month of activity

Considering this factor, the overal estimated emissions of total suspended particulate (TSP) for the entire construction activities would be:

Construction activity	Total emission estimation for TSP	
	For total affected area and duration of work	Per day, per hectare
Sewerage and collection system (18 months duration)	267,3 t	0.089 t/day/ha (89,66 kg/day/ha)
WWTP (20 months duration)	538 t	

This are very rough estimations since no precise data is available, hence it should be considered only as an indication of air impacts.

As per air emissions from vehicles, installations and heavy equipment, the impact is in the form of NO_2, HC, dust ($PM_{2.5}$ and PM_{10}) and CO_2. In general, combustion-related emissions are of no significance in most large projects, even when considered cumulatively; nevertheless, an adequate maintenance of the engines will be required so as to ensure these emissions stay within the lowest possible quantities. The typical emissions coming from heavy equipment have been summarized in the following table.

Table 35 Typical emissions from heavy equipment

Equipment	**HC**	**CO**	**NOx**	**PM**	**CO_2**
			kg/y		
Bulldozer	81.82	169.8	507.25	3.49	34.67
Truck	40.85	92.27	277.45	2.11	20.75
Excavator	88.21	237.35	780.04	7.10	68.13
Road roller	30.00	79.64	260.40	2.33	22.44

Both sources are non-continuous sources of emission. The exhaust systems of the heavy equipment and the transportation vehicles are mobile sources of emission of air pollutants, whereas the former ones are diffuse sources.

Impact

The fugitive emission is composed of particles from the finest fraction of the released solid particles, borne by the wind. It is practically impossible to assess the quantity of the wind-borne fine fraction, because it is too small to be calculated by the balance, and on the other hand it is variable and depends on weather conditions and humidity of the granulate. Within the wind-borne fine fraction, PM10 and PM2.5 deserve special mention, which are particles smaller than 10 microns and 2.5 microns in diameter. Because the mechanically generate dust tends to have larger particle diameters than dust generated through combustion, the dust tends to settle in close proximity to the source through gravity deposition with much of the dust settling within tens of meters of the source. The finer particles in the dust can be transported much further though and studies have shown elevated PM10 concentrations as much as 1000 m from the source but with rapid reductions in concentration thereafter. Because of the nature of construction dust the effects are typically nuisance (soiling of houses and clothes) and visibility reductions rather than necessarily adverse human health effects, but the latter cannot be discounted entirely.

A particular concern may be the construction activities close to residential areas, i.e. construction of sewerage in urban areas.

From the aspect of their impact, more significant are the activities that are implemented in urban areas, in the vicinity of residential buildings. The WWTP construction will be carried out in a rural area, whereas the remaining activities will be carried out in urban areas, near the commercial facilities located along the route where the line construction activities will be undertaken, with possible residential blocks on the way.

The impact intensity will depend on the volume of activities, sources of emission, weather conditions, humidity of the handled materials, frequency of vehicle movement on the dirt roads, the timing when the activities will be undertaken and the atmospheric conditions that determine the soil humidity and its ability to form dust, as well as on the distance to the recipients (people).

The WWTP-related construction activities are at a distance of about 600 m from the nearer residential areas, thus rendering the impact significance rather small.

The sewerage system rehabilitation activities bear greater significance because they will be carried out in urban areas, where in addition to commercial section, residential blocks exist as well. However, this construction work, compared to the WWTP construction, anticipates activities that are both less in number and smaller in volume. These activities will be undertaken along the line structure subject to rehabilitation, and will not be concentrated one by another.

6.2.2 Cumulative impact

The implementation of construction activities in urban areas (City of Bitola) becomes all the more significant when we consider the recorded high levels of air pollutants, which break the threshold limits (for parameter – dust). This indicates to a significantly reduced or fully exhausted absorption capacity of the ambient air and possible cumulative impact during the undertaking of the construction activities in urban areas. The potential cumulative impact would have micro-location character, and would potentially affect only the sites where the construction activities would be carried out. Therefore, greater control measures should be put in place.

At this time, there is no information of significant ongoing or planned developments in the project location area that could cumulatively affect the environment.

6.2.3 Construction phase mitigation

In order to prevent and control the impacts, the following measures will be implemented:

- Vegetation will be not cleared unless essential to the construction requirements. For example soil can be temporarily stockpiled in the road servitude and not outside of the servitude;
- The works will be confined to a minimum surface area,
- Minimization of fills, by way of coordinated implementation of earthworks (excavation, disposal, grading, compaction, etc.),
- A chemical binder (palliative) will be used to control dust on all unsurfaced roads. The binders are more effective than water spraying, and require far less application than water spraying; If not available at the moment, regulat and intensive water spraying will be used (more frequently on dry weather, anything from once to several times a day)
- Stockpiles of topsoil and humus must be stabilized with indigenous fast growing vegetation;
- Halt works when intensive fugitive dust emission is noticed, or reducing the volume of construction activities until the cause of emission is identified and measures for its elimination are undertaken,
- Use of windbreaks to prevent wind-entrained dust from large stockpiles of potential dust generating materials;
- Soil on open trucks must be doused if moved short distances or covered with tarpaulins if travelling longer distances;
- Reduction of traffic and limitation of speed of the vehicles,
- A maximum speed limit will be implemented and enforced to reduce vehicle- entrained dust;
- Progressively to remediate / re-cultivate the soil, successively with the progress of the construction works,
- To clear the vegetation only when necessary for the construction works, that is, to avoid clearing the vegetation unless it is of key importance for securing the construction conditions,
- Transport of earth and the fine-grain materials in closed trucks,
- Construction vehicles and equipment are to be switched off when not in use;
- Load and unload of trucks at the slightest possible drop,
- Regularly to clean the carriageways and other surfaces where the vehicles move, in particular after the completion of the activities for the day,
- Regularl monitoring of the implementation of the measures so as to stay alert to the situation and react in time,
- Conduct dust monitoring during the construction phase and implement immediate additional interventions where monitoring highlights degraded air quality.
- Traffic plan for movement of vehicles during the construction phase.

The efficiency of control measures is represented in the table below.

Table 36 Efficiency of control measures

Source	Control measures	Dust control rate
Soil management	Spraying water	50-90%
	Confinement	75%
	Road coverage	90%
Movement on dirt roads	Limiting the vehicle speed to 50 km/h	44%
	Spraying water	10-74%
	Applying chemical binding materials	84%
	Road coverage	>90%
Wind erosion of exposed surfaces and storage of materials	Planting trees and shrubs as windbreaks	25%
	Building natural barriers, windbreaks (embankments, etc.)	24-93%
	Installing artificial barriers / windbreaks	4-88%
	Gravel	84%
	Sowing grass	90%
	Wetting out the surface	90%

6.2.4 Operations phase impact

Emissions

An overview was made of the sources of air emissions and the emissions that may arise from the implementation of the project in its operational phase.

The most typical emissions for this kind of activities are the organic odour components (hydrogen sulphide H_2S, ammonia, mercaptans, etc.), volatile organic compounds (hydrocarbons) and bioaerosols. Moreover, combustion activities are a source of combustion oxides, which can vary depending on the type of fuel.

Hydrogen sulphide forms during anaerobic processes assisted by particular bacteria. Sulphur is present in WWTP either in the form of organic sulphur coming from faeces or inorganic sulphur coming from sulphate ions. Hydrogen sulphide gives out the foul odour of rotten eggs, identifiable already in very low concentrations. Typical symptoms include vertigo, headache and nausea, and may also cause corrosion and damages in maintenance. Its generation can be prevented by minimizing the formation of anaerobic conditions.

Volatile organic compounds (VOC) form from the evaporation of organic compounds during the treatment process. The most frequent source of VOC are the industrial processes and the wastewaters they generate. The typically used VOC control measures include biofiltration, gas flaring and carbon absorption.

Aerosols are defined as particles in air coming from organic origin. Depending on the place and conditions of generation, they can be linked to a number of different microorganisms.

VOC and aerosols are commonly generated in sites where conditions exist for the generation and release of gasses, aeration, mechanic oxidation and leaks.

The potential impact from the project has been defined and classified together with the details for the sources and types of emission, according to the identification and categorization that was made.

Combustion emissions

The following sources of combustion emissions have been anticipated for this activity, as part of the combined installation generating electrical and heat energy.

- Boiler, which provides the digester with a constant temperature of 35-37°C,
- Cogenerators.

The two sources have been planned to operate on biogas produced by the digester.

Process emissions

Following major odour generating source have been identified within the WWTP:

- Coarse screen house / Inlet pumping station;
- Fine screen buildings;
- Sludge dewatering building.

All these facilities are going to be covered with ventilation systems that will collect the gases and transport it to central odour control system for an appropriate treatment before release to the atmosphere.

Potential emissions

- Sources of potential emissions are sources that are not active during the normal operations of the activity. The WWTP includes two such sources of potential air emissions:Backup electric power supply system that would be fuelled on diesel, This system has been planned to operate in the case when it is necessary to substitute the main electric power supply source so as the ensure continuity of temperature, This operation will result in oxides deriving from fossil fuel combustion,
- Gas flare for combustion of excessive methane, In cases when the methane storage reservoir is full, the flare serves the purpose to fully combust the methane before it is released into the air. This operation will result in oxides deriving from the full combustion of methane.

Diffuse sources of fugitive emissions

The wastewater treatment process contains several potential diffuse sources of fugitive emissions into the air, which are in this case the open areas where some of the wastewater treatment activities are carried out (primary sedimentation tanks and aeration tanks for biological treatment).

Greenhouse gas emissions and impact

The following greenhouse gases are related to the WWTP operational phase.

- Methane (CH_4).
  A greenhouse gas with a global warming potential of GWP = 28-36 for a period of 100 years. It is generated during the degradation of organic matter in anaerobic conditions. In order properly to manage the sludge resulting from the wastewater treatment and to reduce its impact, the project anticipates to use the methane from the sludge digester for the purposes of electricity and heat production. This requires to fully capture the methane that is generated in the processes which are its key sources of generation and combustion. According to the project, it has been envisaged to generate 2334 m^3/day of biogas (methane).

  Though in much smaller quantities, it is possible for methane to be generated in certain sections of the processes, if anaerobic conditions are created for its generation and release as fugitive emission.

- Carbon dioxide (CO_2).
  It is the major greenhouse gas, with a global warming potential of GWP = 1. It is expected to be generated during the combustion processes when producing electricity and heat, as well as in the wastewaters treatment processes.
- Nitrous oxide (N_2O).
  A greenhouse gas with a global warming potential of GWP = 296 for a period of 100 years. It generation is related to the degradation of nitrogen components in wastewaters.

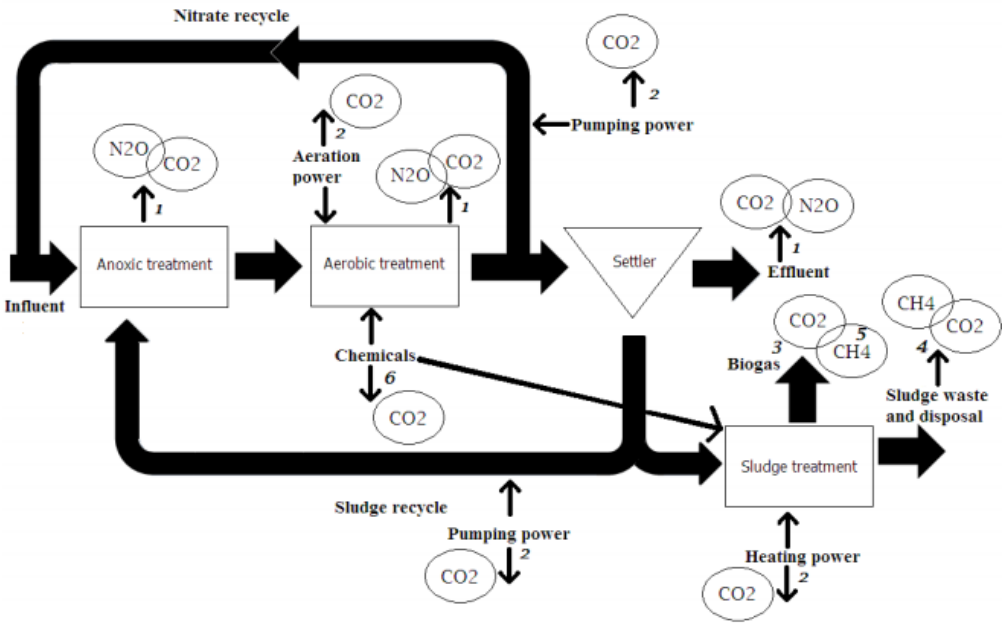


Figure 37 Schematic presentation of greenhouse gas sources in WWTP

In general, wastewaters are one of the larger sources of greenhouse gases in the world, accounting for 9% in the total CH_4 emissions, and 3% in the total N_2O emissions. According to the projections, the total greenhouse gas emissions from the Bitola WWTP are expected to amount to 19,840 t in 2021 and 14,743 t in 2039.

The application of the anaerobic wastewater treatment processes, together with methane capturing and flaring, is an efficient measure for the greenhouse effect reduction in the wastewater treatment plants, and will significantly reduce the Bitola WWTP contribution to this problem.

Impact

The control systems planned for the different phases of the process, the purpose of which is to reduce the odour, and thus also to reduce the gasses and particles released in various processes during the wastewater treatment processes, have the objective to mitigate the impacts significantly and bring them within legally acceptable threshold values. The systems will be so designed as to achieve the following concentrations of release into air:

- Hydrogen sulphide (H_2S): 3 mg/m^3;
- Ammonia (NH_3): 30 mg/m^3;
- Sulphur oxides (SO_2 and SO_3), such as sulphur dioxide: 0.35 g/m^3;

- Nitrogen oxides (NO, NO_2), such as nitrogen dioxide: 0.35 g/m^3.

The following table gives a preview on expected emission volumes.

Table Estimated emission volumes from WWTP

		(H_2S)		(NH_3		SO_2 and SO_3		NO, NO_2	
Operation Building	**VV [m^3/year]**	**C**	**EV**	**C**	**EV**	**C**	**EV**	**C**	**EV**
Inlet pumping station	60.969.600	3	183	30	1.829	0,35	21.339	0,35	21.339
Screen houses	57.816.000	3	173	30	1.734	0,35	20.236	0,35	20.236
Blower station	30.484.400	3	91	30	915	0,35	10.670	0,35	10.670
Service building to Digester	62.328.000	3	158	30	1.577	0,35	18.396	0,35	18.396
Sludge thickening/dewatering building	73.584.000	3	205	30	2.050	0,35	23.915	0,35	23.915
Total emitted volume [kg/year]			**810**		**8105**		**94.555**		**94.555**

VV = Ventilation Volume C=Concentration **[mg/m^3]**; EV = Emitted volumes (kg/year)

In the aeration phase of the biological treatment, it has been envisioned to carry out the aeration process with submersible aerators or air diffusers located at the bottom of the reservoirs, thus rendering the process more efficient and significantly reducing the possibility for emission generation, especially that of aerosols.

Having in mind the characteristics of the sources and emissions, the impact magnitude can be evaluated as a relatively low one, without possibilities for perceptible changes or damages, and with controllable impacts. On the other hand, the environment where the WWTP is located, has a relatively low sensitivity, considering its circumstances. Therefore, the impact significance is evaluated as small.

6.2.5 Odour

Odour is the sensation that is experienced when the olfactory system receives stimuli. People are sensitive to various aromatic compounds. The intensity, detectability, concentration and the character of the chemical compounds influence the human perception of smell.

The release of odour is related to the potential emissions of organic aromatic components that contain sulphur and nitrogen compounds available in wastewaters, such as hydrogen sulphide and ammonia. Every compound has its characteristic odour and a relating sensitivity threshold (the minimum concentration necessary for a person to sense the odour) (Table 39).

Table 37 Selected aromatic compounds in WWTP and their aromatic threshold values

Compound	Threshold value (ppm)	Characteristic odour
Hydrogen sulphide (H_2S):	0.0005[a]	Rotten egg
Methanethiol (methyl mercaptan) (CH_3SH).	0.0016[b]	Rotten cabbage
Dimethyl sulphide ($(CH_3)_2S$)	0.001[a]	Rotten vegetables
Dimethyl disulphide ($(CH_3)_2S_2$)	0.003[c]	Plant sulphides
Ammonia (NH_3)	5.2[b]	Pungent, irritating
Trimethylamine ($(CH_3)_3N$)	0.0004[a]	Ammonia-like, fish

[a] WEF Manual of Practice No. 22 ASCE Manual and Reports on Engineering Practice No. 82

[b] Guide to Filed storage of Biosolids – Odour Characterization, Assessment and Sampling
[c] 1990 Annual Report – Japan Environmental and Sanitation Centre

Several potential sources of odour emissions have been identified in the WWTP site, 3 of which are point (directed) sources, and the remaining ones are diffuse sources of area emissions.

Table 38 Sources of potential odour emissions

#	Source	Type of source
1	Feed pumping stations, coarse screens (WWTP)	Point (ventilation outlet, odour control device)
2	Sludge thickening and dewatering facilities (WWTP)	Point (ventilation outlet, odour control device)
3	Mechanical treatment facilities(WWTP)	Point (ventilation outlet, odour control device)
4	Aeration pools (x2) (WWTP)	Diffuse (area)
5	Secondary sedimentation pools (x3) (WWTP)	Diffuse (area)
6	Pumping stations	Point (ventilation outlet, odour control device)

In order to assess the potential impact from odour, a quantitative evaluation was made of the odour emissions, that is, emission factors emission intensity have been defined based on the recommended parameters, and by way of modelling, odour dispersion zones have been defined, with the purpose to assess as efficiently as possible the effects on the immediate surroundings, as well as the necessary control and protection measures.

Based on this analysis, the conclusion can be made that odour emissions are negligibly small and have only momentary and local significance, whereas higher concentrations (in order of magnitude of ambient norms) outside the facility zone should not be expected at all.

The details of this analysis are given in Annex 2 to this Study.

6.2.6 Operations phase mitigation

In order to control the potential impact, the following measures will be implemented.

- Setting up a shelterbelt plantation.
  The objective of this measure is to isolate the WWTP site from its surrounding. The belt should be incorporated in the urban plan that lays down the urbanization of the plot and the conditions for WWTP construction.

  When it comes to the plantation, adequate tree profiles should be planted in alleys along the site boundaries. The choice of plants should correspond to the protection conditions and its purpose. The disposition of the tall trees and the selection of the proper vegetation species should correspond to the conditions in the working area, so as to be able to provide for a greater absorption.

- Pre-treatment of industrial technological wastewaters before releasing them into the sewerage system as a method of reduction of the organic contents that may become the source of various types of emissions during their treatment in the WWTP.
  There should be a mandatory pre-treatment of the technological wastewater in the industrial installations, before they are released in the sewerage system (according to

Article 116 of the Law on Waters). This obligation is imposed to all legal entities that generate technological wastewaters and release them into the sewerage system, with the MEPP supervising the implementation of this obligation by A IPPC installation, and with municipalities supervising the B IPPC installations and other smaller businesses that are not covered by the IPPC system.

- Regulation of the contractual relations on the reception of pre-treated technological wastewater between the wastewater treatment plant operator and the legal entities managing the industrial installations generating the technological wastewaters.
  This includes the setting of threshold values for wastewater quality and imposing of monitoring obligation according to a predefined frequency.

Odour control measures

- Primary treatment:
  - Regular cleaning of foam scrapers so as to reduce the possibility of biological degradation of fats, greases, etc.
  - Regular removal of the sludge so as to ensure the timely one-hour retention of solids under average flow rates.
  - Prevention of septic conditions by reducing the hydraulic retention time and increasing the cleaning frequency for the sediment materials.
  - Reduction of spillage turbulence by lowering the drop height between the spillage and the channel.
- Activated sludge
  - Maintenance of aerobic conditions in the aeration reservoirs.
  - Maintenance of the reservoir speed at 0.15 m/s.
- Secondary treatment reservoirs.
  - Measures similar to the ones in the primary treatment, but with an increase in the sludge removal rate to 1.5-2 hours.
- Pumping stations
  - The facilities are planned to be equipped with devices for smell control (decrease).
- If so required, application of odour-masking agents.
- Good process management, regular training of staff, diligent care for the hygiene and the operations.
- Regular monitoring of the implementation of the measures.

According to the project, the significant sources of odour are planned to be covered and ventilated so as to capture and remove the odour in the odour control systems.

6.3 Water

6.3.1 Construction phase impact

Surface waters

No direct impacts on surface waters are expected during this phase. The construction activities do not include generation of waste waters.

Groundwaters

The construction works for the construction of the collection system, rehabilitation of the sewerage system and construction of the WWTP entail standard construction activities of a linear form, which do not include deep excavations that may affect the underground waters. Hence no direct impact on groundwater is expected.

Indirect impact on ground water may result only in the case of incidents and improper management and handling of equipment and materials:

- Incorrect storage of materials,
- Leakage of polluted water from the construction ground,
- Leakage of vehicle fuel or oils,
- Dumping of inert material into waterways,
- Incorrect management of solid wastes, wastewater and inert waste.

The likelihood of these events occurring is low and they could be managed through good construction practice. Hence, appropriate protection measures are foreseen.

6.3.2 Construction phase impact mitigation

In order to prevent and control the potential indirect impact, the following mitigation measures will be implemented:

- Organization and confinement of the construction zones with limited access,
- Organization of the storage sites for materials and waste, so as to prevent dispersion or any other actions that may cause impact,
- Fuel or other hazardous materials will not be stored in greater quantities within the construction zones, Storage of smaller quantities will be carried out in a way that a proper protection against leakage will be put in place (closed containers, impervious lining, secured material for management of smaller leakages),
- The use of readymade concrete and asphalt masses,
- Servicing or other repair activities for the vehicles and the heavy equipment will not be undertaken within the construction zones,
- The use of operational transportation and other vehicles and heavy equipment,
- Storage of the generated wastes according to their characteristics and their regular removal, allowing for no possibility to over-stack the wastes within the construction zone,
- Regular monitoring of the implementation of the measures.

6.3.3 Operations phase impact

Emissions

According to the project, the WWTP will continuously release on average Q_{av} = 27090 m^3/day of treated wastewater from the Bitola agglomeration or 1.129 m^3/h, or 314 l/s. The maximum dry weather base flow for the wastewater is Qmdf = 1,842 m^3/h. The maximum wet weather base flow for the wastewater is Qmwf = 2.794 m^3/h, whereby the wet weather total flow for the wastewater that is to be conducted to WWTP is Qtwf = 9.075 m^3/h, and the wet weather diluted flow for the wastewater that is to be released into the river is Qdwf = 6.281 m^3/h.

Having in consideration the release flows, the emission quantities are given in the table below.

Table 39 Emission quantities from Bitola WWTP

Emission quantities	Unit	Value	Dimension
BOD	BOD5	6748	kg/d
		249	mg/l
COD	COD	13497	kg/d
		498	mg/l
Total suspended solids	SS	7873	kg/d

Emission quantities	Unit	Value	Dimension
		291	mg/l
Total nitrogen	Nt	1237	kg/d
		46	mg/l
Ammonia nitrogen	N-NH4	990	kg/d
		37	mg/l
Total phosphorus	Pt	202	kg/d
		7	mg/l

The WWTP is designed to fulfil requirements for discharges from Urban Wastewater Treatment Plants are as per UWWTD 81/271/EEC and the national relevant legislation[17].

Table Consistency of WWTP discharge concentration and national standards

Parameters	Concentration	Emission limit values for dicharges into surface waters
Biochemical oxygen demand	25mg/l	25mg/l
Chemical oxygen demand (COD)	125 mg/l O_2	125 mg/l O_2
Total suspended solids	35mg/l (more than 10 000 p.e.) 60 mg/l (2 000 – 10 000 p.e.)	35mg/l

Impact

The operation of Bitola WWTP is not expected to have a negative hydrological impact on the recipient, the river Dragor, neither on the discharge profile nor on the influx. According to the project, the outlet will be designed and constructed in such a way as to prevent any form of hydrological and erosive impact on the recipient at the discharge point and on the river bed.

Depending on the volume and the conditions, the industrial technological wastewaters released in the municipal sewerage system may affect the operations and the equipment of WWTP, the quality of the sludge and the wastewaters. The potential problems arising from the reception of the industrial technological wastewaters are relating to the hydraulic overload, temperature extremes and excessive quantities of:

- Fats, oils and grease matters,
- Acid and alkaline waste matters,
- Suspended matters,
- Inorganic and organic matters,
- Flammable matters,
- Volatile, odorous and corrosive matters.

[17] The Rulebook of the conditions, method and upper critical values for the emission of the wastewaters release after their treatment/filtering, method of calculation/measurement, having into account the separate requirements for the protection of the protected zones (Official Gazette of RM, no 81 dated 15.06.2011)

As already identified (Chapter 5 Environmental Status), the recipient waters of the river Dragor have a significantly deteriorated status, with water quality of the lowest class. This is the result of the many years of continuous release of untreated wastewaters.

The implementation of the project and the release of treated wastewaters will mark the beginning of the process of water quality improvement in the river Dragor. In the long run, this will contribute for the improvement of the water class of the river Dragor.

The implementation of the project will have a long-term positive impact on the surface waters of the river Dragor.

6.3.4 Cross-border impact

When analysing the potential cross-border impact, several factors have been considered that may affect the analysis: the recipient, discharge point, river course, length of the course until the point of crossing the national borders.

River Dragor is a tributary to the river Crna, which itself is a tributary to the river Vardar, which has an international character by crossing the national borders and entering the Republic of Greece. There is about 6 km of river course from the point where the treated wastewaters will be released into the river Dragor to the confluence point into to river Crna, and then the river bed of Crna stretches for about 100 km to the entry point into the Tikveš accumulation, with additional 22 km until it meets the river Vardar.

In addition to the length of the recipients of the treated wastewaters until they reach river Vardar, the flow rate of the recipients should also be taken into consideration. The following table provides the flow rates of the recipients according to the information from the nearest hydrological stations of the national network.

Table 40 Flow rates of the recipients

#	Recipient	Flow rate (m^3/s)
1.	River Dragor, before confluence with river Crna	Q=1,8 m^3/s
2.	River Crna before meeting river Dragor	Q=10.4 m^3/s
3.	River Crna before confluence with river Vardar	Q=30 m^3/s
4.	River Vardar before meeting river Crna	Q=95 m^3/s

In addition to the length of the recipients and their flow rates, the fact should be taken into consideration that river Crna flows into the Tikveš accumulation, where the waters composition is additionally homogenized to a significant extent.

Having in mind all these factors, a conclusion can be drawn with certainty that significant cross-border impact from the implementation of this project is not to be expected.

6.3.5 Operations phase mitigation

Below follows a list of measures to prevent and control the impacts. The measures have been divided by the responsibility for their implementation.

Industrial installations operators, generators of industrial wastewaters that are released into the sewerage system:

- Mandatory pre-treatment of the technological wastewater in the industrial installations, before they are released in the sewerage system (according to Article 116 of the Law on Waters),
- Regulation of the contractual relations on the reception of pre-treated technological wastewater between the wastewater treatment plant operator and the legal entities managing the industrial installations generating the technological wastewaters, This includes the setting of threshold values for wastewater quality and imposing of monitoring obligation according to a predefined frequency,
- Strict and regular control of the quality of the industrial wastewaters that will be received by the sewerage system (fats, oils, grease, flow rate, pH, temperature, heavy metals, organic matter, etc.),
- Monitoring of the implementation of the obligations arising from the contract for the reception of the wastewaters into the sewerage system, by the competent authorities,
- The following wastewater pre-treatment options need to be implemented by industrial facilities – Table 43.

Table 41 Industrial wastewaters pre-treatment options

Industry	Typical pre-treatment technologies
Food processing, dairy industry	Equalization, biological treatment, whey removal
Meat, poultry, fish	Screening, equalization, gravity separation, neutralization, biological treatment, coagulation / precipitation
Breweries and distilleries	Screening, centrifuge, biological treatment
Pharmacy	Equalization, neutralization, coagulation, extraction of dissolvents, gravity separation, biological treatment, adsorption
Organic chemistry	Gravity separation, flotation, equalization, neutralization, coagulation, oxidation, biological treatment, adsorption
Plastics and resins	gravity separation, flotation, equalization, chemical oxidation, extraction of dissolvents, adsorption, biological treatment
Leather industry	Screening, gravity separation, flotation, coagulation, neutralization, biological treatment

WWTP operator – public utilities enterprise:

- Regulation of the contractual relations on the reception of pre-treated technological wastewater between the wastewater treatment plant operator and the legal entities managing the industrial installations generating the technological wastewaters, This includes the setting of threshold values for wastewater quality and imposing of monitoring obligation according to a predefined frequency,
- Strict and regular control of the quality of the industrial wastewaters that will be received by the sewerage system (fats, oils, grease, flow rate, pH, temperature, heavy metals, organic matter, etc.),
- Obtaining a permit to release the treated wastewaters into the surface recipient (the operator of the Bitola WWTP is applying for the permit to the competent body, Ministry of Environment and Physical Planning),
- Monitoring of the quality of the surface waters of the recipient according to a predefined and approved monitoring programme,

- Storing of the fuels of the digester fuel backup system and the electric power backup system should be secured by a protection system against incidental leakage (bund walls).
- Providing adequate technical conditions for storing of chemical aid materials that are used in water treatment, according to the chemicals legislation and the approval by the competent body.

Competent authorities

- Monitoring of the implementation of the obligations arising from the contract for the reception of the wastewaters into the sewerage system, by the competent authorities.

6.4 Soil

6.4.1 Construction phase impacts

Implementation of linear activities for construction of collection and sewerage system will include removing soil layer and shallow excavations in order to place the linear infrastructure (collection tubes). The construction of the WWTP together with the short access road will include removing soil.

Table Affected soil during construction works

Item	Length (m)	Affected surface ares[18] (m^2)
Reconstruction of sewerage network in v. Gorno Orizari	**1700**	3400
Reconstruction of sewerage network in City of Bitola	13896	27792
Main Pressure Collector from v. Kravari to Main Feeding Collector at connection point with Collector K1	3500	7000
Extension of the sewerage network of v. Dolno Orizari and Main Pressure Collector to the WWTP	3650	7300
Main feeding collector from K0 to WWTP Bitola	4870	9740
Total	27616	51375

Table Volumes of excavated soil from construction activities

Activity	Waste volumes (m^3)
Excavation for construction of collector and sewerage networks	63170
Construction of WWTP Bitola	35000

[18] Expected width of linear excavations of 2 m (in average)

The impacts in this phase are are considered as soil degradation and loss only for the collection systems and degradation for the rest of the activities as they are foreseen in urban areas and in an ares already degradated (inert waste landfill). These impact are local and short term for the linear infrastructure and irreversible for the WWTP site. In regards to agricultural land, the impact are minor since most of it is foreseen on borders of plots and alond roads.

The excavated soil in linear activities shall be temporarelly linearly placed beside the pipe chanels. Upon completion of activities, the soil is returned back and construction area rehabilitated. Any excess soil shall be disposed off as inert waste to a location given by the municipality.

Other potential impact in a form of soil contamination may result from nadequate waste management or leakage of oil or fuel from vehicles.

6.4.2 Construction phase mitigation measures

Following measures should ensure adequate environment protection:

- Taking minimum area for the purpose of placing a construction camp,
- Minimizaтион of piled soil outside of construction area and taking other ares for storage of materials and waste.
- Removal of bulk earth material, as soon as possible.
- Provision of equipment / vessels for collecting leaks.
- Set up mobile toilets and use of authorized service company.
- Use of operable vehicles and machinery,
- Minimization of work on soft ground in wet weather conditions, whenever possible.
- Restriction of movements of vehicles outside the construction area and access roads to reduce soil compaction.
- Providing accidental spills equipment.
- Maintening construction machinery in proper working order.
- Storage of raw and auxiliary materials only in the construction area.

6.4.3 Operational phase impacts

No soil impact are expected during this phase of the project.

6.5 Noise

6.5.1 Construction phase impact

Noise emission at this phase of the project is unavoidable. Construction works on the construction sites will typically include the undertaking of groundworks and concrete works, which entail the use of transportation vehicles, heavy equipment and other means. Heavy equipment and the labour force will be moving about within the established construction zones.

The major sources of adverse noise during the construction phase, including the transportation and installation of equipment, are the heavy-duty vehicles and the equipment, as well as the handling of construction materials. The highest level of this type of noise reaches 80-90 dB (A).

Table 42 Heavy equipment noise levels

Typical representative of the technological group of heavy-duty vehicles	Sound pressure levels in dB [A] at a 10 m distance from the source	Emission limit values (day time, Ld, dB) for 2nd and 3rd degree level of noise protection
Large universal loader	76	55

Typical representative of the technological group of heavy-duty vehicles	Sound pressure levels in dB [A] at a 10 m distance from the source	Emission limit values (day time, Ld, dB) for 2nd and 3rd degree level of noise protection
Bulldozer	69	60
Vibrating road roller	78	
Track-type excavator	69	
Crane – installed on a truck (only the crane engine)	71	
Heavy truck	80 – 85	

** These levels refer to duly maintained vehicles and heavy equipment*

The construction activities will be implemented in rural, but also in urban areas, where the recipient environment is more sensitive. If we consider the fact that the operation of the listed sources is not continuous, the generation of the adverse noise will happen occasionally, and it is not expected to cause a significant impact on the environment and the local population. The undertaking of particular standard operations activities and measures during the construction works will allow for the harmonization of the noise levels and the emission threshold values.

In the point sources, noise intensity reduces by 3 to 5 dB when the distance from the source is doubled, if the landscape accommodating the distance is flat, without barriers on the path travelled by the sound. If several noise sources are found in the same site, the total noise level will be calculated in the following way:

Difference between two sound levels	Quantity added to or subtracted from the higher level
0	3 dB
1	2,5
2	2.1
3	1.8
4	1.5
5	1.2
6	1
7	0.8
8	0.6
9	0.5
10 or more	0

The noise impact may be characterized, in terms of duration as short term and not continuous (couple of hours effective daily work), with local scope of importance. The construction activities will be implemented in rural, but also in urban areas, where the recipient environment is more sensitive. The activiites for construction of sewerage systems are foreseen in urban areas where noise recipients may likely be closer to the noise sources. Activities for construction of collection systems and WWTP are more distanced from recipients. The implementation of the construction activities in urban areas may lead to a short-term excessing of the threshold values for the ambient noise which may result in deterioration of the comfort of the citizens and disturbance. Hence, mitigation measures are identified.

6.5.2 Construction phase mitigation

Considering the fact that the construction activities in this phase represent the major source of noise, the focus of the mitigation measures will be placed on these activities. It is recommended not to undertake the construction works, as well as transportation activities of materials and equipment, inside or near settlements, which implicate increased emission of adverse noise, during the period of rest (15.00 to 18.00 hrs), and particularly not in the course of the night (23.00 to 07.00 hrs) and on weekends.

It is recommended to properly plan and organize all construction activities well in advance, so as to reduce the time of use of those pieces of equipment that generate the most intensive adverse noise. The work hours and rules should be laid down based on the need to reduce the noise causing the disturbance and discomfort to the population, especially by avoiding the cumulative effect of increased noise due to the simultaneous operation of various pieces of heavy-duty vehicles and equipment. If it comes to a serious exceeding or disturbance, or complaints by citizens, the activities will be minimized or halted as required.

6.5.3 Operational phase impact

In this phase, the noise emission is related only to the operation of the future Bitola WWTP. Identification of possible more significant sources of noise has been made.

Table 43 Overview of the more significant sources of noise

Source	Operational level of noise	Time of operation	Control measures
Compressors	Will not exceed 85 dBA calculated at a 1 m distance from the compressor inside the facility where it is located.	24 hours every day	Located inside the facility
Pumps	Will not exceed 80 dBA calculated at a 1 m distance from the pump inside the room where it is located.	24 hours every day	Located inside the facility
Decanter – centrifuge	Will not exceed 80 dBA calculated at a 1 m distance from the source.	16 hours a day, five days in a week	Located inside the facility

Source	Operational level of noise	Time of operation	Control measures
Ventilators	Will not exceed 80 dBA at the entrance and exit	24 hours every day	Located inside the facility
Odour control devices	55 dBA at the exhaust outlet, with the application of control measures	24 hours every day	Located inside the facility; application of alternators for exhaust noise
Diesel aggregate	85 dBA at a 1 m distance from the generator room, with the application of control measures	As needed	Located inside the facility; installation of compartments, door insulation
Cooling devices	55 dBA at the exit unit	8 hours every day	/

The equipment has been designed in a way as to ensure the threshold levels of ambient noise generated by the installation:

- 65 dB (A), in the course of the day, 07 hrs to 19 hrs,
- 60 dB (A), in the course of the evening, 19 hrs to 23 hrs,
- 55 dB (A), in the course of the night, 23 hrs to 07 hrs.

The closest sensitive noise recipient (residential areas) are located at about 400 m from the nearest WWTP site boundary. If we consider that the noise levels in point sources reduce by 3 to 5 dB when the distance from the source is doubled, if the landscape accommodating the distance is flat, without barriers on the path travelled by the sound, the ambient noise is expected to be around 40 dBA in the closest recipients. This is an estimated value which takes into account that the sound intensity would reduce by only 3 dB when doubling the distance. The conclusion does not significantly changes when considering simultaneous work of the total equipment since the noise levels of each of the sources don't add up, but can only contribute up to 3 dB to the maximum noise level. If we consider that shelterbelt plantations will be installed at the site boundary as buffer zones and noise barrier, a significant reduction of the ambient noise can be expected.

6.5.4 Operations phase mitigation

The control of the impact and the achievement of full compliance with the permitted levels of ambient noise will be achieved with the application of the following measures:

- Implementation of control measures envisaged by the Project,
- Regular control of the operations of all equipment,
- Installation of shelterbelt plantation at the WWTP site boundaries, which, among other purposes, will also serve as sound barrier,
- Regular maintenance of the entire equipment, according to manufacturers' manuals,
- Occasional monitoring of the ambient noise at the WWTP site boundaries.

6.6 Waste

6.6.1 Construction phase impact

Waste generation

Sources of waste in this phase are the construction activities and all the relating operation of equipment and labour force. In this stage, the following types of waste are expected to be generated:

- Rubble,
- Land excavations,
- Used sewerage infrastructure (pipes, etc.),
- Vegetation cuttings,
- Scrap metal,
- Waste from packaging – wood, plastics, paper, and cardboard;
- Waste from containers of paint, varnish, grease and oils,
- Municipal waste.

The largest fraction of the generated waste is expected to be the inert waste from clearing of the ground, excavations and similar activities. The following table gives an overview of the expected quaintities of inert waste from the excavations necessary for preparation of the construction activities

Improper management of waste generated may cause environmental impact, potentially affecting air quality by distributing and creating fugitive dust, causing visual discomfort, impact on the soil or groundwater or sewers through leaks and contamination by dangerous substances etc. The impacts from this phase are considered as local by scope, medium term by duration(limited to the duration of the construction works) and limited magnitude (very small adverse changes).

6.6.2 Construction phase mitigation

The application of adequate measures for the proper management of wastes will ensure the prevention of the environmental impact, continuous operation and absence of disturbances for people and other potential recipients. The measures include:

- Establishment of sites for temporary storage of waste, protected against dispersal by wind or animals, without the possibility of contact with rain whenever necessary (hazardous materials),
- The space should be sufficient to allow for the full storage of waste until its final removal outside the construction zones,
- Disposal of rubble only in landfills for construction and inert waste, indicated by the municipality,
- Sufficient number of containers for municipal waste,
- Regular reception of waste and avoidance of over-stacking and occurrence of impacts,
- Avoiding the risk of exposing the people to hazardous waste,
- Separate storage of waste and avoiding the mixing of various types of waste;
- Retention of hazardous materials during a leakage risk;
- Minimum contact with rains,
- Regular monitoring of the implementation of the measures.

The investor, that is, the contractor, will ensure the implementation of the environmental protection measures by developing and implementing a waste management programme, including:

- Identification of all waste types that will be generated during the construction phase and their quantification,
- Assessment of methods for handling every type of waste in accordance with the basic waste management hierarchy so as to determine the possible reduction of quantities of waste that requires disposal,
- Identification of storage sites and conditions,
- Determining the methods and frequency for waste reception and disposal,
- Keeping records of generated and disposed waste.
- Frequent controls over the entire construction zone so as to ensure compliance with the programme requirements.

6.6.3 Operational phase impact

Waste generation

In this phase, the main source of waste is only the activity of the wastewater treatment (WWTP) with all processes that are scheduled to take place on the site. Another small source of waste are the pumping stations, while the municipal wastewater is passing through the finer grids there will be waste.

Having in mind the activity and the processes it involves, we made an overview of the types of wastes that are expected to be generated as direct impacts from this phase, generation frequency and average quantities.

Table 44 Expected waste types and quantities

Source	Waste	Code	Generated quantities
Mechanical coarse and fine clarification through racks and screens (WWTP)	Screenings	19 08 01	- 2.6 m^3/day; - 3.5 t/day - Dry matter – 25%
Reservoirs for disposal of aerated gravel and grease(WWTP)	Waste from desanding - inert waste	19 08 02	- 1.5 m^3/day; - 0.79 t/day - Dry matter – 40%
Biological treatment (WWTP)	Inert waste - Stabilized dehydrated sludge	19 08 05	- Volume of dehydrated sludge 25.65 m^3/day - Mass of dehydrated sludge 23.32 t/day
Fine screens of pumping stations in Dolno Orizari and Kravari	Remains of screens and oars - inert waste	19 08 01	
Administrative activities at the WWTP site	Mixed municipal waste	20 03 01	0,48 t/month, 5,76 t/year[19]

[19] Estimated for 16 WWTP workers and 1 kg/day municipal waste (Annual amount of municipal waste per person (in kg) in 2015, http://stat.gov.mk/pdf/2016/5.1.16.08.pdf

This table provides an overview of the expected types of waste identified in accordance with the existing planning and technical documentation. When more detailed information become available on the project level, this overview will be updated and supplemented so as to tackle all types and quantities of waste that would be generated during the WWTP operation.

The remaining project activities, in their operational phase, are not expected to generate waste in normal operation, except in case of their maintenance.

Description of wastes

Mechanical coarse and fine clarification through racks and screens

This waste is generated by several levels of mechanical clarification of wastewaters. In order to protect the pumps, the inflowing wastewaters pass through 30 mm wide racks that capture all the solids exceeding the indicated dimension. Further on, the wastewaters pass through several levels of screens and sifts, where an additional clarification of the wastewater from finer solids is carried out. This waste is larger than 5 mm and is heterogeneous (from plant and household origin, textile, animal bones, packaging material, etc.) and it is composed of solid waste from households mixed with organic matter. The coarse waste thus separated during the mechanical clarification through racks and screens will be collected and stored in special containers within the WWTP site until its final disposal in the local landfill.

Waste from desanding and degreasing chambers

This waste is a mixture of mineral particles that are easy to sediment (sand, gravel) with sticky organic matter and is classified as non-hazardous waste.

Fats, oils and grease will be removed in this phase as well. By way of aeration, they will come afloat and will be easily removed with the help of scrapers.

Wastewater treatment sludge from the WWTP

The primary function of the WWTP is to reduce the water pollution levels before releasing it into the surface recipient. Sludge is the product from the treatment process both in the primary and the secondary wastewater treatment phase, which may take different forms depending on the treatment unit that is used. The waste sludge has potential beneficial properties, especially with regards to nutrient content, but it can also contain potential microorganisms and bacteria.

This type of wastewaters treatment process results in the generation of smaller quantities of sludge, compared to other processes, including the conventional process of sludge activation. In this way, already in the planning process, prevention measures should be implemented by way of a careful selection.

6.6.4 Operations phase mitigation

The Project foresees appropriate waste management measures, in terms of collection, storage and disposal, thus preventing adverse environmental impact during the operation of the WWTP.

Waste handling and storage

Waste from mechanical coarse and fine clarification through racks and screens (WWTP)

The coarse waste separated during the mechanical clarification through racks and screens will be collected and stored in special containers within the WWTP site until its final disposal in the local landfill.

Waste from desanding and degreasing chambers (WWTP)

After washing, the waste will be collected and stored in special containers within the WWTP site until its final disposal in the local landfill.

The captured quantities of fats, oils and grease will be further concentrated and then stored. The clarifiers, with their containers, will be located inside the facility, without the possibility to freeze. An odour control system will be designed and installed in the clarification facility. The facility will be adequately ventilated.

Wastewater treatment sludge from the WWTP

The sludge generated in the primary treatment process, together with the sludge generated in the secondary, biological treatment, will be subjected to thickening so as to reduce the water content, and then transferred to anaerobic digester. The role of the digester is to treat and stabilize the sludge, so as to be able to handle it as a non-hazardous waste. After the digestion process is complete, the sludge moves on to dehydration.

The final step in sludge treatment is dewatering, which reduced the water content in the sludge, and increases the dry matter content from 2-4% in the conditioning system to around 22-25% dry matter after pressing. When conditioning the sludge, polymers are added which drastically enhance the dewatering capacity. The sludge dewatering process is planned to be carried out in a centrifugal decanter.

Waste of coarse and fine mechanical treatment through screens at pumping stations

The collected bulky waste from mechanical treatment through screens will be collected and stored in separate containers within the location of the pumping stations, until final disposal at the local landfill.

Storage room for the stabilized sludge

The stabilized and dewatered sludge will be stored within the WWTP site. To this end, a designated room will be constructed within the site, with a storage capacity of 3 months. The floor will be made of reinforced concrete, suitable for the movement of excavators, and the room will be confined with concrete walls.

Storage room for the unsuitable sludge

The sludge that will not meet the legal sludge treatment requirements (i.e. when it contains heavy metals, other pollutants, low content of dry matter, etc.) will be stored in a special place within the WWTP site. To this end, a special room will be constructed with a storage capacity of 1 month for the average expected quantity of this kind of sludge. The room will be made of concrete and will have drainage options for the liquids, which will be conducted to the supernatant pump stations.

Waste disposal

Short - term solution for the entire WWTP waste is disposal to the municipal landfill Meglenci, located about 20 km to the north-east from the city of Bitola, in a hilly landscape of the Gradište-Brajinac mountain. The nearest settlement, Meglenci, is at a distance of about 1.5 km from the landfill. The company responsible for waste collection in Bitola is the “Komunalec” public utilities enterprise.

The construction of the regional sanitary landfill will be in line with EU standards and national requirements, so the option of sludge disposal to a sanitary landfill will be significantly limited in terms of quantity. Hence the importance for analysis of the opportunities and the needs to use the treated sludge so a long-term solutions can be identified in near future. This is a responsibility of the municipality of Bitola.

In case of agricultural reuse of sludge, it should be noted that the use is subject to a permit issued by MoEPP as competent authority. The issuing and the permitting is defined within a particular rulebook[20].

6.7 Biological and landscape diversity

6.7.1 Impact

Having in mind the detailed description of the biological and landscape diversity in the project area and the quality of the environment in contrast to the nature and the character of the project, the conclusion can be drawn that its implementation is not expected to have a significant impact on the biological and landscape diversity. This project location does not affect any Emerald areas, protected areas with national status or areas of international importance. In this regards it should be noted that Macedonia has not established yet Natura 2000 ecological network. The conclusion refers in particular to the portion of activities that are envisaged to be carried out in rural areas (in contrast to the ones anticipated for the urban areas, which are almost irrelevant for this issue).

A smaller impact from a local character can be expected from the implementation of the project activities relating to the sites outside the urban areas, and they would be confined to a local significance.

Loss of land area and vegetation. As a result from the construction activities, the topsoil will be removed and some vegetation will be lost in the site.

Limited impact is expected also on the agricultural ecosystems and the weed and ruderal habitats. This impact is of limited intensity and scope, short-term and discontinued. The loss of agricultural land, and in this context also of anthropogenic habitats, will have insignificant impact on the biological diversity, because they do not include any wild plant or animal species. A similar conclusion may be drawn for the ruderal hedge habitats – they are characterized by cosmopolitan species, which are frequent and widely distributed, so that the impact is insignificant.

Considering the volume and the character of the project, the land degradation due to the reassignment of its purpose from agricultural to construction land and the construction of the projected facilities will happen only on a local level, within the site, without affecting the nearby areas and without any loss of vegetation and biological diversity.

With regards to potential impact on fauna, and considering the position of the site, the larger species of animals will not be affected either directly or indirectly, because such species are not typical for the site and have not been registered there. The possibility of having an impact on birds and disturbing them is rather slim, because there are no places attractive to birds and used for nesting registered in the vicinity of the site. The movement of vehicles on dirt roads and rehabilitation activities are possible to have a smaller impact in the rural areas, where some bird species might be nesting, which is related to the available food and nesting opportunities there.

The impact on reptiles and amphibians can be evaluated as slightly significant to insignificant, because there are no significant representatives registered in the wider area around the site, or their population is rather small in the area of interest. This is the consequence from the extremely unfavourable ecological status of the river Dragor in this area.

[20] Rulebook of the method and procedure of the utilization of the sludge, maximum values of concentration of hard metals in the soil where sludge is used, values/quantities of concentration of hard metals in the sludge, considering its use and maximum annual quantities of hard metals that can be tolerated in the soil (Official Gazette of RM no. 73 of 31.05.2011)

The landscape effect may be defined as the physical changes in the landscape resulting from the construction of the facilities planned with the project. The visual effects will not arise from the actual removal of the vegetation, but because of the emergence of new elements in the landscape, which will not be so tall and will have a limited coverage on the surface area.

The wider area is not highly sensitive, nor is it considered to be a landscape of a national or regional value, considering that it is predominantly agricultural land located in the vicinity of or in continuation of an industrial zone. The landscape can be categorized as a landscape with low sensitivity and tolerant to significant changes.

The impact, that is, the changes in the landscape, are more related to the operational phase, and they can be evaluated as significant, but small, without fundamental changes in the environment.

The effects from the visual impact on the landscape are evaluated as not significant, both in terms of extent and magnitude, but they will cause a permanent change in the visual characteristics of the landscape. However, considering the fact that the landscape has no scenic or aesthetic values, the significance of the entailing visual impact from the project on the recipient can be evaluated as low.

6.7.2 Mitigation

During the construction phase of the project, the following is recommended to be implemented as general measures:

- To avoid the temporary occupation and/or destruction of the neighbouring areas. Before using the areas that are not covered by the project design, a prior approval by the owner or some other form of permit must be obtained.
- To use the existing access roads and to minimize the construction of new access roads. The construction of new access roads in addition to the ones planned with the project is recommended to be the subject of an additional impact assessment.
- Prohibition and discontinuation of all activities that prevent the spontaneous development of the indigenous flora and fauna, in particular (i) collection of medicinal herbs, mushrooms and fruits, (ii) harvesting of snails, (iii) disturbance and hunting, (iv) collection of bird eggs, etc.
- Kindling of fire should be prohibited in the construction phase. It is necessary to provide conditions and equipment for fire protection, in compliance with the requirements from the corresponding legislation regulating this issue.
- Worker camps should be located exclusively within the project site. Confinement of the construction zones with heavy equipment, so as to prevent the impact on the remaining area.
- Compliance with the legislation prohibiting the disposal of waste into the waterways and the environment (rubble, municipal waste, plants and cuttings from the removal of vegetation, leakage of fuel/ oils/ lubricants, etc.).
- Installation of shelterbelt plantation, as a buffer zone, with a purpose, among other things, to mitigate the visual effects and reduce the visibility.

6.8 Risk from incidents

The implementation of this type of projects is related to existence of a certain level of risk from the occurrence of incidents caused by various factors. In continuation, we will consider the ones which are normally related to this type of projects.

In general, the occurrence of incidents and the relating impacts mainly refer to the following sources of risk:

- Risk from fire
- Risk from floods
- Risk from incorrect management of materials
- Risks from improper plant functioning.

Impacts

6.8.1 Risk from fire

During the construction phase, the risk from fire is related to the incorrect implementation of the construction works, inadequate handling of machines, inexperienced staff, negligence etc.

However, the risk from fire during the construction phase is not so big because the construction is not related to handling of hazardous and flammable materials to a greater extent or magnitude, nor are the very sites related to flammable materials in their natural surroundings:

- Absence of flammable materials in the disposed waste (the waste is inert and non-hazardous), and
- Absence or very low contents of biodegradable components in the disposed waste. Due to that, the generation of landfill gas is not to be expected.

The risk from fire seems not to be significantly greater in the operational phase as well, as far as WWTP is concerned, considering the nature of the project and its characteristics, which do not include hazardous and flammable material management to a greater extent and magnitude. A more significant risk is related to the handling of biogas that is generated by the digester. Every inadequate handling or mismanagement of gas during its use is related to a certain level of risk. The detailed design will take into consideration all circumstances and will analyse the interrelated risks, thereby anticipating an adequate fire protection system.

6.8.2 Risk from floods

In the period between 3rd and 10th of April 2013 two flood waves in a row hit the river Crna watershed, leading to the overflow in all sites of its middle course in the Pelagonija region from Prilep field to Bitola field. The first wave, which hit on 04.02.2013, caused the river to overflow at just several sites, but the next wave, which hit on 08.02.2013, flooded a large front of agricultural land. Even though for the (second) flood wave the Qmax = 172.0 m^3/s and it had a return period of just T = 10 years, the consequences were disastrous, because there was a so-called double-impact of the flood waves.

The most frequent reason for the occurrence of big floods in the Republic of Macedonia are the intensive rainfalls in the autumn period (normally in November) or the more intensive snow melting from the mountainous massifs in spring time. Local rains occur in smaller watersheds, with rather big rainfall intensity, but relatively short duration. Regional floods occur within larger watersheds and are caused by long-term rainfalls that activate the whole watershed in surface overflows.

The great flood that hit the Republic of Macedonia in November 1979 was caused by rainfalls that persisted for more than 30 hours, and had great intensity, duration and geographic coverage. The 1979 flood was caused by the long rainfalls that hit most of the Central and Western Macedonia, starting on 18th November and ending the next day on 19 November. The

precipitation levels that were recorded in the main meteorological stations in the Pelagonija region are given in the following table.

Meteorological station	Precipitation (mm)
PRILEP	100
BITOLA	95

During the 1962 and 1979 floods, roughly the same area was flooded, but in different regions. The total flooded area in 1979 was estimated to 45,860 ha, with the river Crna flooding an area of 23,125 ha in the Pelagonija region, thereby causing great damage to both the economy and the infrastructure.

From a historical perspective, in the Republic of Macedonia, Pelagonija region, along with the Skopje field and the Polog field, has been the most frequently flooded area, with great damages that sometimes exceeded 50% of the gross income of the municipality. Because of these reasons, after the 1979 floods, the best melioration system in former Yugoslavia was built exactly in the Pelagonija region, which operated flawlessly for more than 30 years, when it was regularly and correctly maintained by the water management utility enterprises. With the dissolution of these enterprises also stopped the regular and qualified maintenance of channels in the primary and secondary network of the system, while the tertiary network installed and agricultural plots was completely destroyed by the very owners. Moreover, the cleaning of river beds was also neglected, thus reducing their capacity to receive the maximum waters with rare recurrence. These undesired consequences were reaffirmed with the last two floods in April 2013 and January-February 2015, when the river beds could not let through a much smaller quantity of water than what they were regulated for. The overflowing of water from the river beds has contributed for the underground water flow to stop, which normally moves in the direction towards the river, and so they were forced to break to the surface and create great lakes. The critical areas are shown on the map given on figure 18 showing that the location of the WWTP Bitola is outside of it.

6.8.3 Risk from incorrect management of materials

The risk from impact from the incorrect management of materials is related to materials that can endanger the environment in any way. During the construction activities, these are the materials that are in any way integrated in the very construction, such as the ready-made concrete mass, asphalt mass, grease and lubricants, fuels, etc. The incorrect management and handling of these materials may have an impact, which can be of greater significance in the urban areas because of the sensitivity of the recipient, but it is also significant at the WWTP site because of the vicinity of the surface recipient.

Having in consideration that it has not been envisaged to prepare the concrete and the asphalt at the site of the construction activities, rather, these materials will be brought in the necessary quantities, no greater problems are expected about this issue. It has not been envisaged to carry out repairs and maintenance of vehicles and heavy equipment on the long run at the site of the construction activities, which also reduces the risk from impact, and also it has not been envisaged to store the fuels and other hazardous liquids in greater quantities at the site where the activities are going to be implemented.

During the operational phase, a certain level of risk will be related to the very operation of WWTP. The risk is related to the handling of waste generated in the different phases of the treatment process. Further on, an additional risk will be related to the incorrect management of liquid fuels that will serve the purpose of alternative fuel in incidental cases.

According to the project documentation, waste generation during the process will be related to the collection and storage in adequate conditions and on designated sites, especially for the larger quantities of waste remaining at the end of the process. Once the storage capacities have been filled with sludge, it has been envisaged to transport this waste to the municipal landfill.

6.8.4 Risks from improper plant functioning

Following risks are related to improper plant functioning:

- The wastewater from industry is discharged without pre-treatment . Failure to comply with the law to limit concentrations of pollutants in wastewater from industrial plants can destabilize the treatment process.
- Disruption of the main power supply for more than eight hours will disrupt the treatment process (especially activated sludge process).
- The failure of a piece of equipment (screen, pump, blower, mixer, scraper, dewatering unit etc.) and the need for repair or replacement.

Mitigation

6.8.5 Fire risk reduction

Fire risk management and the application of adequate protection measures should be carried out in accordance with the national legislation regulating this issue.

In order to reduce the danger from fire of this type, during the construction phase it is recommended to undertake the following measures:

- Compliance by the contractor with the requirements incorporated in the fire protection legislation.
- When necessary, to remove the tall and dry grass and vegetation from the access road and work points.
- Use of fire extinguisher equipment located on the site during the construction activities.
- In case of welding and similar activities, to undertake addition prevention measures.

In the operational phase, in addition to the general fire management guidelines laid down in the corresponding national legislation, a special rulebook[21] stipulates the guidelines for the technical means and equipment for waste disposal activities, and among other issues, the issue of fire protection is also discussed. In line with that, the operator is instructed to implement the fire protection measures mandatorily:

- Regular training in fire protection measures,
- Training in the proper management of the biogas handling system,
- Preparation and implementation of standard operational procedures for the biogas systems,
- Use of firefighting systems – these systems should be in compliance with the rules regulating the fire protection,
- Development of fire protection plans in urgent situations (breakdowns).

[21] Rulebook on the conditions regulating the technical means and equipment used to undertake the activity of waste disposal, and the conditions and manners of training and coaching programmes for the staff (The Official Gazette of the Republic of Macedonia, No. 108/09)

6.8.6 Flood risk reduction

- Facilities such as the wastewater treatment plant, which is envisaged to be constructed in the vicinity of a river, on its left bank, according to the national regulations should be at a distance of at least 50 m from the point where the maximum water level is reached within a return period of T = 50 years, and also at a distance of at least 10 m from the outer footing of the embankment protecting against the maximum water levels.
- In the case of this wastewater treatment plant, the protection against maximum water levels within a return period of T = 50 years should be considered from both rivers, Dragor and Golema Reka, as this terrain is in the vicinity of the wastewater treatment plant.
- Considering the fact that the WWTP is located on a terrain where the tertiary network channels (Figure 7) were once installed, and this channels drained the surface or underground waters to the nearest recipient, river Dragor or the main Channel IV, the WWTP should be protected with lateral marginal channels, one on the upper side, with an inflow direction into the river Dragor, and the other one on the back side, with an inflow direction into the Channel IV.

6.8.7 Risk reduction from incorrect management of materials

The existence of a standard operational procedure (SOP) for the operation of the WWTP means that a high level of professional operation is maintained. This includes the development of written process for all processes and activities relating to the management of the processes in the WWTP. It is necessary to familiarize the entire staff with the SOP, to implement regular trainings, to install visible notices and warning signs throughout the installation, etc. In order to be able to react properly and in time in cases of breakdowns, and thus mitigate the possible environmental impact, it is necessary to prepare the corresponding emergency reaction procedures. These procedures should include the identification of possible breakdown risks, prioritizing the response interventions, definition and delegation of responsibilities of the persons involved in the response, etc.

6.8.8 Improper plant functioning risk mitigation

The following measures are foreseen for risk management:

- Full control of wastewater from industry discharged in urban sanitation. Construction of local wastewater treatment plants in dangerous producing process.
- An emergency diesel generator foreseen to be provided. The capacity of the generator shall be determined by the Contractor based on the installed capacity of the offered equipment and the required power needs during a mains power failure. Periodically to check its condition and sufficient fuel.
- The number of equipment shall be so selected that when one unit is out of operation for maintenance the rest of the equipment shall be able to handle 100% of the maximum flow.

6.9 Cultural and historical heritage

6.9.1 Impact

Part of the project construction activities refer to the City of Bitola, in particular in the central area where numerous monuments of culture with a national protection status are located. Furthermore, the new Law on the old city kernel brought a more rigorous protection regime to the central area. The reconstruction of part of the sewerage network (collectors) in the City of Bitola involves a collector on Shirok sokak with a total length of 356 m to be reconstructed.

Given this information, that particular area is to be given high sensitivity. However, in condition of normal implementation of the construction activities, the impact is expected to be negligible since no changes to the characteristics of that area are foreseen.

6.9.2 Mitigation

All activities must be implemented with a very high precaution, appropriate oversight, prior notice to the relevant competent authority, National Administration for cultural heritage and the Institute for Protection of Cultural Monuments and Museum in Bitola, and in accordance to their specific instructions.

6.10 Social and economic impact

The implementation of the overall project is expected to bring about a series of long-term positive social and economic benefits for the population and the human health. This includes:

- Overcome the water shortage problem in particular periods of the year, especially during the dry spells,
- Risk reduction from diseases relating to poor quality water in the absence of a sewerage system,
- Widespread accessibility to the wastewater collection and disposal services,
- Raising the consumer awareness among the service users, Improvement of the basic living conditions,
- Improvement of the demographic structure and the social position of the rural population.

The implementation of the project will bring about economic benefits for the wider area.

- Stimulation of the economic development of the municipality;
- Boosting the attractiveness of the region and the land,
- A possibility to mitigate the migration trends in the municipality on the long run,
- Strengthening the possibilities for attraction of investments,
- Providing work for the local companies in the construction phase and the operational phase,
- A positive signal for the future potential investors,
- Encouraging agricultural activities in the area,
- Creating social conditions for economic prosperity in the area and economic security for the population,
- Stimulation of the development of the basic activities by activating the local potentials,
- Improvement of the infrastructure.

6.11 Summary of the impacts and significance

The following tables make a summary of the identified impacts and their significance.

Table Classification of impacts

Aspect	Phase	Impacts	Classification
Air	Construction	- Fugitive dust - Combustion gases	Direct, temporary, medium-term (as long as the construction phase lasts), local
	Operations	- Process emissions (H_2S, NH_3, SO_2 and SO_3, NO, NO_2) - Combustion gases	Direct, permanent, long-term, local
		- Combustion gases (Backup electric power supply system & Gas flare)	Potential, short-term
Odour	Construction	/	/
	Operations	- Point source, - Area source	Direct, permanent, long-term, local
Water	Construction	Spillages from bad materials and waste management	Low possibility, Indirect, local
	Operations	Treated waste water	Direct, continuous, long-term, regional
		Improvement of surface water quality, flora and fauna	Indirect, long-term, regional
		Flood waters	Low possibility
Soil	Construction	Clearing, excavation	Direct, permanent, long-term, local
	Operations	/	/
Noise	Construction	Operation of vehicles and machinery	Direct, temporary, medium-term (as long as the construction phase lasts), local
	Operations	Operation of equipment	Direct, permanent, long-term, local
Biodiversity	Construction	Loss of land area and vegetation Disturbance	Direct, permanent, Direct, medium-term
	Operations	/	/
Waste	Construction	Construction waste	Direct, temporary, medium-term
	Operations	Sludges	Direct, long-term
Cultural heritage	Construction	Clearing, excavation	Direct, temporary, short term

Table 45 Summary of identified impacts and evaluated significance

Potential impact	Recipient sensitivity		Impact magnitude		Impact significance	
	Urban	Rural	Urban	Rural	Urban	Rural
Air, construction phase	Medium	Low	Low	Low	Minor	Neutral or minor
Air, operational phase	No changes	Low	/	Medium	Neutral or minor	Minor
Odour, construction phase	Medium	Low	Negligible	Negligible	Neutral or minor	Neutral or minor
Odour, operational phase	/	Low	/	Medium	/	Minor
Noise, construction phase	Medium	Low	Medium	Medium	Medium	Minor
Noise, operational phase	/	Low	/	Medium	/	Minor
Waste, construction phase	Low	Low	Low	Low	Neutral or minor	Neutral or minor
Waste, operational phase	No changes	Medium	No changes	Medium	/	Medium
Water, construction phase	Low	Low	Negligible	Negligible	Neutral or minor	Neutral or minor
Water, operational phase	No changes	Medium	No changes	Medium (positive)	Neutral	Medium (positive)
Biodiversity, construction phase	Negligible	Low	Negligible	Low	Neutral	Neutral or minor
Biodiversity, operational phase	Negligible	Low	No changes	Medium (positive)	Neutral	Neutral or minor
Risk from incidents, construction phase	Low	Low	Low	Low	Neutral or minor	Neutral or minor
Risk from incidents, operational phase	No changes	Low	No changes	Low	Neutral	Neutral or minor
Cultural heritage, construction phase	High	Negligible	Minor	Low	Minor	Neutral
Cultural heritage, operational phase	/	/	/	/	/	/
Social and economic	Low	Low	Medium	Medium	Minor	Minor

7. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

7.1 Introduction

Environmental management involves preparation and implementation of a systematic management method for all issues related to the environment. For this purpose, a Management Plan, containing measures for reduction, prevention, and monitoring, was prepared for the purpose of preventing and controlling to the greatest extent the negative impacts, and achieving a high level of environmental protection.

The role of the Plan is to ensure that all phases of the Project will be implemented in accordance with the national environmental legislation.

The Plan was prepared in a way to be easily understood and applied. It includes the following aspects:

- Description of measures for prevention and mitigation of the impact, and monitoring of the implementation. The practical and effective measures to ensure the prevention of impacts, whenever possible, or control them to the greatest possible extent, were identified. The measures refer to all individual aspects of the impacts identified and analysed in this study. It is determined for each measure who is responsible for its implementation. The measures are shown in Table 51 Action plan for environmental protection and monitoring of the implementation of measures.
- Environmental Monitoring. This part of the Plan aims to provide confirmation of the effectiveness of the measures identified to protect the environment, and the need for reviewing and changing them.

7.2 Responsibilities

Detailed design

This Study was made on the basis of available project documentation in the form of a Feasibility Study and Preliminary Design for the Project. In the next phase, in order to implement the Project, it is necessary to develop the Main Project. The Investor is responsible to take into account the findings of this Study translated into protection measures when preparing the Main Project. Additionally, given the detailed Project, it is necessary to update them in order to reflect any possible changes.

Construction Phase

The Contractor shall be responsible to consistently implement the measures on prevention and controlling of the impacts specified in the Plan. For the purpose of efficient implementation, it is necessary for the Contractor to designate a person in charge of monitoring the performance of measures.

The Ministry of Environment and Physical Planning, as the Project Investor, shall be responsible for the full implementation of the protection measures.

Operational Phase

The municipal utility enterprise, as operator of the treatment plant, shall be responsible for implementation of the protection measures relating to the operational phase, as specified in this Plan.

Despite the protection measures, the Operator shall be responsible for conducting internal monitoring, thus ensuring efficient operation of the systems for work and control of the treatment plant. In addition, the Operator shall be responsible to conduct monitoring as per the national legislation, as set out in section 7.4.

7.3 Amendments and supplementations

The Investor, during the course of the Project, will update (amend and/or supplement) the Environmental Management Plan so as to reflect all changes in the implementation of the Project and its organization. Amendments that would be in conflict with the national environmental legislation shall not be allowed. After each amendment and supplementation, the updated Plan is necessary to be submitted to all relevant Project stakeholders.

Table 51 Action plan for environmental protection and monitoring of the implementation of measures

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
Air						
– Vegetation will be not cleared unless essential to the construction requirements. For example soil can be temporarily stockpiled in the road servitude and not outside of the servitude; – The works will be confined to a minimum surface area, – Minimization of fills, by way of coordinated implementation of earthworks (excavation, disposal, grading, compaction, etc.), – A chemical binder (palliative) will be used to control dust on all unsurfaced roads. The binders are more effective than water spraying, and require far less application than water spraying; If not available at the moment, regulat and intensive water spraying will be used (more frequently on dry weather, anything from once to several times a day) – Stockpiles of topsoil and humus must be stabilized with indigenous fast growing vegetation; – Halt works when intensive fugitive dust emission is noticed, or reducing the volume of construction activities until the cause of emission is identified and measures for its elimination are undertaken, – Use of windbreaks to prevent wind-entrained dust from large stockpiles of potential dust generating materials; – Soil on open trucks must be doused if moved	Reducing fugitive dust emissions	✔		Contractor for construction works	Visually	Contractor's person in charge (contractor will designate a person in charge of monitoring the implementation of measures)

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
short distances or covered with tarpaulins if travelling longer distances; – Reduction of traffic and limitation of speed of the vehicles, – A maximum speed limit will be implemented and enforced to reduce vehicle- entrained dust; – Progressively to remediate / re-cultivate the soil, successively with the progress of the construction works, – To clear the vegetation only when necessary for the construction works, that is, to avoid clearing the vegetation unless it is of key importance for securing the construction conditions, – Transport of earth and the fine-grain materials in closed trucks, – Construction vehicles and equipment are to be switched off when not in use; – Load and unload of trucks at the slightest possible drop, – Regularly to clean the carriageways and other surfaces where the vehicles move, in particular after the completion of the activities for the day, – Regularl monitoring of the implementation of the measures so as to stay alert to the situation and react in time, – Conduct dust monitoring during the construction phase and implement immediate additional interventions where monitoring highlights degraded air quality. – Traffic plan for movement of vehicles during the construction phase. –						
Regular monitoring of the implementation of		✔		Contractor for	Visually	Person in charge

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
measures in order to monitor the situation and react in a timely manner.				construction works		designated by the Contractor, having the role to monitor the implementation of measures
Setting-up a protective greenbelt. The greenbelt has to be envisaged in the Urban Zoning Plan that will ensure urbanisation of the parcel and conditions for construction of the WWTP. Plan adequate profiles of tree rows along the site borders. Selection of greenery should be in accordance with the conditions for protection and its purpose. The disposition of high trees and selection of type of greenery should in accordance with the conditions of the work areas, that is to say, the capability of greater absorption.	WWTP site isolation from the rest of the environment and reducing the impacts.	✔		Investor, Contractor	Adopted Main Design (Project)	Investor
Pre-treatment of technological industrial wastewater before discharging them into the sewerage	Reducing organic content that may be source of various emissions during their treatment in the WWTP		✔	Legal persons, generators and emitters of industrial effluents	Regulated legal relationships for discharging or receiving pre-treated effluents	State Environmental Inspectorate for type A IPPC installations, or local inspectorate for type B IPPC installations and other generators
Regulation of the contractual relations for receiving pre-treated industrial wastewater between the operator of the treatment plant and the legal persons managing industrial plants – generators of industrial wastewater.	Setting quality limits for the wastewater and monitoring obligation as per predetermined frequency		✔	Legal persons, generators and emitters of industrial effluents/ Operator of WWTP Bitola	Regulated legal relationships for discharging or receiving pre-treated effluents	State Environmental Inspectorate for type A IPPC installations, or local inspectorate

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
						for type B IPPC installations and other generators
Application of underwater aerators during the aeration stage of biological treatment.	Preventing formation of aerosols		✔			
Primary treatment: – Regular cleaning of foam scrubbers for the purpose of reducing the possibility for biological degradation of oils and oil materials, and the like. – Regular extraction of sludge for the purpose of ensuring the retention time for solid particles of 1 hour at average flow conditions. – Prevention of septic conditions by reducing the hydraulic retention time and increasing the frequency of cleaning the deposited material. – Reduction of overflow turbulence by the reducing the drop height between the overflow and the canal. – Active sludge – Maintaining aerobic tank conditions for aeration. – Maintaining speed of 0,15m/s in the tank. – Tanks for secondary treatment – Measures similar to those for primary treatment by increasing the sludge extraction rate to 1,5-2 hours.	Controlling odour		✔	Operator of WWTP Bitola	Visually, Daily Logbook	Competent authority - Ministry of Environment and Physical Planning
If needed, apply odour masking agents.	Controlling odour		✔	WWTP Operator		
Good process management, regular employee training, good care for the hygiene and operation.	Continuous, uninterrupted and efficient operation		✔	WWTP Operator		Competent authority
Regular supervision of the implementation of	Efficient		✔	WWTP Operator	Visually, Logbook	Person in charge at

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
measures.	implementation of the protection measures					the Operator of WWTP / competent authority
Water						
– Organization and confinement of the construction zones with limited access, – Organization of the storage sites for materials and waste, so as to prevent dispersion or any other actions that may cause impact, – Fuel or other hazardous materials will not be stored in greater quantities within the construction zones, Storage of smaller quantities will be carried out in a way that a proper protection against leakage will be put in place (closed containers, impervious lining, secured material for management of smaller leakages), – The use of readymade concrete and asphalt masses, – Servicing or other repair activities for the vehicles and the heavy equipment will not be undertaken within the construction zones, – The use of operational transportation and other vehicles and heavy equipment, – Storage of the generated wastes according to their characteristics and their regular removal, allowing for no possibility to over-stack the wastes within the construction zone, – Regular monitoring of the implementation of the measures.	Preventing impact on the water and soil	✔		Contractor for construction works	Visually	Person in charge designated by the Contractor, having the role to monitor the implementation of measures
Regular supervision of the implementation of	Efficient measure	✔		Contractor for	Visually	Person in charge

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
measures.	implementation			construction works		designated by the Contractor, having the role to monitor the implementation of measures
– Mandatory pre-treatment of industrial waste water in industrial plants, before discharging them in the sewerage system (as per Article 116 of the Water Law), – Regulate the contractual relations for receiving pre-treated industrial wastewater between the operator of the treatment plant and the legal persons managing the industrial plants – generators of industrial wastewater. This entails setting quality limits for the wastewater and monitoring obligation as per predetermined frequency.	Controlling the impact of industrial wastewater		✔	Operators of industrial plants, generators of industrial wastewater	Regulated legal relationships for receiving pre-treated wastewater, Reports on wastewater analysis	Operators of industrial plants, generators of industrial wastewater
– Strict and regular quality control of industrial wastewaters that is received in the sewerage (fats, oils and oily substances, flow, pH, temperature, heavy metals, organic materials, and the like). – Monitoring the implementation of the obligations under the agreement for receiving the wastewater in the sewerage by the competent authorities.	Controlling the impact of industrial wastewater		✔	WWTP Operator – Municipal Utility Enterprise	Regulated legal relationships for receiving pre-treated wastewater, Reports on wastewater analysis	WWTP Operator – Municipal Utility Enterprise
– Regulate the contractual relations for receiving pre-treated industrial wastewater between the operator of the treatment plant and the legal persons managing the industrial plants – generators of industrial wastewater. This entails setting quality limits for the wastewater and	Controlling the impact on the water		✔	WWTP Operator – Municipal Utility Enterprise	Regulated legal relationships for receiving pre-treated wastewater, Reports on	WWTP Operator – Municipal Utility Enterprise

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
monitoring obligation as per predetermined frequency. – Strict and regular quality control of industrial wastewaters that is received in the sewerage (fats, oils and oily substances, flow, pH, temperature, heavy metals, organic materials, and the like). – Acquiring a permit for discharging treated wastewater into a surface recipient (the operator of WWTP Bitola shall acquire the permit from the competent authority, the Ministry of Environment and Physical Planning). – Monitoring of the surface water quality of the recipient according to a predetermined and approved Monitoring Programme. – Storing fuel for the backup fuel system of the digester and for the backup energy system should be provided with a system for protection against accidental spills (bund wall), – Providing appropriate technical conditions for the storage of auxiliary chemical materials used in the water treatment as per the legislation on chemicals and the approval from the competent authority.					wastewater analysis, Acquired permit for discharging	
Monitoring the implementation of the obligations under the agreement for receiving the wastewater in the sewerage.	Implementing the contract terms			Competent authorities	Monitoring compliance with the terms of the contract for discharging / receiving the wastewater	Local Environmental Inspectorate

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
Soil						
– Taking minimum area for the purpose of placing a construction camp, – Minimization of piled soil outside of construction area and taking other areas for storage of materials and waste. – Removal of bulk earth material, as soon as possible. – Provision of equipment / vessels for collecting leaks. – Set up mobile toilets and use of authorized service company. – Use of operable vehicles and machinery, – Minimization of work on soft ground in wet weather conditions, whenever possible. – Restriction of movements of vehicles outside the construction area and access roads to reduce soil compaction. – Providing accidental spills equipment. – Maintaining construction machinery in proper working order. – Storage of raw and auxiliary materials only in the construction area.	Preventing impact on the water and soil	✔		Contractor for construction works	Visually	Person in charge designated by the Contractor, having the role to monitor the implementation of measures
Regular supervision of the implementation of measures.	Efficient measure implementation	✔		Contractor for construction works	Visually	Person in charge designated by the Contractor, having the role to monitor the implementation of measures

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
Noise						
– Avoiding construction activities during the rest period (15:00-18:00h), especially at night 23.00-07.00h) and through the weekends. – Construction activities have to be properly planned in advance and well organized in order to reduce the time of using that equipment that creates the most intense and harmful noise. – Minimizing or stopping the activities if there is serious exceeding and nuisance, or complaints from citizens.	Reduction of noise	✔		Contractor for construction works	Audio, citizen complaints	– Contractor's person in charge – (contractor will designate a person in charge of monitoring the implementation of measures) – Local Environmental Inspectorate
– Implementation of the control measures envisaged in the Project, – Setting-up a protective greenbelt at the WWTP site boundaries that, inter alia, will serve as a sound barrier, – Regular control of the operation of the overall machinery, – Regular maintenance of the overall equipment, as per the instructions of the manufacturers, – Provisional monitoring of the ambient noise at the WWTP site boundaries.	Reduction of noise		✔	– Investor, – WWTP Operator, – Municipality of Bitola	– Visually, – Derived measures, – Reports on control and maintenance, – Reports on noise monitoring	– Investor, – WWTP Operator
Waste						
– Establishing locations for provisional storage of the waste, protected against dispersing by wind or animals, without possibility for contact with rain, anytime when needed (hazardous materials), – The premises should be sufficient for full	Controlling the impact of waste handling	✔		Contractor for construction works	Visually	– Contractor's person in charge – (contractor will designate a person in charge of monitoring the

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
storage of the waste until it is finally removed from the construction zones, – Removal of construction waste only at an inert waste landfill, designated by the municipality, – Sufficient number of containers for municipal waste, – Regular collection of the waste and avoiding overstocking and occurrence of impact, – No risk of human exposure to hazardous waste, – Separated waste storing and avoiding mixing different types of waste; – Containment of hazardous material at risk of leakage, – Minimum contact with precipitation, – Regular monitoring of measure implementation.						implementation of measures) - Local Environmental Inspectorate
Preparation and implementation of a Waste Management Programme that includes the following: – Identification of all types of waste that will be generated during the construction phase, and quantification thereof, – Assessment of handling methods for any type of waste in accordance with the basic hierarchy of waste management in order to identify opportunities for reducing the amount of waste that ultimately requires disposal; – Identifying the locations and conditions for storing, – Determine the methods and frequency of collection and disposal, – Records of generated and disposed waste, – Frequent controls the entire construction area in order to ensure compliance with Programme		✔		WWTP Operator	Reports on the Waste Management Programme	MEPP, SEI

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
requirements.						
– Collection and storage of waste after rough and fine mechanical filtering through grates and grills in special containers at the WWTP site, until the final disposal at the local landfill. – Collection and storage of waste comprised of sand and aggregate and chambers for removing fats in special containers at the WWTP site, until the final disposal at the local landfill. – Storage of stable and dewatered sludge at a specific area on the WWTP site. – Storage of non-compliant sludge at a specific area on the WWTP site.	Controlling the impact of waste handling		✔	WWTP Operator	Visually	Person in charge at the WWTP Operator
Disposal of treated WWTP sludge to the municipal landfill Meglenci (short - term solution)						
Analysing the opportunities and needs for the use of treated sludge and seeking end users.	Finding a long-term solution		✔	WWTP Operator, Municipality of Bitola, MEPP	Adopted final solutions	MEPP
Biological and regional diversity						
– Avoid temporary occupation and/or destruction of adjacent surfaces. When using the surfaces that are not included in the Project concept, there must be prior consent by the owner or other type of permit. – Use the existing access roads and minimize the construction of new access roads. Construction of new access roads other than those envisaged in the Project has to be subject matter to an additional impact assessment, – Prohibit and prevent any actions that hinder the spontaneous development of the indigenous flora and fauna, particularly (i) collection of	Controlling the impact	✔		Contractor for construction works	Visually	– Contractor's person in charge (contractor will designate a person in charge of monitoring the implementation of measures) Local Environmental Inspectorate

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
medicinal plants, mushrooms and berries, (ii) collection of snails, (iii) disturbance and hunting, (iv) collection of bird eggs, and the like. – During the construction phase, lighting fires has to be prohibited. It is necessary to ensure conditions and the fire protection equipment as per the relevant legislation regulating this issue. – Labourers' resident area should be located exclusively in the Project area. Build fences around the construction zones with heavy machinery in order to prevent impacts on the remaining space. – Compliance with the legislation prohibiting the disposal of waste into the watercourses and the environment (construction waste, municipal waste, waste from removal of vegetation for the construction purpose, discharge of fuels / oils / lubricants, etc.). – Setting-up a protective greenbelt, as a buffer zone whose role, inter alia, would be to mitigate the visual effects and reduce visibility.						
Incident risk						
Fire – Detailed design the will take into account all circumstances and analyst the related risks, – Preparation and implementation of fire protection system.	Prevent the impact	✔ (designing)		Investor	Review of the Main Design (Project)	Reviewer
– Education and training for all employees with regards to proper risk management and prevention when working with biogas and fast incident response, – Monitor the requirements in the legislation of	Building facilities for environmental management		✔	WWTP Operator	Internal control	WWTP Operator

Measure	Objective	Implementation time		In charge of implementing the measure	Method of monitoring the implementation	In charge of monitoring
		Construction	Operation			
fire protection applying to the contractor of construction works. – Where needed, high and dry grass and vegetation has to be removed from the access roads and the work areas. – Use of fire protection equipment available at the site during construction activities. In case of welding and the like, additional prevention measures have to be undertaken. Regular fire protection training. Training for proper use of the biogas operating system. Preparation and implementation of standard operating procedures for biogas systems. Use of fire protection systems—these systems should be compliant with the fire protection regulation. Drafting fire protection plans for disasters.						
Cultural heritage						
All activities must be implemented with a prior notice to the relevant competent authority, National Administration for cultural heritage and the Institute for Protection of Cultural Monuments and Museum in Bitola, and in accordance to their specific instructions.	Protection of cultural heritage	✔		Investor, Municipality of Bitola		Institute for Protection of Cultural Monuments and Museum in Bitola

7.4 Environmental Monitoring Plan

The Environmental Monitoring Plan aims to provide confirmation of the effectiveness and efficiency of the measures to protect the environment identified in this study, and possibly identify the need for their revision and amendment.

Monitoring is a systematic, continuous measuring, monitoring and controlling of the conditions, quality and changes in the media and the environmental fields. The monitoring is a prerequisite for proper management of the environment, which in turn leads to making the right decisions and activities for environmental management and protection.

Air

Table 46 Monitoring of air emissions

Source	Parameter	Frequency
Combustion of fuels	Filter smoke number	Once a year
	SOx	
	NOx	
	CO	
Treatment of ventilation gases in order to eliminate the odour	H_2S	Once a year
	NH_3	
	SO_2	
	NO_2	

Wastewater and sludge

It is an obligation of an operator of WWTP to monitor the treated wastewaters, including the sludge resulting from treatment , as set in the Rulebook on the methodology, reference measurement methods, the manner and parameters of monitoring wastewater, including the sludge resulting from treatment of urban wastewater, Official Gazette of RM, no. 108 of 12.8.2011.This Rulebook prescribes the methodology, reference measurement methods, the manner and parameters of monitoring. The purpose is to control emissions and protect the environment against the harmful impact of discharged wastewater.

The Project identified the following requirements for the WWTP Operator in terms of monitoring:

Sampling of wastewater

Arrangements for sampling shall be provided at the following locations, as a minimum:

- At the inlet to the plant;
- At the effluent outlet.

Sampling of wastewater and treated effluent at the various locations listed above shall be carried out with automatic flow proportional and time composite sampling units. Sampling station shall be provided with 24 sample bottles with automatic probe pump. The samples shall be refrigerated. The total sampling equipment shall be included in the Contractors offer. This has to include on-line temperature and pH measurement.

The Contractor shall ensure that all sampling points in the wastewater treatment plant have an open section with suitable safe access to allow the taking of grab samples.

Sampling points for grab samples shall be provided at appropriate places in the sludge pumping and dewatering installations.

The facilities for quality and quantity measuring are marked under numbers 6, 16 on the general layout (Annex 2).

Flow measurements

The following flows shall be continuously measured and monitored:

- Inlet flow to WWTP;
- Outlet flow - treated wastewater;
- Septage flow;
- Air flow to aeration tank
- Primary sludge flow;
- Return sludge flow;
- Excess sludge flow;
- Polymer dosing flow to mechanical thickener;
- Raw sludge flow to digester;
- Digested sludge flow;
- Polymer dosing flow to centrifuge;
- Biogas production flow;
- Biogas utilization flow;
- LPG flow;

Inlet and outlet wastewater flow measurement shall be standard open channel or in line flow measurement unit. The accuracy of flow measurement system shall be ±3 percent of the actual flow.

8. CONCLUSION

According to the obligations set out in the Law on Environment, the project investor has initiated a procedure for an environmental impact assessment and has prepare a study for the planned activity for construction of a collection system, rehabilitation of the sewerage network, and construction of a wastewater treatment plant in Bitola. The purpose of this study and the procedure is to evaluate the impact of the project in all its phases, starting with the planning, then the design, the operational phase, and due care after the decommissioning.

The Project for building a collection system, rehabilitation of the sewerage network, and construction of a wastewater treatment plant in Bitola is part of the overall national priority for reconstruction and modernisation of the infrastructure in Macedonia, including the water sector as per the requirements and standards of the European Union (EU). This technical assistance for preparation of the Bitola wastewater Project is financed within the provisions of Regulation (EC) no. 1085/2006 of 2006/07/17 and the establishment of the Instrument for Pre-Accession Assistance (IPA).

Within the Study, a cross-section of the general condition of the environmental media and sectors was prepared, potential impacts arising from the Project implementation were determined and assessed, and adequate prevention and control measures were envisaged, for the purpose of achieving high level environmental protection.

The environmental impacts related to the proposed Project were identified and addressed in this Study, as per the requirements of the Macedonian EIA regulations, best international practices and the guidelines from the Report on determining the EIA scope, submitted by the Ministry of Environment and Physical Planning. During the preparation of this Study, no significant negative impacts on the environment and the human health were determined. Identified impacts are within the standard impacts that may be avoided or mitigated by implementing the identified protective measures. In doing so, it is necessary to particularly focus on managing the sludge resulting from the wastewater treatment process. Short-term sludge solution is deposing it at the municipal landfill, as final removal measure. Taking into account that the future regional sanitary landfill will be restricted at receiving biodegradable waster, a long-term sludge solution is necessary. Considering that this waste is specific for this kind of activities, and it may be also expected to a larger extent in the remaining treatment plants in Macedonia in the future, a national sludge solution may be considered.

In accordance with the conducted analyses, general assessment of the Study is that the Project implementation is no threat to the environment or the nature, that is to say, it is not expected to have a significant impact, and its work is justified if implemented in accordance with the regulations for this kind of projects and with the measures envisaged in this Study.

The purpose of adopting and implementing the proposed measures set in the Management Plan is to prevent and control, to a largest possible extent, the negative impacts and achieve a high level of environmental protection. Its full implementation is responsibility of the Project investor.

Successful implementation of the Project will result in significant long-term impacts on the environment, but also on the socio-economic situation in the region.

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Appendix 1 Solution for defining the scope of the study

СИСТЕМ ЗА УПРАВУВАЊЕ СО КВАЛИТЕТ ISO 9001:2008

РЕПУБЛИКА МАКЕДОНИЈА
МИНИСТЕРСТВО ЗА ЖИВОТНА СРЕДИНА
И ПРОСТОРНО ПЛАНИРАЊЕ
Бр. 10-6[illegible] од [illegible] 2016 година
Скопје

Врз основа на член 81 од Законот за животна средина ("Службен весник на РМ" бр. 53/05, 81/05, 24/07, 159/08, 83/09, 48/2010, 124/2010, 51/2011, 123/2012, 93/2013, 42/2014, 148/2015, 129/2015 и 36/2016), Министерот за животна средина и просторно планирање донесе

РЕШЕНИЕ

1. Со ова решение се утврдува потребата од оцена на влијанието на Проектот: Изградба на колекторски систем, рехабилитација на канализациона мрежа и изградба на пречистителна станица за отпадни води во Битола, за потребите на инвеститорот Министерство за животна средина и просторно планирање со седиште на бул. "Гоце Делчев" бр.18 во Скопје, како и обемот на студијата за оцена на влијанието на проектот врз животната средина.
2. Обемот на студијата за оцена на влијанието на проектот врз животната средина е определен во Листата на проверка за определување на обемот на студијата за оцена на влијанието на проектот врз животната средина: прашања за карактеристиките на проектот, која е составен дел на ова решение.
3. Обемот на студијата за оцена на влијанието на проектот врз животната средина е во прилог. Листата на проверка за определување на обемот на студијата за оцена на влијанието на проектот врз животната средина треба ги опфати и прашањата кои се однесуваат на: геолошки и хидрогеолошки аспекти, влијанијата врз атмосферата, влијанијата од бучава, кумулативни влијанија и социо-економски аспекти.
4. Во обемот на студијата се вклучени и изградбата на колекторски систем и канализациона мрежа, како и рехабилитација на канализационата мрежа при што треба да се опфатат прашањата за влијание врз животната средина и од овој дел на проектот.
5. Ова решение влегува во сила со денот на донесувањето, а ќе се објави во најмалку еден дневен весник достапен на целата територија на Република Македонија, на интернет страницата, како и на огласната табла во Министерството за животна средина и просторно планирање.

СИСТЕМ ЗА УПРАВУВАЊЕ СО КВАЛИТЕТ ISO 9001:2008

Образложение

На ден 22.03.2016 година од страна на инвеститорот до Министерството за животна средина и просторно планирање е доставено Известување за намера за изведување на Пректот: Изградба на колекторски систем, рехабилитација на канализациона мрежа и изградба на пречистителна станица за отпадни води во Битола и барање за определување на обемот на оцена на влијанието на проектот врз животната средина со број 21-611/26.

Целта на Проектот е подобрување на системот за собирање и третман на отпадните води во агломерацијата Битола. Пречистителната станица за отпадни води ќе овозможи пречистување на комуналните отпадни води од скоро 112.474 еквивалент жители и индустриски отпадни води од неколкуте индустриски зони, кои гравитираат во овој дел. Во проектот се вклучени и изградба на колекторски систем од 15,6 км со потребните пумпни станици, како и рехабилитација на приближно 20 км канализациона мрежа и поврзување на домовите со истата.

Предвидената локација за изградба на оваа пречистителна станица се наоѓа во близина на новите гробишта помеѓу селата Долно и Горно Оризари, на КП број 25 КО Битола 5 во Општина Битола.

Врз основа на направените анализи, за третман на отпадните води препорака е постројка за третман на отпадни води со активна тиња со резервоари за таложење и анаеробна стабилизација на тињата во дигесторот.

Пречистителната станица ќе користи аеробен третман на отпадните води и аеробен третман на милта. Ќе бидат изградени приемни резервоари за исталожување, биореактори, резервоари за секундарен третман, терциерен третман-резервоар за дезинфекција и испумпување во крајниот реципиент река Тркања.

Пречистителната станица ќе опфаќа неколку објекта и тоа: објекти за третман на отпадните води и тињата (објект за прелиминарен третман/пумпна станица, објект за фино пречистување на цврстите материи, компресорска станица, анаеробен дигестор, станица за обезводнување), административна зграда, трансформаторска станица, работилница, гаража и место за складирање на отпади.

Согласно Законот за животна средина ("Службен весник на РМ" бр. 53/2005, 81/2005, 24/2007, 159/08, 83/09, 48/2010, 124/2010, 51/2011, 123/2012, 93/2013, 42/2014, 44/2015, 129/2015 и 36/2016) и Уредбата за определување на проекти и за критериумите врз основа на кои се утврдува потребата за спроведување на постапката за оцена на влијанијата врз животната средина ("Службен весник на РМ" бр. 74/2005, 109/2009 и 164/2012), предложениот проект се наоѓа во Прилог 1 – Проекти за кои задолжително се врши оцена на влијанијата врз животната средина, точка 11 – Пречистителни станици за отпадни води, со капацитет над еквивалентот од 10.000 жители и за овој проект е потребно да се спроведе постапката за оцена на влијанието врз животната средина. За таа цел се пристапи кон пополнување на Листата на проверка за определување на обемот на студијата за оцена на влијанието на проектот врз животната средина: прашања за карактеристиките на проектот и се изврши определување на обемот на студијата за оцена на влијанието на проектот врз животната средина. Покрај прашањата опфатени во Листата на проверка за определување на обемот на студијата за оцена на влијанието на проектот врз животната средина, инвеститорот треба подетално да ги разработи следните прашања:

СИСТЕМ ЗА УПРАВУВАЊЕ СО КВАЛИТЕТ ISO 9001:2008

Геолошки и хидрогеолошки аспекти

Овие аспекти се важни во релација со животната средина во текот на фазата на изградба на овој вид на проекти. Од тие причини претставуваат важен сегмент која треба да ги опфати Студијата за ОВЖС.

Влијанијата врз атмосферата

Овие аспекти се едни од најважните од овој вид на проекти во релација со животната средина во текот на фазата на изградба, а особено во оперативната фаза. Од тие причини претставуваат важен сегмент која треба да ги опфати Студијата за ОВЖС.

Биолошка разновидност

Обемот на ОВЖС треба да вклучи анализа на состојбите со билошката разновидност на подрачјето, евентуално присуство на заштитени и засегнати видови флората, присуство на заштитени подрачја, евидентирани подрачја за заштита, присуство на еколошки мрежи, како и потенцијалните влијанија од спроведување на истиот.

Влијанија од бучава

Бучавата може да преставува голем проблем во време на градежните активности, но постои можност и во оперативната фаза. Студијата за ОВЖС треба да вклучи анализа на влијанието од бучава во сите фази, вклучувајќи ја и фазата на изградба.

Отпадни аспекти

Овие аспекти се важни во релација со животната средина во текот на изградбената фаза и во фазата на искористување на овој вид на проекти. Од тие причини претставуваат важен сегмент на Студијата за ОВЖС, која треба да опфати ефекти врз здравјето.

Кумулативни влијанија

Во случај да постојат проекти/инсталации со потенцијал за слични влијанија врз животната средина во опкружувањето на предвидениот проект, Студијата за ОВЖС треба да вклучи анализа на кумулативните ефекти.

Социо-економски аспекти

Оцената на социо-економските аспекти ќе даде преглед на потенцијалните директни и индиректни ефекти од проектот врз економијата и социјалните состојби во подрачјето од спроведување на истиот.

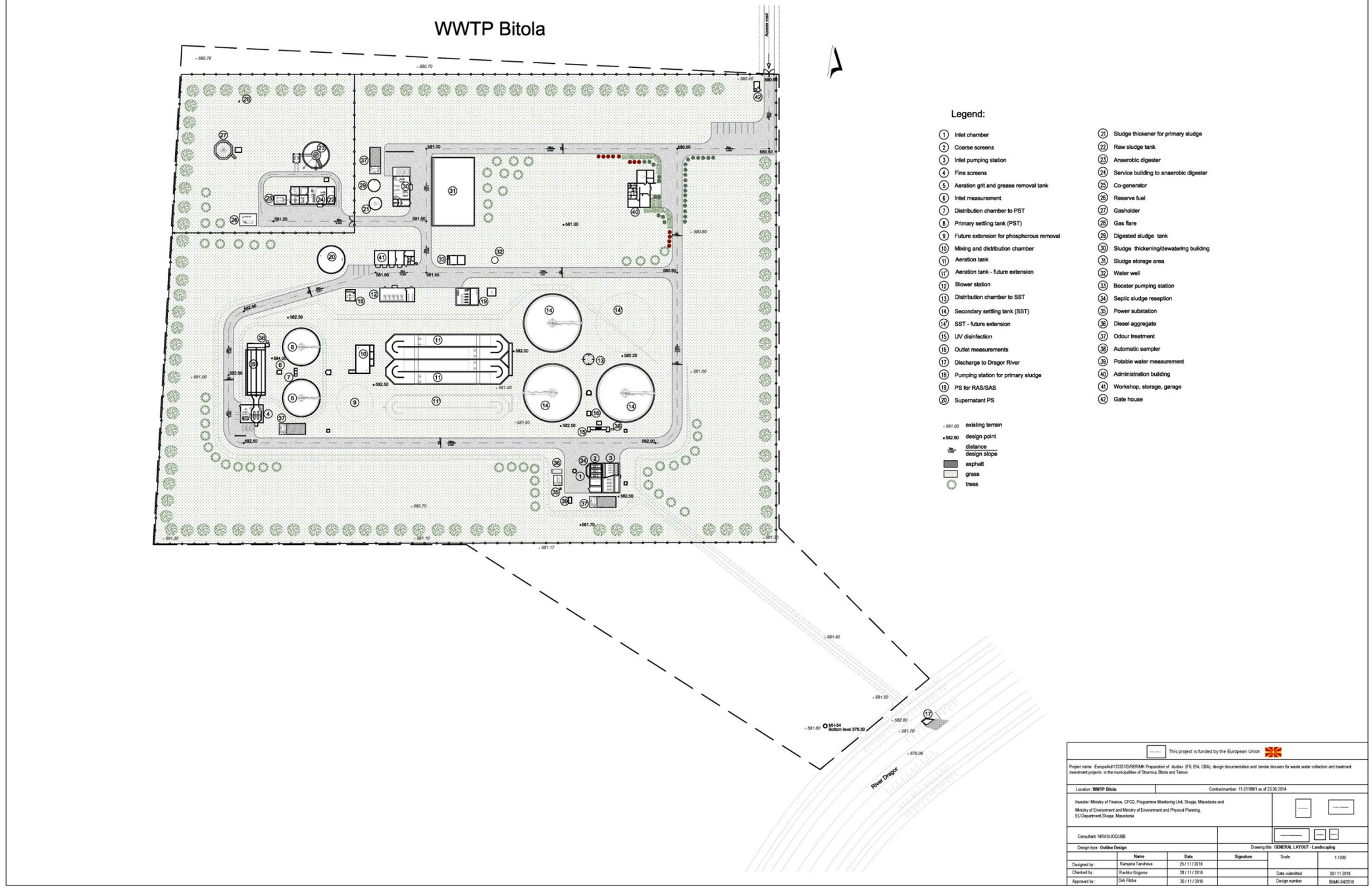
Врз основа на горенаведеното го одлучи како во диспозитивот на ова решение.

Правна поука: Против ова решение инвеститорот, засегнатите правни или физички лица, како и здруженијата на граѓани формирани за заштита и за унапредување на животната средина, можат да поднесат жалба до Државна комисијата за одлучување во управна постапка и постапка од работен однос во втор степен, во рок од осум дена од денот на објавувањето на решението.

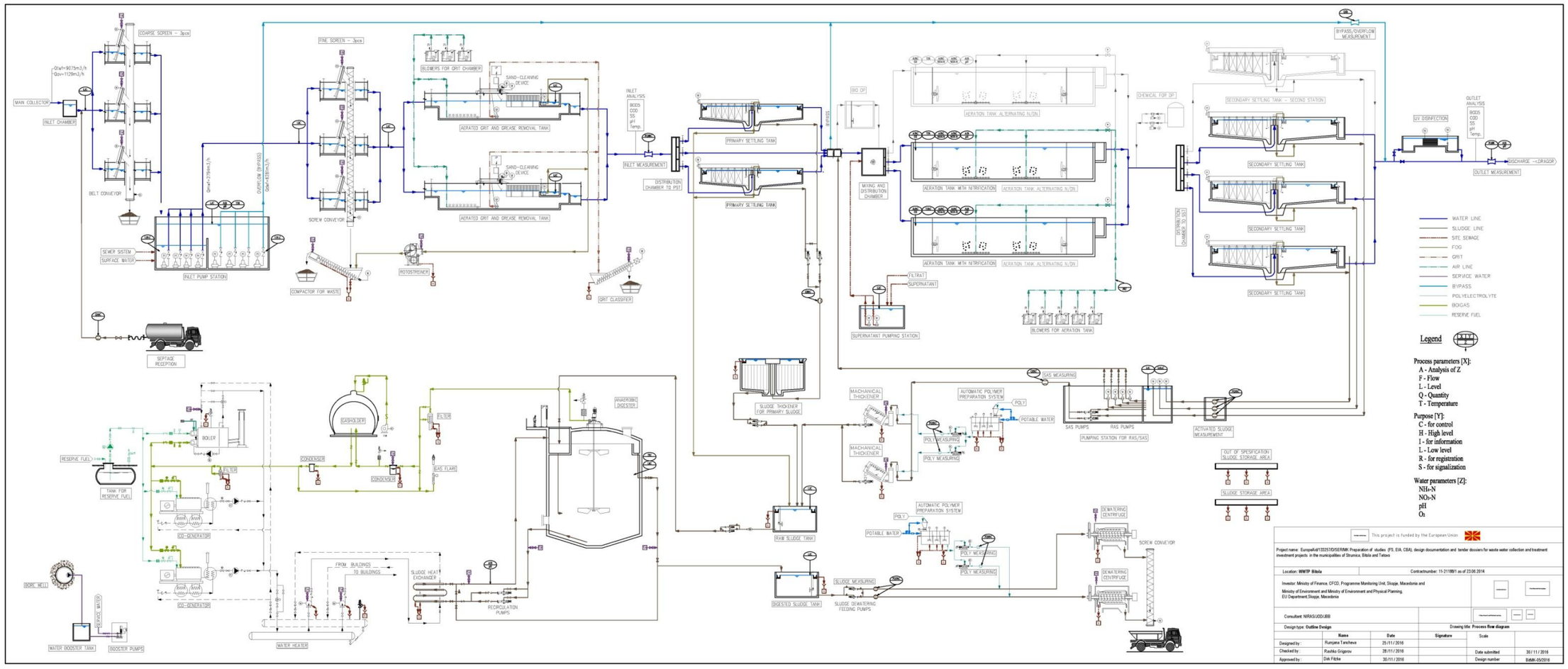
МИНИСТЕР
Bashkim Ameti

Подготвил: м-р Зоран Бошев
Контролирал/Согласен: Александар Петковски
Одговорно в.д.Директор на управа за животна средина
Даниел Ефтимов

Appendix 2 WWTP site, General layout



Appendix 3 Technological workflow of the WWTP



Appendix 4 Modelling the dispersion of odour

Background information

As part of a detailed technical analysis of the WWTP in the previous part of the Study, a detailed inventory of all sources of emissions, grouped as point or fugitive emission sources of odour, was conducted. This Appendix is dedicated to the quantitative assessment of odour emissions, that is to say, the emission factors and intensity were defined based on the recommended parameters, and by way of modelling, the odour dispersion zones were defined, in order to more efficiently assess the effects on the immediate surroundings, as well as the required control and protection measures.

Taking into account the type of pollutants, that is to say, the large number of various materials related to odour intensity and the large subjectivity with regards to their acceptability, their concentration is described in relative units, so called European Odour Unit, expressed in a cubic meter of air - OUE/m^3.

Within the human population, there are significant differences in sensitivity/acceptability of odours. As generally defined how odours are perceived by people of average sensitivity, the following parameters are used:

- 1.0 OUE/m^3 – is considered as detection limit in the laboratory,
- 2.0 ÷ 3.0 OUE/m3 – is a specific odour that may be distinguished from a background of outdoor odours,
- 5.0 OUE/m^3 – is a specific odour that would be normally distinguished if known, but would be described as weak,
- > 10.0 OUE/m^3 - the odour intensity is described as moderate to strong, and if repeated, it is likely to be deemed as unpleasant.

The Environment Agency of UK has published guidelines for odour management (H4 - Odour Management), where in Annex 3 - Modelling the odour exposure, the tolerance thresholds, based on the 98th percentile of average hourly concentrations of odours modelled for long periods (over one year), are defined, as follows:

- 1.5 OUE/m^3 - threshold for most of the unpleasant odours,
- 3.0 OUE/m3 - threshold for moderately unpleasant odours,
- 6.0 OUE/m^3 - threshold for less unpleasant odours.

All model results, where exposures are above these thresholds, are likely probable to be unacceptable concentrations of odorous substances in the lower atmospheric layer.

Based on the previously stated assertions, criteria for acceptable exposure to odour sensitive areas: schools, hospitals, homes for the elderly, public buildings, food industry, residential buildings, kindergartens or playgrounds, sporting facilities, and other facilities, are set.

Table 47 Odour exposure criteria

Exposure	Zones
1.5 OUE/m^3 - Lower sensitivity threshold (25% of 6.0 OUE/m3)	Areas with hospitals, schools, kindergartens or playgrounds, homes for the elderly, rehabilitation centres and public facilities for the most sensitive population groups - young children, students and adults who attend them regularly or for an extended period of time and have a high sensitivity to changes in odour concentration in the air.
3.0 OUE/m3 - Upper sensitivity threshold	Areas with social facilities and the food industry (restaurants), processing and packaging of food

Exposure	Zones
(50% of 6.0 OUE/m3)	and beverages, residential buildings, rest areas, camping and sporting facilities.
6.0 OUE / m^3 - Ambient norm	All other zones as well as work premises (work environment) in the chemical industry, waste and wastewater treatment, refineries and others.

Within the technical analysis, several potential sources of odour emissions at the WWTP Bitola site were identified, of which 3 are point (targeted) and the other are diffuse or surface sources. The emission parameters of these sources are given in section 6.1.

Table Sources of potential odour emissions

#	Source	Source type
1	Ingress pumping station	Point (ventilation exhaust, odour controlling device)
2	Facilities for sludge thickening and drainage	Point (ventilation exhaust, odour controlling device)
3	Facilities for mechanical treatment	Point (ventilation exhaust, odour controlling device)
4	Aeration tanks (x2)	Diffuse (surface)
5	Secondary sedimentation tanks (x3)	Diffuse (surface)

Taking into account the type of pollutants, and the level of data that are available at this stage of the Project, only models of critical conditions were developed. In addition, "model of critical conditions" means the definition of an average 24-hour concentration at optimal conditions for creation of maximum area of dispersion and concentrations of a specific pollutant (odour), that is to say, a model generated with the following assumptions:

- Atmospheric stability P = 1 = A (approximate laminar airflow)
- Dilution ratio due to sedimentation, chemical or other reactions in the atmosphere Dc = 0
- Maximum recorded wind speed in the direction of the recipients.

These conditions, although slightly realistic, may lead to maximum concentration of pollutants and maximum dispersion thereof in the recipient zone, so it may be assumed that if at said conditions the average daily concentrations do not exceed the prescribed limits, this is unlikely to occur in any other case.

Description of the model development

In order to model the dispersion zones for individual pollutants within the Study, the software for dispersion modelling DISPER - version 5.2 of Canarina Environmental Software was used.

The numeric algorithm in this software used equations that calculate the dispersion of pollutants in the air, based on meteorological and emission data. The software calculates the concentration of pollutants resulting from each of the mentioned sources, where the average time value (daily, monthly or yearly) is obtained in order to calculate the average concentration at each point of the exposed area.

Depending on the nature of sources, the modelling is performed on the following source groups:

- *Point sources* (such as stacks) which are very small compared to the area in which the simulation is carried out, and for which information on the physical height of the stack, the speed and temperature of the flue gas, the internal diameter of the stack, emission factor, dilution and flow rates are entered.
- *Line sources,* where the width of the source is small compared to the area in which the simulation is performed, and the necessary data are: emission factor and dilution ratio.
- *Surface sources*, specific for fugitive missions, for which data on the emission factor and dilution ratio are also necessary.

For all modelling runs, it is necessary to define the topographical and meteorological parameters of the space for which the simulation is carried out.

Meteorological analysis performed by DISPER 5.2 are using assumptions of stable ambient conditions. Necessary parameters for defining the meteorological conditions are as follows:

- *Pasquill stability,* which describes the degree of atmospheric turbulence, ranging from A = 1 for unstable to F = 6 for extremely stable. Unstable conditions lead to rapid dispersion of pollutants in the air which results in lower concentration values compared to stable conditions.
- *Wind speed* at reference atmospheric height.
- *Wind direction* (0-360 °), which is a horizontal angle of the wind measured in clockwise direction starting from the north.
- *Ambient temperature* is the temperature at the location (°K).
- *Mixing height,* which is used to quantify the vertical height of mixing in the atmosphere, and assumes the smallest volume in which the pollutant will be dispersed in the environment. For summer conditions throughout the day, the maximum mixing height may be at several thousand meters, whereas in winter conditions it would be at few hundred meters.

Calculation of the average daily concentrations is carried out by XY or HZ - coordinates which gives a different outlook of the pollutant, and after performing the calculations the following is obtained; iso-linear view, numeric view or colour gradient view.

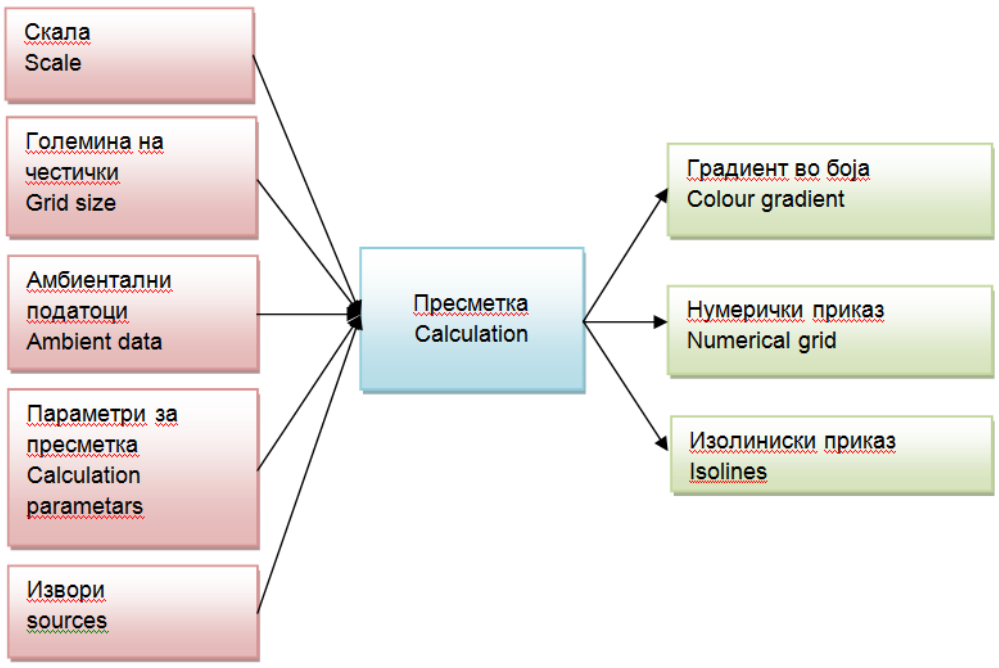


Figure 38 Data required for calculating the dispersion of dust and ways of representation

Mathematical algorithms

The mathematical model used by the software allows generation of emission models from a wide range of sources, present in industrial and urban areas. The model calculates the concentration values for each source and combination of recipients, and calculates the averages selected by the user.

The basis of all model is a linear, reliable and easy Gaussian equation, which is used for modelling of emissions from point sources (stacks), roads, linear groups and surface groups. Emission sources are classified into 3 main sources: point, linear and surface sources. The following text describes the algorithms that are used for modelling of all 3 types of sources.

Emissions from point sources

The model uses the stable-state Gaussian equation for continuous sources. For each source, the origin of the stack coordinate system is placed at the ground surface at the base of the stack. The x axis is positive in the downwind direction, the y axis is crosswind (normal) to the x axis and the z axis extends vertically. The fixed receptor locations are converted to each source's coordinate system. The hourly concentrations calculated for each source at each receptor are summed to obtain the total concentration produced at each receptor by the combined source emissions. For a Gaussian plume, the hourly concentration at downwind distance x (meters) and crosswind distance y (meters) is given by:

$$\mathbf{c = (QxKxVxD/2\ x\ pi\ x\ u_s\ x\ sig_y\ x\ sig_z)\ exp[-0.5(y/sig_y)^2]}$$

where:

Q = pollutant emission rate (mass per unit time)

K = a scaling coefficient to convert calculated concentrations to desired units

K = a scaling coefficient to convert calculated concentrations to desired units (default value of 1×10^6 for Q in g/s and concentration in $\mu g/m^3$)

V = volume

D = dilution/decay ratio

sig_y, sig_z = standard deviations from the lateral and vertical distribution of concentration (m)

U_s= mean wind speed (m/s) at release height

The model uses receptors set at (X,Y) coordinates prior to performing the dispersion calculations, where the X axis is positive to the East of the user-specified origin and the Y axis is positive to the North. The user must define the location of each source with respect to the origin of the grid using Cartesian coordinates. If the X and Y coordinates of the source are X(S) and Y(S), the downwind distance x to the receptor, along the direction of plume travel, is given by:

$$\mathbf{x=-[X(R)-X(S)]sin(WD)-[Y(R)-Y(S)]cos(WD)}$$

where WD is the direction from which the wind is blowing. The downwind distance is used in calculating the distance-dependent plume rise and the dispersion parameters.

The crosswind distance y to the receptor from the plume centerline is given by:

$$\mathbf{y=-[X(R)-X(S)]cos(WD)-[Y(R)-Y(S)]sin(WD)}$$

The wind power law is used to adjust the observed wind speed (U_{ref}), from a reference measurement height (z_{ref}), to the stack or release height, hs. The stack height wind speed (U_s), is used in the Gaussian plume equation:

$$\mathbf{U_s=U_{ref}(h_s/z_{ref})^p}$$

where p is the wind profile exponent. Values of p may be provided by the user as a function of stability category and wind speed class. Default values are as follows:

Stability category	Rural exponent	Urban exponent
A	0.07	0.15
B	0.07	0.15
C	0.10	0.20
D	0.15	0.25
E	0.35	0.30
F	0.55	0.30

The stack height wind speed, u_s, is not allowed to be less than 1.0 m/s.

The plume height is used in the calculation of the Vertical Term. The distance dependent momentum plume rise equations are used to determine if the plume is affected by the wake region for building downwash calculations.

In order to consider stack-tip downwash, modification of the physical stack height is performed h_s, which comprises of:

$$\mathbf{h_s'=h_s+2d_s[(v_s/u_s)-1.5]} \text{ за } \boldsymbol{vs<1.5u_s}$$

or

$$\mathbf{h_s'=h_s} \text{ за } \boldsymbol{v_s> o =1.5u_s}$$

where h_s is physical stack height (m), V_s is stack gas exit velocity (m/s), and d_s is stack top diameter (m).

If stack tip downwash is not considered, hs'= hs in the following equations.

Briggs buoyancy flux:

$$\mathbf{F_b=g\ x\ v_s\ x\ d_s^2(D_t/4t_s)}$$

where $D_t = T_s - T_a$, T_s is stack gas temperature (K), and T_a is ambient air temperature (K).

For determining plume rise, the momentum flux parameter, F_m (m^4/s^2) is calculated based on the following formula:

$$\mathbf{F_m=g\ x\ v_s^2\ x\ d_s^2(T_a/4T_s)}$$

For cases with stack gas temperature greater than or equal to ambient temperature, it must be determined whether the plume rise is dominated by momentum or buoyancy. The crossover temperature difference, $(D_T)c$, is determined as follows:

for Fb < 55,

$$\mathbf{(D_t)c=0.0297\ T_s(v_s/d_s^2)^{1/3}}$$

and for Fb >= 55,

$$\mathbf{(D_t)_c=0.00575\ T_s(v_{s2}/d_s)^{1/3}}$$

If D_T exceeds or is equal to $(D_T)c$, as defined above, plume rise is assumed to be buoyancy dominated, otherwise plume rise is assumed to be momentum dominated.

For situations where D_T exceeds $(D_T)c$ as determined above, buoyancy is assumed to dominate. The distance to final rise, x_f, is assumed to be 3.5x*, where x* is the distance at which atmospheric turbulence begins to dominate. The value of x_f is calculated as follows:

for Fb < 55:

$$\mathbf{x_f = 49\ Fb^{5/8}}$$

and for Fb ≥ 55:

$$\mathbf{x_f = 119\ Fb^{2/5}}$$

For situations where the stack gas temperature is less than or equal to the ambient air temperature, the assumption is made that the plume rise is dominated by momentum. If D_T is less than $(D_T)c$, the assumption is also made that the plume rise is dominated by momentum. The plume height is calculated as:

$$\mathbf{h_e = h_s + 3d_s(v_s/u_s)}$$

Briggs suggests that this equation is most applicable when v_s/u_s is greater than 4.

For stable situations, the stability parameter, s, is calculated as follows:

$$\mathbf{s = g[(dT/dz)/Ta]}$$

As a default approximation, for stability class E (or 5) dT/dz is taken as 0.020 K/m, and for class F (or 6), dT/dz is taken as 0.035 K/m.

For cases with stack gas temperature greater than or equal to ambient temperature, it must be determined whether the plume rise is dominated by momentum or buoyancy. The $(D_T)c$ is determined and solving for D_T, as follows:

$$\mathbf{(D_t)_c = 0.019582\ T_s\ v_s\ s^{1/2}}$$

If the difference between D_T exceeds or equals $(D_T)c$, plume rise is assumed to be buoyancy dominated, otherwise plume rise is assumed to be momentum dominated.

For situations where D_T exceeds $(D_T)c$ as determined above, buoyancy is assumed to dominate. The distance x_f is determined by:

$$\mathbf{x_f = 2.0715\ u_s\ s^{-1/2}}$$

Height h_e, is defined as:

$$\mathbf{h_e = h_s + 2.6\ [F_b/(u_s s)]^{1/3}}$$

Where the stack gas temperature is less than or equal to the ambient air temperature, the assumption is made that the plume rise is dominated by momentum. Then:

$$\mathbf{h_e = h_s + 1.5[F_m/(u_s s^{1/2})]^{1/3}}$$

The equation for unstable-neutral momentum rise is also evaluated. The lower result of these two equations is used as the resulting plume height

Where gradual rise is to be estimated for unstable, neutral, or stable conditions, if the distance downwind from source to receptor, x, is less than the distance to final rise:

$$\mathbf{h_e = h_s + 1.60\ [(F_b\ x^2)^{1/3}/u_s]}$$

This height will be used only for buoyancy dominated conditions; should it exceed the final rise for the appropriate condition. For momentum dominated conditions, the following equations are used to calculate a distance dependent momentum plume rise:

a) unstable conditions:

$$h_e=h_s+[3F_m x/(bet_j^2 u_s^2)]^{1/3}$$

where x is the downwind distance, with a maximum value x_{max}:

$$x_{max}=4d_s(v_s+3u_s)/(v_s u_s) \text{ for } F_b=0$$

$$x_{max}=49\ F_b^{5/8} \text{ for } 0 < F_b < 55\ m^2s^3$$

$$x_{max}=119\ F_b^{2/5} \text{ for } F_b > 55\ m^2s^3$$

b) stable conditions:

$$h_e=h_s+(3F_m)^{1/3}\{\sin[x\ s^{1/2}/u_s]\}^{1/3}[bet_j^2 u_s s^{1/2}]^{-1/3}$$

where x is the downwind distance, with a maximum value x_{max}:

$$x_{max}=0.5\ pi\ u_s/s^{1/2}$$

The jet entrainment coefficient, bet_j, is given by:

$$bet_j=(1/3)+(u_s/v_s)$$

If the distance-dependent momentum rise exceeds the final rise for the appropriate condition, then the final rise is substituted instead.

Equations that approximately fit the Pasquill-Gifford curves are used to calculate sig_y and sig_z (in meters) for the rural mode. The equations used to calculate sig_y are of the form:

$$sig_y = 465.11628\ x \tan (TH)$$

where:

$$TH = 0.017453293\ [c - d \ln(x)]$$

In both Equations the downwind distance x is in kilometers.

The equation used to calculate sig_z is of the form:

$$sig_z=ax^b$$

where the downwind distance x is in kilometers and sig_z is in meters.

Procedures used to account for buoyancy-induced dispersion. With this method, the effective vertical dispersion s_{ze} is calculated as follows:

$$sig_{ze}=[sig_z^2+(Dh/3.5)]^{1/2}$$

where sig_z is the vertical dispersion due to ambient turbulence and D_h is the plume rise due to momentum or buoyancy. The lateral plume spread is:

$$sig_{ye}=[sig_y^2+(Dh/3.5)]^{1/2}$$

where sig_y is the lateral dispersion due to ambient turbulence. It should be noted that D_h is the distance-dependent plume rise if the receptor is located between the source and the distance to final rise, and final plume rise if the receptor is located beyond the distance to final rise.

The Vertical Term (V) accounts for the vertical distribution of the Gaussian plume. It includes the effects of source elevation, receptor elevation and plume rise. In addition to the plume height, receptor height and mixing height, the computation of the Vertical Term requires the vertical dispersion parameter (sig_z). The Vertical Term without deposition effects is then given by:

$$V= \exp\{-0.5\ [(z_r-h_e)/ sig_z]^2\}+\exp\{-0.5\ [(z_r+h_e)/ sig_z]^2\}+$$

$$+\{\exp[-0.5\ (H_1/sig_z)^2]+\exp[-0.5\ (H_2/sig_z)^2]\}_{i=1,2,...}+$$

$$+\{\exp[-0.5\ (H_3/sig_z)^2]+\exp[-0.5\ (H_4/sig_z)^2]\}_{i=1,2,...}$$

where:

$h_e = h_s + D_h$

$H_1 = z_r - (2iz_i - h_e)$

$H_2 = z_r + (2iz_i - h_e)$

$H_3 = z_r - (2iz_i + h_e)$

$H_4 = z_r + (2iz_i + h_e)$

z_r = receptor height above ground (flagpole) (m)

z_i = mixing height (m)

The infinite series term accounts for the effects of the restriction on vertical plume growth at the top of the mixing layer. This equation assumes that the mixing height in rural and urban areas is known for all stability categories.

The model make the following assumption about plume behavior in elevated simple terrain (terrain that exceeds the stack base elevation but is below the release height):

• The plume axis remains at the plume stabilization height as it passes over elevated or depressed terrain.

• The mixing height is terrain following.

• The wind speed is a function of height above sea level.

Thus, a modified plume stabilization height h_e - is substituted for the effective stack height h_e. For example, the effective plume stabilization height at the point x, y is given by:

$$\mathbf{h'_e = h_e + z_s - z_{(x,y)}}$$

where:

z_s= elevation above the stack (m)

z(x,y)= elevation of the site (x,y) (m)

The DISPER model includes algorithms for modelling linear and surface sources, where the point sources are used to simulate the effects of emissions from very large sources (linear and surface sources...). The pattern of the surface sources is used to simulate the effects of fugitive emissions. In this modelling algorithm, the surface and linear sources (non-point sources) are shown as small point sources with many intervals. The program simulates the point sources, resolving each of them at certain intervals and by calculating the total concentration. The large number of point sources simulates the geometry of these non-point sources.

Input parameters

As already mentioned, the models are based on the properties of the emission sources, as well as the meteorological or topographical data. A detailed description of the input parameters used to generate the models, data sources and calculation methods is given below.

Meteorological parameters

Data on the meteorological parameters (temperature, humidity, wind speed and wind direction) for the last 5 years, for the area where WWTP Bitola will be located, has been collected from public databases using a specialized browsers and report generators, including:

- Wolfram | Alpha platform for dynamically generating aggregated data based on publicly available sources,
- Windrose IEM – wind rose generator.

* Data refer to the meteorological station Bitola, for the last 5 years (April 2010-April 2015).

The absolute minimum in the last 5 years is - 22^{oC} (on 12.02.2012), and the absolute maximum 41^{o}C (on 05.08.2012). The average 24-hour temperatures range between 3°C and 23°C. The average relative annual humidity in the last five years was 66%, and varied in the range between 40% and over 90% (Source: Wolphram Alpha, 23.04.2016)

Specific for the area of Bitola valley are Northwest and South winds, and to a lesser extent the North wind. According to the data generated by the IEM for the measuring station Bitola, the following chart shows a cumulative wind rose for the period 2011-2015.

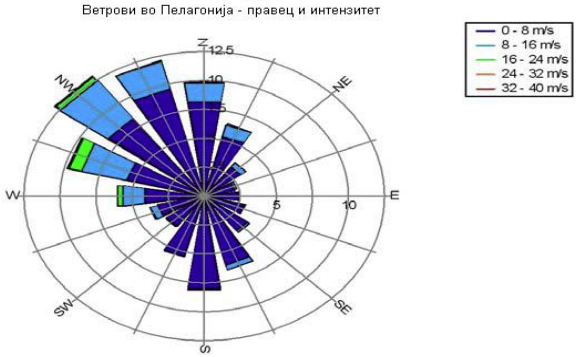


Figure 39 Wind rose for Bitola for the period 2011-2015, according to the data measured at measuring station Bitola Source: IEM, 18.04.2016

According to the data analysed, 45.1% of the analysed period was peaceful weather without wind. Dominant airflow directions are Northwest, South and North, with the maximum wind speeds of up to 24 m/s Northwest and up to 16 m/s North and South. Additionally, much less wind speed occur in the Southeast and West directions. Although the average wind speed is 2.3 m/s, the development of critical conditions model adopted maximum speed of 24 m/s and in the Southeast direction, as well as in the South direction, as the dominant airflow direction.

Emission sources and emission factors

As mentioned above, due to the low amount of data at this stage of design, emission factors are defined based on the assumed sizes of the facilities, and using the generic emission factors (UK Water Industry Research -www.ukwir.org). Summary overview of the adopted dimensions, generic factors and calculated aggregate annual emissions are given in table below:

Table 48 Summary overview of the odour emission parameters for WWTP Bitola

Description	Dimensions	Height [m]	Emission factor [OUE/m^2/s]	Total emission [OUE/s]
Ingress pumping station	D = 0.3 m	2	50.0	Control of 90%, negligible
Facilities for sludge thickening and drainage	D = 0.3 m	2	5.0	Control of 90%, negligible
Facilities for mechanical treatment	D = 0.3	2	5.0	Control of 90%, negligible
Aeration tanks (x2)	30 m^2 x 2	60	250	15.000
Secondary sedimentation tanks	40 m^2 x 3	120	250	30.000

Description	Dimensions	Height [m]	Emission factor [OUE/m²/s]	Total emission [OUE/s]
(x3)				

Results of the modelling

Based on the parameters defined above, the models of dispersion of odour substances were developed. In addition, concerning the controlled point sources that should be embedded with control devices, the values of the calculated emission factors are negligibly low and cannot be included in the model. Only surface fugitive sources were modelled in two critical cases, wind directions Southeast and South.

Figure 40 Odour dispersion model – 24-hour average concentrations (wind direction southeast)

Figure 41 Odour dispersion model – 24-hour average concentrations (wind direction South)

In addition, the results of the model for assessing the maximum single field of odour dispersion, on the ground layer of the atmosphere in a critical case, are summarised below.

Table 49 Modelling results for SO_2, NO_x and HCl.

Critical case	Maximum average 24-hour odour OUE/m³		
	In the area of the facility	At the recipient	Weather conditions
Southeast (> 24m/s)	< 10.504 OUE/m³		Speed: 24 m/s Direction: 130 Stability: A
Southeast (> 16m/s)	< 10.504 OUE/m3		Speed: 16 m/s Direction: 180 Stability: A

The images above show the maximum single fields of odour dispersion, where the isolines are curves of defined concentration in OUE/m³. The minimum and maximum odour concentrations defined in the model are presented in blue and red colour respectively. Isolines clearly show that in both cases, the maximum odour levels are above the ambient norm of 6 OUE/m³, only within the area of the facility, but far from the residential or other buildings. Single concentration in a critical case with wind direction Southeast are below 2.61 OUE/m³, which is under the threshold for moderately unpleasant odours, and below the ambient norm. During a critical case with wind direction South, these concentrations are below 1.24 OUE/m³, which is under the threshold for all unpleasant odours, and far below the ambient norm.

Conclusion

Pursuant to this analysis, it may be clearly asserted that the odour emissions are insignificantly small, and have only momentary and local significance, and higher concentrations (order of magnitude of the ambient norms) outside the facility area should not be expected in any case.

Therefore, it may be concluded that even in a short-period (maximum single), WWTP Bitola will not cause undesired impacts of the surrounding inhabited zones and the surroundings in general. The working surrounding are the only one concerned, which requires implementing measures for reducing and controlling the impacts and protecting the health of the employees.

Impacts are acceptable at a local level, but not without measures to protect the working surroundings.

Appendix 5 Reply from MOEPP on the sites of nature conservation importance

[Coat of Arms of Republic of Macedonia]

REPUBLIC OF MACEDONIA

MINISTRY OF ENVIRONMENT AND PHYSICAL PLANNING

Skopje

Archive number: 11-530/1

Date: 30.01.2017

To: NIRAS Conzortium

Blvd.Ilinden 64-1/3

Skopje

Subject: Notification

Dear Sir,

In regards to your letter archived as 11-7021/1 from 06.12.2016 related to a request for information about Natura 2000, for the needs of development of project and tender documentation for collection and treatment of waste waters in the municipalities of Strumica, Bitola and Tetovo, the Department of Nature within the Environment Administration a constituent body in the Ministry of environment and physical planning, is hereby informing you that the Republic of Macedonia has not established the ecological network Natura 2000.

Ministry of Environment and Physical Planning

Minister

Bashkim Ameti

[signature-illegible] [stamp]

Prepared by: Roska N.Vukojevik [signature-illegible]

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Concent by: Vlatko Trpevski [signature-illegible]

Approved by: Daniel Eftimov, temporary director of Environment Administration [signature-illegible]a