MINISTRY OF ENVIRONMENT AND WATER
THE REPUBLIC OF BULGARIA

THE STUDY
ON
INTEGRATED WATER MANAGEMENT
IN
THE REPUBLIC OF BULGARIA

FINAL REPORT
VOLUME 1: SUMMARY

MARCH 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI Engineering International Co., Ltd.

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PREFACE

In response to a request from the Government of Bulgaria, the Government of Japan decided to conduct a study on Integrated Water Management and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr.Keiji SASABE of CTI Engineering International Co., LTD. between May 2006, and March, 2008.

The team held discussions with the officials concerned of the Government of Bulgaria and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Bulgaria for their close cooperation extended to the study.

March 2008

Ariyuki Matsumoto,
Vice President
Japan International Cooperation Agency

March 2008

Mr. Ariyuki Matsumoto
Vice President
Japan International Cooperation Agency
Tokyo, Japan

Sir:

LETTER OF TRANSMITTAL

We are pleased to submit herewith the Final Report on *the Study on Integrated Water Management in the Republic of Bulgaria.*

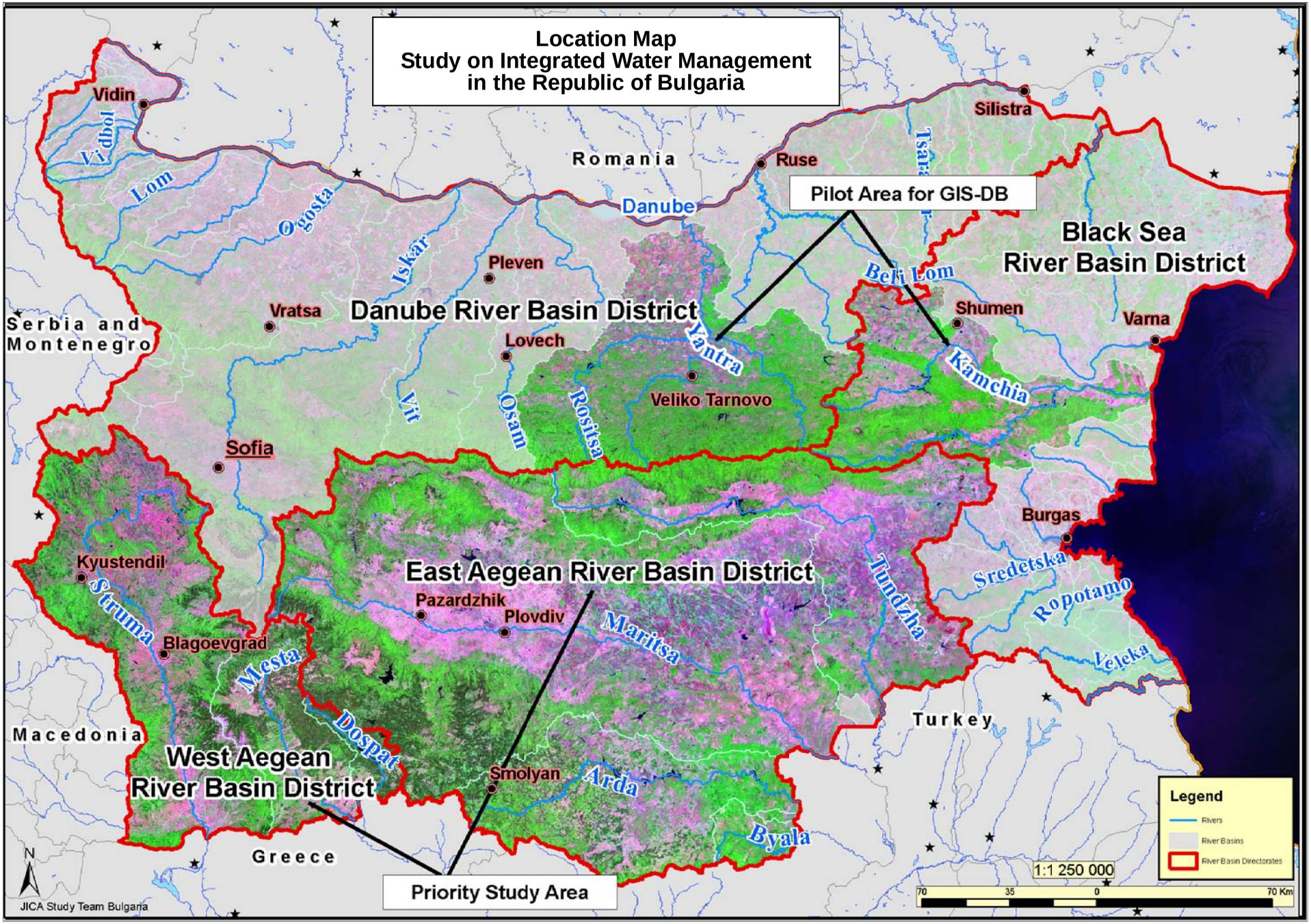
The study was conducted by CTI Engineering International Co., Ltd. under contracts with Japan International Cooperation Agency (JICA) during the period from May 2006 to March 2008. In conducting the study, we have paid much attention to assist the Ministry of Environment and Water (MoEW) to prepare the River Basin Management Plans for the selected areas and to develop the tools for the river basin management such as GIS database and analysis model.

We wish to take this opportunity to express our sincere gratitude to the Government of Japan, particularly, JICA, the Ministry of Foreign Affairs, and other offices concerned. We also wish to express our deep appreciation to MoEW and other authorities concerned of the Government of the Republic of Bulgaria for their close cooperation and assistance extended to the JICA study team during the study.

Finally, we hope that this report will contribute to the further improvement of water management in the Republic of Bulgaria.

Very truly yours,

Keiji Sasabe
Leader, JICA Study Team
CTI Engineering International Co., Ltd.


Location Map
Study on Integrated Water Management
in the Republic of Bulgaria
Vidin
Vidbol
Lom
Ogosta
Iskar
Pleven
Romania
Ruse
Silistra
Danube
Pilot Area for GIS-DB
Black Sea
River Basin District
Beli Lom
Shumen
Varna
Kamchia
Yantra
Lovech
Vratsa
Danube River Basin District
Serbia and
Montenegro
Veliko Tarnovo
Vit
Osam
Rositsa
Sofia
Burgas
Kyustendil
Struma
East Aegean River Basin District
Pazardzhik
Plovdiv
Tundzha
Sredetska
Ropotamo
Maritsa
Blagoevgrad
Mesta
Vejeka
Turkey
Macedonia
Dospat
West Aegean
River Basin District
Smolyan
Arda
Byala
Greece
Priority Study Area
Legend
Rivers
River Basins
River Basin Directorates
1:1 250 000
70
35
0
70 Km
N
JICA Study Team Bulgaria

COMPOSITION OF THE REPORT

Volume 1: Summary

Volume 2: Main Report

Volume 3: Guideline (Digital Version Only)

Volume 4: Supporting Report (Digital Version Only)

Sector	**A**	**GIS Database**
Sector	**B**	**Water Quantity**
Sector	**C**	**Water Quality**
Sector	**D**	**Groundwater**
Sector	**E**	**Integrated River Basin Analysis Model**
Sector	**F**	**Socioeconomy and Domestic Water Usage**
Sector	**G**	**Laws, Institution and Organization**
Sector	**H**	**Public Consultation**
Sector	**I**	**Economic and Financial Evaluation**
Sector	**J**	**Environmental and Social Considerations**

Executive Summary

1. Introduction

1.1 Objective of the Study

This is an Executive Summary of the Final Report of "The Study on Integrated Water Management in the Republic of Bulgaria" that has been conducted by the Government of Japan, through the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programmes of the Government of Japan, in response to the request of the Government of Bulgaria. The Study has been carried out in accordance with the Scope of Work (S/W) signed between the Ministry of Environment and Water (MoEW) and JICA on October 14, 2005.

The Study aimed to conduct the following objectives:

- To assist the MoEW in the implementation of the requirements of the EU Water Framework Directive (hereinafter referred to as " WFD") which includes:
    - Preparation of the River Basin Management Plans for EABD and WABD as selected areas,
    - Development of GIS, Monitoring Programmes and Water Balance for the whole country,
- To transfer technology and conduct training on Integrated Water Management to the counterpart personnel in the course of the Study.

Based on the new Water Act of 2000 the government of Bulgaria has divided the whole country into four river basin management districts, and set up the following four river basin directorates:

- Danube River Basin Directorate (DRBD)
- Black Sea River Basin Directorate (BSRD)
- East Aegean Sea River Basin Directorate (EABD)
- West Aegean Sea River Basin Directorate (WABD)

The Study has formulated the River Basin Management Plan (RBMP) (not exactly following EU-WFD format but considering Water Act of Bulgaria) for EABD and WABD as the selected areas, and prepared the GIS Data Model of the Yantra River and the Kamchia River as the pilot river, respectively for DRBD and BSBD.

Bulgaria has joined EU in January 2007. the EU member countries are requested to conduct necessary actions in order to achieve the requirement that target realization of preferable status of all the water bodies[1] in the area by the year 2015. The EU-WFD sets milestones for the key actions to the member states as follows:

- Formulation of RBMP by 2008
- Explanation of the plan to the citizens by 2009

[1] There is no definition of "preferable status of all the water bodies" in terms of numeric criteria, though it is explained that preferable condition in biology and water quality also considering water quantity in all the water bodies.

- Submission of the plan to EU by 2010
- Realization of the improvement of water environment in river basins by 2015

1.2 Basic Approach

The River Basin Management Plan (RBMP) has been formulated applying the Integrated Water Management approach in accordance with the EU-WFD and the Water Act of Bulgaria. The established RBMP consists of the management plans for water quantity and water quality, and also includes studies on river morphology management, monitoring and the implementation plans. The Study also has developed the GIS database and the Integrated Basin Analysis Models, as decision support tools for formulation of the RBMP and its implementation.

Capacity development of the staff of MoEW and counterpart personnel of EABD/WABD has been conducted mainly through on the job training, and supplemented by a series of technical meetings (three times), technology transfer seminars (three times) and three Public Consultation Meetings for each BD.

1.3 Study Schedule

The duration of the Study is 23 months from May 2006 to March 2008. The Study has been conducted as follows:

Phase I (From May to December 2006)

After the explanation and discussion on the Inception Report (May 2006), the field study was commenced and the Basic Study on the current conditions was conducted including supplementary surveys of water quality and river cross sections, and the results were compiled in the Interim Report (January 2007).

Phase II (From January 2007 to March 2008)

After explanation and discussion on the Interim Report (January 2007) the plan formulation study for EABD and WABD has been commenced on the River Basin Management Plans for both EABD and WABD. Based on the discussions on the Interim Report, a GIS Working Group was organized in order to develop a uniform GIS Data Model for the MoEW system and a TOR for the MoEW information system has been prepared. Support activities for DRBD and BSBD have been added to prepare the GIS Data Model respectively for the Yantra River and the Kamchia River as a pilot for the RBMP and thus the Study period was extended for three months. The results have been compiled in the Draft Final Report (January 2008). The Final Report has been compiled in March 2008 after incorporating the results of discussion and comments from the Government of Bulgaria on the Draft Final Report.

1.4 Counterpart Agency

The counterpart agencies for the Study are MoEW, EABD and WABD. The counterpart personnel have been selected from MoEW, EABD and WABD, and the members of GIS Working Group have been selected from MoEW, ExEA and the four RBDs. MoEW has organized a steering committee for the Study, which is consisting of representatives of the related agencies including MoEW, MoEE, MoRDPW and MoAF.

2. Programmes of Measures for River Basin Management Plan

In the Study, the programmes of measures have been studied and elaborated for the RBMP of EABD and WABD. The proposed programmes of measures are summarized as follows:

2.1 Basic Scenario for Programmes of Measures

2.1.1 Summarization of Issues

The EU-WFD aims to attain the target defined as "good water status for the surface waters and groundwater by 2015". According to the results of the Study, a large gap exists between the current water status and the good water status defined by the EU-WFD.

The physico-chemical conditions of the rivers are in general Class III (Moderate) to Class V (Bad), but more than 50% are in Class IV (Poor) to Class V (Bad), and the hydro-biologicaal conditions are poor to bad conditions. The conditions show the results of the wastewater discharge with insufficient treatment as well as inflow of nutrients (nitrogen and phosphorous) into the rivers. Also the discharges of heavy metals (As, Pb, Zn, Cd) have been identified. There are many problems to be solved for improvement of water quality.

The major water users in the basin districts are hydropower, agriculture, domestic and industrial sectors, and the major pollution sources are wastewaters from urban settlements, industries, animal breeding farms and agricultural lands. They all have problems to be improved.

During the old order, the country had developed hydropower systems and large irrigation systems (irrigation area: over 1,200,000 ha in total) including large inter-basin transfer of water with little consideration of the environmental aspects like river water quality and quantity, environmental flows, and also developed water supply facilities (service population: over 98%). However the irrigation systems and water supply networks are deteriorated because of poor maintenances and superannuation. Current irrigation potential areas have been decreased to about 500,000 ha (with actual irrigation area at about 50,000 ha) with water loss over 60-70%, and the water supply systems have a large loss over 60%. Urgent improvement works will be required from effective water management aspect.

A lot of urban settlements and industries discharge their sewerage and wastewaters to rivers without proper treatment. There are 73 existing WWTPs, but the existing WWTPs and sewer networks have become old and superannuated, and sewer pipes are leaking sewage and polluting groundwater. Urgent measures are required.

Also inadequate river management has been causing many problems like improper issues of permissions for water intakes and discharges, excessive extraction of sand and gravels from riverbeds and flood plains, illegal dumping of solid wastes into rivers, and erosion of riverbanks and flood dikes and aggravating risks of flood damages. Establishment of river management will be required.

2.1.2 Target Year for the Completion of the Programmes of Measures

According to the time schedule set by the EU-WFD, the RBMP including improvement plans should be formulated by the end of 2008 and commenced in 2010. Bulgaria is

paying effort to follow the schedule, however, it may not be an easy task to formulate the RBMP of the national level. For the implementation of measures starting from 2010, implementation of effective procedures is deemed difficult considering experiences in RBDs. Implementation of the proposed River Basin Management Plan by the target year 2015 is thus deemed difficult, and hence, the target year should be set at 2021 or 2027, years for every six years review defined by the EU-WFD.

2.1.3 Basic Scenario of the Programmes of Measures

In order to attain the good water status and conduct the sustainable use of water resources, the programmes of measures require various measures composed of structural and nonstructural measures. The river basin management plan is to be formulated based on the integrated water management approach, including required measures for management of water quality, water quantity, river morphology and disaster prevention. The basic scenario for the programs of measures to formulate the RBMP is proposed as follows:

- To improve water quality for attaining the good physico-chemical status was given priority for surface water and groundwater;
- To improve water quality by phased expansion of the municipal wastewater treatment capacities by new construction of wastewater treatment plants (WWTPs) and also by phased rehabilitation of the existing WWTPs by reducing organic pollutants and nutrients inflow to water bodies;
- To rehabilitate the existing sewer networks to reduce the sewage loss to increase the efficiency of wastewater treatment and also reduce the seepage of sewerage into the ground to avoid possible groundwater pollution;
- To improve the management and regulation in order to conduct more strong control of reducing the discharge of untreated or improperly treated wastewaters from industries, mines and animal breeding farms;
- To rehabilitate water supply networks to reduce the high rate of water supply loss over 60%;
- To improve facilities required for efficient water use of water use sectors like domestic water supply networks and irrigation facilities;
- To improve the permission of water intakes and the distribution of water resources based on the water balance of each river basin;
- To improve the management and regulation in order to conduct more systematic management for rivers morphology, river channels, river flows, sediment and also floods disaster, flood hazard areas;
- To prepare programs of measures composed of the following components:
    - Water quality improvement and management;
    - Water quantity improvement and management;
    - Management of river morphology.

2.2 Water Quality Improvement and Management Plan

2.2.1 Structural Measures

Direction of Formulation of Structural Measures

In order to improve the current situation of water quality, the direction of formulation of structural measures has been determined as follows:

- From the view point of water quality improvement in the entire river basin, the water quality of the main river course has been selected as in indicator, and set up priority zones based on the BOD loads;
- To select high priority towns for wastewater treatment by considering the effects of BOD load reduction in the catchment area as well as referring to the priority zones;
- To construct new wastewater treatment plants (WWTPs) and rehabilitate existing WWTPs from major towns, then treatment of wastewater from medium to small size towns and settlements;
- Treatment for nitrogen and phosphorous; and,
- Improvement of sewer networks.

Proposed Measures

The proposed measures are formulated under the following conditions:

- As infrastructure improvement, new WWTPs and rehabilitation of the existing WWTP are proposed for the high priority towns.
- To attain good water quality (Class II, BOD 3.0 mg/l), required reduction of BOD load is about 50% for the Maritsa, Tundzha, Struma and Mesta rivers are to be reduced. Considering the realistic plan for the completion of the implementation by 2015 or 2021, however, target reduction of BOD load by the WWTPs for the priority towns is set at 30%.
- The proposed high priority towns for treatment are selected from reduction % of BOD load against the near future BOD load case (existing, presently under construction WWTPs, and WWTPs to be implemented in the coming 2-3 years (already funded by EU, etc. or committed)) and high priority zones.
- The proposed WWTPs (new and rehabilitation) will have treatment facilities for BOD, TN and TP.
- High Priority Towns for wastewater treatments are as follows:

(1) EABD Areas: 22 towns

Construction of New WWTPs (18 towns) and rehabilitation of sewer networks:

- Maritsa River: 13 towns
- Tundzha River: 4 towns
- Arda River: 1 town

Rehabilitation of existing WWTPs (4 towns) and rehabilitation of sewer networks:

- Maritsa River: 3 towns
- Tundzha Rivers: 1 towns

(2) WABD Areas: 9 towns

Construction new WWTPs (6 towns) and rehabilitation of sewer networks:

- Struma River: 3 towns
- Mesta River: 2 towns
- Dospat River: 1 town

Rehabilitation of existing WWTPs (3 towns) and rehabilitation of sewer networks:

- Struma River: 3 towns

Cost for Proposed Measures

Project costs are estimated and shown in the following table:

Estimated Rough Construction Cost for the New and Rehabilitation of WWTPs and Improvement of Sewer Networks in EABD and WABD Areas

Basin District	WWTP		Sewer Networks		Total Cost (in 1,000 euros)
	PE in 2015	Cost (in 1,000 euros)	Rehabilitation (m)	Cost (in 1,000 euros)	
EABD	1,352,249	206,050	3,130,054	1,628,082	1,834,133
WABD	336,711	72,074	1,216,948	536,553	608,627
Total	1,688,960	278,124	4,347,002	2,164,635	2,442,760

2.2.2 Non-structural Measures

The non-structure measures for water quality improvement and management has been proposed as follows:

- Apart from the surface water monitoring system as discussed in the next sub-section, to strengthen collaboration between the RBDs and local governments for daily water quality management work in order to monitor what is happening in the river basins and prepare for quick action, e.g. for accidental pollution, to be required;
- Reduction of pollution loads from industries and large livestock farms by strengthening of regulation;
- Improvement of septic tanks to sealed type or to introduce individual treatment. Periodically sludge should be extracted and treated. Financial support system to people shall be necessary for the improvement;
- Reduction of pollution load from the agricultural lands by changing farming methods and technology to reduce chemical fertilizer and pesticide
- To conduct a study on pressures and impacts from discharges or priority substances, 33 harmful substances defined by the EU-WFD, and heavy metals, and also closed mines in the basin necessary to protect people from possible hazard caused by discharge of toxic substances.

2.2.3 Improvement of Surface Water Monitoring System

Based on the risk assessment of surface water bodies and groundwater bodies, MoEW and the Basin Directorates formulated a New Monitoring Programs in March 2007, which is composed of new programs for surface water monitoring and groundwater monitoring.

The proposed points are those rearranged on the basis of the present ExEA stations, and which is slightly more than the number of the points of the existing surface water monitoring of ExEA, thus there is no much change in the number of monitoring stations. However, the parameters to be monitored are very much increased and their frequency for monitoring is also rather high. Furthermore, Bulgaria has no much experience for measuring many of the priority substances.

Considering this situation, it is recommendable to set key monitoring stations as well as important monitoring stations among the surveillance monitoring points to ensure stable monitoring and to overview the water quality conditions of the river basins. Furthermore, at these key stations, it is necessary to measure the water quantity as well. In order to conduct this kind of permanent monitoring at the key monitoring stations, the Basin Directorates are necessary to establish their own monitoring stations both for water quality and water quantity.

2.3 Water Quantity Improvement and Management Plan

2.3.1 Structural Measures

Direction of Formulation of Structural Measures

The direction for the formulation of structural measures is set as follows:

- Improvement of water supply pipes to reduce water loss at presently over 60% mainly asbestos cement and steel pipes,
- The existing irrigation systems are deteriorated with high water loss over 60-70%. Although actual water consumption is small, water abstraction is thought much larger due to large water loss and no or improper intake and distribution facilities (gate and canal). It is necessary to renovate the irrigation system considering the current and future demand of irrigation water. Irrigation improvement will be one of the key issues for efficient and sustainable water use and also for the sustainable development of agriculture and region based on the efficient water use.
- Improvement of irrigation facilities to provide irrigation area with optimum water volume and to make efficient water use including reduction of water loss has thus been proposed.

Proposed Measures

(1) Water Supply Improvement for Reducing High Water Loss over 60%

Necessary replacement of water supply pipes of the existing water supply systems is as follows (rough estimates based on the interview at WSSs):

Improvement of Water Supply System and Cost

Basin Directorate	Length of replacement (1,000m)	Cost (in million euros)
EABD	Max. about 16,564	3,139
WABD	Max. about 4,886	919
Total	Max. about 21,450	4,058

Order of the necessary cost for rehabilitation is about 4.0 billion euros. .

(2) Improvement of Irrigation System in EABD and WABD

In EABD there are 8 irrigation branches and 82 irrigation systems, and in WABD there are 4 branches and 41 irrigation systems. The proposed improvement of potential irrigation areas is as follows (see **Figures 11** and **12**), and rehabilitation mainly of intake and diversion structures, and canals will be conducted:

Proposed Irrigation Area for Improvement and Its Cost

Basin Directorate	Irrigation Area (ha)	Number of Irrigation Systems	Cost (in million euros)
EABD	316,468	82	231
WABD	50,738	41	42
Total	367,206	123	273

The following is priority areas for the improvement of irrigation system.

Priority Group of Irrigation System Rehabilitation

BD	Irrigation Area (ha)	Irrigation Branch	Cost (in million euros)
EABD	94,948	- Provdiv - Pazardjik	84
WABD	17,730	- Pernik - Sandanski - Gotse Delchev	20
Total	112,678		104

2.3.2 Non-structural Measures

Non-structural measures of water quantity management and improvement are as follows:

- Review and improvement of water use permission for optimum water intake and use, and also water transfer to the other river basins;
- Monitoring of water intake volume by installing measurement devices by water users for intake sides as well as Basin Directorate at key locations in the rivers; and,
- Improvement of quality of data required for water quantity management, including collaboration with National Institute for Meteorology and Hydrology (NIMH) as well as other relevant institutes.

2.4 Groundwater Management Plan

Preliminary programme of measures for groundwater management is proposed in the sense of directions for improvement and management of the groundwater. Furthermore, some recommendations are presented for the New Monitoring Plan for groundwater, which was formulated by MoEW and the RBDs in March 2007.

Preliminary Programme of Measures for EABD

- Main ore mineralization is concentrated in EABD. There are old tailings that present threat to ecological safety. Database and GIS-map of old pollutions, especially tailings, is necessary. Abandoned mine sites inventory and cleanup program for remediation are especially important for EABD. An appropriate cleanup program will improve water quality and enhance public safety.
- The problem with arsenic in drinking waters in Poibrene village is not yet solved. It is situated downstream from mining area; pollution from old tailing may occur from there. It is a hot spot problem. Urgent measures are required to solve this problem.
- Application of good agricultural practices is necessary to reduce nitrate content in the region of Stara Zagora.
- A plan for regional model of the groundwater flow in the region of Yambol-Elhovo area is needed.

Preliminary Programme of Measures for WABD

- Special attention should be paid to quantitative monitoring of Blagoevgrad GWB – '*At risk*'. Groundwater research and modeling should be planned to re-assess groundwater resources of this groundwater body.
- Assessment of specific natural groundwater quality in mountain regions impacted by ore mineralization – for reference should be conducted.
- It is necessary to carefully control groundwater abstractions in the region of the winter resort Bansko.

According to the proposed groundwater monitoring programs, the monitoring at a total of 480 locations in the whole country for 4-12 times a year under the coordination among Basin Directorates, NIMH and WSSs. The problems are: Possible cooperation with NIMH and WSSs has no legal basis – no agreements signed between MoEW and NIMH/WSSs; Laboratories have low human resource to respond to increasing tasks due to insufficient staff. Several vacancies are in Laboratories in Blagoevrad and Sofia

2.5 River Morphology Plan

The proposed river morphology plan is as follows:

- To regulate sand/gravel extraction more strictly, so that not to make unstable condition of the river channel and surrounding flood plain areas;
- To control any illegal activities or improper activities along the river, including solid waste dumping and land development;
- To conduct a study of " River Maintenance Plan" for the basis of prevention of flood damages and control sand and gravel extraction as well as improvement of environmental status of water bodies from the view point of river morphology; and,
- To conduct a water resources development study (river flow regulation study) considering detailed river regime, water transfer, water use, environmental flow, etc. and will assess the need of additional hydro-technical facilities to be constructed as well as the restarting of construction of the suspended ones as a part of the integrated water management in Bulgaria and to meet the challenge of global climate change.

2.6 Scale of Annual Disbursement for Structural Measures

Scales of annual disbursement for structural measures in EABD and WABD based on the rough implementation plan in the established River Basin Management Plan (Draft) are as shown in the table below. The improvement of water quality areas from the present Class III to V condition to the middle of Class II and III will be realized with the total investment scale of 2,443 million euros to the sewerage sector. With regard to the improvement of water supply network, annual investment scale at 239 million euros will be necessary if the target year for completion is set at 2027. Improvement of irrigation facilities will require annual investment scale at 27 million euros for the target year at 2020.

Item	Investment Plan (in million euros)	Annual Scale of Investment (in million euros)
Sewerage	2011－2014: 4 yeas 2,051 2015－2018: 4 years 392	513 98
Water supply	2011－2027: 17 years 4,057	239
Irrigation	2011－2020: 10 years 273	27

2.7 Economic Analysis on Structural Measures

The results of the economic analysis showed certain economic feasibility as shown below:

(1) Water Quality Improvement Measures

Area	NPV (Million Levs)	EIRR	B/C
EABD	108	10.8%	1.06
WABD	208	14.0%	1.35
Both Areas	316	11.7%	1.14

Note: Discount rate：10%, Target year：2021

(2) Improvement of Water Supply Networks

Area	NPV (Million Levs)	EIRR	B/C
EABD	1,454	17.8%	1.63
WABD	275	15.0%	1.41
Both Areas	1,729	17.1%	1.58

Note: Discount rate：10%, Target year：2021

(3) Improvement of Irrigation Facilities

Area	NPV (Million Levs)	EIRR	B/C
EABD	65	14.5%	1.29
WABD	14	15.2%	1.34
Both Areas	79	14.6%	1.30

Note: Discount rate：10%, Target year：2021

3. Project Evaluation

3.1 Technical Aspect

The proposed structural measures for water quality and quantity improvement include new construction and rehabilitation of wastewater treatment plants, rehabilitation of sewerage networks, rehabilitation of irrigation networks, rehabilitation of domestic water supply facilities. It has thus been judged there are no specific technical difficulties and all the work could be covered by the technology available in Bulgaria. Support from the EU member countries would be available if there is no enough technical know-how in Bulgaria.

GIS Database and Integrated River Basin Analysis Model developed as the decision support tools for the formulation and implementation of the river basin management plan are based on the state of the art technology. Simulation of water quantity and quality could thus be conducted with a high technical level, and river basin management with the sound technical background could be realized with these tools. The river basin management in Bulgaria is now supported by the high level technology and it is evaluated good results of the Study.

3.2 Economic Aspects

The proposed structural measures for water quality improvement and water quantity improvement have sufficient economic feasibility. This means that the deterioration of water quality and loss of water quantity were giving a huge adverse impact to the national economy of Bulgaria.

3.3 Financial Analysis

An expenditure group of activities as “Housing, Public Utilities and Amenities, and Protection of Environment” includes the work for water management. The amount and the share to the total expenditure are 586 million Levs and 3.9% in 2004, and 726 million Levs and 4.4% in 2005. The state budget had surplus at around 655 million Levs in 2004 and 1,334 million Levs in 2005, it is thus deemed possible to increase the state budget for river basin management as “Housing, Public Utilities and Amenities, and Protection of Environment”.

The tariff systems for domestic water are decided by the State Energy and Water Regulatory Commission based on applications of the services provider including WSSs. The tariff systems are decided not based on the financial status of the service providers, especially no to be based on cost for works, but based on welfare standard for the people. International financing institutions as the World Bank suggest that projects with collecting some charges should be based on recovery of cost for business, thus review of the tariff systems will be deemed necessary. Of course, affordability of people to pay (ATP) should be taken into consideration in this case.

Current financial status of Irrigation Systems Company PLC, the share of the current operating profit are extremely low at around 0.04% (year 2005) to the total liability (=assets). As the commercial enterprises, it is expected that the share of current operating profit to the total liability (=assets) should be kept at least at around 2% through 5%.

If the irrigation systems are improved and if the irrigation areas will be expanded, and if the potable water supply systems are improved as recommended in this Study, the said

current operating profit will be drastically increased and financial status will be improved.

3.4 Environmental and Social Consideration Aspects

The draft RBMPs have their objectives for "good status of water environment", and themselves will contribute many favorable environmental and social impacts such as water quality improvement for surface water and groundwater, sanitary improvement and conservation of flora/fauna and ecosystem due to water quality improvement, social infrastructure services improvement (reduction of high water loss, etc.), local socio economic development due to promotion of effective water uses, and conservation of living environment related to appropriate river management plan and others.

On the other hand, there are possibilities that the construction of the proposing facilities based on the draft RBMPs may cause some slight adverse impacts (temporary water pollution, or dust or noise related to the construction of WWTPs, and others) on the existing natural and social environments. There are also possibilities that any adverse gaps for the poor, ethnic peoples in the remote areas in terms of socio-economic benefits by implementation of effective water supply plan or flood control plan may expanded, if the implementation measures are not appropriately.

Therefore, the mitigation measures for the possible adverse impacts and the recommended monitoring and control plan shall be considered as one of the activities of the finalized RBMPs.

4. Implementation Organization

4.1 Summarization of Issues

Issues related to organizational and institutional aspects for the implementation of programmes of measures of the proposed RBMP are summarized as follows:

Basin Directorates are responsible to conduct a variety of river basin management work and monitoring and surveillance of them, conservation of protection areas, and actions for emergency, e.g. floods. However, responsibilities and authorization are scattered to relevant agencies and this situation makes the river basin management complicated and difficult.

The body of the river management is different by location and by facility, and there are many related authorities, thus the necessary actions are made ad hoc.

MoEW and Basin Directorates are responsible, defined by the Water Act, for the establishment of river basin management plan matching to the request of EU-WFD and periodical (every six years) review of the plan. From now on, they should install a lot of monitoring facilities and conduct monitoring work by them selves following the new monitoring plan that satisfies the requirement of EU-WFD. The Basin Directorates at present even lack budget to maintain the office and staff, and it is very difficult to increase staff necessary to implement required tasks for the river basin management. Preparation for the new fields for river basin management, capacity development of staff, increases in staff numbers are deemed necessary.

With regard to the sector of floods, MSPDA has been established in 2006 and there established a system for emergency activities, though institutions for flood control has not been established. Directorate of Water of MoEW and Basin Directorates should be

responsible for flood control as a pat of river basin management work. Management of river morphology and river related facilities, and control of development activities and illegal activities in rivers and riverine areas should be added to the work of river basin management, though technical know-how for the preparation is lacking.

Implementation of river basin management through public participation as requested by EU-WFD, and it should be continued in the future.

4.2 Improvement of Institution and Organization

In order to solve the institutional and organizational issues as summarized above, the following measures should be conducted. The amendment of laws and regulations, change in responsibilities, and reform of institution and organization require detailed studies. They are correlated each other, e.g. necessary staff numbers of organization is determined after changing responsibilities, etc. Only the direction is shown below in the present Study, it should be studied in detail by the Bulgaria Government in parallel with the formulation of the final River Basin Management Plan.

- In order to implement river basin management in an organized manner, is should be made clear the responsibilities of the Basin Directorate and strengthen the responsibility accordingly. With regard to river management, principally RBD shall review responsibilities of relevant organizations for the management.

- In order to implement the River Basin Management Plan in Bulgaria in accordance with the requirement of EU-WFD, strengthening of organizations both in the central level (Water Directorate of MoEW) and the regional level (four Basin Directorates) is indispensable. Through the review of responsibilities of each organization to strengthen the authority, considerable increase (at least double) of the staff number, the capacity development, and corresponding increase of the budget shall be indispensable. The Bulgarian Government shall conduct further study on the way of strengthening the organizations and establishing a good collaboration with relevant agencies

- For the proper implementation of river basin management, establishment of collaboration system with the various stakeholders upon raising their awareness is deemed important. Inclusion of stakeholders to the monitoring work shall be considered.

5. Conclusion and Recommendation

5.1 Conclusions

The Study Team supported MoEW and Basin Directorates for the formulation of River Basin Management Plan throughout the Study, and the concrete output of the Study includes the following:

- Through the investigation and evaluation of the present condition related to the river basin management focusing on the water quality and quantity, it has been revealed that there exists a large gap between the current water status in the country and the “good water status” defined by the EU-WFD.

- As a result of the Study, established is GIS Database that is required by EU-WFD. In the GIS Database, the core portion covers the whole country, the WFD portion covers EABD, WABD, the pilot river basins of DRBD and BSBD, and the local portion covers EABD and WABD. The RBDs are able to conduct the river basin management activities based on the correct GIS Database.

- As an integrated river basin management model, sophisticated model (using Mike11) and simple model (using MS-Excel) both for water quantity and quality have been developed. Simulation of water quantity and quality could thus be conducted with a high technical level.

- Utilizing these decision and policy support tools, the Study proposed programme of measures mainly for water quantity and water quality improvement.

- The proposed RBMPs are basic plans prepared based on the requirements both of the EU-WFD and the Bulgarian Water Act, but not the RBMPs according to the EU-WFD requirements.

According to the programmes of measures in the proposed RBMP (Draft), investment of 2.4 billion euros scale amount for the new construction of WWTPs and rehabilitation of existing WWTPs and sewer networks in order to improve the present water quality in the levels of Class III to V to the levels around the middle of Class II and III in EABD and WABD. Water quantity improvement in the EABD and WABD will be realized by the improvement of domestic water supply systems with the investment of 4.0 billion euros scale amount and by the improvement of irrigation facilities with the investment of 270 million euros scale amount.

The proposed non-structural measures, e.g. strengthening of regulation, strengthening of monitoring are necessary to improve the parts not covered by the structural measures, to implement the structural measures smoothly and to assure the effect of the structural measures.

5.2 Recommendations

Through the Study, it is recommended that the government should take immediate actions and arrangement for the implementation of the RBMP as follows:

- In order to attain the target of the EU-WFD, the Government of Bulgaria should finalize the RBMP and commence the implementation of the RBMP in 2010. It is recommended to prepare the river basin management plans for EABD and WABD through the utmost utilization of the results of the Study and to prepare the river basin management plans for the whole nation.

- The implementation of proposed programmes of measures to attain the “good status of water” defined by the EU-WFD should be conducted as the national project for water. The proposed measures for improvement and management of water quality and quantity and river morphology management are all basic measures for the attainment of the “good status of water” in the country and recommended to be conducted under the national project for water and not by relevant implementation bodies independently.

- In order to implement the River Basin Management Plan in Bulgaria in accordance with the requirement of EU-WFD, strengthening of organizations

both in the central level (Water Directorate of MoEW) and the district level (four Basin Directorates) is indispensable. Through the review of responsibilities of each organization to strengthen the authority, considerable increase (at least double) of the staff number, the capacity development, and corresponding increase of the budget shall be indispensable. The Bulgarian Government shall conduct further study on the way of strengthening of the organizations and establishing of collaboration with other relevant agencies, including NIMH, which has basic meteorological and hydrological data of the basins.

- The RBD should conduct basic studies for the river basin management as follows:
  - The study on "River Management Plan" for the basis for prevention of flood damages and controlling sand and gravel extraction as well as improvement of environmental status of water bodies from the view point of river morphology,
  - The study on pressures and impacts from discharges or priority substances, which are 33 harmful substances defined by the EU-WFD, and heavy metals, and also closed mines in the basin necessary to protect people from possible hazard caused by discharge of toxic substances, and
  - The study on water resources development study (river flow regulation study), considering detailed river regime, water transfer, water use, environmental flow, etc., and assessing the need of additional hydro-technical facilities to be constructed as well as the restarting of construction of the suspended ones, as a part of the integrated water management in Bulgaria and to meet the challenge of global climate change.
- The decision support and managing tools of GIS Data Model and Integrated Water Management Models should be maintained and updated in a sustainable manner for effective use for river basin management.

Location Map
Executive Summary

Table of Contents

List of Tables

List of Figures

List of Annexes

Abbreviations

ATP	:	Affordability of People to Pay
B/C	:	Benefit Cost Ratio
BEN	:	Balkan Endemic Nephropathy
BI	:	Biotic Index
BOD	:	Biochemical Oxygen Demand
BSBD	:	Black Sea River Basin Directorate
C/P	:	Counterpart
COD	:	Chemical Oxygen Demand
CPI	:	Consumer Price Index
DEM	:	Digital Elevation Models
DO	:	Dissolved Oxygen
DRBD	:	Danube River Basin Directorate
EA	:	Environmental Assessment
EABD	:	East Aegean Sea River Basin Directorate
EC	:	European Commission
EEC	:	European Economic Community
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
EMEPA	:	The Enterprise for Management of Environmental Protection Activities (PUDOOS)
EPA	:	Environmental Protection Act
ETM	:	Enhanced Thematic Mapper
EU	:	European Union
EUR	:	Euro
EU-WFD	:	EU Water Framework Directive
ExEA	:	Executive Environment Agency, MoEW
GDB	:	GeoDataBase
GDP	:	Gross Domestic Products
GFSM	:	Government Financial Statistics Manual
GIS	:	Geographical Information System
GIS-DB	:	Geographical Information System Database
GNP	:	Gross National Product
GWB	:	Groundwater Body
GWL	:	Groundwater Level
HDPE	:	High Density Polyethylene
HG	:	Hydro-geological
HH	:	Household
HMS	:	Hydro-metric Station
HPP	:	Hydro-electric Power Plant
ICPDR	:	International Commission for the Protection of the Danube River
IEE	:	Initial Environmental Examination
IS	:	Irrigation Systems Company
ISPA	:	Instrument for Structural Policies of EU
IT	:	Information Technology
IUCN	:	The World Conservation Union
JICA	:	Japan International Cooperation Agency
MoAF	:	Ministry of Agriculture and Food Supply (former Ministry of

		Agriculture and Forestry)
MoEE	:	Ministry of Economy and Energy
MoEW	:	Ministry of Environment and Water
MoH	:	Ministry of Health
MoRDPW	:	Ministry of Regional Development and Public Work
MoSPDA	:	Ministry of State Policy for Disasters and Accidents
MoT	:	Ministry of Transport
MPD	:	Monitoring Department, EABD
NEK	:	Natsionalna Elektricheska Kompania (National Electricity Company)
NGO	:	Non-governmental Organization
NH_4-N	:	Ammonia Nitrogen
NHGN	:	National Hydrogeological Networks
NIMH	:	National Institute of Meteorology and Hydrology, Bulgaria Academy of Sciences
NO_3-N	:	Nitrate Nitrogen
NPV	:	Net Present Value
NSI	:	National Statistical Institute
NVZ	:	Nitrate Vulnerable Zones
O/M	:	Operation and Maintenance
PET	:	Potential Evapo-transpiration
PMD	:	Planning and Managing Department, EABD
RBD	:	River Basin Directorate
RBMP	:	River Basin Management Plan
RIEW	:	Regional Inspectorate of Environment and Water
S/W	:	Scope of Works
SAF	:	State Agency for Forests
SEA	:	Strategic Environmental Assessment
SPM	:	Suspended Particulate Matter
TDS	:	Total Dissolved Solids
TN	:	Total nitrogen
ToR	:	Terms of Reference
TP	:	Total phosphorous
UTM	:	Universal Transverse Mercator (UTM) Coordinate System
VAT	:	Value Added Tax
WABD	:	West Aegean Sea River Basin Directorate
WB	:	The World Bank
WCD	:	Water Cadastre Department, EABD
WGS	:	World Geodetic System
WHO	:	World Health Organization
WICU	:	Supreme Consulting Council on Water
WQ	:	Water Quality
WSS	:	Water Supply and Sewerage Company
WTP	:	Willingness of People to Pay
WWTP	:	Wastewater Treatment Plant

Measurement Units

(Length)

mm	:	millimeter (s)
cm	:	centimeter (s)
m	:	meter (s)
km	:	kilometer (s)

(Area)

mm^2	:	square millimeter (s)
cm^2	:	square centimeter (s)
m^2	:	square meter (s)
km^2	:	square kilometer (s)
ha	:	hectare (s)
dec	:	decare (=0.1 ha)

(Weight)

mg	:	milligram
g, gr	:	gram (s)
kg	:	kilogram (s)
ton	:	ton (s)

(Time)

s, sec	:	second (s)
min	:	minute (s)
h, hr	:	hour (s)
d, dy	:	day (s)
y, yr	:	year (s)

(Volume)

cm^3	:	cubic centimeter (s)
m^3	:	cubic meter (s)
l, ltr	:	liter (s)
mcm	:	million cubic meter (s)

(Speed/Velocity)

cm/s	:	centimeter per second
m/s	:	meter per second
km/h	:	kilometer per hour

1. INTRODUCTION

1.1 Objective of the Study

This is a summary of the Final Report of "The Study on Integrated Water Management in the Republic of Bulgaria" that has been conducted by the Government of Japan, through the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programs of the Government of Japan, in response to the request of the Government of Bulgaria. The Study has been carried out in accordance with the Scope of Work (S/W) signed between the Ministry of Environment and Water (MoEW) and JICA on October 14, 2005.

The Study aimed to conduct the following objectives:

- To assist the MoEW in the implementation of the requirements of the EU Water Framework Directive (hereinafter referred to as " WFD") which includes:
  - Preparation of the River Basin Management Plans for the EABD and WABD as selected areas,
  - Development of GIS, Monitoring Programs and Water Resources Balance for the whole country,
- To transfer technology and conduct training on Integrated Water Management to the counterpart personnel in the course of the Study.

Based on the new Water Act of 2000 the government of Bulgaria has divided the whole country into four river basin management districts, and set up the following four river basin directorates:

- Danube River Basin Directorate (DRBD)
- Black Sea River Basin Directorate (BSRD)
- East Aegean Sea River Basin Directorate (EABD)
- West Aegean Sea River Basin Directorate (WABD)

The Study has formulated the River Basin Management Plan (RBMP) (not exactly following the EU-WFD format but considering the Water Act of Bulgaria) for EABD and WABD as the selected areas, and prepared the GIS Data Model of the Yantra River and the Kamchia River as the pilot river, respectively for DRBD and BSBD.

Bulgaria has joined EU in January 2007. EU member countries are requested to conduct necessary actions in order to achieve the requirement that target realization of preferable status of all the water bodies[1] in the area by the year 2015. The EU-WFD sets milestones for the key actions to the member states as follows:

- Formulation of RBMP by 2008
- Explanation of the plan to the citizens by 2009
- Submission of the plan to EU by 2010

[1] There is no definition of "preferable status of all the water bodies" in terms of numeric criteria, though it is explained that preferable condition in biology and water quality also considering water quantity in all the water bodies.

- Realization of the improvement of water environment in river basins by 2015

1.2 Basic Approach

The River Basin Management Plan (RBMP) has been formulated applying the Integrated Water Management approach in accordance with the EU-WFD and the Water Act of Bulgaria. The established RBMP consists of the management plans for water quality and water quantity, and also includes studies on river morphology management, monitoring and the implementation plans. The Study also has developed the GIS database and the Integrated Basin Analysis Models, as decision support tools for formulation of the RBMP and its implementation.

Capacity development of the staff of MoEW and counterpart personnel of EABD/WABD has been conducted mainly through on the job training, and supplemented by a series of technical meetings (three times), technology transfer seminars (three times) and three public consultation meetings for each BD.

1.3 Study Schedule

The duration of the Study is 23 months from May 2006 to March 2008. The Study has been conducted as follows:

- Phase I (From May to December 2006)
    - After the explanation and discussion on the Inception Report (May 2006), the field study was commenced and the Basic Study on the current conditions was conducted including supplementary surveys of water quality and river cross sections, and the results were compiled in the Interim Report (January 2007).
- Phase II (From January 2007 to March 2008)
    - After explanation and discussion on the Interim Report (January 2007) the plan formulation study for EABD and WABD has been commenced on the River Basin Management Plans for both EABD and WABD. Based on the discussions on the Interim Report, a GIS Working Group was organized in order to develop a uniform GIS Database for the MoEW system and a TOR for the MoEW information system has been prepared. Support activities for DRBD and BSBD have been added to prepare the GIS Database respectively for the Yantra River and the Kamchia River as pilot areas for the RBMP and thus the Study period was extended for three months. The results have been compiled in the Draft Final Report (January 2008). The Final Report has been compiled in March 2008 after incorporating the results of discussion and comments from the Government of Bulgaria on the Draft Final Report.

1.4 Counterpart Agency

The counterpart agencies for the Study are MoEW, EABD and WABD. The counterpart personnel have been selected from MoEW, EABD and WABD, and the members of GIS Working Group have been selected from MoEW, ExEA and the four RBDs. MoEW has organized a Steering Committee for the Study, which is consisting of representatives of the related agencies including MoEW, MoEE, MoRDPW and MoAF.

1.5 Participants

The participants for the Study are as follows:

- JICA Study Team and MoEW/EABD/WABD counterpart teams,
- GIS Working Group members, and
- Steering Committee.

The lists of participants are shown in *Annexes 1 - 6*.

2. CHARACTERISTICS OF THE STUDY AREA

2.1 Natural Conditions

2.1.1 Topography

Bulgaria has a total land area of approximately 111,000km^2. The country's topography is roughly separated into the zones: the Danubian Table Land in the northern part, the Balkan Mountains in the center, the Thracian Plain in the southern part and the Rhodope, Rila, and Pirin Mountains that lie in the southwestern part.

The average elevation of the country is about 480 meters MSL and the highest point of the country is the Musala in the Rila Mountains, which reaches to 2,925m. About 31% of the country is lower than 200m and about 20% is higher than 800m.

The high zone plays an important role for providing water resources in Bulgaria. The upper reaches of EABD and WABD rivers are very important zones from the water resources conservation aspects. The territories and average elevation of EABD and WABD are 35,230km² and 533m, 11,966km² and 1,008m, respectively.

2.1.2 Land Use and Land Cover

According to the land cover conditions in 2000 based on Corine Land Cover, "agricultural area including fruit crops" is more than 49.7% of the entire country. "Forest" and "shrub land and grassland" follow with about 31.5% and 10.5%, respectively.

In the Tundzha and Maritsa River Basins in EABD, agricultural lands are superior to the others, which cover 50.6% and 46.6%, respectively. In the Arda and Biala River Basins, the ratios of forest are 51.5% and 56.7%, respectively.

In WABD, the ratios of agricultural area are low, which covers only 26.8%, but forest areas cover 45.9%.

2.1.3 Meteorology

Most of the lowland has annual precipitation of 500-700mm, but the mountain area has much more precipitation, in some places, annual precipitation exceeds 900mm. In most of Bulgaria, annual potential evapo-transpiration (PET), calculated by Thornthwaite Method based on the monthly average temperature provided by WORLDCLIM database, exceeds annual precipitation is lower than 600 mm in mountain areas and over 700 mm in lowland areas.

Annual water balance as the comparison between annual precipitation and annual PET shows that only high mountain area has positive value of precipitation minus PET and the remaining areas of the country show negative value. This shows that the mountain areas play important role in the water resources. In the mountain area, not only rainfall but also snowfall contributes to annual precipitation. Winter snow accumulation and subsequent

melting process is thus very important component when considering water resources in Bulgaria.

In recent years, the annual precipitation fluctuates very much. In 2000, the annual precipitation was extremely low; less than 400mm, but in 2005 was more than 900mm.

2.1.4 Hydrology

List of the major rivers for the whole country is prepared and their locations and catchment areas are shown in **Table 1**. The longest river in Bulgaria is the Iskar River that has 338 km in total and the largest basin is the Maritsa River that has about 21,292 km^2 in total.

It is assumed that a hydrological year starts in November and ends in October. The averaged ratio of total loss, mainly by evapo-transpiration, against total precipitation in 5 hydrological years during 2000-2005 is similar to the long-term averaged one. However, the water balance in single hydrological year varies every year and seems to be affected by precipitation amount in the previous hydrological year. When the previous hydrological year is dry, the run-off tends to be small.

In hydrological year 2000-2005, annual unit runoff (mm) and runoff rate that is defined as (unit runoff) / (precipitation) from each watershed for the representative hydrometric stations for EABD and WABD are calculated. The values are varied very much from place to place. In EABD the runoff rates of the Tundzha River are 0.08 - 0.41, the Maritsa River: 0.17 - 0.46, the Arda/Biala Rivers: 0.30 - 0.60, and in WABD the Struma River: 0.16 - 0.39, the Mesta River: 0.40 - 0.72.

2.1.5 Water Balance across the Country

Precipitation in the country, except evapo-transpiration, flows to the Danube River, the Black Sea and to the neighboring countries (Turkey, Greece, Serbia and Rumania. Inflow from the neighboring countries is that from Macedonia and Serbia to the Struma River Basin in WABD.

The long-term averaged water balance across the country shows that more than 70% of precipitation is lost, about 16% flows to neighbouring countries and about 12% flows directly to the Danube River and the Black Sea. The external inflow volume is small compared to the other factors when considering nation-wide water balance. However, it could be important for local scale water balance. It should be noted that the water balance is affected by human activities such as inter-basin water transfer and water abstraction works.

2.2 Social Conditions

2.2.1 Administrative Structures

The whole territory of Bulgaria consists of 6 regions as North West Region, North Central Region, North East Region, South East Region, South Central Region and South West Region. Under those 6 regions, there are 27 districts and the Capital City of Sofia, and

each district consists of several municipalities, and cities and/or villages are the lowest administrative units under the municipalities.

2.2.2 Population

According to the Statistics, the population of the nation increased until the year 1985, after that year, it was decreased from 8,948,649 in 1985 to 7,928,901 in 2001. This trend still continued to the year 2005. However, the South West Region has increased since 2001. The Capital Sofia, the Municipality Blagoevgrad (Blagoevgrad) in the South West Region and the Municipality Plovdiv (Plovdiv) in the South Central Region have also tendency of increasing population in these years.

2.2.3 Gross Domestic Products (GDP) and GDP per Capita

The Gross Domestic Product (GDP) and GDP per capita in the country were 38.3 billion Levs and 4,919 Levs per capita as of the year 2004. The annual average increasing rates of the GDP and GDP per Capita are high as 8.82% and 9.44%, respectively based on the current rate. However, the actual annual increasing rates taking into account of the consumer price index (CPI) are 4.35% and 4.96%, which are almost half of the said rates above.

2.2.4 Financial Status of the Government

In Bulgaria, the Government reports its financial status in two ways as (1) GFSM 2001 System ("Government Financial Statistics Manual 2001" System) recommended by the International Monetary Fund, and (2) the National Accounting System.

The finance of the Government consists of three categories as (1) the finance of the Central Government, (2) the finance of the Local Government and (3) the finance of Social Security. The overall finance of the Government is called as "the Finance of the General Government" consisting of the said three categories. Accordingly, "the Finance of the General Government" by means of the National Accounting System is to be used to grasp the overall domestic financial status of the Government by items. However, to grasp the international balance of payment, "the Finance of the General Government" by means of the GFSM 2001 System is to be used.

Though the Government has suffered losses in two years since 1998 amounting to168 million Levs in 2000 and 253 million Levs in 2002, the financial status of the Government has been sound in general after 1998. However, from the viewpoint of "net acquisition of financial assets other than cash", the Government has registered deficits since 1998 till to date from the viewpoint of the international balance of payment.

The Government revenue consists of (1) tax revenue, (2) non-tax revenue and (3) grants. Among the revenues, the tax revenue is the highest in share, which is almost 80% to the revenue in total.

2.2.5 Industrial Perspective

Almost 80 % of industrial output are coming from private sector and the output of enterprise are increased from 21,360 million Levs in 2001 to 29,866 million Levs in

2004. Especially, from 2003 to 2004, the increase of outputs was greater than that of the previous year as around 21%.

The main industrial activities are the manufacture of food products and beverages and tobacco (18%), the manufacture of basic metals and fabricated metal products (18%), textiles and textile products (8%), chemicals and chemical products (5%), not the manufacturing but the electricity and gas and water supply (16%) to the total outputs as of 2004.

2.2.6 Income and Family Status

The average family size decreased year by year from 2.77 person/house hold (HH) in 2000 to 2.58 person/HH in 2004. The old-age depending ratio (rate of male of 63 and over plus female of 58 and over in the family members) of family increased from 21.41% in 2000 to 22.15% in 2004 and around 22% of family members are aged persons.

The average annual incomes per HH and per capita in 2004 are 6,356 Levs and 2,466 Levs, respectively. The amount of wages and salaries shares the highest rate as around 40%, and the amount of pensions shares the second highest rate as around of 22%. The average annual expenditures per HH and per capita in 2004 are 5,332 Levs and 2,068 Levs respectively.

2.3 Water Quantity

2.3.1 Overview of Water Use in the Country

According to the Bulletin for Environment in 2000 - 2005 issued by NSI, about 2.7 billion m^3/year, which are about 5% of annual total precipitation over the country and about 15% of the annual total disturbed runoff, was abstracted from the internal of Bulgaria. About 2.2 billion m^3 / year was from surface water, of which 90% is through reservoirs and from groundwater about 500 million m^3 / year. The water supply system is divided into the two categories as follows.

- Public Water Supply System
- Others, including Self-Supply System

In the Public Water Supply System, groundwater contributes significantly. Almost all of the water provided by public water supply system is used for domestic water sector. The transmission and distribution loss of the Public Water Supply System is estimated high at 60% or more.

The others including self-supply system relies more on surface water, especially on reservoir. About 80% of the abstracted water is from reservoir. The water is used mainly for industrial and agricultural purposes. However, industrial water use is about four times larger than agricultural water use. The loss is also large. About 40% of the abstracted water is not used and lost somewhere.

About 1.5 billion m^3/year are sent to other purposes after the water is used for hydropower. The shares by purpose are irrigation 54%, domestic 12% and industry 34%.

Part of this water may be lost somewhere and/or converted to be used for other purposes. The control of this water could be one of important issues for efficient use of water.

2.3.2 Water Supply

There are 51 major water supply and sewerage (WSS) companies. They are composed of state owned company (13), state and municipality owned company (16) and municipality owned company (22). The existing water supply systems are operated by the major WSS Companies. The water supply networks have a serious problem of water loss at 50% to 60%, because of poor maintenance and deteriorated pipes (asbestos cement pipe: 74%, steel pipe: 15%), which are necessary to be replaced to HDPE pipes and others.

2.3.3 Outline of Irrigation

The Irrigation sector is one of the large water users. In 1980s, irrigated area was about 1.0 million ha, about 10% of the whole country. The used water for irrigation was about 3.5 billion m^3 / year at that time. After the change of political system in the beginning of 1990s, the former agricultural system was collapsed and the system has hat been re-established. The current irrigation potential area is about 500,000 ha, but current irrigation areas are about 20,000-30,000 ha. Accordingly the current used water are informed at the level of 100 - 200 million m^3 / year, however, extracted irrigation water is assumed by far large according to the observation and the volume sent from the hydropower after use.

The existing irrigation systems lack control facilities for proper intake and distribution and do not fit for the current situation and also a high rate of loss over 60–70% is assumed. It is necessary for the irrigation systems to improve the irrigation facilities to meet the current conditions and use water resources efficiently.

2.3.4 Significant Reservoirs and Water Transfer

In Bulgaria, there are a number of reservoirs and lakes. Of these, 51 reservoirs are specified as significant reservoirs in the Water Act. Total volume of the significant reservoirs is about 6.6 billion m^3. It is almost one third of the average total annual runoff volume from the territory of Bulgaria in the current disturbed condition.

Based on the record of reservoir operation submitted to MoEW, the following average inter-basin water transfers in 2001 - 2005 are estimated.

- The Tundzha River Basin to the Maritsa River Basin: 254 million m^3/ year
- The Struma River Basin to the Maritsa River Basin: 37 million m^3/ year
- The Mesta River Basin to the Maritsa River Basin: 42 million m^3/ year
- The Mesta River Basin to the Dospat River Basin: 63 million m^3/ year
- The Dospat River Basin to the Maritsa River Basin: 140 million m^3/ year

2.3.5 Existing Water Balance

Water balance for existing condition (2001-2005) is presented. The water balance for each river basin was estimated using the result of the calibrated rainfall-runoff model, the

operation record of significant reservoirs and the permission data for water use etc. Simple model was used in calibrate the water balance.

Spatial distribution of water balance including inter-basin water transfer for EABD and WABD is shown in **Figures 1** and **Figure 2**, respectively. Average annual water balance at downstream end (national boarder) of river basin in 2001-2005 reveals the following characteristics. Reduction from quasi-natural flow to disturbed flow is distinguished in the Tundzha River in EABD and the Dospat River in WABD. The rates of abstraction to the potential flow show higher values in the larger river basins, e.g., the Maritsa, Tundzha and Struma Rivers, and smaller values in the smaller river basins.

2.3.6 Results of Interview Survey on the Problems of Water

In order to know what municipality people are thinking about the problems of water especially drinking water supply and sewerage, the Study conducted interview surveys at various municipality offices both in EABD (17) and WABD (9).

The major problems identified are described below.

(1) Problems Related to Domestic Water Supply

- The most serious problem is the old or deteriorated pipes with asbestos cement and steel pipes with high loss and frequent accidents, and shortage of water due to high loss and also low water pressure in the pipe.
- In general, quantity of water supply is sufficient. However about 1/5 of the municipalities in the survey answered about the insufficient of water sources. Furthermore, most of the municipalities, which answered about the insufficient water sources belong to WABD area. This is probably due to the fact that the WABD areas depend more on surface water than groundwater in general.
- There are problem of manganese in water mainly in EABD areas.
- There is a problem of lack or insufficient water purification plants.

(2) Problems Related to Sewerage

- The most serious problem is the lack of wastewater treatment plants in many municipalities. Insufficient coverage of sewerage system is also a large problem.
- Insufficient or no treatment of wastewater from industries and large animal breeding farms are also problems because they discharge directly into the rivers and water bodies almost without treatment.
- Sewer pipes are old and deteriorated in general, and it is also serious problem.

(3) Problems of Floods

- Most of the municipalities answered that they have suffered from flood damages in recent years including 2005 and 2006. Flood damage happened to the houses, town and villages, infrastructures including road and bridge, railroad, water supply system, sewerage system, agricultural lands and bank protection and dikes.
- Warning of floods to the people and evacuation of the people was insufficient.

(4) Problems of Accidental Pollution

- About 40 to 50% of the municipalities in the interview survey answered that they have experienced accidental pollution. However, the situation of the accidental pollution is not so clear.

2.4 Groundwater

2.4.1 General Tendency of the Potential of Groundwater Resources

The highest values for modules of the groundwater flow (more than 10-20 l/s/km^2) are related to karstified limestone in mountain areas. Here enhanced precipitation values along with high permeable formations make the best combination for abundant groundwater recharge. Proterozoic marbles in the Rhodopes and Pirin are the most outstanding examples.

Large groundwater resources are common for porous aquifers along rivers, especially for kettles filled in with coarse alluvial proluvial sediments and for lowlands near to the Danube River. Here the most common values of the module are 5-7 l/s/km^2.

Low recharge plus low permeable formations make the worst combination. In such areas, the modules of the groundwater flow are below 0.5 l/s/km^2. In Bulgaria, such values are usual for southern parts of the country.

2.4.2 Problematic Areas in terms of Groundwater Quantity

A major issue of groundwater in the country is over extraction and the decrease of base flow. Under pristine conditions, many ecosystems along rivers used to be considerably dependent from water recharge from the upper parts of the watershed. During springtime, large territories in middle and low river course have been flooded every year. This process contributed to additional groundwater recharge. Abstraction of surface water from the Tundzha River has led to lower groundwater recharge of the porous aquifer along the river.

2.4.3 Problematic Areas of Groundwater Quality

Shallow groundwater is the most concerned. The primary problematic areas in terms of groundwater quality are indicated:

- North-East Bulgaria - Sarmatian limestone formation - nitrates.
- Groundwater in the Plovdiv-Pazardzhik, Haskovo and Sofia areas – nitrates, heavy metals, iron and manganese.
- Stara Zagora; south from Yambol and Bourgas areas – nitrates (Vertisols).
- Razgrad – nitrates.

In addition, territories that are *under threat of flooding* are vulnerable to pollution. They are situated in low lands with shallow groundwater levels. During floods, all pollution loads within the flooded areas may be remobilized and mixed with fresh water. The example is Topolnitsa dam polluted from mining activities. Flooding occurs on the Plovdiv-Pazardzhik area, which is characterized with high anthropogenic impact from

different origins. The last serious floods occur in August 2005. Many low lands in different regions of Bulgaria were affected. Groundwater receives many pollutants including pathogens from the land surface, and becomes insecure for drinking purposes.

2.5 Water Quality

2.5.1 Current Water Quality Conditions

(1) Water Quality of Common Physico-chemical Parameters

The current physico-chemical monitoring network is composed of 509 sampling sites and some additional ones. A total of 24 to 43 parameters are examined with frequency of 4, 6 or 12 times per year.

MoEW has proposed a new classification of water quality of physico-chemical parameters since 2005, which is also referred to the EU-WFD and ICPDR's water quality classification. This new proposal has not been officially approved yet, but it is considered appropriate for classifying the water quality conditions in general, which is also similar to the Japanese "Water Quality Standard for Rivers and Conservation of Living Environment" in terms of BOD_5 and DO.

The conditions of normal maximum values of BOD_5, COD_{Mn}, NH_4-N and NO_3-N, which are the normal range of the high values in a year especially during summer season, when water quantity in the river is relatively small. Based on these values, the water quality in the country is moderate (Class III) to bad (Class V) conditions in general with locations of more than 50% of poor (Class IV) to bad conditions. Organic matters especially by discharge of untreated sewage from urban areas, industrial wastewater with in sufficient treatment, pollution loads from agricultural lands are the reasons for these wide spread pollution in the country (see **Figures 3** and **4**).

(2) Hydro-biological Water Quality

ExEA has the hydro-biological monitoring network covering the whole country with sampling points of about 2000. Up to now, benthic macroinvertabrates fauna is observed. Based on the observation, ecological status of the rivers are assessed and classified by Biotic Index (BI), which is calculated by Irish Method.

Mainly based on the ExEA's data of 2004 as well as referring to the data from 2000 to 2005, hydro-biological water quality map for the whole country was prepared in this Study as shown in **Figure 5**.

Based on this map, the hydro-biological water quality in many of the rivers in the country is moderate to bad conditions. The poor to bad hydro-biological water quality are also the results of the wastewater discharge with insufficient treatment as well as inflow of nutrients (nitrogen and phosphorous) into the rivers.

(3) Supplemental Water Quality Survey

In this study, in EABD and WABD, a supplemental water quality survey was conducted from the beginning of September to middle of November 2006, which includes field

sampling (one time per each site) from beginning of September to middle of October 2006 at 24 points in EABD and 12 points in WABD with a total of 36 points.

Based on the results, many locations have problem of organic pollution with water quality class more than Class III. In many places, nutrients indicated by total nitrogen (TN) and total phosphorous (TP) are rather high, which might be caused from agriculture as well as wastewater from settlements, industry and animal breeding farms.

(4) Water Quality of Specific Parameters (Heavy Metals)

Water quality conditions in the whole country in terms of specific parameters (heavy metals) of arsenic (As), lead (Pb), zinc (Zn), cadmium (Cd) and copper (Cu) were examined based on the ExEA's data from 2000 to 2005. **Figure 6** shows the water quality class of the maximum values of these heavy metals for the most recent year 2005.

The major rivers, where high values of these heavy metals are recorded during these six years, are the Ogosta River, Iskar River, Osam River, Yantra River, Rusenski Lom River, Kamchia River, Maritsa River, Tundzha River, Arda River, Struma River and Mesta River. Although there is a question about the accuracy of the data, it is difficult to deny the possibility of occurrence of such heavy metal pollution.

The heavy metal pollution might be related to the wastewater from mines under operation and closed ones as well as wastewater and emission to the air from the ferrous and non-ferrous metal industry etc. There are clear relation between the locations of the mines and heavy metal pollution in the Topolnitsa River (left tributary of the Maritsa River), Arda River, and middle part of the Tundzha River. However, in general, the relation is not so clear. As the pollution by heavy metal is not only problem to the water quality in the river, but also have a risk of causing problem to the soil around irrigation channel and health to the people. Some basic study should be conducted.

2.5.2 Existing Urban and Municipal Wastewater Treatment Plants and National Plan

(1) Existing Municipal Wastewater Treatment Plants

There are 73 numbers of the existing municipal wastewater treatment plants (WWTP) and 25 WWTPs under construction. The locations of the plants are shown in **Figure 7**. The existing WWTPs in EABD and WABD have following problems.

- Many of the WWTPs were mostly constructed in 1970s and 1980s. However, many of them have not yet fully replaced the mechanical and electrical equipments. Therefore these equipments have become very old and sometimes do not work.
- Inflow concentration of BOD_5 to the WWTPs is generally very low at about 40 to 60 mg/l. This implies that the sewage goes out from the sewer pipe to the ground and surrounding water flows into the sewer pipes.
- It is said that WWTPs have problems of inflow of petrol or heavy metal from the industries, which cannot be treated by the WWTPs. Furthermore, this causes problem to the sludge, which includes heavy metal or oil.

- Even in the case of no harmful substances in the sludge, sludge has not been utilized for agriculture etc.

(2) National Program for Constructing WWTPs

Considering the requirement of EU-WFD, Bulgaria has a national program for constructing new WWTPs. The name of the program is "Implementation Program for Directive 91/271/EC concerning Urban Wastewater Treatment" in 2003, which aims to construct new WWTPs for the towns and settlements with population equivalent (PE) above 2000 by Year 2015. Total number of the town and settlements above PE 2000, which should have WWTPs by 2015 are 430. Therefore, based on this program, 364 towns or settlements should have new WWTPs by 2015.

There is another program called "National Program for Priority Construction of Urban Waste Water Treatments Plants for Populated Areas with Over 10,000 Equivalent Populations in the Republic of Bulgaria" in 1999. It proposed to construct 36 new WWTPs for the towns with more than PE 10,000. About 15 WWTPs have been constructed until 2007 among them.

2.6 Natural Environment

2.6.1 Flora and Fauna

Concerning the flora of Bulgaria, the Balkan Mountains areas are covered by broadleaf forests at lower altitudes and by needle-leaf conifers at higher elevations. The vegetation of the Thracian Plain is a mixture of the middle-latitude forest of the north and Mediterranean flora and is observed diversified flora. However, most of the trees in Bulgaria, particular in the Danube River Basin and EABD area. have been cut down to develop farmland.

The fauna of Bulgaria is also diverse. On the other hand, the bears, foxes, squirrels, elks, wildcats, and rodents of various types are registered in the Red Data Book of Bulgaria as the rare species. Concerning the fish, a total of 24 fish species, which includes sea fish in the Black Sea and fresh water fishes are registered in the Red Data Book of Bulgaria as rare, or endangered, or extinct species. Bulgaria has only coastal area in the east area, which is covered by most of the sands in the Black Sea. There is no coastal area within both EABD and WABD.

2.6.2 Protected Areas

As discussed above, Bulgaria is rich in biological diversity due to its highly varied ecosystems. The following table shows proposed protected areas in Bulgaria and the whole Europe area in 2003, according to the Earth Trends.

Protected Area

Categories of the Protected Areas	Bulgaria	Whole Europe
Nature Reserves, Wilderness, and National Parks (IUCN Category I and II)	75	34,628
Natural Monument, Species Management Areas, and Protected Landscapes and Seascapes (IUCN Category III, IV and V)	518	95,234
Areas Management for Sustainable Use and Unclassified Areas (IUCN Category VI and "other"	523	50,859
Total Protected Areas (IUCN all categories)	1,117	180,721
Protected Areas as a percent of the Total Land	10.1%	8.4%
Wetlands of International Importance (Ramsar Sites) 2002	Number of sites: 5 Total Areas: 3	Number of sites: 699 Total Areas: 19,248

Note: Each unit is thousand hector except percentage and the number of sites.
Source: "Country Profile of Bulgaria – Biodiversity and Protected Areas, 2003, Earth Trends"

In the Study Area, three national parks; i) Central (Tseritralen) Balkan National Park (almost of half of the Park); ii) Pirin National Park; iii) Rilla National Park are located. Also, there are four nature parks; i) Sinite Kamani Nature Park, ii) Vitosha Nature Park (almost of half of the Park), iii) Rila Monastery Nature Park; iv) Balgarka Nature Park (small parts of the Park).

The main responsible organization for the protected area in Bulgaria is MoEW. All the "national parks" have own management bodies (Park Directorate), which are subordinate to MoEW. On the other hand, the State Agency for Forests (SAF) is responsible for managing the "nature parks" in Bulgaria.

Each national park has own management plan (every-ten year revising plan), which is stipulated by the Protected Areas Act. The national park management plan is considered the following management elements: Natural resources management, security; Ecological monitoring; Maintenance of the tourist routes, paths, and additional services; and, Public awareness, education tools, and activities with local authorities.

The locations of national parks in EABD and WABD areas are as follows:

- In EABD area, the southern parts of the Central (Tsentraien) Balkan National Park is located in the upstream of the Tundzha River and the eastern parts of the Rila National Park are located in the upstream of the Maritsa River basin
- In WABD area, the whole Pirin National Park and the west part of the Rila National Park are located in the two river basins of the Struma and Mesta River Basin.

2.6.3 Proposed Area by WFD

EU-WFD requires to designate protected area within four year after the announcement of EU-WFD, both EABD and WABD have not completed the designation of the protected area defined by the EU-WFD.

2.7 Forest Management

2.7.1 Characteristics of the Forest Areas in Bulgaria

The total area of forests in Bulgaria is approximately 4.1 million hectares (more than one third of the total territory) in Bulgaria. More than 3.6 million hectares of the forests are afforested. It is the results of immense forestation for the past fifty years aiming to increase the area of forests and the prevention of natural disasters. The forests are contributing to soil and water conservation, and prevention of natural disasters such as floods and landslides.

2.7.2 Institutions of Forest Management in Bulgaria

The forest management in Bulgaria is said to have a long history over 120 years. Currently the administrative responsibility on the issues related to the forests in Bulgaria is the SAF, which is established in 2007 and responsible for the preparation and execution of the forestry policy.

2.7.3 National Strategies for the Forestry Sector Development in Bulgaria

The strategic plan for the development of the forestry sector for 2007-2011 has developed the execution of the "National Strategy for Sustainable Development of the Forestry Sector 2006-2015" regarding the necessity of taking specific actions for the improvement of the functioning of the forestry branch offices. The strategic plan has the following strategic objectives:

- Economical reinforcement of the forestry sector through improvement of its competitive power and increase in the stable consumption of goods and services from the forests,
- Management of healthy forest ecosystems and the conservation of bio diversity as well as long-term storing of carbon by their ecological functions,
- Improvement of the quality of life by protecting and improving the social and cultural changes in forests,
- Improvement of the awareness, co-ordination and inter-sector cooperation for the forest conservation.

The MoAF, through the SAF is responsible for organizing the execution of the strategic plan. The forest management plan has a close relation with the RBMPs, because the forest areas are mostly located in the upper reaches of rivers. It is important for the RBDs to have a close coordination with the SAF about the management of forest areas in the territories.

2.8 Laws and Institutions

2.8.1 Water Act

In Bulgaria, the water institution is mostly contained in the Water Act, which was issued in 1999, and was the first integrated legal document on water resources, water use, and water quality in Bulgaria. The Water Act was prepared on account of the EU-WFD. The

Water Act regulates the ownership and management of waters within the territory of Bulgaria as a national indivisible natural resource and the ownership of the water development systems and facilities.

In August 2006 the Water Act was revised. Although the Article 1 was exactly the same as Article 1 in the previous Act, the objective (Article 2) of the latest was totally changed. The objective of the previous Act was to ensure a uniform and balanced management of waters in the interest of the public, the protection of public health, and the sustainable development of Bulgaria by means of multipurpose, efficient use and development of water resources, restoration of water quality, conservation of ecosystem, etc. In the objective of the new Act, water resources are not mentioned and the idea of integrated management has newly been introduced. The objective of the new Act is to provide the integrated management of waters in the interest of society and for protection of the health of the population as well as to create conditions to provide sufficient quantity and good quality of surface, underground and sea waters for sustainable, balanced and fair extraction of water through introduction of river basin unit management principle, polluter pay and user pay principle.

Also, the latest Water Act adds the waters of the Danube River, the Rezovska River, and the Timor River within the state borders of Bulgaria as one of the waters within the national territory of Bulgaria.

2.8.2 Main Government Organizations for Basin Management

There are three key organizations and many related organizations for the river basin management in Bulgaria. The three key organizations are “the Council of the Ministers”, “the Ministry of the Environmental Water (the Minister)” and “the four River Basin Directorates”, and the authorities and responsibilities of the key organizations and others are explained as follows:

(1) The Council of Ministers

- Award concessions for extraction of minerals, waters constituting exclusive state property;
- Adopt national program in the sphere of protection and sustainable use of waters;
- Permit use of waters for the purposes of national defense and natural security;
- Impose restrictions on the use of waters in unforeseeable or exceptional circumstances affecting individual parts of Bulgaria.

The Council of Ministers is supported by the MoEW for implementation of the above responsibilities.

(2) The Ministry of the Environment and Water (MoEW)

The MoEW is responsible for environmental protection, and use of natural resources, including water as the competent governmental body. The Water Directorate of MoEW is responsible for carrying out the national policy in integrated and sustainable water management.

The MoEW has the following main authorities in terms of water management according to the latest Water Act:

- Implement the state policy of water management;
- Develop a National Strategy for Management and Development of the Water Sector before the Council of Ministers for approval;
- Endorse the river basin management plans;
- Elaborate national programs in the sphere of protection and sustainable development of waters;
- Issue permits for water abstract and/or use in the cases provided under the Water Act.

The MoEW is also responsible for wastewater management and treatment in the protection of national water resources.

(3) Basin Directorates

The Basin Directorates are one of the direct subordinations of the Minister of the MoEW. The Director of a Basin Directorate has the following main responsibilities within own basin district, according to the Article 155 of the latest Water Act:

- Delimit the boundaries of waters and water bodies constituting public state property jointly with the technical services and the Geodesy, Cartography Offices of the municipalities;
- Develop the river basin management plan;
- Issue the permit under the Water Act within each basin district

(4) Executive Environment Agency (ExEA)

The ExEA is one of the direct subordinations of the Minister of the MoEW. The ExEA is managed and representative by the executive Director. The ExEA has the following main responsibilities especially for the water sector according to the latest Water Act:

- Implement water monitoring on a national level;
- Maintain a national level Geographical Information System (GIS) about the conditions of waters;
- Prepare an annual report on the conditions of waters.
- Maintains a Database on a national level about the national monitoring network, which includes all environmental components.
- Reports annually to the European Environment Agency on 11priority data flows.
- Reports annually to the Danube Commission.
- Reports annually to the Black Sea Commission.

(5) Inter Institutional Unit (Supreme Consulting Council on Water: *WICU*)

This Inter Institutional Unit has the following important tasks and the other co-ordination tasks for the EU-WFD implementation among the relevant governmental organizations in Bulgaria according to the Order No. RD-848, Sofia, 18.08.2004:

- Co-ordinate and control over the integrated implementation of the EU-WFD in Bulgaria;
- Raise public awareness for the different stages of the EU-WFD requirements implementation.

(6) Basin Boards (Basin Councils)

The Basin Boards have established in 2003 by the Water Act to assist the River Basin Directorates in their operational activities through ensuring public participation in the decision-making processes. A Basin Board in a River Basin District comprise representatives of the state administration, the local administration, the water users and non profit legal persons within the scope of the basin, as well as research organizations engaged with water issues.

(7) Regional Inspectorate of Environment and Water (RIEW)

The RIEW implement some environmental protection policies at the regional level and support the Basin Directorates in their activities as bodies of the MoEW. Some of the specific tasks are identified as follows by the latest Water Act:

- Implement waste water monitoring;
- Control sites generating waste waters;
- Maintain a database on the monitoring and control concerning the conditions of waters.

(8) Municipalities

The municipalities are also direct actors in terms of the water management within the municipal property. The municipality mayor could implement the policy related to activities involving operation, construction, remodelling, and modernization of water development systems and facilities constituting municipal property, based on the Article 10 of the latest Water Act. Also, each mayor of the municipality has the authorities of the following controlling items, according to the Article 191 of the latest Water Act:

- The construction, maintenance, and proper operation of sewer networks and municipal wastewater treatment plants;
- The construction, maintenance, and operation of water development systems and facilities constituting public municipal property;
- The construction and registration of wells for individual water abstraction of ground waters within the territory of the municipality.

2.8.3 Other Organization involved in the Basin Management

The following governmental agencies, the institutes, and organizations are involved in and have each role for river basin management:

(1) Ministry of Regional Development and Public Works (MoRDPW)

The MoRDPW has two responsibilities with respect to river basin management.

- Construction of drinking and wastewater facilities in the local areas;

- Management for public company in terms of drinking and wastewater.

(2) Ministry of Health (MoH)

The MoH is controlling the water quality i) for drinking and household uses, including bottled and non bottled mineral waters; ii) for bathing, and has responsible for the following activities concerning river basin management:

- Regulate water quality for drinking water and bathing;
- Conduct regular water sampling and analysis for drinking water in water sources and groundwater;
- Conduct water monitoring with the Executive Environmental Agency (ExEA).

(3) Ministry of Agriculture and Food Supply (MoAF)

The MoAF is managing irrigation facilities in Bulgaria through a public cooperation of the irrigation systems.

(4) State Agency of Forest (SAF)

On the other hand, the SAF is managing forestry and forest conservation entire Bulgaria's territory as a state agency with the 16 regional offices in the whole region. The SAF was established on July 2007.

The Agency has a close relation with the river basin management through the conservation activities of the forest area.

(5) Ministry of Economy and Energy (MoEE: former Ministry of Energy and Energy Resources)

The MoEE is managing pumped storage hydroelectric power stations, normal hydroelectric power stations, and dams through the National Electric Company relating to river basin management.

(6) Ministry of Transport (MoT)

The MoT is managing use of internal waters and the territorial seawaters and the waters of the Danube River for transportation purposes relating to river basin management.

(7) Ministry of State Policy for Disasters and Accidents (MoSPDA)

The MoSPDA was establishes after the floods 2005 and unites the existing agencies responsible for prevention, response, management and recovery in case of crises, which includes large-scale flood disaster in Bulgaria.

(8) National Institute of Meteorological and Hydrology, Bulgaria (NIMH)

This NIMH is consists of one main center in Sofia and the four local centers within Bulgaria territory. The main activities of the NIMH are to provide and forecast

meteorological and hydrological data and conditions for concerned organizations. With respect to hydrological observation, the monitoring has started since 1920.

(9) Water Companies

In Bulgaria, there are 51 major water supply and sewerage (WSS) companies, which are composed of state owned company (13), state and municipality owned company (16) and municipality owned company (22). They are operated since 1999, and conducting the provision, as well as the O/M for drinking water and sewerage system, collecting water tariff.

(10) NGOs

There are some local NGOs in Bulgaria relating to river basin management. Some of the NGOs are involving wetland or bird conservation, as well as are conducting public involvement for water related environmental issues in Bulgaria.

3. DEVELOPMENT OF GIS DATABASE

3.1 Main Purpose of GIS-DB

The objectives of the Study include the development of GIS Database (GIS-DB) for storing all basic data and information needed for the river basin management. The GIS database and the integrated basin analysis model are effective tools for the development and updating of the river basin management plan.

Attention has been paid to create an effective geo-spatial database, using contemporary GIS principles and technologies, based on international and national standards and legislation in order to provide accurate and up-to-date geographic information, related to the river basin management. The development of the GIS-DB is based on the existing technical infrastructure (software, hardware) of MoEW and related institutions, but it introduced some additional hardware and software products, technologies and procedures for use of geographical data.

The general functions for the use of the GIS-DB for MoEW are:

- Collection and integration of digital and non-digital data from variety of sources and formats to a standardized and structured model;
- Storing of geographic information and other related non-spatial information on a geodatabase level;
- Actualization of the geographic and other related non-spatial information;
- Performing of analysis and modeling of the geographic information;
- Facilitating the exchange of geographic information between the different informational databases within MoEW system; and,
- Exchange of geographic information with external systems (other ministries, governmental institutions, European commission).

The GIS-DB has been designed for the use in MoEW (Water Directorate), ExEA and the four RBDs. .

3.2 General Structure of the Data Model

The informational scope of GIS-DB includes three main parts:

- Core Portion of GIS-DB – basic data, including fundamental data common to all basin directorates,
- WFD Portion of GIS-DB – specialized data, required by the Water Framework Directive, and
- Local Portion of GIS-DB – specialized data, used by River Basin Directorates and MoEW, due to the regulations of the Water Act.

The Core Portion includes all fundamental data, which covers the whole territory of Bulgaria. It provides the “common picture” and up-to-date map of country, including over 50 layers of information.

Local Portion of the Data Model provides information, which is generated and used by the River Basin Directorates. The Local Portion of the Data Model is built and maintained "on the top" of the Core Portion.

WFD portion of the Data Model provides information for the reporting requirements to EU. This data is generated from Core Portion and Local Portion, following the WFD data requirements.

3.3 GIS Activities

Apart from the GIS Data Model development other main GIS activities during the project were as follows:

- Establishment of GIS workgroup,
- Development of Terms of Reference for Integrated Information System for MoEW and related institutions (delivered as separated document), and
- Training of counterparts.

3.3.1 GIS Workgroup Activities

The GIS Workgroup was established with the main purpose for discussion, review and acceptance of the common structure of the GIS Data Model, including all main parts. There were five official meetings of the GIS workgroup and one additional interim meeting. The GIS Workgroup includes participants from MoEW, all River Basin Directorates, ExEA and JICA Study Team members.

The main topics discussed were as follows:

- Review of the collected data from all RBDs: data condition and structure;
- Review and discussion on Core Portion of data model – review of documentation and geodatabase;
- Review and discussion on WFD Portion of data model – review of documentation and geodatabase structure; and,
- Review and discussion on Local Portion of data model – review.

3.3.2 GIS Training

The GIS training includes trainings of all members of GIS Workgroup. For EABD and WABD there was training on their premises, which included additional GIS personal from different departments. Main topics of the trainings were:

- Introduction of main building blocks of GeoDataBase;
- Review and use of Core Portion of the Data Model;
- Review and use of the WFD Portion of the Data Model; and,
- Review and use of the Local Portion of the Data Model.

3.4 Future Activities

Future activities for MoEW and RBD in regards to GIS are:

- MoEW should continuously maintain and expand the core portion of GIS Model;
- RBDs should continuously maintain and further develop and populate of the local portion of GIS Data Model;
- RBDs should further populate thee WFD portion of the data model based on the WFD time frame requirements;
- MoEW should continue the meeting of the GIS working group on a regular basis in order to discuss the date maintenance, further data model development and all other GIS related issues; and,
- MoEW should use and implement the proposed TOR for integrated information System.

4. INTEGRATED RIVER BASIN ANALYSIS MODEL

4.1 Modeling Concept

4.1.1 General

The model developed in the Study aims to be mainly utilized for the following purposes.

- Assessment for existing conditions,
  - Observed point data to spatially distributed presentation with some assumptions (e.g. estimation of basin average rainfall from the point rainfall).
- Planning such as long term strategy for water management, program measures
  - Checking effectiveness of some of program measures,
  - Reference for permission based on long-term strategy for water management.

The Study proposes the model that will be directly handled by Basin Directorates and will support their river basin management activity. Transparency of the model with clear explanation on assumptions for the model was important for this purpose.

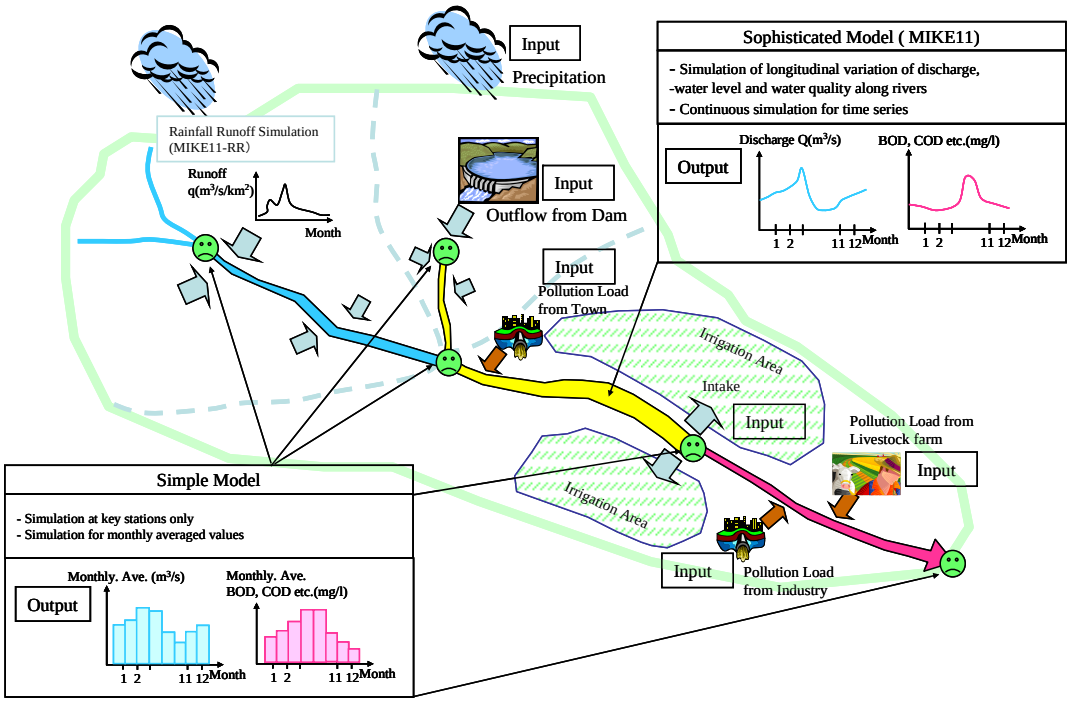
4.1.2 Simple Model and MIKE11 Model

In the Study, two different types of model are prepared. One is "Simple Model", which is based on basically simple mass balance and can be working in general software such as MS-Excel. Another one is "MIKE11 Model" which is well known but requires specific software for implementing the simulation.

Characteristics of the two models are summarized as below.

- Simple Model:
  - No specific modeling software
  - Spread sheet calculation only
  - Point representation at key points for management
  - Time scale: Monthly or Average in whole year and/or summer time
  - Reference for permission
  - Scenario setting for improvement plan
- MIKE11 Model:
  - Specific software (MIKE11& MIKE BASIN)
  - Physical process-based model
  - Spatio-temporal representation along river network
  - Time scale: Daily
  - Detailed simulation for confirming effects of improvement plan

The illustration below shows the relationship between Simple Model and MIKE11 model.



Relationship between Simple Model and MIKE11 Model

As for MIKE11 model, the following modules are introduced in the present study.

- Rainfall-Runoff Module (MIKE11-RR)
  - Conversion of Precipitation *to* Runoff in Catchment,
  - NAM model has been selected.
- Hydro Dynamic Module (MIKE11-HD)
  - Conversion of Inflow (Runoff in Catchment) *to* Flow Condition along River
- Water Quality Module (MIKE11-AD & Eco-Lab)
  - Conversion of Flow Condition and pollution load in River *to* Water Quality Condition along River

It is noted that MIKE11 can run the above components simultaneously. The GIS-DB developed by the Study, is a base of the modeling environment.

4.2 MIKE 11 Model for Water Quantity

4.2.1 Outline of Model

The outline of the model set-up is shown in the following table.

Outline of MIKE11 River Network and Rainfall-Runoff (NAM) Catchment

River Basin	Total Modeling Catchment Area (km^2)	Number of Rainfall-Runoff (NAM) Catchment	Total Length of Modeling River Network (km)	Number of Branch
Struma	8,667.18	25	343.14	6
Mesta & Dospat	3,397.71	14	141.80	3
Arda & Biala	5,811.84	12	332.10	5
Tundzha	7,890.93	20	409.46	5
Maritsa	21,272.27	34	954.98	20

The simulated results by MIKE11 water quantity model are utilized further for MIKE11 water quality analysis directly. Furthermore, the outputs of Rainfall-runoff model are utilized for Simple Model for water quantity.

4.2.2 Input Data for Water Quantity Model

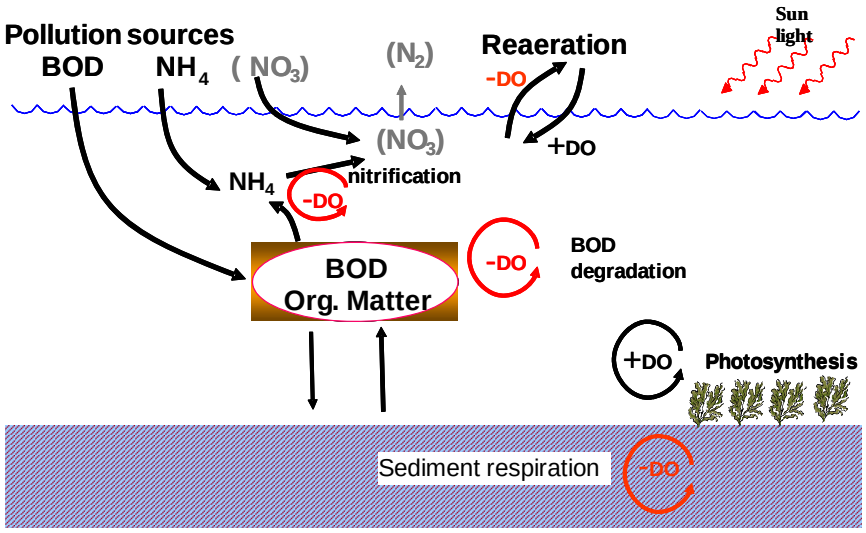
The following data were collected for modeling in the present study.

- Meteo-Hydrological Data
  - Precipitation
  - Potential evapo-transpiration (PET)
  - Air Temperature
  - Water quantity at key HMSs
- Water Transfer, Abstraction, Discharge Data
  - Reservoir operation (for significant reservoir)
  - Water abstraction
    - Irrigation water use
    - Domestic & Industrial water use
  - Water discharge (waste water)
- River Condition Data
  - Cross-section data

4.3 MIKE 11 Model for Water Quantity

4.3.1 Introduction

A MIKE 11 Water Quality Model (MIKE 11 EcoLab) is set up for all the water bodies described by the MIKE 11HD Hydraulic Model for water quantity. The selected water quality module focuses on degradation of organic matter, transformation of N-components and the consequences for the oxygen concentrations. The selected model includes in addition phosphorus compounds. The BOD, oxygen and N-transformation processes are outlined in the following illustration.



Basic Processes with Respect to BOD, N-Component and Oxygen (DO) Included in the MIKE 11 WQ Model Used under This Study

The WQ-module describes the following concentration (State Variables):

- BOD (Biological Oxygen Demand)
- Dissolved Oxygen (DO)
- Total Ammonium (NH_4-N)
- Nitrate (NO_3-N)
- Phosphate (PO_4-P)
- Phosphor bound to particulate material (Particulate –P)
- Temperature

4.3.2 Input Data for Water Quality Model

- Agricultural sources
  - From domestic live stock
  - From use of fertiliser
- Urban point sources
  - Out flow from WWTP (may include industrial wastewater)
  - Sewered but not treated sewage (may include industrial wastewater)
- Urban non-point sources
  - Sewered small settlements
- Non severed settlements and individual houses/farms
  - Industries point sources:
  - Direct discharge (including large animal breeding farms)

4.4 Simple Model

4.4.1 Water Quantity

Basic ideas of model for simple model is as follows:

- The Simple model for water quantity is basically based on monthly mass balance calculation. The calculation is implemented on spreadsheet such as Ms-Excel.
- Unit of analysis in space for the simple model for water quantity is a catchment. Water movement and balance among the catchments are analyzed by the simple model. To develop the simple model for water quantity, connectivity of the catchments is examined and an additional attribute for modeling catchment layer is recorded using GIS environment.
- In a catchment, the following sources are estimated.
  - Catchment Area
  - Run-off from Catchment
  - Abstraction from Catchment
  - Discharge from Catchment
  - Transfer from Catchment

4.4.2 Water Quality

In order to facilitate the formulation of water quality management plan and for future use for water quality management, simple model for water quality was developed in the Study. Basic Concept of the Simple Model for Water Quality (WQL Simple Model) is as follows:

- The WQL Simple Model will simulate the effect of reducing pollution loads to the river water quality in terms of BOD_5.
- The simulation will be done at key calculation points along the rivers.
- The calculation will be done by MS-Excel.
- The model can be utilized for quick review of the conditions of BOD loads in the river basins comparing the future required BOD loads to attain good status of water (such as Class II with BOD_5 3.0 mg/l).

5. SOCIOECONOMIC FRAMEWORK

5.1 Population

Population in Bulgaria shows a falling trend as a whole from the year 1985 as a peak, but in some municipalities Plovdiv in EABD and Blagoevgrad in WABD together the Capital City, Sophia are increasing during past several years and will increase on the trend. The population in 2015 in the project area has been estimated as follows for the planning purpose:

- In EABD, the population of the Municipalities of Plovdiv will increase to 348,206 with 0.18% (Case 2 Medium case) in the year 2015 from 341,673 in 2005, and that of the other municipalities will remain on the same level as it is.
- In the WABD, the municipality of Blagoevgrad will increase to 77,601 with 0.03% (Case-2 Medium case)) from 77,462 in 2005, and that of the other municipalities will remain on the same level as it is.

5.2 Economic Growth

According the actual growth of GDP trend in the past several years, the GDP of EABD and WABD will increase around 5% per annum in average through 2015.

Although the GDP has increased by 8.8% annually in average, and GDP per Capita has also increased by 9.4% annually in average, so these trend seems to be quite firm. In case taking price increase into account, both the actual GDP and the actual GDP Per Capita have been fluctuated around middle to upper end of 4%. Accordingly, it may be appropriate that GDP will be increased around 5% for the future too.

6. PROGRAMMES OF MEASURES FOR RIVER BASIN MANAGEMENT

6.1 Basic Scenario for the Programme of Measures

6.1.1 Summarization of the Issues

The EU-WFD aims to attain the target defined as "good water status for the surface waters and groundwater by 2015". According to the results of the Study, a large gap exists between the current water status and the good water status defined by the EU-WFD.

The physico-chemical conditions of the rivers are in general Class III (Moderate) to Class V (Bad), but more than 50% are in Class IV (Poor) to Class V (Bad), and the hydro-biological conditions are poor to bad conditions. The conditions show the results of the wastewater discharge with insufficient treatment as well as inflow of nutrients (nitrogen and phosphorous) into the rivers. Also the discharges of heavy metals (As, Pb, Zn, Cd) have been identified. There are many problems to be solved for improvement of water quality.

The major water users in the basin districts are hydropower, agriculture, domestic and industrial sectors, and the major pollution sources are wastewaters from urban settlements, industries, animal breeding farms and agricultural lands. They all have problems to be improved.

During the old order, the country had developed hydropower systems and large irrigation systems (irrigation area: over 1,200,000 ha in total) including large inter-basin transfer of water with little consideration of the environmental aspects like river water quality and quantity, environmental flows, and also developed water supply facilities (service population: over 98%). However the irrigation systems and water supply networks are deteriorated because of poor maintenances and superannuation. Current irrigation potential areas have been decreased to about 500,000 ha (with actual irrigation area at about 50,000 ha) with water loss over 60-70%, and the water supply systems have a large loss over 60%. Urgent improvement works will be required from effective water management aspect.

A lot of urban settlements and industries discharge their sewerage and wastewaters to rivers without proper treatment. There are 73 existing WWTPs, but the existing WWTPs and sewer networks have become old and superannuated, and sewer pipes are leaking sewage and polluting groundwater. Urgent measures are required.

Also inadequate river management has been causing many problems like improper issues of permissions for water intakes and discharges, excessive extraction of sand and gravels from riverbeds and flood plains, illegal dumping of solid wastes into rivers, and erosion of riverbanks and flood dikes and aggravating risks of flood damages. Establishment of river management will be required.

6.1.2 Target Year for the Completion of the Programmes of Measures

According to the time schedule set by the EU-WFD, the RBMP including improvement plans should be formulated by the end of 2008 and commenced in 2010. Bulgaria is paying effort to follow the schedule, however, it may not be an easy task to formulate the RBMP of the national level.

The implementation of structural measures will require the three steps, "F/S", "D/D" and "construction", and require more than two years for tendering, selection of consultants and constructors. When the conditions of lack of implementing organization and lack of experience are considered, it may be difficult to expect effective preparation activities.

There are many existing sewerage facilities, which need rehabilitation because of poor maintenance work and superannuation, and also there may be increment of many unexpected measures to cope with.

Implementation of the proposed River Basin Management Plan by the target year 2015 is thus deemed difficult, and hence, the target year should be set at 2021 or 2027, years for every six years review defined by EU-WFD.

6.1.3 Basic Scenario of the Programmes of Measures

In order to attain the good water status and conduct the sustainable use of water resources, the programmes of measures require various measures composed of structural and nonstructural measures. The river basin management plan is to be formulated based on the integrated water management approach, including required measures for management of water quality, water quantity, river morphology and disaster prevention.

The basic scenario for the programs of measures to formulate the RBMP is proposed as follows:

- To improve water quality for attaining the good physico-chemical status was given priority for surface water and groundwater;
- To improve water quality by phased expansion of the municipal wastewater treatment capacities by new construction of wastewater treatment plants (WWTPs) and also by phased rehabilitation of the existing WWTPs by reducing organic pollutants and nutrients inflow to water bodies;
- To rehabilitate the existing sewer networks to reduce the sewage loss to increase the efficiency of wastewater treatment and also reduce the seepage of sewerage into the ground to avoid possible groundwater pollution;
- To improve the management and regulation in order to conduct more strong control of reducing the discharge of untreated or improperly treated wastewaters from industries, mines and animal breeding farms;
- To rehabilitate water supply networks to reduce the high rate of water supply loss of 60-70%;
- To improve facilities required for efficient water use of water use sectors like domestic water supply networks and irrigation facilities;
- To improve the permission of water intakes and the distribution of water resources based on the water balance of each river basin;

- To improve the management and regulation in order to conduct more systematic management for rivers morphology, river channels, river flows, sediment and also floods disaster, flood hazard areas;
- To prepare programs of measures composed of the following components:
  - Water quality improvement and management;
  - Water quantity improvement and management;
  - Management of river morphology.

6.2 Water Quality Improvement and Management Plan

6.2.1 Structural Measures

Direction of Formulation of Structural Measures

In order to improve the current situation of water quality, the direction of formulation of structural measures has been determined as follows:

- From the view point of water quality improvement in the entire river basin, the water quality of the main river course has been selected as in indicator, and set up priority zones based on the BOD loads;
- To select high priority towns for wastewater treatment by considering the effects of BOD load reduction in the catchment area as well as referring to the priority zones;
- To construct new wastewater treatment plants (WWTPs) and rehabilitate existing WWTPs from major towns, then treatment of wastewater from medium to small size towns and settlements;
- Treatment for nitrogen and phosphorous; and,
- Improvement of sewer networks.

Applied Ratio of PE / Population (PE: Population Equivalent)

PE size of Town / Settlement	Ratio of PE / Population
PE ≥ 10,000	• 1.5 in principle, or • Ratio in Document A.
2,000 ≤ PE < 10,000	• 1.2 in principle, or • Ratio in Document A.
500 ≤ PE < 2,000	• 1.2 in principle
PE < 500	• 1.0
Document A: "Implementation Program for Directive 91/271/EC concerning Urban Wastewater Treatment" (National Program for WWTP).	

Unit Loads for Domestic and Industrial Load discharged into Sewerage Systems

Item	BOD (g/day/PE)	TN (g/day/PE)	TP (g/day/PE)
1) Raw: 1pe	60	11	1.8
2) Sewered without treatment	60	11	1.8
3) With primary treatment by the existing WWTP	35	11	1.8
4) With secondary treatment by the existing WWTP	10	4	1
5) Without sewerage system	15	3	1
6) With new WWTP including TN and TP treatment	6	2.5	0.9

Proposed Measures

The proposed measures are formulated under the following conditions:

- As infrastructure improvement, new WWTPs and rehabilitation of the existing WWTP are proposed for the high priority towns.
- To attain good water quality (Class II, BOD 3.0 mg/l), required reduction of BOD load is about 50% for the Maritsa, Tundzha, Struma and Mesta rivers are to be reduced. Considering the realistic plan for the completion of the implementation by 2015 or 2021, however, target reduction of BOD load by the WWTPs for the priority towns is set at 30%.
- The proposed high priority towns for treatment are selected from reduction % of BOD load against the near future BOD load case (existing, presently under construction WWTPs, and WWTPs to be implemented in the coming 2-3 years (already funded by EU, etc. or committed)) and high priority zones.
- The proposed WWTPs (new and rehabilitation) will have treatment facilities for BOD, TN and TP.
- High Priority Towns for wastewater treatments are as follows (see **Figures 8** and **9**):

(1) EABD Areas: 22 towns

Construction of New WWTPs (18 towns) and rehabilitation of sewer networks:

- Maritsa River: 13 towns
- Tundzha River: 4 towns
- Arda River: 1 town

Rehabilitation of existing WWTPs (4 towns) and rehabilitation of sewer networks:

- Maritsa River: 3 towns
- Tundzha Rivers: 1 towns

High Priority Towns (22 Towns) for Treatment in EABD Areas

Priority	Town	River Basin	PE in 2015	WWTP	Sewerage	Remarks
I.	**New WWTPs in the Maritsa River Basin**					
I-1	Asenovgrad	Maritsa	78,054	New	Improvement	
I-2	Plovdiv	Maritsa	681,985	Existing	Improvement	Only SW improve.
I-3	Karlovo	Maritsa	37,181	New	Improvement	Under construction (only a part). Increase the budget is required.
I-4	Velingrad	Maritsa	28,752	New	Improvement	
I-5	Peshtera	Maritsa	28,691	New	Improvement	
I-6	Harmanli	Maritsa	28,538	New	Improvement	
I-7	Svilengrad	Maritsa	28,050	New	Improvement	
I-8	Chirpan	Maritsa	25,413	New	Improvement	
I-9	Rakovski	Maritsa	23,453	New	New	
I-10	Panagyurishte	Maritsa	23,029	New	Improvement	
I-11	Parvomay	Maritsa	22,200	New	Improvement	
I-12	Stamboliyski	Maritsa	18,068	New	Improvement	
I-13	Kostenets	Maritsa	11,048	New	Improvement	Most upstream town.
II.	**New WWTPs in the Tundzha River Basin**					
II-1	Yambol	Tundzha	118,971	New	Improvement	
II-2	Karnobat	Tundzha	28,916	New	Improvement	
II-3	Elhovo	Tundzha	16,808	New	Improvement	
II-4	Kalofer	Tundzha	4,229	New	Improvement	Most upstream town.
III.	**New WWTPs in the Arda River Basin**					
III-1	Kardzhali	Arda	67,346	New	Improvement	
IV.	**Rehabilitation of the Existing WWTPs**					
IV-1	Nova Zagora	Maritsa	36,185	Rehabilitation	Improvement	
IV-2	Radnevo	Maritsa	20,691	Rehabilitation	Improvement	
IV-3	Ihtiman	Maritsa	20,234	Rehabilitation	Improvement	
IV-4	Pavel banya	Tundhza	4,407	Rehabilitation	Improvement	

(2) WABD Areas: 9 towns

Construction new WWTPs (6 towns) and rehabilitation of sewer networks:

- Struma River: 3 towns
- Mesta River: 2 towns
- Dospat River: 1 town

Rehabilitation of existing WWTPs (3 towns) and rehabilitation of sewer networks:

- Struma River: 3 towns

High Priority Towns (9 Towns) for Treatment in WABD Areas

Priority	Town	River Basin	PE in 2015	WWTP	Sewerage	Remarks
I.	**New WWTPs in the Struma River Basin**					
I-1	Petrich	Struma	45,020	New	Improvement	
I-2	Sandanski	Struma	40,358	New	Improvement	
I-3	Simitli	Struma	8,242	New	Improvement	
II.	**New WWTPs in the Mesta River Basin**					
II-1	Gotse Delchev	Mesta	30,185	New	Improvement	
II-2	Bansko	Mesta	11,493	New	Improvement	
III.	**New WWTPs in the Dospat River Basin**					
III-1	Dospat	Dospat	3,218	New	Improvement	Currently, only sewage from the town flow in the river.
IV.	**Rehabilitation of the Existing WWTPs**					
IV-1	Pernik	Struma	121,350	Rehabilitation	Improvement	
IV-2	Dupnitsa	Struma	55,224	Rehabilitation	Improvement	
IV-3	Radomir	Struma	21,621	Rehabilitation	Improvement	

Cost for Proposed Measures

Project costs are estimated and shown in the following table:

Estimated Rough Construction Cost for the New and Rehabilitation of WWTPs and Improvement of Sewer Networks in EABD and WABD Areas

Basin District	WWTP		Sewer Networks		Total Cost (in 1,000 euros)
	PE in 2015	Cost (in 1,000 euros)	Rehabilitation (m)	Cost (in 1,000 euros)	
EABD	1,352,249	206,050	3,130,054	1,628,082	1,834,133
WABD	336,711	72,074	1,216,948	536,553	608,627
Total	1,688,960	278,124	4,347,002	2,164,635	2,442,760

6.2.2 Non-structural Measures

The non-structure measures for water quality improvement and management has been proposed as follows:

- Apart from the surface water monitoring system as discussed in the next sub-section, to strengthen collaboration between the RBDs and local governments for daily water quality management work in order to monitor what is happening in the river basins and prepare for quick action, e.g. for accidental pollution, to be required;
- Reduction of pollution loads from industries and large livestock farms by strengthening of regulation;

- Improvement of septic tanks to sealed type or to introduce individual treatment. Periodically sludge should be extracted and treated. Financial support system to people shall be necessary for the improvement;
- Reduction of pollution load from the agricultural lands by changing farming methods and technology to reduce chemical fertilizer and pesticide
- To conduct a study on pressures and impacts from discharges or priority substances, 33 harmful substances defined by the EU-WFD, and heavy metals, and also closed mines in the basin necessary to protect people from possible hazard caused by discharge of toxic substances.

6.2.3 Improvement of Surface Water Monitoring System

(1) New Monitoring Program for Surface Water

Based on the risk assessment of surface water bodies and groundwater bodies, MoEW and the Basin Directorates formulated a New Monitoring Programs in March 2007, which is composed of new programs for surface water monitoring and groundwater monitoring.

Total number of the monitoring points of the New Surface Water Monitoring Program in the country is 522 points (surveillance monitoring: 259 and operational monitoring: 263). The surveillance monitoring will make overview the condition of the basin, give idea for efficient monitoring programme, and monitor long-term changes of the basin. The operational monitoring will monitor the status of the water bodies at risk, and assess the impact of the programme of measures.

The proposed 522 points are those rearranged on the basis of the present ExEA stations, and which is slightly more than the number of the points of the existing surface water monitoring of ExEA, thus there is no much change in the number of monitoring stations. However, the parameters to be monitored are very much increased and their frequency for monitoring is also rather high (e.g. 12 times per year for the priority substances for surveillance monitoring for one year at least). Furthermore, Bulgaria has no much experience for measuring many of the priority substances.

(2) Proposals for Setting Key and Important Monitoring Stations

Considering this situation, it is recommendable to set key monitoring stations as well as important monitoring stations among the surveillance monitoring points to ensure stable monitoring and to overview the water quality conditions of the river basins. Furthermore, at these key stations, it is necessary to measure the water quantity as well. In order to conduct this kind of permanent monitoring at the key monitoring stations, the Basin Directorates are necessary to establish their own monitoring stations both for water quality and water quantity.

In EABD and WABD, key monitoring zones as well as important monitoring zones, in which the key monitoring stations and important monitoring stations are to be set, are proposed by the Study. The key monitoring zones and the important monitoring zones are shown in **Figure 10**.

Proposed Key Monitoring Zones and Important Monitoring Zones in EABD and WABD

Key/Important Monitoring Zones	EABD	WABD	Monitoring
Key Monitoring Zone	12 places	7 places	Daily ocular observation and simple on-site measurement. Monthly sampling and analysis.
Important Monitoring Zone	10 places	4 places	Weekly ocular observation and simple on-site measurement. Monthly sampling and analysis.
Total	22 places	11 places	

If key monitoring zones and important monitoring zones will be in EABD and WABD as above and also set in DRBD and BSBD areas with the same principle, order of the key monitoring zones in the country will be around 50 and important monitoring zones will be around 25.

It is recommended to report EU the results of the monitoring at the key monitoring zones and important monitoring zones instead of the results of monitoring at 259 surveillance stations.

6.3 Water Quantity Improvement and Management Plan

6.3.1 Structural Measures

Direction of Formulation of Structural Measures

The direction for the formulation of structural measures is set as follows:

- Improvement of water supply pipes to reduce water loss at presently over 60% mainly asbestos cement and steel pipes,
- The existing irrigation systems are deteriorated with high water loss over 60-70%. Although actual water consumption is small, water abstraction is thought much larger due to large water loss and no or improper intake and distribution facilities (gate and canal). It is necessary to renovate the irrigation system considering the current and future demand of irrigation water. Irrigation improvement will be one of the key issues for efficient and sustainable water use and also for the sustainable development of agriculture and region based on the efficient water use.
- Improvement of irrigation facilities to provide irrigation area with optimum water volume and to make efficient water use including reduction of water loss has thus been proposed.

Proposed Measures

(1) Water Supply Improvement for Reducing High Water Loss over 60%

Necessary replacement of water supply pipes of the existing water supply systems is as follows (rough estimates based on the interview at WSSs):

Improvement of Water Supply System and Cost

Basin Directorate	Length of replacement (1,000 m)	Cost (in million euros)
EABD	Max. about 16,564	3,139
WABD	Max. about 4,886	919
Total	Max. about 21,450	4,058

Order of the necessary cost for rehabilitation is about 4.0 Billion euros.

(2) Improvement of Irrigation System in EABD and WABD

In EABD there are 8 irrigation branches and 82 irrigation systems, and in WABD there are 4 branches and 41 irrigation systems. The proposed improvement of potential irrigation areas is as follows (see **Figures 11** and **12**), and rehabilitation mainly of intake and diversion structures, and canals will be conducted:

Proposed Irrigation Area for Improvement and Its Cost

Basin Directorate	Irrigation Area (ha)	Number of Irrigation Systems	Cost (in million euros)
EABD	316,468	82	231
WABD	50,738	41	42
Total	367,206	123	273

The following is priority areas for the improvement of irrigation system.

Priority Group of Irrigation System Rehabilitation

Basin Directorate	Irrigation Area (ha)	Irrigation Branch	Cost (in million euros)
EABD	94,948	- Provdiv - Pazardjik	84
WABD	17,730	- Pernik - Sandanski - Gotse Delchev	20
Total	112,678		104

6.3.2 Non-structural Measures

Non-structural measures of water quantity management and improvement are as follows:

- Review and improvement of water use permission for optimum water intake and use, and also water transfer to the other river basins;

- Monitoring of water intake volume by installing measurement devices by water users for intake sides as well as Basin Directorate at key locations in the rivers; and,
- Improvement of quality of data required for water quantity management, including collaboration with National Institute for Meteorology and Hydrology (NIMH) as well as other relevant institutes.

6.4 Groundwater Management Plan

Preliminary programme of measures for groundwater management is proposed in the sense of directions for improvement and management of the groundwater. Furthermore, some recommendations are presented for the New Monitoring Plan for groundwater, which was formulated by MoEW and the RBDs in March 2007.

6.4.1 Preliminary Programme of Measures for EABD

- Main ore mineralizations are concentrated in EABD. There are old tailings that present threat to ecological safety. Database and GIS-map of old pollutions, especially tailings, is necessary. Abandoned mine sites inventory and cleanup program for remediation are especially important for EABD. An appropriate cleanup program will improve water quality and enhance public safety.
- The problem with arsenic in drinking waters in Poibrene village is not yet solved. It is situated downstream from mining area; pollution from old tailing may occur from there. It is a hot spot problem. Urgent measures are required to solve this problem.
- Application of good agricultural practices is necessary to reduce nitrate content in the region of Stara Zagora.
- A plan for regional model of the groundwater flow in the region of Yambol-Elhovo area is needed.

6.4.2 Preliminary Programme of Measures for WABD

- Special attention should be paid to quantitative monitoring of Blagoevgrad GWB – '*At risk*'. Groundwater research and modeling should be planned to re-assess groundwater resources of this groundwater body.
- Assessment of specific natural groundwater quality in mountain regions impacted by ore mineralization – for reference should be conducted.
- It is necessary to carefully control groundwater abstractions in the region of the winter resort Bansko.

6.4.3 Recommendations for Improvement of the Groundwater Monitoring

The proposed groundwater monitoring programs by EABD and WABD are very ambitious.

Number of Monitoring Stations in the Proposed Monitoring Plan

Monigorint	EABD	WABD	DRBD	BSBD
Water Quality Surveillance	38	33	49	66
Water Quality Operation	12	-	21	37
Water Quantity	41	34	86	63

Its overview shows some weaknesses and obstacles, some of them foreseen by the RBDs. The difficulties marked by RBDs are as follows

- Possible cooperation with NIMH and WSSs has no legal basis – no agreements signed between MoEW and NIMH/WSSs.
- Laboratories have low human resource to respond to increasing tasks due to insufficient staff. Several vacancies are in Laboratories in Blagoevrad and Sofia.

6.5 River Management Plan

The proposed river management plan is as follows:

- To regulate sand/gravel extraction more strictly, so that not to make unstable condition of the river channel and surrounding flood plain areas;
- To control any illegal activities or improper activities along the river, including solid waste dumping and land development;
- To conduct a study of " River Maintenance Plan" for the basis of prevention of flood damages and control sand and gravel extraction as well as improvement of environmental status of water bodies from the view point of river morphology; and,
- To conduct a water resources development study (river flow regulation study) considering detailed river regime, water transfer, water use, environmental flow, etc. and will assess the need of additional hydro-technical facilities to be constructed as well as the restarting of construction of the suspended ones as a part of the integrated water management in Bulgaria and to meet the challenge of global climate change.

6.6 Scale of Annual Disbursement for Structural Measures

Scales of annual disbursement for structural measures in EABD and WABD based on the rough implementation plan in the established River Basin Management Plan (Draft) are as shown in the table below. The improvement of water quality areas from the present Class III to V condition to the middle of Class II and III will be realized with the total investment scale of 2,443 million euros to the sewerage sector. With regard to the improvement of water supply network, annual investment scale at 239 million euros will be necessary if the target year for completion is set at 2027. Improvement of irrigation facilities will require annual investment scale at 27 million euros for the target year at 2020.

Item	Investment Plan (in million euros)	Annual Scale of Investment (in million euros)
Sewerage	2011－2014: 4 yeas 2,051 2015－2018: 4 years 392	513 98
Water supply	2011－2027: 17 years 4,057	239
Irrigation	2011－2020: 10 years 273	27

6.7 Economic Analysis on Structural Measures

6.7.1 Water Quality Improvement Measures

The cost for new construction and rehabilitation of sewerage facilities has been estimated based on the unit cost per PE (Population Equivalent) multiplied by the PE for each project. Unit cost per PE is different case by case. Project life has been set at 30 years after completion of the construction works, and operation and maintenance cost at 7.5% of the direct construction cost has been considered. Benefit from WWTP has been determined based on the assumption that improvement of water quality results in the increase of water that could be used, thus the unit benefit has been determined from the source water cost. The benefit to be derived from the reduction of water born disease (reduction in medical cost and reduction in income loss due to absence of work) has also been considered.

Benefit from the rehabilitation of sewerage network is considered as the reduction of water leakage and resulting pollution of groundwater. Assuming the groundwater is used for people if no pollution, thus the unit cost of average domestic water was applied as the basis for the benefit estimation. The implementation of the project has been considered for eight years from 2011-2018. The calculated EIRRs are over 10% and it is judged feasible in terms of national economy.

Area	NPV (Million Levs)	EIRR	B/C
EABD	108	10.8%	1.06
WABD	208	14.0%	1.35
Both Areas	316	11.7%	1.14

Note: Discount rate：10%, Target year：2021

6.7.2 Improvement of Water Supply Networks

Basic information on the improvement water supply networks was obtained through interview to WSSs. Information was available at 22 WSSs out of the total at 26. The economic evaluation on the improvement of water supply networks has been conducted for these 22 WSSs. Feasibility study is needed for each project before proceeding to the implementation of the project in the future, the results of sample evaluation show relatively higher economic feasibility, though there is much fluctuation. The cost was based on the interview results. The project life at 30 years has been considered after the completion of the construction works, and the operation and maintenance cost at 1.5% of the direct construction cost has been adopted. Benefit has been estimated based on the

assumption that reduced water loss would create people's expenditure for domestic water use. Implementation period was set for 10 years period from 2011-2020. .

Area	NPV (Million Levs)	EIRR	B/C
EABD	1,454	17.8%	1.63
WABD	275	15.0%	1.41
Both Areas	1,729	17.1%	1.58

Note: Discount rate：10%, Target year：2021

6.7.3 Improvement of Irrigation Facilities

Cost for the improvement of irrigation facilities has been estimated based on the results of the interview at Irrigation Companies. Project life has been determined at 30 years period and annual operation and maintenance cost at 5.0% of the direct construction cost has been adopted. Benefit from the improvement of the irrigation facilities was assumed based on the assumption that the water loss saved by the improvement would be used for the new irrigation and hence the agricultural production would increase. Implementation period of 10 yeas from 2011-2020 has been considered. The proposed improvement of irrigation facilities is considered feasible.

Area	NPV (Million Levs)	EIRR	B/C
EABD	65	14.5%	1.29
WABD	14	15.2%	1.34
Both Areas	79	14.6%	1.30

Note: Discount rate：10%, Target year：2021

7. PROJECT EVALUATION

7.1 Technical Aspect

The proposed structural measures for water quality and quantity improvement include new construction and rehabilitation of wastewater treatment plants, rehabilitation of sewerage networks, rehabilitation of irrigation networks, rehabilitation of domestic water supply facilities. It has thus been judged there are no specific technical difficulties and all the work could be covered by the technology available in Bulgaria.

The proposed non-structural measures include revision of laws and regulations, improvement of organizations and institutions, strengthening of enforcement of regulations, strengthening of organizational collaboration. There would be no difficulties in technical aspects. With regard to the changing of farming practices and renovation of technology for the reduction of agricultural chemicals and fertilizers, support from the EU member countries would be available if there is no enough technical know-how in Bulgaria.

GIS Database and Integrated River Basin Analysis Model developed as the decision support tools for the formulation and implementation of the river basin management plan are based on the state of the art technology. Simulation of water quantity and quality could thus be conducted with a high technical level, and river basin management with the sound technical background could be realized with these tools. The river basin management in Bulgaria is now supported by the high level technology and it is evaluated good results of the Study.

7.2 Economic Aspects

As discussed above, the proposed structural measures for water quality improvement and water quantity improvement have sufficient economic feasibility. This means that the deterioration of water quality and loss of water quantity were giving a huge adverse impact to the national economy of Bulgaria.

For the implementation of each project for water quantity and water quality improvement, feasibility studies should be conducted to confirm the economic feasibility of each project.

7.3 Financial Analysis

An expenditure group of activities as “Housing, Public Utilities and Amenities, and Protection of Environment” includes the work for water management. The amount and the share to the total expenditure are 586 million Levs and 3.9% in 2004, and 726 million Levs and 4.4% in 2005. The state budget had surplus at around 655 million Levs in 2004 and 1,334 million Levs in 2005, it is thus deemed possible to increase the state budget for river basin management as “Housing, Public Utilities and Amenities, and Protection of Environment”.

The tariff systems for domestic water are decided by the State Energy and Water Regulatory Commission based on applications of the services provider including WSSs.

The tariff systems are decided not based on the financial status of the service providers, especially no to be based on cost for works, but based on welfare standard for the people. International financing institutions as the World Bank suggest that projects with collecting some charges should be based on recovery of cost for business, thus review of the tariff systems will be deemed necessary. Of course, affordability of people to pay (ATP) should be taken into consideration in this case.

Current financial status of Irrigation Systems Company PLC, the share of the current operating profit are extremely low at around 0.04% (year 2005) to the total liability (=assets). As the commercial enterprises, it is expected that the share of current operating profit to the total liability (=assets) should be kept at least at around 2% through 5%.

If the irrigation systems are improved and if the irrigation areas will be expanded, and if the potable water supply systems are improved as recommended in this Study, the said current operating profit will be drastically increased and financial status will be improved.

7.4 Environmental and Social Consideration Aspects

The draft RBMPs have their objectives for "good status of water environment", and themselves will contribute many favorable environmental and social impacts such as water quality improvement for surface water and groundwater, sanitary improvement and conservation of flora/fauna and ecosystem due to water quality improvement, social infrastructure services improvement (reduction of high water loss, etc.), local socio economic development due to promotion of effective water uses, and conservation of living environment related to appropriate river management plan and others.

On the other hand, there are possibilities that the construction of the proposing facilities based on the draft RBMPs may cause some slight adverse impacts (temporary water pollution, or dust or noise related to the construction of the WWTP, and others) on the existing natural and social environments. There are also possibilities that any adverse gaps for the poor, ethnic peoples in the remote areas in terms of socio-economic benefits by implementation of effective water supply plan or flood control plan may expanded, if the implementation measures are not appropriately.

Therefore, the mitigation measures for the possible adverse impacts and the recommended monitoring and control plan shall be considered as one of the activities of the finalized RBMPs themselves. The concrete construction locations or scales of the proposing physical facilities are not identified yet in the draft RBMPs stage. Therefore, Bulgaria's sides could be evaluated more detail possible adverse environmental and social impacts and their affected areas by the proposing facilities after finishing this JICA Study.

It is proposed that Bulgaria's side could conduct environmental and social considerations, which will become an Environmental Assessment and based on EU and Bulgaria's relevant regulations, for the finalized RBMPs by referring the IEE for the draft RBMPs. IEE includes the preparation of the draft Environmental Assessment Report, which is based on the EU and Bulgaria's regulations.

8. IMPLEMENTATION ORGANIZATION

8.1 Summarization of Issues

Issues related to organizational and institutional aspects for the implementation of programmes of measures of the proposed RBMP are summarized as follows:

Basin Directorates are responsible to conduct a variety of river basin management work which includes approval for intake, discharge, groundwater well installation, sand and gravel mining in rivers and riverine areas, construction works in rivers, and development activities in rivers, etc., and monitoring and surveillance of them, conservation of protection areas, and actions for emergency, e.g. floods. However, responsibilities and authorization are scattered to relevant agencies, e.g. approval for discharge from industries to sewer is by local governments, approval for intake from major reservoirs and drilling for mineral water is by MoEW, and this situation makes the river basin management complicated and difficult.

River management is by local governments in their territory, though the management of river related facilities are different depending on the owner of the facilities. Hydropower generation facilities are under MoEE, riverbanks are under MoAF and local governments, solid waste treatment related matters are under local governments and RIEW, inspection of wastewater discharged from industries is under RIEW. The body of the management is different by location and by facility, and there are many related authorities, thus the necessary actions are made ad hoc.

MoEW and Basin Directorates are responsible, defined by the Water Act, for the establishment of river basin management plan matching to the request of EU-WFD and periodical (every six years) review of the plan. From now on, they should install a lot of monitoring facilities and conduct monitoring work by them selves following the new monitoring plan that satisfies the requirement of EU-WFD. The Basin Directorates at present even lack budget to maintain the office and staff, and it is very difficult to increase staff necessary to implement required tasks for the river basin management. Preparation for the new fields for river basin management, capacity development of staff, increase in staff numbers are deemed necessary.

With regard to the sector of floods, MSPDA has been established in 2006 and there established a system for emergency activities, though institutions for flood control has not been established. Directorate of Water of MoEW and Basin Directorates should be responsible for flood control as a pat of river basin management work. Management of river morphology and river related facilities, and control of development activities and illegal activities in rivers and riverine areas should be added to the work of river basin management, though technical know-how for the preparation is lacking.

Implementation of river basin management through public participation as requested bythe EU-WFD, and it should be continued in the future.

8.2 Improvement of Institution and Organization

In order to solve the institutional and organizational issues as summarized above, the following measures should be conducted. The amendment of laws and regulations, change in responsibilities, and reform of institution and organization require detailed studies. They are correlated each other, e.g. necessary staff numbers of organization is determined after changing responsibilities, etc. Only the direction is shown below in the present Study, it should be studied in detail by the Bulgaria Government in parallel with the formulation of the final River Basin Management Plan.

- In order to implement river basin management (water quality, water quantity and river morphology) in an organized manner, is should be made clear the responsibilities of the Basin Directorate and strengthen the responsibility accordingly. With regard to river management, responsibilities of relevant organizations shall be reviewed for the management principally by RBD. The present responsibilities should firstly be analyzed and ideal distribution of the responsibilities shall be proposed.
- In order to implement the River Basin Management Plan in Bulgaria in accordance with the requirement of EU-WFD, strengthening of organizations both in the central level (Water Directorate of MoEW) and the regional level (four Basin Directorates) is indispensable. Through the review of responsibilities of each organization to strengthen the authority, considerable increase (at least double) of the staff number, the capacity development, and corresponding increase of the budget shall be indispensable. The Bulgarian Government shall conduct further study on the way of strengthening the organizations and establishing a good collabolation with relevant agencies.
- For the proper implementation of river basin management, establishment of collaboration system with the various stakeholders (water users, wastewater discharging bodies, developers, etc.) upon raising their awareness is deemed important. Inclusion of stakeholders to the monitoring work shall be considered through giving responsibility of the installation of measurement devices for intake water volume, discharging water volume and quality, sand and gravel mining volume, etc.

9. CONCLUSION AND RECOMMENDATION

9.1 Conclusions

The Study Team supported MoEW and Basin Directorates for the formulation of River Basin Management Plan throughout the Study, and the concrete output of the Study includes the following:

- Through the investigation and evaluation of the present condition related to the river basin management focusing on the water quality and quantity, it has been revealed that there exists a large gap between the current water status in the country and the "good water status" defined by the EU-WFD.
- As a result of the Study, established is GIS Database that is required by the EU-WFD. In the GIS Database, the core portion covers the whole country, the WFD portion covers EABD, WABD and the pilot river basins of DRBD and BSBD, and the local portion covers EABD and WABD. The RBDs are able to conduct the river basin management activities based on the correct GIS Database.
- As an integrated river basin management model, sophisticated model (using Mike11) and simple model (using MS-Excel) both for water quantity and quality have been developed. Simulation of water quantity and quality could thus be conducted with a high technical levelUtilizing these decision and policy support tools, the Study proposed programme of measures mainly for water quantity and water quality improvement.
- The proposed RBMPs are basic plans prepared based on the requirements both of the EU-WFD and the Bulgarian Water Act, but not the RBMPs according to the EU-WFD requirements.

According to the programmes of measures in the proposed RBMP (Draft), investment of 2.4 billion euros scale amount for the new construction of WWTPs and rehabilitation of existing WWTPs and sewer networks in order to improve the present water quality in the levels of Class III to V to the levels around the middle of Class II and III in EABD and WABD. Water quantity improvement in the EABD and WABD will be realized by the improvement of domestic water supply systems with the investment of 4.0 billion euros scale amount and by the improvement of irrigation facilities with the investment of 270 million euros scale amount.

The proposed non-structural measures, e.g. strengthening of regulation, strengthening of monitoring are necessary to improve the parts not covered by the structural measures, to implement the structural measures smoothly and to assure the effect of the structural measures.

9.2 Recommendations

Through the Study, it is recommended that the government should take immediate actions and arrangement for the implementation of the RBMP as follows:

- In order to attain the target of the EU-WFD, the Government of Bulgaria should finalize the RBMP and commence the implementation of the RBMP in 2010. It is recommended to prepare the river basin management plans for EABD and WABD through the utmost utilization of the results of the Study and to prepare the river basin management plans for the whole nation.
- The implementation of proposed programmes of measures to attain the "good status of water" defined by the EU-WFD should be conducted as the national project for water. The proposed measures for improvement and management of water quality and quantity and river morphology management are all basic measures for the attainment of the "good status of water" in the country and recommended to be conducted under the national project for water and not by relevant implementation bodies independently.
- In order to implement the River Basin Management Plan in Bulgaria in accordance with the requirement of EU-WFD, strengthening of organizations both in the central level (Water Directorate of MoEW) and the district level (four Basin Directorates) is indispensable. Through the review of responsibilities of each organization to strengthen the authority, considerable increase (at least double) of the staff in number, the capacity development, and corresponding increase of the budget shall be indispensable. The Bulgarian Government shall conduct further study on the way of strengthening of the organizations and establishing of collaboration with other relevant agencies, including NIMH, which has basic meteorological and hydrological data of the basins.
- The RBD should conduct basic studies for the river basin management as follows:
  - The study on "River Management Plan" for the basis for prevention of flood damages and controlling sand and gravel extraction as well as improvement of environmental status of water bodies from the view point of river morphology,
  - The study on pressures and impacts from discharges or priority substances, which are 33 harmful substances defined by the EU-WFD, and heavy metals, and also closed mines in the basin necessary to protect people from possible hazard caused by discharge of toxic substances, and
  - The study on water resources development and river flow regulation, considering detailed river regime, water transfer, water use, environmental flow, etc., and assessing the need of additional hydro-technical facilities to be constructed as well as the restarting of construction of the suspended ones, as a part of the integrated water management in Bulgaria and to meet the challenge of global climate change.
- The decision support and managing tools of GIS Data Model and Integrated Water Management Models should be maintained and updated in a sustainable manner for effective use for river basin management.

Summary

Tables

Table 1 List of Major Rivers

No	Name	Length (km) (*1)	Total Cacthment Area (km^2) (*1)	Average Discharge (m^3/s) (*2)	Annual Flow Patterns (*2)	
					Maximum	Minimum
1	Ogosta	135	4,282	18	April	August
2	Iskar	338 (*3)	8,634	54	April	August
3	Vit	157 (*4)	3,228	15	May	October
4	Osam	199 (*5)	2,838	15	May	October
5	Yantra	219	7,862	42	April	October
6	Rusensli Lom	165 (*6)	2,985	5	March	September
	Others		13,007			
	DRBD total		42,837			
7	Kamchia	191	5,363	22	April	October
	Other		15,603			
	BSBD total		20,966			
8	Tundzha	310	7,901	38	April	October
9	Maritsa	302	21,292	108	March-May	August
10	Arda	229	5,213	73	January	September
11	Biala	70	636			
	Other		823			
	EABD total		35,230			
12	Struma	266	10,852 (8,541 in Bulgaria)	80	May	August
13	Mesta	122 (*7)	2,785	32	May	August-October
14	Dospat	79	635			
	Other		5			
	WABD total		11,966			

(*1) Source: JICA Study Team
(*2) Source: Knight and Staneva, The Water Resources of Bulgaria. An Overview, GeoJournal, 40-4, pp.347-362, 1996.
(*3) includes Beli Iskar River, (*4) includes Beli Vit River, (*5) includes Cherni Osam River
(*6) includes Beli Lom River, (*7) includes Bela Mesta River