MINISTRY OF ENVIRONMENT AND WATER
THE REPUBLIC OF BULGARIA

THE STUDY
ON
INTEGRATED WATER MANAGEMENT
IN
THE REPUBLIC OF BULGARIA

FINAL REPORT

VOLUME 2: MAIN REPORT

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.*

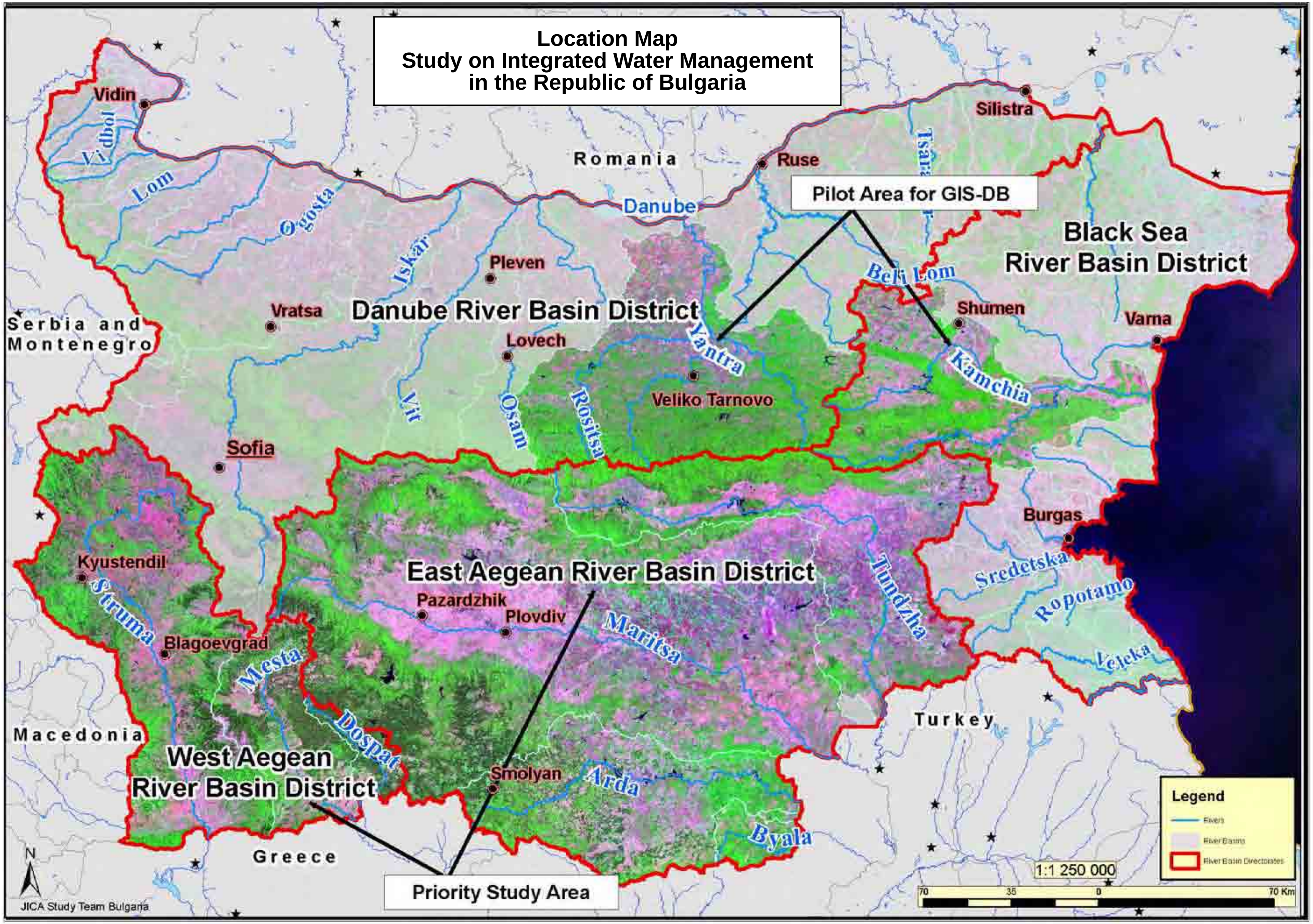
The study was conducted by CTI Engineering International Co., Ltd. under contracts with Japan International Cooperation Agency (JICA) during the period from May 2006 to March 2008. In conducting the study, we have paid much attention to assist the Ministry of Environment and Water (MoEW) to prepare the 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
Romania
Serbia and Montenegro
Macedonia
Greece
Turkey
Black Sea River Basin District
Danube River Basin District
East Aegean River Basin District
West Aegean River Basin District
Pilot Area for GIS-DB
Priority Study Area
Vidin
Silistra
Ruse
Pleven
Vratsa
Lovech
Veliko Tarnovo
Shumen
Varna
Burgas
Sofia
Kyustendil
Blagoevgrad
Pazardzhik
Plovdiv
Smolyan
Danube
Lom
Ogosta
Iskar
Vit
Osam
Rositsa
Yantra
Beli Lom
Kamchia
Sredetska
Ropotamo
Veleka
Tundzha
Maritsa
Arda
Byala
Dospat
Mesta
Struma
Legend
Rivers
River Basins
River Basin Directorates
1:1 250 000
70
35
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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**
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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

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[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

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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
GFSM	:	Government Financial Statistics Manual
GIS	:	Geographical Information System
GIS-DB	:	Geographical Information System Database
GDP	:	Gross Domestic Products
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 System 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
REIW	:	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

CHAPTER 1 INTRODUCTON

1.1 Background of the Study

This is 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 (hereinafter referred to as "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 (hereinafter referred to as "Bulgaria"). The Study has been carried out in accordance with the Scope of Work (S/W) signed between the Ministry of Environment and Water (hereinafter referred to as "MoEW") and JICA on October 14, 2005. The Study was conducted from May 2006 to March 2008.

Bulgaria is located in the east of the Balkan Peninsula in east longitudes of 22°36'-28°36' and in north latitudes of 41°14'-44°13', and has a population of 7.7 million as of 2005 on the land area of 111,000 km^2. GNP per capita in 2004 is US$3,100. The country borders Rumania in the north, Serbia and Macedonia in the west, Greece and Turkey in the south, and faces the Black Sea in the east.

Average annual precipitation is approximately 700 mm and hence water resources are one of the valuable resources of the country. The use of water needs improvement in many aspects. In the water quality aspect, deterioration of water quality in the major rivers due to the insufficient treatment of urban sewage and industrial wastewater and the poor maintenance of the existing sewerage facilities are serious problems. There also exists worry about the groundwater affected by the polluted surface water and urban sewage leaking from poor sewage pipes.

Bulgaria has become a member of the European Union (hereinafter referred to as "EU") since January 2007. The member states need to follow the requirements of the EU Water Framework Directive (hereinafter referred to as "EU-WFD"), which aims at achieving good water status[1] of all the water bodies in the country by the year 2015. EU-WFD sets targets as follows:

- Formulation of river basin management plan by 2008
- Explanation of the plan to the citizens by 2009
- Submission of the plan to EU, start the implementation of the plan by 2010
- Realization of improvement of river basin water environment by 2015

[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.

The Government of Bulgaria enforced the new Water Act (hereinafter referred to as "the Water Act") in 2000. The Water Act divides the country into four river basin management districts, and established the following four river basin directorates in 2003.

- 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 Team prepared an Inception Report in May 2006 based on the S/W, and conducted the 1st field work in Bulgaria from June through November 2006, after the explanation and discussion on the study items and methodologies proposed in the Inception Report (May 2006), the results of which are shown in the Minutes of Meeting (Annex 3). The Study Team successively conducted the Basic Study in Bulgaria until November 2006 and compiled the results of the field study in the Interim Report (January 2007).

The 2nd field study was conducted from January to September 2007, after explanation and discussion on the Interim Report (January 2007). Draft programmes of basic measures for River Basin Management Plans (RBMP) for EABD and WABD were proposed and discussed in September 2007, and the draft RBMPs for EABD and WABD were compiled in a Draft Final Report in December 2007 and submitted to MoEW in January 2008.

1.2 Objectives of the Study

The objectives of the Study are:

(1) To assist the MoEW in the implementation of the requirements of EU-WFD which includes:
  - Preparation of the River Basin Management Plans for the selected areas; and,
  - Development of GIS, Monitoring Programmes and Water Resources Balance for the whole country.

(2) To transfer technology and conduct training on Integrated Water Management to the counterpart personnel in the course of the Study.

1.3 Study Area

The selected areas are East Aegean Sea River Basin District and West Aegean Sea River Basin District as shown in the Location Map.

1.4 Basic Approach and Methodology

The River Basin Management Plan (RBMP) has been studied in accordance with the EU-WFD and the Water Act of Bulgaria, and the RBMP is composed of the management plans of water quantity, water quality, environment, disasters caused by floods and incidental pollutions, and their implementation.

The GIS database and the integrated basin analysis models have been developed in the Study as decision support tools for formulation and implementation of the RBMP. The monitoring programmes are also considered as important tools for assessment of the pressures and impacts, and the effects of programmes of measures.

The relationships among the river basin management plans, monitoring activities and decision support tools are shown in Figure 1.4.1.

During the Study, the capacity development of staff of MoEW and counterpart personnel of River Basin Directorates have been conducted through on the job training, supplementary technical meetings and technology transfer seminars.

1.5 Study Schedule

The duration of the Study is 23 months from May 2006 to March 2008. The Study is composed of the following phases as follows:

(1) Phase I

The First Field Study (From May to December 2006)

The Basic Study was conducted and the results of the Study were compiled in the Interim Report (January 2007).

(2) Phase II

The Second Field Study (From January to September 2007)

The plan formulation study was conducted on River Basin Management Plans for both EABD and WABD, and draft programmes of basic measures for RBMP were prepared.

The Third Field Study (From October to December 2007)

The draft RBMP for EABD and WABD was formulated and assistance to DRBD and BSBD on their GIS data for RBMP of the Yantra and Kamchia Rivers as pilot rivers was conducted. All the results of the Study have been compiled in Draft Final Report.

The Fourth Field Study (From January to March 2008)

The Draft Final Report (January 2008) has been compiled and submitted to MoEW, and discussed in January 2008. After receiving the comments from the Bulgarian side on the Draft Final Report and incorporating them into the report, the Final Report has been compiled in March 2008 and submitted to the Government of Bulgaria.

The reporting schedule for the Study is as follows:

(1) Inception Report in May 2006

(2) Interim Report in January 2007

(3) Draft Final Report in January 2008

(4) Final Report in March 2008

1.6 Outline of the Study

1.6.1 Phase I: Basic Study from June to December 2006

In the Phase I, data and information were collected and analyzed, field surveys on river cross sections and water quality were conducted, development of GIS database has been started, and technology transfer activities were conducted:

(1) Study and Analysis

1. Presentation and discussion on study items and methodologies proposed in the Inception Report (May 2006)

2. Study and analysis of the collected data and information

3. Field reconnaissance on major river facilities and wastewater treatment plants (WWTPs)

4. Assessment, updating and development of GIS Database

5. Development of the integrated river basin simulation model

6. Analysis and evaluation of the problems and constraints for Integrated Water Management

7. Preparation of Interim Report

(2) Field Surveys

1. Supplementary river cross-section survey for MIKE 11 modeling of EABD and WABD river basins

2. Supplementary water quality survey for EABD and WABD

1.6.2 Phase II: Formulation of River Basin Management Plan from January 2007 to March 2008

In the Phase II, supplemental data and information were collected and analyzed. Integrated river basin simulation model was developed and utilized for planning and evaluation. GIS database (GIS-DB) development was continued, and RBMPs were formulated for EABD and WABD.

In addition to the above, terms of reference (TOR) for future integrated information system for MoEW and River Basin Directorates (RBDs) was prepared. Furthermore, developing sample GIS-DB for the Yantra and Kamchia River Basins as pilot river basins assisted GIS-DB developments for DRBD and BSBD.

Study, Analysis and Plan Formulation

1. Presentation and discussion on the Interim Report.
2. Supplemental data collection, analysis and field reconnaissance.
3. GIS-DB development (continued).
4. Development of the integrated river basin simulation model (continued).
5. Water demand projection and water resources potential analysis.
6. Water quality analysis.
7. Formulation of strategy for integrated water management for EABD and WABD.
8. Analysis on the effect of the integrated water management.
9. Formulation of draft RBMP.
10. Economic analysis.
11. Evaluation of the draft RBMP.
12. Preparation of guideline for integrated water management plan.
13. Preparation of Draft Final Report.
14. Preparation of TOR for integrated information system.
15. Assist GIS-DB development for the Yantra and Kamchia River Basins.

1.6.3 Technology Transfer Activities

Technology transfer activities have been conducted through On the Job Training for the counterpart personnel of the MoEW, EABD and WABD during the Study. For the supplemental technology transfer purposes a series of technical meetings and technology transfer seminars have been held during the Study. The meetings held are listed as follows:

1) Technical Meetings

- Discussion meeting on GIS-DB at MoEW on September 29, 2006
- Discussion meeting on Modeling at ExEA on October 25, 2006
- Discussion meeting on Economic Evaluation at MoEW on September 2007

2) Technology Transfer Seminars

- The First Technology Transfer Seminar on GIS at ExEA on February 7, 2007
- The Second Technology Transfer Seminar on Modeling at ExEA on June 25, 2007
- The Third Technology Transfer Seminar on RBMP at ExEA on January 30, 2008

3) Technical Support for EABD and WABD to hold Public Consultation Meetings to formulate River Basin Management Plans

EABD: Public Consultation for the Tundzha River Basin

- The First Public Consultation at Sliven on November 6, 2006
- The Second Public Consultation at Yambol on September 10, 2007
- The Third Public Consultation at Kazanlak on December 4, 2007

WABD: Public Consultation for the Mesta and Struma River Basins

- The First Public Consultation at Blagoevgrad on November 2, 2006
- The Second Public Consultation at Blagoevgrad on September 5, 2007
- The Third Public Consultation at Blagoevgrad on December 10, 2007

1.7 Counterpart Agency and Participants for the Study

The counterpart agency is MoEW and the executing agencies are the Water Directorate of MoEW, EABD and WABD. During the Study, a Steering Committee was organized, and counterpart personnel and GIS working group members were assigned. They are shown in the tables as follows:

Table 1.7.1 JICA Study Team

Table 1.7.2 MoEW Counterpart Team

Table 1.7.3 EABD Counterpart Team

Table 1.7.4 WABD Counterpart Team

Table 1.7.5 Steering Committee

Table 1.7.6 GIS Working Group Members

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Table 1.7.1 JICA Study Team

Name	Assignment
SASABE Keiji	Team Leader
TANAKA Hajime	Deputy Team Leader/River Basin Management Planner
FURUKAWA Takashi	Water Quality Management/Monitoring Planner
CHOI Jaeyoung	GIS/Database Specialist
KITAMURA Tadanori	Hydrological and Hydraulic Modeling Specialist
Jorgen Krogsgaad JENSEN	Water Quality Modeling Specialist
ISHIZUKA Yoshiaki	Economics/Water Demand/Water Tariff Structure Specialist
ITO Tsuyoshi	Water Act/Institution/Organization/Environmental and Social Consideration Specialist
OJIMA Ryota	Administrative Coordinator
NAKAMURA Kazuhiro	Hydrological and Hydraulic Modeling/Administrative Coordinator

Table 1.7.2 MoEW Counterpart Team

Name	Position	Office
Mr. Geogi Ivanov	State Expert	Water Directorate
Mr. Nikola Matev	State Expert	Water Directorate
Ms. Nevyana Teneva	Chief Expert	Water Directorate
Ms. Galina Balusheva	Senior Expert	Water Directorate
Mr. Bojidar Magerov	Senior Expert	Water Directorate
Ms. Maria Godjevargova	Senior Expert	Water Directorate

Table 1.7.3 EABD Counterpart Team

Name	Position	Responsibility
Eng. Maria Babukchieva	Head of Planning and Managing Department (PMD)	River basin management plan (RBMP), Public participation
Eng. Krasi Kolcheva	Senior Expert, PMD	Water abstraction, river morphology, economic analysis, Water quantity modeling
Eng. Nadegda Aneva	Senior Expert of PMD	Urban wastewater and treatment plants, Public participation, water quality modeling
Vasil Usunov	Senior Expert of PMD	GIS information for RBMP and ecosystem, modeling
Marine Marinov	Head of Monitoring Department (MPD)	Monitoring program and bio-monitoring
Kiril Belanski	Main Expert of MPD	Industrial pollution and chemical monitoring, WQ modeling
Doichin Todorov	Senior Expert of MPD	Surface drinking water, Natura 2000 zones, hydro-morphology
Petia Groseva	Senior Expert of MPD	Groundwater quality and groundwater monitoring program
Nina Stoianova	Senior Expert of MPD	GIS and database
Maria Pavlova	Head of Water Cadastre Department (WCD)	GIS, protection zones for drinking water
Zdravka Toromanova	Senior Expert of WCD	Water bodies coding, GIS, protection zones for drinking water and water for bathing, water quality modeling
Gergana Georgieva	Junior Expert of WCD	GIS, protection zones for drinking water and water for bathing, water quantity modeling
Yanka Yordanova	Junior Expert of WCD	GIS and database, modeling

Table 1.7.4 WABD Counterpart Team

Chief for Group	Name of Members	Responsibility
Eng. Avram Todorov		Coordinator of Team
Eng. Desislava Buiuklieva		Coordinator for management plan
Eng. Vanina Miceva		Coordinator for water monitoring and water quality
Lubomir Markovski		Hydrological modeling and water quality modeling, GIS database
	Eng. Vasilena Boyanska	Hydrological modeling and water quality modeling
	Eng. Gerge Jbantov	Hydrology
	Stoianka Manova	Water quality modeling
Kiril Bojkov		GIS database
	Svetla Ramova	GIS
George Georgiev		Natural environment
	Marta Zlatkova	Natural environment
Radslav Georgiev		Economist /Water tariffs
	Anton Tsvetanov	Water tariffs
Eng. Momchil Pashov		Hydrogeologist
	Eng. Vasilena Boyanska	Hydrogeologist
Eng. George Jbantov		Irrigation engineer
	Eng. Pavel Pavlov	Hydropower engineer
Eng. Kalina Bacheva		Water supply
	Eng. George Seganov	Water supply
	Eng. Svetozar Nikolov	Water supply
Eng.Vangelia Ivanova		Waste water
	Eng. Chavdar Molov	Waste water
Marta Zlatkova		Public relations
Ralitsa Stefanova		Public relations

Table 1.7.5 Steering Committee

Name of Members	Position and Organization
Ms. Lyubka Kachakova	Chairperson, Deputy Minister of MoEW
Mr. Vladimir Donchev	Director of the Water Directorate, MoEW
Ms. Tzvetanka Dimitrova	Director of DRBD, MoEW
Mr. Ventzislav Nikolov	Director of BSBD, MoEW
Mr. Nikola Karnolski	Director of EABD, MoEW
Mr. Vladimir Dinov	Director of WABD, MoEW
Mr. Dimitar Vergiev	Director of the Executive Environmental Agency
Representative	The Ministry of Economy and Energy
Representative	The Ministry of Regional Development and Public Work
Representative	The Ministry of Agriculture and Forestry
Prof. Georgi Gergov	The National Institute of Meteorology and Hydrology, Bulgarian Academy of Science
Associate Prof. Stefan Modev	The University of Architecture Building and Geodesy
Personnel concerned	To be decided by Bulgarian side

Table 1.7.6 GIS Working Group Members

Organization	Name	Position
MoEW	Bozhidar Magerov	Senior Expert
	Grisha Yordanov	GIS Expert
ExEA	Velcho Kuyumdzhiev	Head of Department
	Doychin S. Delichev	Chief Expert
	Cveta Krasteva	Expert
	Borislava Borisova	GIS Expert
EABD	Vasil Usunov	Senior Expert
	Nina Stoianova	Senior Expert
	Yanka Yordanova	Junior Expert
WABD	Lyubomir Markovski	Chief Expert
	Kiril Bojkov	Senior Expert
	Svetla Ramova	Chief Specialist
DRBD	Rumelia Petrova	Chief Expert
	Milena Geshkova	GIS Expert
	Vanya Docheva	Senior Expert
BSBD	Nikolay Bonex	GIS/IT Expert

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Figures

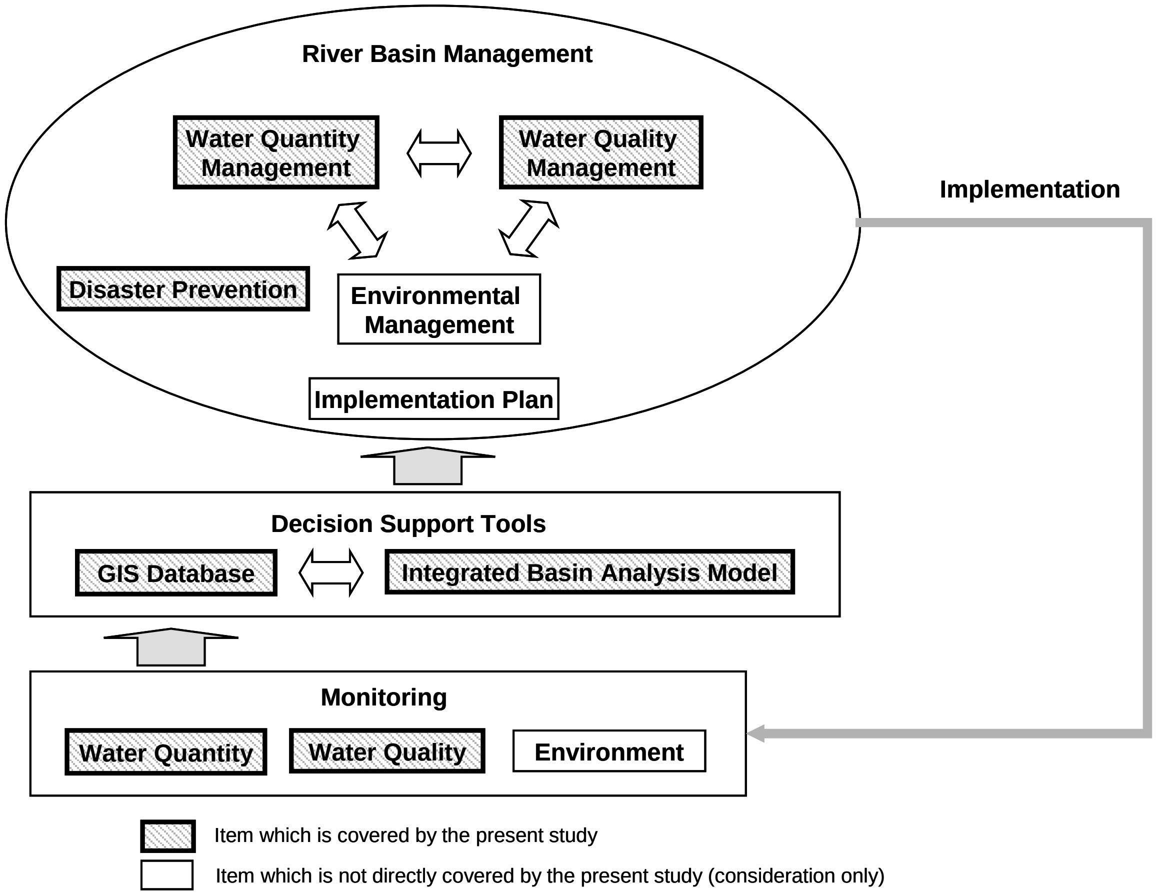


Figure 1.4.1 Schematic Illustration for River Basin Management, Decision Support Tools and Monitoring

CHAPTER 2 CURRENT STATUS OF THE STUDY AREA

2.1 Physical Conditions

2.1.1 Topography

(1) Overview of the Country

Bulgaria has a total land area of 111,000 km^2. It is roughly separated by a number of east-west zones. The Danubian Tableland is in the northern part of Bulgaria. The Balkan Mountains exists in the center. The Thracian Plain that is drained by the Maritsa River is located in the southern part of Bulgaria. The Rhodope, Rila, and Pirin Mountains lie in the southwestern part of the country. Average elevation of the country is 480 meters. The highest point of the country is the Musala in the Rila Mountains, which reaches to 2,925 meters.

Distribution of elevation zones in Bulgaria, which is derived from DEM, is summarized as the following table (see Figure 2.1.1 for graphical view of the elevation zones).

Ratio of Elevation Zones in Bulgaria

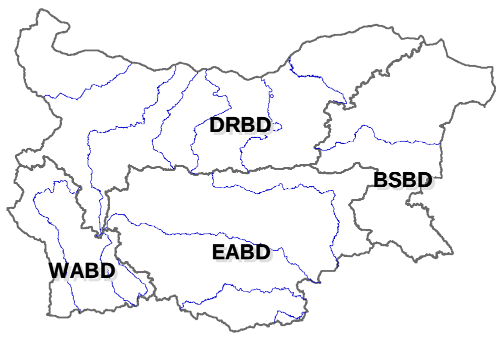
Elevation Zone Ratio (%)						
< 200 (m)	200 - 500 (m)	500 - 800 (m)	800 - 1100 (m)	1100 - 1500 (m)	1500 - 2000 (m)	> 2000 (m)
31.3	35.7	13.7	9.4	6.4	2.7	0.8

Source: JICA Study Team

About 31% of the country is in the elevations less than 200 meters, which can be said as lowland area. About 20% is more than 800 meters. This higher zone plays an important role for providing water resources in Bulgaria.

(2) Territory of River Basin Directorate

Drainage system in Bulgaria can be roughly separated into three zones. In the northern part of Bulgaria, water is drained to the Danube River. Along the Black Sea, water is directly drained to the Black Sea. Water in almost all of the remained southern part of Bulgaria flows to the south, passing through Greece and Turkey, and is finally drained to the Aegean Sea.



Districts of River Basin Directorates

Reflecting to the drainage characteristics in Bulgaria, the country is separated into the following four River Bain 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)

It should be noted that the boundary between DRBD and BSBD is defined not only by surface drainage system but also by administrative boundary. This is mainly because of the difficulty to set adequate managing boundary considering only by surface water drainage. In this area, there is a large karst groundwater aquifer, which introduces complicated hydrological process.

(3) East Aegean Sea River Basin Directorate (EABD)

Total area of EABD is about 35,200 km^2. There are four major river basins in EABD as follows:

- Tundzha River Basin
- Maritsa River Basin
- Arda River Basin
- Biala River Basin

Major River Basins in EABD

Total area, average elevation and ratio of elevation zones for the major river basins in EABD are summarized as follows.

Total Area, Average Elevation, Ratio of Elevation Zones in Major River Basins in EABD

	Total Area (km^2)	Average Elevation (m)	Elevation Zone Ratio (%)						
			< 200 (m)	200 - 500 (m)	500 - 800 (m)	800 - 1100 (m)	1100 - 1500 (m)	1500 - 2000 (m)	> 2000 (m)
Total in EABD	**35,230**	**533**	**25.6**	**36.3**	**15.0**	**9.7**	**8.9**	**4.1**	**0.4**
Tundzha	7,901	386	33.1	43.7	11.8	7.6	2.9	0.8	0.1
Maritsa	21,292	569	28.6	31.5	13.0	9.0	11.3	6.1	0.6
Arda	5,213	639	3.2	41.0	27.2	17.1	9.5	2.1	0.0
Biala	636	402	14.2	58.8	23.9	2.6	0.5	0.0	0.0

Source: JICA Study Team

The overall topographic properties in EABD are almost the same as the one for the entire country. However, the Arda and Biala River Basins have much less low land area compared to the other river basins. The Maritsa River Basin has slightly more medium elevation zone than the country average. The detailed distribution of elevation zones by the catchment can be seen in Figure 2.1.2.

(4) West Aegean Sea River Basin Directorate

Total area of WABD is about 12,000 km^2. There are three major river basins in WABD as follows:

- Struma River Basin
- Mesta River Basin
- Dospat River Basin

Major River Basins in WABD

Total area, average elevation and ratio of elevation zones for the major river basins in EABD are summarized as follows.

Total Area, Average Elevation, Ratio of Elevation Zones in Major River Basins in WABD

	Total Area (km^2)	Average Elevation (m)	Elevation Zone Ratio (%)						
			< 200 (m)	200 - 500 (m)	500 - 800 (m)	800 - 1100 (m)	1100 - 1500 (m)	1500 - 2000 (m)	> 2000 (m)
Total in WABD	**11,966**	**1,008**	**2.5**	**8.0**	**26.5**	**28.1**	**20.2**	**9.7**	**5.0**
Struma	8,541	913	3.5	10.6	31.7	29.7	13.6	6.6	4.3
Mesta	2,785	1,225	0.0	2.1	16.1	26.8	31.2	15.4	8.5
Dospat	635	1,338	0.0	0.0	1.1	12.3	60.4	26.2	0.0

Source: JICA Study Team

It can be said that river basins in WABD are characterized as a mountainous river basin. There is little low land area. The average elevation is 1,008 meters, which is much higher than the one in EABD and the other RBDs. The detail distribution of elevation zones by catchment can be seen in Figure 2.1.3.

2.1.2 Land Use and Land Cover

(1) Overview of the Country

Land use condition in 2000 for the entire country based on Corine Land Cover is re-grouped to 8 categories (see Figure 2.1.4). The ratio of land use for the entire country is summarized as follows.

Land use Ratio for the Entire Country

Land use Ratio (%)							
Forest	Shrub and Grass Land	Open Space	Artificial Surfaces	Agricultural Area	Fruits Crops	Wet Land	Water Bodies
31.5	10.5	0.5	4.9	49.7	1.9	0.1	0.8

Source: JICA Study Team based on Corine Land Cover

Agricultural area including fruits crops is more than 50% of land use in the entire country. It should be noted that agricultural area includes both irrigation area and non-irrigation area. About 15% of agricultural area is potential irrigation area according to the data provided by Irrigation Systems Ltd. (see also *Chapter 2.4.3*).

For other land use, "forest" and "shrub and grass land" share about 30% and 10%, respectively.

(2) East Aegean Sea River Basin Directorate

The following table shows the ratio of land use for the river basins in EABD. In the Tundzha and Maritsa River Basins, an agricultural area is dominant, whereas ratio of forest is more than 50% in the Arda and Biala River Basins. Detailed spatial distribution of the ratio of agricultural area including fruit crops for each catchment in EABD is shown in Figure 2.1.5. The figure implies how intense the water use for agricultural activity is for each catchment.

Land use Ratio in Major River Basins in EABD

	Land use Ratio (%)							
	Forest	Shrub and Grass Land	Open Space	Artificial surfaces	Agricultural Area	Fruits Crops	Wet Land	Water Bodies
Total in EABD	**35.0**	**13.2**	**0.2**	**4.3**	**44.1**	**2.4**	**0.0**	**0.8**
Tundzha	29.2	12.2	0.2	4.2	50.6	2.8	0.0	0.7
Maritsa	32.5	12.3	0.2	5.0	46.4	2.8	0.0	0.7
Arda	51.5	17.7	0.5	1.9	27.0	0.2	0.0	1.2
Biala	56.7	19.5	0.0	1.2	22.0	0.6	0.0	0.0

Source: JICA Study Team based on Corine Land Cover

(3) West Aegean Sea River Basin Directorate

The following table shows the ratio of land use for the river basins in WABD. Compared to the basins in EABD, the ratio of agricultural area is low, ranging 15-30%. Almost half of the land is covered by forest in WABD.

Detailed spatial distribution of the ratio of agricultural area including fruit crops for each catchment in WABD is shown in Figure 2.1.6.

Land use Ratio in Major River Basins in WABD

	Land use Ratio (%)							
	Forest	Shrub and Grass Land	Open Space	Artificial surfaces	Agricultural Area	Fruits Crops	Wet Land	Water Bodies
Total in WABD	**45.9**	**20.5**	**1.9**	**2.8**	**26.8**	**1.7**	**0.0**	**0.4**
Struma	41.4	22.0	1.7	3.3	29.1	2.1	0.0	0.3
Mesta	54.0	18.8	2.9	1.7	22.1	0.6	0.0	0.0
Dospat	70.5	8.8	0.1	1.1	15.7	0.0	0.0	3.8

Source: JICA Study Team based on Corine Land Cover

2.2 Meteorology and Hydrology

2.2.1 Observation Network

Meteorological and hydrological observation data are fundamental elements for river basin management. They support to consider actual water balance over a river basin.

NIMH has long been responsible for observing, transmitting, processing and storing meteorological and hydrological data. Almost all of the data had been published yearly before the beginning of 1980s. However, limited data are available as public domain nowadays. To obtain full set of data, it is necessary to contact NIMH directly, which usually requires a contract. The type of monitoring stations kept by NIMH is shown in the following table.

Type of Monitoring Stations by NIMH

Type of Station (*1)	Item (*1)	Frequency (*1)	Observer (*1)	Total number (*1)	Number for operational database (*1)	Number of available station in August 2006 (*2)
Synoptic	Meteorological Data	Every 3 hours every day	Professional staff	40	40	40
Climatic	Meteorological Data	Every day at 7, 14, 21 o'clock	Voluntary staff	100	70	95
Rainfall	Precipitation	Every day at 7 o'clock when it happens	Voluntary staff	290	0	286
Hydrometric	River level (can be converted to discharge)	Every day at 8, 20 o'clock	Voluntary staff	204	52	208
Groundwater spring	Water level	Daily or Weekly	Voluntary staff or routs of professional staff	101	37	(*3)
Groundwater artesion well	Water level	Daily or Weekly	Voluntary staff or routs of professional staff	22	2	(*3)
Groundwater well	Water table	Weekly or Monthly	Routs of professional staff	285	91	(*3)

(*1) Source: http://www.hydro.bg, NIMH dada flow
(*2) Source: List provided by NIMH to The Study Team on August 2006 as a form of .shp file
(*3) There is duplication of some stations in .shp files. So, it is difficult to count the number.

There are two types of stations with respect to the data transmission. One is “Operational stations” which transmit data at real or near real time. Another one is “Regime stations” in which data are submitted to the NIMH branches as a form of paper monthly.

Maintenance of the monitoring stations is a key issue. Without proper maintenance supported by appropriate budget allocation, monitoring stations are easily deteriorated. Special attention should be paid that a lot of voluntary staffs contribute to the observations and their efforts have been supported the observation network.

2.2.2 Meteorology

(1) Overview of the Country

The major part of Bulgaria belongs to the European Moderate-Central Zone in climatic aspect. However, the southern and southeastern regions are strongly affected by the Mediterranean Continental-Subtropical Zone.

Spatial pattern of annual precipitation, annual Potential Evapo-Transpiration (PET) over the country can be seen using WORLDCLIM database, which shows averaged condition during 1950-2000 (see Figures 2.2.1 and 2.2.2). The WORLDCLIM database contains long-term averaged 1km mesh monthly precipitation and temperature based on observed data with correction considering altitude. PET in the figure is estimated using Thornthwaite method.

Most of lowland in Bulgaria has annual precipitation of 500-700 mm. In the mountain area, annual precipitation is much higher; in some places, annual precipitation exceeds 900 mm. In the mountain region gives lower annual PET than 600 mm. Lowland area has more than 700 mm of annual PET.

Potential annual water balance pattern can be drawn by the pattern of precipitation minus PET (see Figure 2.2.3). In the most areas of Bulgaria, annual PET exceeds annual precipitation. Only the mountain area has positive value of precipitation minus PET. The mountain area, in which the positive value can appear, plays a critical role for water resources in Bulgaria. 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.

Yearly variation of estimated spatially averaged annual precipitation over the country is shown in Figure 2.2.4. In the recent years, the annual precipitation fluctuates very much year by year. In 2000, the precipitation was extremely low at less than 400 mm, while more than 900 mm annual precipitation occurred in 2005.

(2) East Aegean Sea River Basin Directorate (EABD)

Long-term averaged (1950-2000) annual precipitation and PET based on WORLDCLIM database for each river basin in EABD are calculated as shown in the following table.

Average Annual Precipitation and PET for River Basins in EABD

River Basin	Annual Precipitation (mm)	Annual PET (mm)
Tundzha	639	689
Maritsa	611	669
Arda	632	672
Biala	633	720

Source: JICA Study Team based on WORLDCLIM database

Annual PET is higher than annual precipitation in all of the basins in EBAD. It indicates that quantitative water resource is under severe condition in EABD in general.

Statistical analysis for the estimated long-term annual precipitation has been conducted. As shown in the later chapter for hydrology, annual average water quantity is related to not only 1-year total precipitation but also 2-year total precipitation. The following table shows the probable 1-year total and 2-year total precipitation.

Statistical Analysis for Estimated Long-term Annual Precipitation for EABD Territory

Probability of Exceedance	1Year Total Precipitation (mm)	2Years Total Precipitation (mm)
95%	472	1010
90%	512	1085
75%	578	1200
50%	656	1325
25%	734	1423
10%	804	1516

Source: JICA Study Team

Based on the above table, probability for averaged precipitation in EABD in 2000-2005 is evaluated as follows.

Evaluation of Probability of Exceedance for Precipitation Amount in EABD

Year	1 Year Total		2 Years Total	
	Precipitation Amount (mm)	Probability of Exceedance	Precipitation Amount (mm)	Probability of Exceedance
2000	388	>95%	1073	90%
2001	603	75%	991	>95%
2002	781	15%	1384	33%
2003	643	30-70%	1424	25%
2004	643	30-70%	1286	30-70%
2005	925	<5%	1568	5%

Source: JICA Study Team

From the above table, the followings are confirmed.

- Year 2004 is almost average year in terms of both 1-year and 2-year total precipitation in EABD territory.
- Both the years 2000 and 2001are extremely dry in EABD territory.
- Year 2005 is extremely wet in EABD territory.

(3) West Aegean Sea River Basin Directorate (WABD)

Long-term averaged (1950-2000) annual precipitation and PET based on WORLDCLIM database for each river basin in WABD are calculated as shown in the following table.

Average Annual Precipitation and PET for River Basins in WABD

River Basin	Annual Precipitation (mm)	Annual PET (mm)
Struma	566	629
Mesta	630	577
Dospat	664	551

Source: JICA Study Team

In Mesta and Dospat River Basins, annual precipitation is higher than the annual PET, which indicates high water resources potential. On the other hand, relatively low annual precipitation is observed in the Struma River Basin.

Statistical analysis for the estimated long-term annual precipitation has been conducted. As shown in the later chapter for hydrology, annual average water quantity is related to not only 1-year total precipitation but also 2-year total precipitation. The following table shows the probable 1-year total and 2-year total precipitation.

Statistical Analysis for Estimated Long-term Annual Precipitation for WABD Territory

Probability of Exceedance	1-Year Total Precipitation (mm)	2-Year Total Precipitation (mm)
95%	442	952
90%	490	1048
75%	578	1181
50%	644	1304
25%	715	1397
10%	773	1458

Source: JICA Study Team

Based on the above table, probability for averaged precipitation in WABD in 2000-2005 is evaluated as follows.

Evaluation of Probability of Exceedance for Precipitation Amount in WABD

Year	1-Year Total		2-Year Total	
	Precipitation Amount (mm)	Probability of Exceedance	Precipitation Amount (mm)	Probability of Exceedance
2000	322	95%>	1029	90%
2001	559	80%	881	95%>
2002	786	10%	1344	40%
2003	671	30-70%	1457	10%
2004	698	30-70%	1369	30-70%
2005	835	5%<	1532	5%<

Source: JICA Study Team

From the above table, the followings are confirmed.

- Year 2004 is almost average year in terms of both 1-year and 2-year total precipitation in WABD territory.
- Both the years 2000 and 2001 are extremely dry in WABD territory.
- Year 2005 is extremely wet in WABD territory.

2.2.3 Hydrology

(1) Overview of the Country

(a) Major Rivers

List of major rivers for the whole country is presented in Table 2.2.1. The Iskar River is the longest river that has 338 km in total. The Maritsa River is the largest river basin that has about 21,292 km^2 in total.

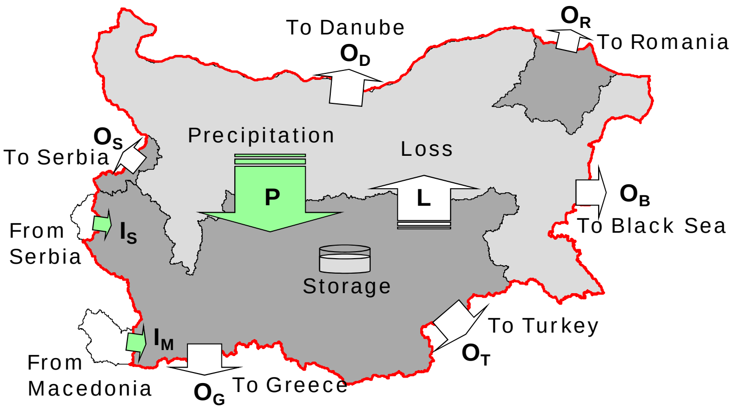
(b) Preliminary Water Balance across the Country

The following table and figure show the summary of long-term averaged water balance across the country. It is assumed that the basin storage is negligible. One can see that more than 70% of precipitation is lost. About 16% flows to neighbouring countries and about 12% flows directly to the Danube River and to the Black Sea. Amount of external inflow is small compared to 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 impact such as inter-basin water transfer and water abstraction.

Summary of Long-term Averaged Water Balance across the Country

				Long-Term Average (million m^3)	Ratio to Precipitation (%)
In	Precipitation (*1)		P	67,604	100.0
	External Inflow (*2)	Inflow from Serbia	I_S	493	0.7
		Inflow from Macedonia	I_M		
Out	Total Loss (*3)		L	48,664	72.0
	Outflow to Danube & Black Sea (*2)	Outflow to Danube	O_D	8,260	12.2
		Outflow to Black Sea	O_B		
	Outflow to Neighboring Countries (*2)	Outflow to Turkey	O_T	11,173	16.5
		Outflow to Greece	O_G		
		Outflow to Serbia	O_S		
		Outflow to Romania	O_M		

(*1) Average Annual Precipitation for 1950-2000 by WORLDCLIM (609mm/year) is used.
(*2) Source: National Statistical Institute: Environment 2004
(*3) It is assumed that total loss is equal to total inflow minus total outflow.



Source: JICA Study Team

Water balance in 5 hydrological years during 2000-2005 year by year, as well as the averaged one during 2000-2005, has also been examined (see Table 2.2.2). It is assumed that the basin storage could be negligible when calculating the water balance in single hydrological year. It is also assumed that the hydrological year starts in November and ends in October, referring the annual flow pattern for major rivers shown in Table 2.2.1 and previous literature. The averaged percentage of total loss in 5 hydrological years during 2000-2005 is similar to the long-term averaged one. However, the total loss in single hydrological year varies every year. It seems to be affected by precipitation amount in the previous hydrological year. When the previous hydrological year is dry, the total loss tends to be high. This tendency can be seen also in Figures 2.2.6 and 2.2.9, which shows the relationship between total precipitation amount and annual average runoff.

One of the possible reasons for the changeable water balance year by year may be artificial storage in reservoirs. However, as shown in the later chapter, total storage by significant reservoirs within single year is up to about 20% of total effective storage volume, which is about 1.20 billion m^3. It is about 1.5% of total precipitation in average in 2000-2005. This amount is not enough to explain the changeable water balance year by year. Therefore, it is highly possible that the changeable water balance year by year is mainly because of natural hydrological process.

(c) Hypothesis on Hydrological Process

Mechanism of the changeable water balance year by year in Bulgaria is very interesting topics from hydrological point of view. It may also be related to effective management of water resources in Bulgaria. Therefore, it is recommended for academic institutes to investigate more intensively on the mechanism of the changeable water balance year by year in the future.

One of hypotheses on the mechanism of the changeable water balance year by year based on experience on analysis on runoff process and modelling in the present study is shown below.

- Key factors are snow and its melting process. In Bulgaria, annual runoff volume is strongly affected by snow melting flow.
- Snow accumulation usually starts at around November and snow melting starts at around March. During the snow accumulation, almost all of precipitation is stored as snow pack on the surface. Precipitation rarely infiltrates during the winter time (November to March). Therefore, water contents in surface soil during the wintertime are determined only by the condition of surface soil before the snow accumulation started at around November. The condition of surface soil at around November is strongly affected by the precipitation amount during summer time of the previous year. If the previous year is dry, the water contents of surface soil at around November are very low, and vice versa.
- The condition of surface soil at around March, at which snow melting starts, affects runoff process very much. If the water contents of the surface soil at around March are low, melting water firstly has to fill the large storage volume of surface soil by infiltration. After the surface soil is almost saturated, much runoff can appear. During the filling process for the surface soil, large amount of evapo-transpiration loss is expected. In this case, runoff amount becomes relatively small. On the other hand, if the water contents of the surface soil at around March are high, melting water can be easily runoff to rivers without filling storage volume of surface soil. In this case, relatively large amount of runoff is expected, because of relatively small evapo-transpiration loss of melting water, which is infiltrated to surface soil.
- Because the water contents of the surface water contents at around March, at which snow melting starts, is strongly affected by the precipitation amount during summer time of the previous year, as have already discussed, the runoff volume is affected not only by the precipitation amount of the same year but also by the one of the previous year.

The process described in the above hypothesis could appear only at the region with semi-arid climate condition with large amount of snow on wintertime.

The above hypothesis has not yet been proved scientifically. However, if it is almost true, monitoring of surface soil condition during wintertime may give useful information for predicting available runoff volume for water resources for the coming spring and summer time.

Also, the precipitation amount in the previous year can be one of good indicators for possible water resources for the current year, which can be utilized for risk management of water resources. For example, if the precipitation amount is small in the current year, risk of shortage of water resources for the next year becomes relatively high. To avoid the risk, it is recommended that reservoir should try to keep the original storage volume for the next year as much as possible, even if there is a lack of water resources in the current year. It means that single year operation of reservoir to avoid the risk is recommended.

(2) East Aegean Sea River Basin Directorate (EABD)

There are four major rivers in EABD: the Tundzha, Maritsa, Arda and Biala Rivers. The Tundzha River flows to Turkey, and the Arda and Biala Rivers flow to Greece. The Maritsa River flows to the border between Turkey and Greece. All the rivers merge to one river, which goes through again the border between Turkey and Greece, and finally reaches to the Aegean Sea.

There are several hydrometric stations to observe channel discharge. Based on the observed discharge, runoff condition can be investigated. One should remind that the observed discharge reflects the disturbed condition by human impact such as water abstraction and transfer. Figure 2.2.5 shows representative hydrometric stations and those watershed areas in EABD.

Relationship between 1-, 2-, 3-year total precipitation and annual average discharge (runoff) is shown in Figure 2.2.6. It can be seen that correlation between 2-year total precipitation and annual average discharge is the highest.

Using the currently available data during 1945-2005, the long-term averaged monthly variation of discharge for selected hydrometric stations is calculated (see Figure 2.2.7). Lowest flow condition appears in August for the Tundzha, Maritsa and Arda Rivers. The peak flow appears in March in the Tundzha and Maritsa Rivers and in January in the Arda River. Difference between discharges in dry period and wet period is higher in the Arda River than that in the Tundzha and Maritsa Rivers.

In hydrological year 2000-2005, annual unit runoff (mm) from each watershed for the representative hydrometric stations is calculated. The followings are identified.

- In general, dry year and its consequent year have lower runoff rate for the entire watershed.
- The Tundzha River except the uppermost watershed of HMS 74650 has significantly low runoff rate, which ranges 0.08-0.14. This indicates significant amount of water is abstracted from the river and/or the catchment.
- In the Maritsa River, the watersheds of HMS 72460 and 72520 have relatively high runoff rate, which is more than 0.4. This is mostly because of less human impact in these watersheds. The runoff rate for the rest watershed ranges from

0.17-0.43, most of which are less than 0.25. This also indicates heavy water abstraction from the river and/or the catchment.

- All of the HMSs in the Arda River shown here is located at the upstream of reservoirs in the main stream of the Arda River. The runoff rate is generally high compared to those in the Tundzha and Maritsa Rivers.

(3) West Aegean Sea River Basin Directorate (WABD)

There are three major rivers in WABD: Struma, Mesta and Dospat Rivers. All these rivers flow to Greece. The Struma River receives external inflow from Serbia and Macedonia.

There are several hydrometric stations to observe channel discharge. Based on the observed discharge, runoff condition can be investigated. One should remind that the observed discharge reflects the disturbed condition by human impact such as water abstraction and transfer. Figure 2.2.8 shows representative hydrometric stations and those watershed areas in WABD.

Relationship between 1-, 2-, 3-year total precipitation and annual average discharge (runoff) is shown in Figure 2.2.9. It can be seen that correlation between 2-year total precipitation and annual average discharge is the highest.

Using the currently available data during 1945-2005, the long-term averaged monthly variation of discharge for selected hydrometric stations is calculated (see Figure 2.2.10). Lowest flow condition and peak flow condition appear in August and in May, respectively, for the Struma and Mesta Rivers. Difference between discharges in dry period and wet period is higher in the Mesta River than that in the Struma River.

In hydrological year 2000-2005, annual unit runoff (mm) from each watershed for the representative hydrometric stations is calculated. In the Struma River, runoff from the watershed of HMS 51360 & 51560 is excluded in order to investigate the runoff characteristics within the Bulgarian territory. The followings are identified.

- In general, dry year and its consequent year have lower runoff rate for the entire watershed.
- Uppermost watersheds of HMS 51700 in the main channel of the Struma River has significantly low runoff rate, which is less than 0.2. Runoff rate tends to increase toward the downstream in the Struma River.
- In the Mesta River, runoff rate is generally high compared to the other rivers in EABD and WABD, which range from 0.4-0.7.

2.3 Socio-economy

2.3.1 Administrative Structure and Boundaries

The whole territory of the nation of Bulgaria consists of 6 regions as North West Region, North Central Region and North East Region from the north-west to the north-eastward along the southern side of the Danube River being boundary with Romania, South East Region, South Central Region and South West Region from the south-west to the south-eastward along the southern side of the Balkan Mountain Range running through the central part of the nation from the west to the east. Under those 6 regions, there are 27 districts and the Capital city of Sofia. South end of the nation abuts with Turkey and Greece. Each district consists of several municipalities, and city and/or villages are the lowest administrative units under the municipalities.

Based on Statistical Year Book issued by National Statistical Institute (NSI), total area of the nation is 111,000 km^2 and it consists of 63,764.8 km^2 of agricultural area, 37,157.5 km^2 of forest area, 4,603.4 km^2 of residential area (settlements and other urbanized areas), 2,010.4 km^2 of water flows and water area, 2,710.9 km^2 of areas for mining and quarrying raw materials and 754.9 km^2 of roads and infrastructural area.

2.3.2 Population

According to the Statistics, population of the nation has been increased by the year 1985 historically, but after that year, it was decreased as shown below.

Historical Population Trend in the Nation of Bulgaria by Census Year

	1887	1892	1900	1905	1910	1920	1926	1934
Rural	593,547	652,328	742,435	789,689	829,522	966,375	1,130,131	1,302,551
Urban	2,560,828	2,658,385	3,001,848	3,245,886	3,507,991	3,880,596	4,348,610	4,775,388
Total	3,154,375	3,310,713	3,744,283	4,035,575	4,337,513	4,846,971	5,478,741	6,077,939
Share Rate of Urban Population to the Total Population	431.44%	407.52%	404.32%	411.03%	422.89%	401.56%	384.79%	366.62%

	1946	1956	1965	1975	1985	1992	2001
Rural	1,735,188	2,556,071	3,822,824	5,061,087	5,799,939	5,704,552	5,474,534
Urban	5,294,161	5,057,638	4,405,042	3,666,684	3,148,710	2,782,765	2,454,367
Total	7,029,349	7,613,709	8,227,866	8,727,771	8,948,649	8,487,317	7,928,901
Share Rate of Urban Population to the Total Population	305.11%	197.87%	115.23%	72.45%	54.29%	48.78%	44.83%

Source: "Statistical Yearbook", 2005, NSI.

This trend is still continuing to the year 2005 according to the said Statistics. However, the pattern of population increase/decrease is not the same for all the regions, districts and/or municipalities (see Table 2.3.1). It may depend on their socioeconomic background of each district and/or municipalities. Since the year 2001 till 2005, population of the nation has been still decreased as indicated in Table 2.3.1. However, only the South West Region has been increased since 2001. In Table 2.3.1, the population trends of some municipalities and city as the Capital Sofia, the Municipality Blagoevgrad (Blagoevgrad) in South West Region and the Municipality Plovdiv (Plovdiv) in the South Central Region are indicated for reference. The population of the Capital Sofia has been constantly increased from 1,178,579 in 2001 to 1,231,622 in 2005. The other population trends of Blagoevgrad and Plovdiv fluctuate year by year, but during the last several years (last 2 or 3 years), they have also been increased as shown in the table. In Figures 2.3.1 - 2.3.3, population projections for the future based on the above data are indicated.

According to a survey result of NSI on medical expenditure, the average family size in Bulgaria is less than 3 persons. The following table shows annual fluctuation of family size in Bulgaria.

Fluctuation of Family Size in Bulgaria

(Persons/HH)

	2001	2002	2003	2004	2005
Fluctuation on Family Size	2.71	2.66	2.62	2.58	2.55

Source: NIS.

2.3.3 Economic Active Population (Labor Forces)

According to another statistics[1], around half of the total population has shared by the economic active population since 2001. Unemployment rates have been decreased year by year since 2001. On the other hand, labour forces themselves have been decreased too (see Table 2.3.2). The reason of decrease of labour forces comes from labour emigration mainly to the other counties as Russia according to information from some officials of the nation

Nevertheless the labour forces have been decreased since 2001 because of immigration to the other countries as mentioned above, employment population among the labour forces has gradually been increased. Therefore, the unemployment rate has been drastically decreased from around 20% in 2001 to 10% in 2005 as a whole. However, the unemployment rate of 10% seems to be still high.

Using these data on economic active population together with the population as mentioned in *Chapter 2.3.2*, a number of workable persons per household (HH) could be estimated as follows.

Number of Workable Persons per Household

(Persons/HH)

	2001	2002	2003	2004	2005
Number of Workable Persons per Household in the Nation	2.35	2.35	2.38	2.34	2.33
Share Rate to HH Members in Total in the Nation	86.57%	88.38%	90.58%	90.62%	91.34%

[1] Statistics being opened to the public on the official web site of the National Statistic Institute (NSI) as of October 2006.

Share rate of workable persons to the average family size as mentioned in *Chapter 2.3.2* has reached even by around 90%. It means that, in almost of all the HHs, they are "both-working households".

2.3.4 Gross Domestic Products (GDP)

The following table shows a summary of the Gross Domestic Products (GDP) and GDP per Capita at current price level in Bulgaria.

Actual Annual Increasing Rates of GDP and GDP per Capita in the Nation of Bulgaria

(At current price)

Description	2001	2002	2003	2004	Annual Average Increasing Rate
GDP (million Levs)	29,709	32,335	34,547	38,275	8.82%
GDP per Capita (Levs/capita)	3,754	4,109	4,416	4,919	9.44%

Source: NSI.

Annual average increasing rates of 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 almost of half of the said rates as show below.

Actual Annual Increasing Rates of GDP and GDP per Capita in the Nation of Bulgaria

Description		2002	2003	2004	Annual Average Increasing Rate
GDP	Annual increasing rate	8.84%	6.84%	10.79%	8.82%
	CPI	3.81%	5.64%	3.98%	4.48%
	Actual annual increasing rate	5.02%	1.20%	6.82%	4.35%
GDP/capita					
	Annual increasing rate	9.46%	7.47%	11.39%	9.44%
	CPI	3.81%	5.64%	3.98%	4.48%
	Actual annual increasing rate	5.64%	1.83%	7.41%	4.96%

2.3.5 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. And the finance of the Government consists of 3 categories as (ｉ) the finance of the Central Government, (ii) the finance of the Local Government and (iii) the finance of Social Security. The overall finance of the Government is called as "the Finance of the General Government" consisting of the said 3 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. The following table shows a summary of annual financial status of the General Government by means of GFSM 2001.

Consolidated Financial Status of the General Government by Means of GFSM 2001

(mill. Levs)

	1998	1999	2000	2001	2002	2003	2004	2005
CASH FLOWS FROM OPERATING ACTIVITIES:								
1. Cash receipts from operating activities	8,452	9,156	10,311	11,468	12,370	13,817	15,662	17,607
2. Cash payments for operating activities	7,468	8,349	9,656	10,413	11,662	12,906	13,912	14,957
3. Net cash inflow from operating activities (1-2)	984	808	654	1,055	708	911	1,751	2,650
CASH FLOWS FROM INVESTMENTS IN NONFINANCIAL ASSETS (NFAs):								
4. Net cash outflow from investments in nonfinancial assets	703	772	822	994	961	909	1,094	1,317
Cash surplus / deficit (1-2-4)	282	36	-168	61	-253	1	657	1,334
Net Acquisition of Financial Assets Other Than Cash	-296	-252	-260	-557	-1,223	-312	-1,230	-1,337

Source: Ministry of Finance.

Though the Government has suffered losses in two years since 1998 as 168 million Levs in 2000 and 253 million Levs in 2002, the financial status of the Government has been sound in general. However, from the viewpoint of “net acquisition of financial assts other than cash”, the Government has registered the deficits since 1998 till to date from the viewpoint of the international balance of payment.

On the other hand, to grasp actual revenue sources and expenditure items, the financial report by means of the National System is to be clearer than that by means of GFSM system. The following table shows a summary of the financial status by means of the National system.

Consolidated Financial Status of the General Government by Means of National System

(mill. Levs)

	1998	1999	2000	2001	2002	2003	2004	2005
Total Revenue and Grants	8,907	9,676	11,064	11,837	12,523	14,070	15,855	17,991
Total Expenditures	8,620	9,639	11,234	12,017	12,733	14,069	15,199	16,657
Balance (Deficit (-)/Surplus (+))	287	38	-170	-180	-209	1	656	1,334

Source: Ministry of Finance.

As shown in above two tables, there are some differences in balance in figures. It may be caused by different of classification systems of items of revenues and expenditures between the GFSM 2001 System and the National system.

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, almost 80%, to the revenue in total as shown in the following table.

Share Rates of Tax Revenue to the Revenue in Total

	1998	1999	2000	2001	2002	2003	2004	2005
Share Rate of Tax Revenue to the Revenue in Total	79.44%	77.31%	78.70%	77.64%	76.63%	78.99%	80.59%	80.51%

On the other hand, the Government expenditure consists of (1) current expenditure and (2) Capital Expenditures and State Reserve Gain. The following table shows their share rates to the expenditure in total.

Share Rates of Expenditure in Each Item to the Expenditures in Total

	1998	1999	2000	2001	2002	2003	2004	2005
Current Expenditures	89.28%	87.98%	89.66%	89.71%	90.38%	90.34%	89.58%	87.48%
Capital Expenditures and State Reserve Gain	10.72%	12.02%	10.34%	10.29%	9.62%	9.66%	10.42%	12.52%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Furthermore, the current expenditure consists of (1) Compensation of Employees, (2) Maintenance and Operating, (3) Subsidies, (4) Interests and (5) Social Expenditures and Scholarships. Of these, the Social Expenditures and Scholarships shows the highest share rate as ranging from 30% to 40% or over, Maintenance and Operating shows the second highest as 30%, and Compensation of Employees shows the third highest as ranging from 15% to 20% since 1998.

From the viewpoint of distribution of expenditure as mentioned above, it has made clear that how the Government has given priority to the social welfare and education.

2.3.6 International Trade

In international balance of trade in Bulgaria, an excess of imports over exports has been continued since 1995 up to the present as shown in the following summary table.

International Balance of Trade

(mill. EUR)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Export in Total	3,837	3,744	4,256	3,747	3,734	5,253	5,714	6,063	6,668	7,985	9,454
Import in Total	4,112	3,935	4,307	4,416	5,140	7,085	8,128	8,411	9,611	11,620	14,682
Balance of Trade	-275	-190	-50	-669	-1,406	-1,832	-2,414	-2,348	-2,942	-3,635	-5,228

Source: Bulgarian National Bank.

The greatest trading sum of Bulgaria is, in both the exports and imports, the one with EU countries which have been members prior to May 1, 2004 as France and so on (see Table 2.3.3). On the other hand, from the viewpoint of category of commodities, the raw materials show the highest trading sums in both the export and import (see Table 2.3.4). However, second highest commodities are the consumer goods in exports and investment goods in imports.

2.3.7 Balance of Payment

The balance of payment of Bulgaria has registered deficits since 2001 because that the excess of imports over exports has been continued as discussed in previous chapter (see Table 2.3.5).

2.3.8 Industrial Perspective

In Bulgaria, almost 80% of industrial output is coming from private sector as shown in the following table.

Output of Industrial Enterprises by Kind of Ownership

(mill. Levs)

	2001	2002	2003	2004
Output				
Public Sector	4,770	4,883	4,611	4,656
Private Sector	16,590	17,981	20,131	25,210
Total	21,360	22,864	24,742	29,866
Increasing Rate	-	7.04%	8.21%	20.71%
Share Rates of Outputs				
Public Sector	22.33%	21.36%	18.64%	15.59%
Private Sector	77.67%	78.64%	81.36%	84.41%
Total	100.00%	100.00%	100.00%	100.00%

Source: Statistical Yearbook of Bulgaria 2005.

The output of enterprise in Bulgaria is constantly increased from 21.36 billion Levs in 2001 to 29.86 billion Levs in 2004. Especially, from 2003 to 2004, the increase of outputs was greater than that until previous year as around 21%.

In the whole industrial status, the category of manufacturing has shared at around 80% to the total industrial outputs, but, in case of limited ownership of the private sector, it shares at around 95% to the total outputs since 2001 for both the cases of ownership (see Table 2.3.6). If that be the case, what kind of manufacturing activities is there in Bulgaria? The main industrial activities in Bulgaria are (1) the manufacture of Food, Beverage and Tobacco, and (2) the manufacture of Basic Metals and Fabricated Metal Products as both 18% to the total outputs as of 2004. Here, it must be noted that the outputs of, not the manufacturing, but electricity, gas and water supply shows rather high share rate as 16% to the total outputs regarding utilization of water resources (see Table 2.3.7).

2.3.9 Water Sector Status

The following table shows a summary of "Total Available Water Volume in the Water Supply System" in Bulgaria.

Total Available Water Volume in the Water Supply System in Bulgaria

(1,000 m^3/year)

Water Distribution	2000	2001	2002	2003	2004
Water Abstraction in Total	1,177,971	1,075,444	1,057,107	1,048,309	997,331
Surface Water	768,025	695,603	691,822	706,657	676,905
Rivers	60,535	53,220	57,053	48,136	43,608
Dams	528,682	479,806	495,224	505,799	491,478
Shaft, Kettle, Mining	131,895	120,475	100,344	111,969	99,480
Drainage	46,913	42,102	39,201	40,753	42,339
Under-Ground Water	409,946	379,841	365,285	341,652	320,426
Springs	129,558	123,748	129,523	116,065	103,343
Drilling Wells	280,388	256,093	235,762	225,587	217,083
Water Sent to the Other Public Water Works (-)	162,619	75,728	136,840	102,437	90,522
Water Received from the Other Public Water Works	184,156	94,051	157,148	133,289	105,655
Total Available Water Volume in the Water Supply System in Bulgaria	1,199,508	1,093,767	1,077,415	1,079,161	1,012,464

Source: Environmental Bulletin 2004 , Ministry of Environment and Water.

Both the "Water Abstraction Volume" and the "Total Available Water Volume" in the water supply system in Bulgaria has been gradually decreased from 1.17 billion m^3 in

2000 to 997 million m^3 in 2004 and from around 1.20 billion m^3 in 2000 to 1.01 billion m^3 in 2004, respectively.

Almost 70% of "Water Abstraction in Total" is from ground water, and around three fourths of remaining surface water is abstracted from dams. Among the water abstraction volume in total, actual supplied water volume is as shown in the following table. In total supplied water volume, only about 37% of the volume is purified completely for drinking in Bulgaria.

Supplied Water Volume by Treatment (Purification) Status

(1,000 m^3/year)

	2000	2001	2002	2003	2004
Water with Treatment	446,183	407,949	376,863	383,707	376,845
Drinking Water with Treated for Disinfection	255,904	238,136	217,815	218,158	228,207
Drinking Water with Treated for Precipitation and Disinfection	5,255	4,096	3,525	3,560	6,306
Complete Treated Water for Drinking	185,024	165,717	155,523	161,989	142,332
Water without Any Treatment	21,817	16,165	15,837	14,111	12,010
Supplied Water Volume in Total	468,000	424,114	392,700	397,818	388,855

Source: Environmental Bulletin 2004 , Ministry of Environment and Water.

Supplied water volume has also decreased year by year from 468 million m^3 in 2000 to 388 million m^3 in 2004 corresponding to the water abstraction volume as shown below.

Supplied Water Volume by Water Users

(1,000 m^3/year)

	2000	2001	2002	2003	2004
By Industrial Water Users	83,990	69,982	70,183	69,065	66,036
For Drinking	62,569	55,900	54,496	55,099	54,107
For Industries	21,421	14,082	15,687	13,966	11,929
By Agricultural Water Users	1,819	1,656	1,786	1,569	3,793
For Drinking	1,699	1,541	1,684	1,471	3,712
For Agriculture	120	115	102	98	81
By Domestic Water Users for Households, Tourism, and Other Uses	382,191	352,476	320,731	327,184	319,026
For Drinking	381,915	350,508	320,684	327,139	319,026
For Other Purposes	276	1,968	47	45	0
Supplied Water Volume by Water Users in Total	468,000	424,114	392,700	397,818	388,855

Source: Environmental Bulletin 2004 , Ministry of Environment and Water.

Against total available water volume in the water supply system in Bulgaria, almost 60% or more of water lost in 2000 - 2004 as shown below.

Water Loss in Bulgaria

(1,000 m^3/year)

	2000	2001	2002	2003	2004
External Leakage for Water Sent to the Other Public Water Works	80,965	64,016	67,764	65,587	90,470
Internal Leakage for Water Abstracted and Received for the Other Public Water Works	650,543	604,096	616,951	615,756	522,925
Evaporation	-	-	-	-	10,216
Total Water Loss	731,508	668,112	684,715	681,343	623,611
Loss Rate	60.98%	61.08%	63.55%	63.14%	61.59%

Source: Environmental Bulletin 2004 , Ministry of Environment and Water.
(Note) Water Loss incl. Loss between Intake Point and Purification Point.

By the way, the water sector status has varied by the Region. Table 2.3.8 shows a variation of the water sector status in each Region in 2004. In the South West Region including the capital city Sofia, the total available water volume shows the highest share rate as 33%. In the supplied water volume in total, the distribution pattern is almost the same nevertheless there exists a little bit changing. Furthermore, a loss rate from the "total available water volume" to the "supplied water volume" is around 62% as an average rate in the nation of Bulgaria ranging from around 59% in the South West Region to 67% in the North East Region. Further detail, it is ranging from 23% in the Blagoevgrad District of the South West Region to 80% in the Dobrich District of the North East Region.

2.3.10 Salary and Wages, and Family Status and Family Economy

<u>Income and Family Status</u>

Summary of average annual income by sources per household (HH) and that per capita since 2000 till 2004 is shown in Table 2.3.9. Average family size of household can be estimated in addition to the average income level per HH and that per capita as 2.77 persons/HH (= 6,356/2,466) in 2000, 2.71 persons/HH (= 4,532/1,672) in 2001, 2.66 persons/HH (= 5,556/2,085) in 2002, 2.62 persons/HH (= 5,887/2,244) in 2003 and 2.58 persons/HH (= 6,356/2,466) in 2004. Namely, the average family size in Bulgaria has gradually decreased year by year with indicating that the family size has become small year-by-year showing a trend toward the nuclear family. The amount of ordinary income by the compensation for working shares the highest rate, and this is quite in the natural order of things. On the other hand, the amount of wages and salaries shares the highest rate as around 40%, and also this is quite in the natural order of things. But, it must be noted that the amount of pensions shares the second highest rate as around of 22%. The data have expressed by the amount of benefits, so that it is not exactly accuracy, but it may be said that around 22% of the families are aging families in Bulgaria, or the around 22% of family members are aged persons (male over 63 and female over 58). This trend has been kept since 2000 as shown below.

Aging Rates in Bulgaria

	2000	2001	2002	2003	2004
Aging Rate	21.41%	23.73%	20.05%	20.62%	22.15%

Source: Statistical Yearbook of Bulgaria 2005.

By the way, the average annual incomes per HH and per capita in 2004 are 6,356 Levs and 2,466 Levs, respectively (see Table 2.3.10). This income level has varied by the Region.

A variation of the income level in each Region in 2004 is shown in Table 2.3.10. In the South West Region including the capital city Sofia, nevertheless the total income levels are lower as 6,440 Levs/HH per year or 2,599 Levs/Capita per year than those as 7,306 Levs/HH per year or 2,985 Levs/Capita per year in the North West Region, the amount of wages and salaries shows the top as 2,792 Levs/HH per year or 1,127 Levs/Capita per year in the nation in 2004.

Expenditure

The amount of income is greater than the amount of expenditure as shown below.

Cash Balance of Income and Expenditure of Household in Bulgaria

(Levs/year)

	2000	2001	2002	2003	2004
Average per Household					
Income	4,610	4,532	5,556	5,887	6,356
Expenditure	4,018	4,043	4,556	4,861	5,332
Cash Balance	592	489	1,000	1,026	1,024
Average per Capita					
Income	1,664	1,672	2,085	2,244	2,466
Expenditure	1,450	1,492	1,710	1,853	2,068
Cash Balance	214	180	375	391	398

Source: Statistical Yearbook of Bulgaria 2005.

According to the data shown in Table 2.3.11, the amount of saving amounts per HH and per capita since 2000 is 95 Levs, 108 Levs, 115 Levs, 125 Levs and 142 Levs in HHs and 34 Levs, 40 Levs, 43 Levs, 47 Levs and 55 Levs in each year. Therefore, the amounts of cash in hand including saving in deposit are as shown in the following table together with their share rates.

Share Rate of Cash Balance to the Total Income in Household

	2000	2001	2002	2003	2004
Per HH	687	597	1,115	1,151	1,166
Per Capita	248	220	418	438	453
Share Rate to the Total Income	14.90%	13.17%	20.07%	19.55%	18.34%

Source: Statistical Yearbook of Bulgaria 2005.

The share rate of the cash in hand including saving amount has been increased from around 15% in 2000 to the total income to around 18% in 2004 to also total income nevertheless it fluctuates year by year. The following table shows the share rate of the amount of "Food and Non-Alcoholic Beverage" to the ordinary income in total, so called as "the Engel coefficient".

Share Rate of the Amount of Food and Non-Alcoholic Beverage to Ordinary Income in Total in Household

	2000	2001	2002	2003	2004
Engel coefficient	38.78%	40.10%	34.71%	33.20%	33.28%

Source: Statistical Yearbook of Bulgaria 2005.

The rates of around 40% in 2000 and 2001 are rather high comparing with those in developed countries, but around 35% in 2002 2003 and 2004 are almost the same with those in developed countries.

The average annual expenditures per HH and per capita in 2004 are 5,332 Levs and 2,068 Levs respectively in the nation as indicated in the following table. These amounts of expenditure have also varied by the Region. Differences among the amounts of expenditures by the Regions may indicate those of prices of goods and services in each Region.

Amount of Expenditure for Food and Non-Alcoholic Beverage by Region in 2004

(Levs/year)

Income Source	Region						Whole Nation of Bulgaria
	North West	North Central	North East	South East	South Central	South West	
Average per Household	5,421	5,289	5,094	5,376	5,077	5,682	5,332
Average per Capita	2,215	2,079	1,905	2,126	1,875	2,293	2,068

Source: Statistical Yearbook of Bulgaria 2005.

2.3.11 Prices

Exchange Rate

Officially, Bulgaria has applied the fixed rate of local currency (Levs), against EURO, Austrian Schilling, Belgian Franc, Deutsche Mark, Spanish Peseta, Finnish Markka, French Franc, Greek Drachma, Irish Pound, Italian Lira, Luxembourg Franc, Dutch Guilder, and Portuguese Escudo since January 1, 1999 except Greek Drachma. The rate of Greek Drachma is fixed on January 1, 2001. However, the actual exchange rates of Levs against them in the foreign exchange market are slightly changed day-by-day being linked with value of US Dollar because that the above currencies are floating linking with US Dollars. The flowing table shows a summary of historical exchange rates of Levs against main currencies.

Exchange Rates of Levs against Major Currencies

(Levs/unit)

	Nov.30, 2006	2005	2004	2003	2002	2001	2000	1999	1998
Against USD 1.00*	1.49215	1.68187	1.76036	1.83640	2.12334	2.18472	2.07697	1.73262	1.57511
Against JPY 100**	1.28600	1.40800	1.38600	1.46300	1.56400	1.68900	1.81800	1.86607	1.44893
Against EURO 1.00**	1.96621	1.96175	1.95794	1.95531	1.95436	1.96214	1.95872	1.91491	1.95428

Source: * Bulgarian National Bank.
** Foreign Exchange Currency Converter servied by OANDA.
(Note) The rate against US Dollars is the annual average, but that against the other currencies is that at the end of Year.

And, the Government of Bulgaria has devalued the currency of Lev from 1,000 Levs to 1.00 Lev from July 1999. Therefore, figures in 1998 and from January to June 1999 shown in the above table are converted ones for the devalued rate.

Consumer Price Index

The following table shows a summary of consumer price index in general in Bulgaria.

Consumer Price Index in General in Bulgaria

(1995 = 100)

	2001	2002	2003	2004	2005
January	3,657	3,913	3,981	4,236	4,377
February	3,670	3,977	3,986	4,251	4,415
March	3,671	4,008	4,001	4,248	4,429
April	3,665	4,003	4,013	4,259	4,477
May	3,667	3,920	3,988	4,261	4,456
June	3,664	3,854	3,902	4,186	4,397
July	3,657	3,858	3,937	4,236	4,401
August	3,668	3,832	3,966	4,217	4,427
September	3,715	3,863	4,004	4,257	4,489
October	3,779	3,901	4,031	4,264	4,542
November	3,787	3,907	4,106	4,291	4,587
December	3,801	3,956	4,179	4,345	4,625

Source: Ministry of Finane.

On the basis of the data shown in the above table, the Bulgarian National Bank estimates the following deflator in Bulgaria.

Deflator and Its Annual Changes Based on Consumer Price Index in Bulgaria

(June 1997 = 100)

	2001	2002	2003	2004	2005	Average Annual Increasing Rate
Deflator	126.8	131.4	140.1	141.9	141.8	
Changes against Previous Year	3.01%	3.66%	6.62%	1.26%	-0.02%	2.91%

Source: Ministry of Finane.

Therefore, several socio-economic indicators like GNP, GDP and so on expressed by the monetary terms are to be revised by using these deflators for making clear actual figures. In other words, these are the actual consumer price indexes. The annual average consumer price in Bulgaria may be increased at 2.91% in general from 2001 to 2005 as shown in the above table.

2.4 Water Quantity

2.4.1 Overview of Water Use in the Country

Gross water abstraction in the recent years is shown in the following table. This table is prepared based on the Bulletin for environment in 2000 - 2005 issued by National Statistical Institute (NSI).

Gross Water Abstraction

	1991	1995	1997	1998	1999	2000	2001	2002	2003	2004	2005	Average 2000-2005
Total	9,417 (100)	6,718 (100)	7,940 (100)	8,294 (100)	7,136 (100)	6,378 (100)	6,251 (100)	6,938 (100)	7,289 (100)	6,643 (100)	6,407 (100)	6,651 (100)
Non-Fresh Water	669 (7.1)	392 (5.8)	407 (5.1)	389 (4.7)	318 (4.5)	246 (3.9)	418 (6.7)	349 (5.0)	371 (5.1)	362 (5.4)	390 (6.1)	356 (5.4)
Fresh Water	8,748 (92.9)	6,326 (94.2)	7,534 (94.9)	7,905 (95.3)	6,818 (95.5)	6,132 (96.1)	5,833 (93.3)	6,589 (95.0)	6,918 (94.9)	6,282 (94.6)	6,017 (93.9)	6,295 (94.6)
Ground Water Total	1,446 (15.4)	907 (13.5)	798 (10.1)	793 (9.6)	585 (8.2)	574 (9.0)	525 (8.4)	493 (7.1)	467 (6.4)	434 (6.5)	447 (7.0)	490 (7.4)
Surface Water Total	7,302 (77.5)	5,418 (80.7)	6,735 (84.8)	7,112 (85.8)	6,233 (87.3)	5,558 (87.1)	5,308 (84.9)	6,096 (87.9)	6,451 (88.5)	5,848 (88.0)	5,570 (86.9)	5,805 (87.3)
from Reservoirs						1,886 (29.6)	1,504 (24.1)	1,421 (20.5)	2,373 (32.6)	2,068 (31.1)	1,843 (28.8)	1,849 (27.8)
from Inland Rivers						215 (3.4)	179 (2.9)	200 (2.9)	320 (4.4)	221 (3.3)	222 (3.5)	226 (3.4)
from Danube						3,233 (50.7)	3,430 (54.9)	4,307 (62.1)	3,577 (49.1)	3,391 (51.0)	3,360 (52.4)	3,550 (53.4)

Unit: million m^3 / year

Source: NSI, Environment, 2000-2005, rearranged by JICA Study Team

Both fresh water and non-fresh water (salty water) are abstracted and used. However, the ratio of non-fresh water is just about 5% of the total abstracted water. Almost all of non-fresh water is used for industrial purpose. Among the abstracted fresh water, about 50% is directly abstracted from the Danube River. It is mainly used for industrial purpose, especially for power generation plants (cooling water etc.)

Remaining abstracted water is from inland part of Bulgaria. Totally about 2.60 billion m^3/year, which is about 5% of annual total precipitation over the country and about 15% of annual total disturbed runoff, are abstracted. About 2.10 billion m^3/year are from surface water, 90% of which is through reservoirs. Groundwater abstraction is about 500 million m^3/year in average in the recent five years. However, the amount of groundwater abstraction tends to decrease gradually.

Water supply system can be divided into the following two categories.

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

Based on the data in the Bulletin by NSI, the ratio between the amount of water provided by public water supply system and that by others is about 1:2 as shown in the following table. The water provided by "the others" cannot be ignored when considering water balance.

Water Abstraction and Use by Sectors and Sources (Average during 2000 – 2005)

	Total	Public Water Supply					Others (including Self-Water Suply)				
		Total	SW			GW	Total	SW			GW
			Total	Reservoir	Others			Total	Reservoir	Others	
Abstraction	2,746	1,041	683	494	189	358	1,704	1,573	1,355	217	132
		Total					Total				
Loss	1,271	632					639				
		Total	Domestic Sector	Industry	Agriculture		Total	Domestic Sector	Industry	Agriculture	
Use	1,474	409	336	71	3		1,065	18	868	179	

unit: million m^3/year
SW: Surface Water
GW: Ground Water

Source: NSI, Environment, 2000-2005, rearranged by JICA Study Team
Note: The abstracted and used water from the Danube River and non-fresh water are excluded.

In the public water supply system, groundwater source contributes significantly. Its amount is about one third of the total abstracted water. Almost all of the water provided by public water supply system is used for domestic sector. The loss during the transportation of the water is more than 60%, which should be improved for effective use of the water.

The others including self-supply system relies on surface water more, 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.

In EABD and WABD areas, public water supply depends more on groundwater in EABD, and depends more on surface water in WABD in general (see Figure 2.4.1).

The following table shows water use in hydroelectric power plant (HPP) and sent water after use during 2000 - 2005. About 1.50 billion m^3/year are sent to other purposes after the water is used for HPP. Although actual water use by agriculture is not so large as shown in the table, about 50% of the used water is sent for agricultural purpose. Part of this water may be lost somewhere and/or converted to be used for other purposes. The proper control of this water could be one of important issues for efficient use of water. It should be noted that the amount of the sent water varies drastically year by year. It could be influenced by available water in reservoirs.

Water Use in Hydroelectric Power Plant (HPP) and Sent Water after Use in 2000 - 2005

	2000	2001	2002	2003	2004	2005	Average 2000 - 2005
Fresh Water Use	6,682	4,098	6,649	8,466	9,445	15,075	8,403
Sent Water after Use	1,205	700	1,416	2,011	1,876	1,801	1,502
Irrigation	710	232	699	1,099	1,012	1,142	816
Domestic Sector	192	124	160	185	238	144	174
Industry	303	345	557	727	626	515	512

Unit: million m^3/year

Source: NSI, Environment, 2000-2005, rearranged by JICA Study Team

The following table shows total wastewater discharge. It can be recognized as one of returned water after water use. One can see that about two third of the total actually used water in domestic, industrial and agricultural purposes is returned to rivers as wastewater. However, it should be noted that considering the high loss rate of abstracted water, amount of actual return flow is much smaller compared to the abstracted water amount. About 70% of wastewater discharged is categorized as treated wastewater.

Total Wastewater Discharge in 2000-2005

	2000	2001	2002	2003	2004	2005	Average 2000 - 2005
Total Wastewater Discharged	879	785	746	1,194	1,192	823	937
Treated	550	488	517	951	943	587	673
Non-Treated	328	297	230	243	248	236	264

Unit: million m^3 / year

Source: NSI, Environment, 2000-2005, rearranged by JICA Study Team

2.4.2 Existing Water Supply Systems

There are 51 major water supply and sewerage (WSS) companies in Bulgaria. They are composed of state owned company (13), state and municipality owned company (16) and municipality owned company (22). Detail of the existing water supply systems, which are operated by the major WSSs in Bulgaria, is summarized in Table 2.4.1. This table also includes the information of sewerage systems.

Among the water supply networks, share of asbestos cement pipe is 74% and that of steel pipe is 15% in Bulgaria. These two kinds of pipes are the most deteriorated pipes causing significant loss of water such as 50% to 60%, which are highly necessary to be replaced to HDPE pipes and others.

Following photos shows the condition of the deteriorated asbestos pipes etc., which are exhibited in Kyustendil WSS Company.

Cracked Asbestos Cement Pipe (above) and Corroded Steel Pipe (below)

Damaged Asbestos Cement Pipe by penetration of Wooden Root

2.4.3 Outline of Irrigation

Irrigation had been one of large water users. In 1980s, irrigated area was about 1.00 million ha, which was about 10% of the territory of Bulgaria. The used water volume for irrigation at that time was about 3.50 billion m^3/year. It is more than the total abstracted water (excluding the Danube River and non-fresh water) in the recent years. However, in the beginning of 1990s, it decreased very rapidly. It becomes now about 20,000-30,000 ha. The used water is also decreased to 100 - 200 million m^3/year, which is about 1 - 2% of that in 1980s (see Figure 2.4.2).

Although the irrigated area has been reduced, there is potential irrigation system, which was once fully operated as irrigation area (see Table 2.4.2). There are 21 irrigation branches in Bulgaria. Each irrigation branch has many irrigation systems. The irrigation area set-up by irrigation system for EABD and WABD is shown in Figure 2.4.3. Irrigation areas are categorized by water supply condition. In EABD, especially in the Maritsa and Tundzha River basins, there are wide irrigation areas whose water source are significant reservoirs. On the other hand, many of irrigation areas in WABD utilize water taken from rivers.

Table 2.4.3 summarizes average water use and estimated abstracted volume by irrigation systems in 2001 - 2005 according to the data provided by Irrigation Systems Ltd. Loss rate is very high in general at 60-80%. For efficient utilization of the water, it is necessary to improve the current condition.

It should be noted that the estimated abstracted water volume by Irrigation System Ltd. does not always reflect actual situation, because of the difficulty of getting correct data under the current institutional situation. For the study on water balance in the present study, the abstracted water volume for irrigation system, especially for the one related to significant reservoirs, are estimated by the other data sources such as the record of operation of significant reservoir and the water quantity measured at hydrometric stations.

2.4.4 Significant Reservoirs and Water Transfer

In Bulgaria, there are a number of reservoirs and lakes. Of these, a total of 51 reservoirs are specified as significant reservoirs in the Water Act (see Figure 2.4.4 for the list of significant reservoir and those locations). Total volume of the significant reservoirs is about 6.60 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.

Figure 2.4.5 shows change in percentage of total stored water volume against total effective volume of significant reservoirs during 1999 - 2003. Regarding annual fluctuating pattern of the stored water volume in the reservoirs, maximum volume usually appears in June and minimum appears in December to February. One can see that volume of stored water in reservoirs does not recover to its full capacity within single hydrological year. During 1999 - 2003, the stored water volume recovered to 80% of the total effective volume in maximum case. In 2001 and 2002, the recovery was just up to 60%. This is presumably because of reduction of inflow to the reservoirs due to low precipitation in 2000 and 2001. From January 2002 to January 2003, total volume in the reservoirs was increased about 20% of the total effective volume, which is almost equal to 1.20 billion m^3. (It is assumed that the effective volume is 90% of total volume.)

For estimating detailed water balance considering operation of the significant reservoirs, the data stored in MoEW are basically used. However, there were many difficulties for utilizing the data. The followings are assumed in the present study.

- Even in the data stored to MoEW, there is lack of information for water use condition for 2000 - 2001. For 2000-2001, the condition of water use has been assumed referring the water use condition of 2002-2005.
- Some reservoirs gather water through feeder channels from neighboring river basins. However, the data in MoEW show only total inflow volume. Based upon the available information on the design scheme of significant reservoirs, how the feeder channels contribute to inflow to the significant reservoirs in EABD and WABD has been assumed.
- One of unclear factors when one considers the water balance is how the used water for hydroelectric power plant (HPP) is re-used for another purpose. It is not always clearly shown in the records submitted to MoEW. Considering possible water balance based upon the available information such as water quantity measured at hydrometric stations, re-used water has been assumed. There are two patterns assumed as follows.
    - *Pattern 1*: All of used water for HPP is re-used for irrigation purpose and does not come back to downstream reach of the river that HPP locates.
    - *Pattern 2*: All of used water for HPP comes back to downstream reach of the river that HPP locates. Only the water for irrigation that is specified in the records is used for irrigation purpose.
- Another unclear factor is share of industrial water supply and domestic water supply. The records in MoEW show only the total water use for industrial and domestic water. In the present study, the share between industrial and domestic water supply has been assumed based on the permitted water volume.

For accurate estimation of water balance for water management purpose, it is highly recommended to use more solid and reliable information to make clear all of the above-mentioned points, so that one can avoid applying many assumptions.

Figures 2.4.6 - 2.4.8 summarize main water transfer related to the significant reservoirs in EABD and WABD. Very complicated artificial water transfers can be seen in the figures. Typical water transfers are:

- The Struma and Mesta River Basins to the Belmeken Reservoir (the Maritsa River Basin),
- The Mesta River Basin to the Dospat Reservoir (the Dospat River Basin),
- The Dospat Reservoir (the Dospat River Basin) to the Vacha River Basin (the Vacha Reservoir) (the Maritsa River Basin),
- The Dospat River Basin to the Batak Reservoir (the Maritsa River Basin),
- Upper part of the Vacha River Basin (the Maritsa River Basin) to the Batak Reservoir (the Maritsa River Basin),

- The Koprinka Reservoir (the Tundzha River Basin) to the Maritsa River Basin, and
- The Zhrebchevo Reservoir (the Tundzha River Basin) to the Maritsa River Basin.

The following average volume of inter-basin water transfer in 2001 – 2005 is estimated based on the data stored in MoEW under the above-mentioned assumptions.

- 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
- The Tundzha River Basin to the Maritsa River Basin: 254 million m^3/year

2.4.5 Water Balance for Existing Condition

In this section, estimated water balance under existing condition (2001 - 2005) is presented. The water balance for each river basin has been 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 (see Chapter 4) has been used to calculate the water balance.

Table 2.4.4 summarizes average annual water balance at downstream end (national border) of the river basin in 2001 - 2005. In the table, the definitions of the terms used are as follows.

- Quasi-Natural Flow (NF)
  - Flow without human disturbances such as abstraction, discharge and transfer
  - Likely natural, however, not exactly natural.
  - In the model, regime change of local reservoir is not taken into account.
- Potential Flow with Significant Reservoir (PF)
  - Flow with influence of significant reservoir, but no abstraction from reservoir
  - Potentially usable water amount after regime change by significant reservoir
- Disturbed Flow (DF)
  - Existing condition
  - It can be expressed as follows.
    - (Potential Flow) – (Total abstracted water) + (Total discharged water)

Figures 2.4.9 - 2.4.15 show locations of the reference points in each basin and the water balance along mainstream of each river basin. Detail spatial distribution of 1) water balance, 2) ratio of abstracted water amount against potential flow, 3) maximum permitted water amount for local HPP against potential flow, and 4) ratio of wastewater discharge against disturbed flow for EABD and WABD are shown in Figures 2.4.16 - 2.4.19 and Figures 2.4.20 - 2.4.23, respectively. From the above table and figures, the followings can be identified.

Struma	• There is inter-basin water transfer from the Struma River to the Maritsa River Basin. The transfer from the Struma River reduces potential flow in the Struma River about 2% of quasi-natural flow at the downstream end (country border) of the Struma River. It does not affect so much to overall water balance in the Struma River Basin. It is less than the volume of abstracted water for use in the Struma River Basin, about 5% of potential flow. However, it should be noted that the effect of water transfer at local scale might not be ignored (see Figure 2.4.20 for detail spatial distribution of water balance). • In upstream portion of the Pchelina Reservoir, water abstraction for domestic and industrial water use is relatively high. At downstream portion of the Studena Reservoir does have very small amount of water, because of water abstraction by the Studena Reservoir. • Ratio of wastewater discharge against disturbed flow is about 7%. It is expected that higher pollution can be expected in the reach with higher ratio of wastewater discharge. This high ratio can be seen along small tributary with big cities, especially at upstream portion of the Pchelina Reservoir.
Mesta and Dospat	• There are inter-basin water transfers from the Mesta and Dospat rivers to the Maritsa River Basin. The transfer from the Mesta River reduces potential flow in the Mesta River about 10% of quasi-natural flow at the downstream end (country border) of the Mesta River, although water abstraction for use in the Mesta River Basin is much smaller than the transferred volume. • Impact of water transfer from the Dospat Reservoir on the downstream portion of the Dospat River is very large. Almost two third of quasi-natural flow does not reach to the downstream end (country border) of the Dospat River. • Special attention should be paid to water abstraction from a weir at Gotse Delchev. The water abstracted from this weir is used not only for irrigation but also for local hydroelectric power plant. In summer time, the abstraction form this weir significantly reduces the water quantity of mainstream of the Mesta River, although it is limited to some stretches. • Ratio of wastewater discharge against disturbed flow is about 3%.
Arda and Biala	• There is no inter-basin transfer in the Arda River Basin. However, loss in reservoirs such as evaporation reduces annual average potential flow. It should be noted that the potential flow significantly increases in summer time because of regime change by reservoir operation.
Tundzha	• There are inter-basin water transfers from the Tundzha River to Maritsa River Basin. Those transfers significantly reduce potential flow in the Tundzha River about 25% of quasi-natural flow in the Tundzha River. In the Tundzha River Basin, volume of water abstraction is also very large. About 30% of potential flow is abstracted. Because of these, actual flow is almost half of quasi-natural flow. It can be said that the Tundzha River Basin is significantly modified in terms of water quantity condition. • More than 80% of water abstraction is for irrigation purpose. As have already discussed, loss of irrigation water use is very large. To reduce loss of irrigation water use and to control irrigation water properly is one of key factors for improvement of river condition. • Ratio of wastewater discharge against disturbed flow is about 7%. It is expected that higher pollution can be expected in the reach with higher ratio of wastewater discharge. This high ratio can be seen along small tributary with large cities.

Maritsa	• The Maritsa River receives much water from the neighboring river basins. This makes potential flow in the Maritsa River almost 10% higher than the quasi-natural flow. Some of transferred water is lost by evaporation in reservoirs. About 20% of potential flow is abstracted for water use in the Maritsa River Basin. Without the water transfer, river condition may become much worse if the same level of water abstraction is kept. • More than 80% of water abstraction is for irrigation purpose. As have already discussed, loss of irrigation water use is very large. To reduce loss of irrigation water use and to control irrigation water properly is one of key factors for improvement of river condition. • Ratio of wastewater discharge against disturbed flow is about 7%. It is expected that higher pollution can be expected in the reach with higher ratio of wastewater discharge. This high ratio can be seen along small tributary with large cities.

2.4.6 Results of Interview Survey on the Problems of Water

In order to know how municipality people feel about the problems of water especially drinking water supply and sewerage, the Study Team conducted interview survey to some of the municipality offices. The visited municipalities are as follows:

EABD Area	
Maritsa River Basin	Asenovgrad, Velingrad, Pazardzhik, Panagyurishte, Plovdiv, Hisarya, Karlovo, Stara Zagora, Galabovo, Dimitrovgrad, Haskovo and Svilengrad
Tundzha River Basin	Kazanlak, Sliven, Yambol and Elhovo
Arda River Basin	Smolyan and Ivaylovgrad
WABD Area	
Struma River Basin	Pernik, Dupnitsa, Kyustendil, Blagoevgrad and Sandanski
Mesta River Basin	Razlog, Bansko and Gotse Delchev
Dospat River Basin	Dospat

The results of the interview survey are summarized in Table 2.4.5. The major problems are described below.

(1) Problems related to Drinking Water Supply

- The most serious problem is old or deteriorated pipes: asbestos cement and steel pipes with high loss and frequent accidents. This problem also causes shortage of supply 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 insufficiency of water sources. Furthermore, most of the municipalities, which answered about insufficiency of water sources, belong to WABD area. This is probably due to the fact that the water source in WABD area depends more on surface water than groundwater in general.
- There is problem of manganese in water mainly in EABD area.
- There is 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 rather large problem.
- There is serious problem of insufficient or no treatment of industrial water as well as large animal breeding farms. They discharge directly into the rivers and water bodies almost without treatment.
- Sewer pipes are old and deteriorated in general, and 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, towns and villages, infrastructures including road and bridge, railroad, water supply systems, sewerage systems, agricultural land and bank protection and dikes.
- However, 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 survey answered that they have experienced accidental pollution. However, the situation of the accidental pollution is not so clear.

2.5 Groundwater

2.5.1 General Hydrogeological Conditions in Bulgaria

All kinds of groundwater reservoirs are presented in Bulgaria: porous, fissured and karstic. Porous aquifers are widespread at lower altitudes: within lowlands and kettles, along rivers. Fissured and karstic groundwater reservoirs are usual in mountain regions. Where present, carbonate deposits (marble, limestone, dolomite) are fissured and somewhere karstified.

From hydrogeological point of view, the country is divided into 3 regions:

- Low-Danube artesian (in North Bulgaria),
- Intermediate, and
- Rilo-Rhodopian (Figure 2.5.1)

(1) Hydrogeological Map(s)

Two kinds of maps are available for the territory of Bulgaria in scale 1:200,000:

- Map of groundwater flow and natural groundwater resources (1979);
- Map of "groundwater safe yield" or "exploited resources" (1981).

(a) The Groundwater Flow Maps

These maps give quantitative characteristics of the main aquifers and aquifer systems containing fresh groundwater suitable for public water supply. These maps show average long-term values of groundwater discharge. It should be emphasized that groundwater discharge values, characterizing the natural productivity of aquifers or aquifer systems, are the major indicator of groundwater resources availability in an area (Zektser & Everett, 2004). These maps present estimates for the total potential of groundwater resources.

Generally, natural groundwater resources are expressed by ***module of groundwater flow***, which is defined as groundwater flow discharge from a unit of catchment area, given in liters per second per 1 km^2 (Zektser, 2002; Zektser & Everett, 2004). Additional characteristics may be groundwater runoff/precipitation ratio and ratio of groundwater discharge to total river runoff.

In Bulgaria, the regional assessment and mapping of the natural groundwater resources have been made with support of Russian hydrogeologists. A map of natural groundwater resources is available in the scale 1:200,000 (1979).

The legend includes:

- I. Age of aquifers;
- II. Long-term value of module of groundwater flow (in $l/s/km^2$);
- III. Areas of recharge of confined (deep) aquifers (in layer, mm);

- IV. Other symbols (areas with TDS content > 1 g/l; open karst area; areas with intensive evaporation from groundwater and salinization of soils; losing streams, etc.)

(b) The Map of "Groundwater Safe Yield" or "Exploited Resources"

This map is a prognostic map that presents a part of natural resources (of the total potential of groundwater resources) that may be used for water supply. It is based on the regional evaluation of safe yield. The map compiled for Bulgarian territory in 1981 contains 28 map sheets in scale 1:200,000.

The legend includes:

- I. A. Modules of "exploited resources" (in l/s/km^2) that are given in seven gradations and presented by different colors. Regions defined as practically without "exploited resources" are with grey color. For low confidence of data, only presumed values are given; they are marked with vertical lines. Regions with groundwater development mainly through tapping of spring are delineated.
- B. Modules characterizing additional (induced) recharge from rivers under exploitation (linear module – l/s/km) are given in five gradations.
- II. Transmissivity values (m^2/d) – in seven gradations.
- III. Spring discharge (l/s) – in six gradations.
- IV. Characteristics of exploitation wells (depth, m; productivity, l/s) – in five gradations.
- V. Other symbols (age of aquifer, open karst, large groundwater abstractions, groundwater unfit for water supply, etc.).

It should be emphasized that this map refers to groundwater resources that have not been explored, but only estimated based on regional consideration and available data, without additional field works. Based on this map, areas favourable for the resources formation may be defined. To explore the groundwater resources, especial research is needed.

The Study team transferred some elements of the above-mentioned map (1981) to GIS-maps – "Distribution of transmissivity" for WABD and EABD, and for Bulgaria as a whole.

(c) Other Hydrogeological Maps

For some regions of Bulgaria, hydrogeological maps are available in scale 1:25,000. The Committee of Geology and Mineral Resources commissioned the preparation of these maps in the period 1992-1997. The legend includes different hydrogeological aspects including transmissivity values in the applied gradations, depth to groundwater levels and sometimes-equipotential lines.

(d) New Hydrogeological Map

Digital groundwater map of Bulgaria, 1:500,000 - the new groundwater map of Bulgaria (P. Pentchev et al.) is intended for a wide range of users. It gives a general idea of the groundwater in Bulgaria including mineral waters.

Four classes according to groundwater productivity and four subclasses depending on the porosity type of water-bearing rocks have been used to categorize the hydrogeological formations:

- Major aquifers (class A), major aquifers (class B), minor aquifers (class C), and non-aquiferous formations (class D);
- Porous aquifers (subclass 1), fractured aquifers (subclass 2), fractured-karst aquifers (subclass 3), and porous-karst aquifers (subclass 4).

The different letter indices and colours, while the separate subclasses by the different numerical indices and patterns, identify the separate classes.

There are presented explanatory notes on stratigraphic levels, names of aquifers, and the official litho-stratigraphic units to which these are associated. The map reveals the lithological type of the water-bearing formations. It includes only the most significant groundwater springs and mineral water sources. The map has been prepared as a digital model in GIS - MapInfo. Nevertheless, it presents all aquifers in the only GIS-layer, and does not show stratified aquifers in depth.

(2) Groundwater Aquifers and Their Characteristics

Porous aquifers are widespread in the northern part of the country. Lowlands along the Danube River are good groundwater reservoir with transmissivity values from 500-1000 m^2/d or more (see Figure. 2.5.2). The aquifers are built from the Quaternary alluvial deposits (sand and gravels) with thickness 10-20 m, overlain by low permeable layer (silt loam, loam, loess, etc.).

Alluvial aquifers along rivers are characterized by similar structure, but with lower thickness and transmissivity (usually from 100 to 500 m^2/d).

In NW Bulgaria, within Lomski sub-region, there is a stratified system of aquifers, mainly porous (sands).

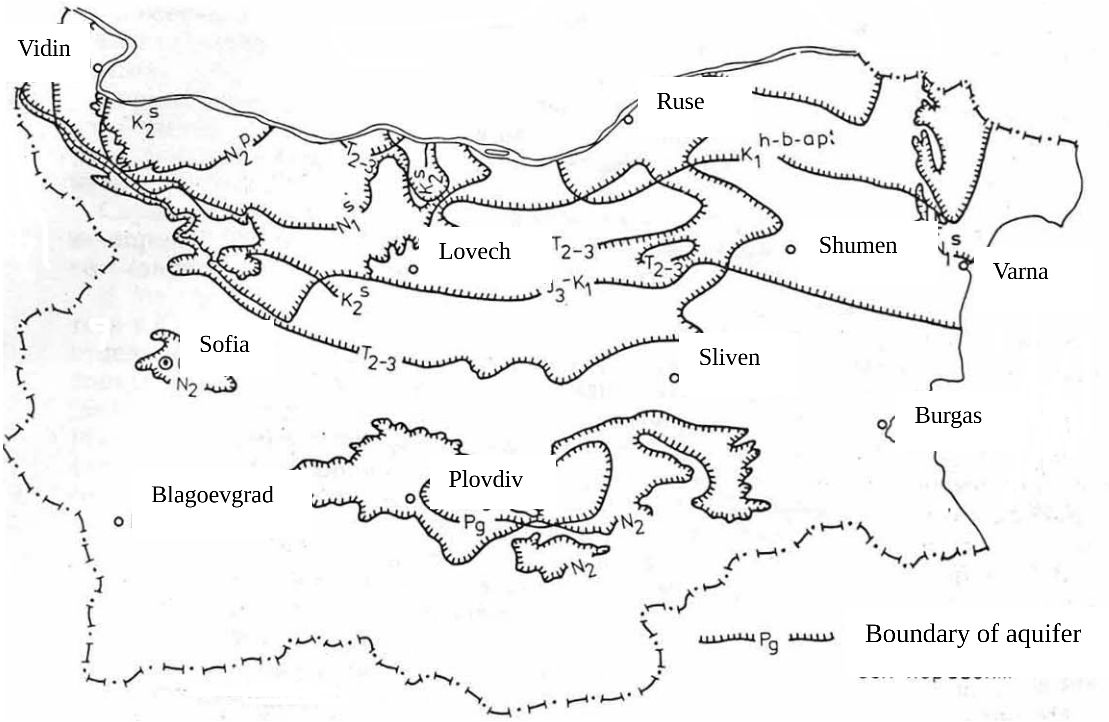
Large porous aquifer is formed in South artesian basin from the Intermediate region. The alluvial and proluvial deposits in the valley of the Maritsa River are characterized with high transmissivity value (from 500 to 2000 m^2/d).

Important porous aquifers are related to kettles filled in with alluvial and proluvial deposits.

In NE part of the country, carbonate deposits are widespread. There a huge and deep groundwater reservoir is formed in Mesozoic formations, which is referred both to the Danube and the Black Sea River Basins. Its groundwater divide is oriented NE – SW. The limestone formations are highly heterogeneous. Other aquifers in younger carbonate formation overlay partially this aquifer. The upper aquifer is the Sarmatian in the Black Sea River Basin, with very high permeability, which is not protected from contamination. The deepest and the upper aquifers are Tran boundary, shared between Bulgaria and Romania.

Within the Rilo-Rhodopian and Intermediate regions, many important local karst basins occur, which are discharged mainly by karst springs.

The major part of the aquifers occurs in the northern part of the country, within the Moesian platform (see figure below). Local groundwater systems prevail in Bulgaria; in many regions there is no large aquifer systems.



Sketch Map of the Principal Deep Aquifers in Bulgaria (Kehajov et al., 1988)

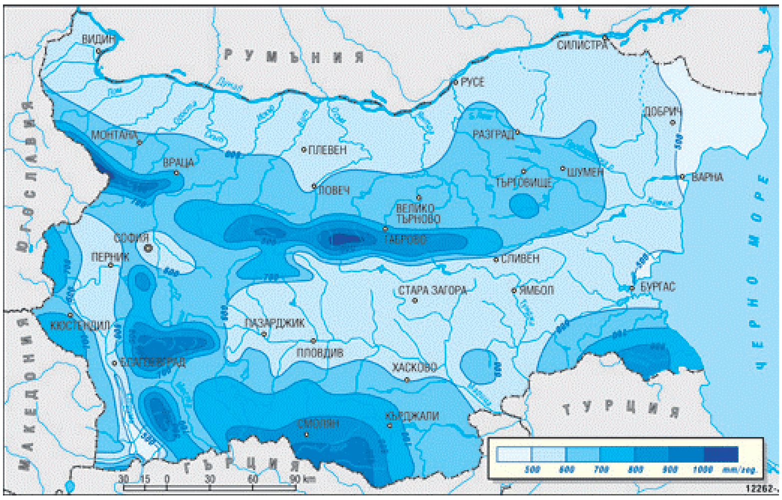
The basic manual for many generations of students-hydrogeologists is the book "Groundwater in the Republic of Bulgaria" by Antonov and Danchev (1980). More recent information is presented in General Master Plans (2000).

(3) 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 (due to orographic effect) 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. Many of such karst reservoirs are not well protected against contaminations, but in high mountains the anthropogenic impact is usually low.

Large groundwater resources are common for porous aquifers along rivers, especially for and 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.



Precipitation Amounts in Bulgaria (Geography, 2002)

Groundwater discharge is a major component of surface water generation in headwater streams.

2.5.2 Groundwater Monitoring Networks

(1) Existing Groundwater Monitoring Networks of NIMH

Nowadays, National Institute of Meteorology and Hydrology (NIMH) supports two networks of groundwater monitoring stations (see table below):

- Network of groundwater quantitative monitoring and
- Network of groundwater qualitative monitoring.

Groundwater Stations of NIMH

Kind of the GW station	Quantitative monitoring		Qualitative monitoring	
	Yes/No	Monitoring program	Yes/No	Monitoring program
Well (shaft or borehole)	Yes	H, t	No	-
Artesian well	Yes	Q, t	(Yes)	t, pH, TDS, basic components, **nitrogen forms, phosphates, iron**
Spring	Yes	Q, t	(Yes)	t, pH, TDS, basic components, **nitrogen forms, phosphates, iron**
Well with pumping station	No	-	Yes	t, pH, TDS, basic components, **nitrogen forms, phosphates, iron**

H – groundwater level
Q – discharge
t – water temperature
(Yes) – means: only for the chosen stations

The measurements for groundwater quantity network are on monthly basis for most of the stations; some are on the daily basis.

Sampling for the groundwater quality network – 4 times yearly.

NIMH Wells

The Figure 2.5.3 "NIMH Monitored Wells" contains wells for the groundwater quantity monitoring:

- Wells (shafts and boreholes) for measurement of groundwater level and temperature;
- Artesian wells (boreholes) for measurement of discharge and temperature; some of them are included into groundwater quality network;

The Figure 2.5.4 "NIMH Wells with Pumping Stations" refers to:

- Wells with pumping stations for water supply - for groundwater quality monitoring (only some of them are used for groundwater level measurements - only in NE Bulgaria, where GWL is deep, and wells are scarce).

The frequency of the measurement for the category "Wells" is usually once per month. Some stations are measured few times in a month, and only few are supplied with groundwater level recorders (limnigraphs).

NIMH Springs

The Figure 2.5.5 "NIMH Monitored Springs" contains springs that may be divided into:

- Springs with measurements on monthly basis;
- Springs with measurements on daily basis.

For the last category, daily measurements of the stage at hydrometric station are available. Based on rating curve, data on daily discharge are obtained.

National Hydrogeological Networks (NHGN) in Bulgaria is in operation since 1958-1961. They were found with the assistance of Russian hydrogeologists. From the year 2000, the MoEW supports functioning of the networks. Still, there is no fund for technical improvement of existing equipment.

MOEW does not have data from the groundwater quality network of NIMH during last years.

(2) Existing Groundwater Monitoring Networks of ExEA

The Groundwater monitoring system from the ExEA has data from 1980 year for ground water and from 1989 for surface water. After last increase and improve, it refers to 233 stations for the period 2000 – 2005 (springs, pumping stations, wells, see Figure 2.5.6). The frequency of data is usually 4 or 2 times per year. There are some gaps in data series for some stations. For the project, data concerning pesticides and heavy metals is given on different sheets or files.

All components included into Bulgarian Regulation N 9 for drinking waters are defined. The Regulation N 9 is harmonized with the European Drinking Water Directive (Council Directive 98/83/EC on the quality of water intended for human consumption).

The bulletins issued by the ExEA, which is available in its web page, determine problematic stations in terms of the Regulation N 1 for research, utilization and protection of groundwater (ET - ecological threshold; PT - pollution threshold). The different threshold values (the maximum permissible values) according to Regulations N 1, N 9 and Drinking Water Directive are presented in the table below (only for basic components).

Threshold Values according to Different Regulations.

Parameters	Symbols	Dimension	Regulation № 1		Dimension	Regulation № 9	Drinking Water Directive
			ET	PT			
Hydrogen ion concentration	pH	pH units			ph units	6.5 - 9.5	6.5 - 9.5
Oxidisability	COD-Mn	mg/l O_2			mg/l O_2	5.0	5.0
Chloride	Cl	mg/l	30	100	mg/l	250	250
Sulphate	SO_4	mg/l	50	150	mg/l	250	250
Sodium	Na	mg/l	50	100	mg/l		200
Calcium	Ca	mg/l			mg/l	150	
Magnesium	Mg	mg/l			mg/l	80	
Iron	Fe	μg/l	50	200	μg/l	200	200
Manganese	Mn	μg/l	20	50	μg/l	50	50
Cadmium	Cd	μg/l	1	5	μg/l	5.0	5.0
Chromium	Cr total	μg/l	5	50	μg/l	50	50
Arsenic	As	μg/l	10	30	μg/l	10	10
Lead	Pb	μg/l	30	200	μg/l	10	10
Copper	Cu	μg/l	30	100	mg/l	2.0	2.0
Zink	Zn	μg/l	200	1000	mg/l	5.0	
Nickel	Ni	μg/l	20	100	μg/l	20	20
Ammonium	NH_4	mg/l	0.12	1.2	mg/l	0.50	0.50
Conductivity		μS/cm			μS/cm	2000	2500
Nitrite	NO_2	mg/l	0.025	0.125	mg/l	0.50	0.50
Nitrate	NO_3	mg/l	10	30	mg/l	50	50
Phosphate	PO_4	mg/l	0.1	1	mg/l	0.5	0.50

It should be noticed that the corresponding threshold values according to Regulations N 9 may be lower (for Pb - lead, for example), or higher (for Cu - copper) compared with the threshold of pollution according to Regulations N 1.

<u>Groups of Components or Indicator Parameters</u>

For the purposes of analysis, the parameters had been divided into groups as shown below:

Groups of Indicator Parameters for GIS-Maps

I group	II group	III group	Pesticides	Heavy metals
NO_3 av	Fe max	Conductivity		Cd
NO_3 max	Mn max	SO_4 max		Cr
NO_2 max	pH	Cl max		As
NH_4 max	Na max	Ca max		Pb
PO_4 max		Mg max		Zn
COD-Mn				Ni
				Cu

The first group includes one of the most important pollutants of groundwater - nitrate. This pollutant is widespread in Bulgaria. The basic sources of contamination are: application of fertilizers (agriculture) and lack of wastewater treatment plants (from settlement or animal breeding). This group includes all analyzed forms of nitrogen in groundwater and related pollutants/parameters as phosphate and oxidisability.

The main goal of GIS-maps on groundwater quality is to identify problematic areas, aquifers in groundwater bodies, where groundwater does not meet the requirements of the Regulation N 9.

The principal approach is to show the groundwater quality by colour. The main threshold values between “good” and “bad” quality are according to Regulation N 9. The registered maximal values of indicator parameters are used. The respective information is presented for each year from 2000 up to 2005. For nitrate, due to its importance as pollutant, additional threshold value is used (30 mg/l). In addition, for each station the average value of nitrate content is calculated for the period 2000-2005.

<u>Representative and Non-representative Stations and Data</u>

Unreal data

Many of the unreal data refer to the initial stage - the year 2000. Some of the unreal data have been corrected after additional check in Laboratories.

Violated sampling procedure

One of the problems is related to quality of the data due to violated sampling procedure. According to information from the ExEA, there are about 10 stations - wells, where pumping sampling could not precede because of any pumping facilities available. Such stations are non-representative for the corresponding aquifers and/or groundwater bodies. They show high content of Fe, Mn and/or other components (for example, stations N 194 and 195 in Sofia, 234 – Yana, 202 - Stoletovo). The overall list of such stations is lacking.

Local pollution

Some stations are under local impact of pollution. One example is station N 169 - Radomir (at the railway station, where carriages, or coaches are washed). Another examples - station N 203 (Straldzha), situated in the grounds of a factory; station N 99 (Katunitza) situated in the grounds of an alcohol factory.

Mixed groundwater

There are stations, which show mixed water from shallow and deep aquifers. For example, station 206 (Dobrich) refers to a pumping station from 2 deep and 13 shallow boreholes. The corresponding important aquifers are N1srm and J3 m-K1vlg.

2.5.3 Conditions of Groundwater and the Problematic Areas

(1) Groundwater Quantity and the Problematic Areas

(a) Groundwater Table of Wells

Some of problematic areas in terms of groundwater quantity are related to extremely shallow groundwater.

Besides unfavourable conditions for agriculture and building, they make a premise for concentration (increase of TDS) of groundwater due to high evapotranspiration, and thus frequently coincide with problematic areas in terms of groundwater quality. Groundwater level close to the land surface hampers aeration of the soil, and may result in anaerobe conditions.

Areas with extremely shallow groundwater level are presented in Figure 2.5.7 based on the groundwater quantity network from NIMH for the period 2000-2005. The depth to GWL is given as multi-annual average for the given period.

During severe floods in August and September 2005, measurement of some stations from the eastern part of the country was impossible due to inundated areas. Substantial rise of the groundwater table have been registered in wells near to the Danube River (see Figure 2.5.8). Within the Danube lowlands, groundwater tables above the land surface have been registered both in April and in August 2005, due to direct hydraulic connection with the Danube River and high river stages for the river.

In other parts of the country, high GW tables have been registered only in April 2005.

In general, the year 2005 is characterized with high groundwater levels, especially in comparing with very dry year 2001.

<u>Shift of Shallow Groundwater Systems under Human Impact</u>

A case of evident impact from irrigation on GWL in shallow groundwater has been registered for the region of Ivajlo, west from Plovdiv (EABD). The groundwater tables have been observed before and after planting of rice crops and starting of the associated intensive irrigation.

In Figure 2.5.9 GWL hydrographs are presented for the two periods: 1956-1959 and 1981-1984. There is a clear difference in patterns of the hydrographs for the two periods. An evident shift of the groundwater regime from natural to agricultural occurred as a result of new land use - rice crops with associated irrigation (Boteva et al., 1986).

Another case that demonstrates considerable change of groundwater regime refers to the Slivenski proluvial fan (EABD). Important groundwater recharge of the Quaternary aquifer here is due to waters of perennial river Asenovska that partly looses water within the proluvial fan. Such recharge produced considerable rise of the groundwater table. In this region observational well N 310 showed large amplitude in groundwater level fluctuations (up to 10 –12 m) - see Figure 2.5.10.

The peaks of high groundwater levels (GWL) on Figure 2.5.10 indicate more intensive recharge events. Such events are manifested with enhanced amplitude for the respective year (Figure 2.5.11). Low recharge values lead to decrease of the amplitude - during 1972, 1976 and since 1989.

Evident decrease of recharge occurred. One very probable cause is drought period (1982-1994), and the second - possible result of human impact and decrease of recharge from river Asenovska.

Evidently, the described changes do not present a natural variation of the system, but a shift to other state characterized with worse groundwater recharge conditions from river and consequently, lower resource. It is interesting that for the mean annual groundwater level this shift is almost not expressed. This shift is well noticed however for the amplitude of groundwater variation and high annual values - these variables depend directly from the recharge events.

(b) Groundwater Discharge from Springs

Since the year 2005 was abundant in precipitation amount, spring flows were higher then usually. During the year 2005, high discharge values have been registered for karst springs (Figure 2.5.12).

Well-expressed seasonal pattern is due to snowmelt in the high Pirin Mountain. Gradually increase of the mean and extreme discharge values are well expressed from the dry year 2001 to subsequent normal and wet years. Evidently, the reaction of the karst system strongly depends from the recharge conditions.

For karst springs a problem of water shortage during low flow period is actual. This problem affects mainly regions with water supply from karst springs and water intakes from small streams and rivers in mountainside regions. Such water sources are characterized with well-expressed seasonal regime with low flow period during late summer and early autumn. Simultaneously, July and August are the periods with enhanced need of water for irrigation. In rural regions, drinking water de facto is used for watering of crops in households. As a result, water shortage is usual event during summer.

Seasonal scarcity of the groundwater resources is inherent to carbonate massifs in mountain areas, drained by karst springs of conduit type. These regions receive much recharge, but the groundwater flow is fast, and the low flow periods are strongly expressed due to limited regulative capacity of the aquifer. Classical example is NW Bulgaria and especially the region of Vratsa.

The same regularity as described above for the spring N 59 is observed for the karst springs N 19 and 600 (see Figure 2.5.13). For spring 19, two graphs are given: remaining spring flow after water abstraction (N 19) and spring flow with added water abstraction from pumps (N 19P). In such way, undisturbed (or natural) spring discharge is estimated. Here, as in many similar cases, the gauge station is situated after the water intake. On the Figure long lasting low flow period may be seen (from August 2001 up to September 2002). The highest discharge value refers to May 2005. The relation Qmax/Qmin is more than 20.

The spring N 600 is fed additionally by river waters, and shows lower seasonal variation.

Water regime is usual in the areas where water supply is based on karst or surface waters that are vulnerable to droughts. High spring flow during winter and spring often remains unused, with water shortage during low flow periods.

In 2007, water regime was introduced in July and August in many settlements of district of Vratsa, Lovech, Gabrovo, Targovishte, Kotel, etc. The measures were hard somewhere - in some settlements water supply was twice per week, or even once within 5 days. Population has been provided with water tanks.

An example of Kotlenski springs near Kotel town (in East part of the country) is given below. The discharge of these karst springs is highly variable (from 40 l/s to about 20 m^3/s). Quick response to changes in the recharge conditions have been registered (Figure 2.5.14).

The seasonal distribution of spring flow shows a well expressed low flow period from July to October. For some years the karst spring discharge decreases considerably as a result of winter and/or summer droughts (Figure 2.5.15). Droughts during cold period (mild winters) have strong negative influence on the discharge of Kotlenski springs. The reference period for average monthly data is 1961-1990. The spring flow showed its high vulnerability to droughts (Orehova & Benderev, 2004).

(c) Deep Aquifer - Long Lasting Decline of the Groundwater Level

The Upper Jurassic - Lower Cretaceous aquifer in NE Bulgaria is the most productive in Bulgaria. It is a transboundary aquifer shared between Bulgaria and Romania. It receives main recharge in the territory of Bulgaria. The calcareous formation is up to 1000 m thick and highly karstified locally. The aquifer is characterized with high degree of heterogeneity. All the Bulgarian part of this aquifer takes large area (14,000 km^2) including sub-thermal waters in its deep peripheral parts.

The Upper Jurassic - Lower Cretaceous (sometimes called as Malm-Valanginian) aquifer in northeast Bulgaria forms huge hydrogeological reservoir with regional importance. Many water supply systems withdraw groundwater mainly for water supply of towns and surrounding villages in the region, partly for industrial purposes, and very little – for agricultural needs. Deep groundwater level (from 20 to more than 100 m) for large areas hampers the aquifer development.

Since 1960-1975 small dams have been built that reduced natural recharge to the aquifer. This was possibly one of the reasons, together with the 1982-1994 drought period and active aquifer development, for the registered decline of water levels in observational wells in south part of the region, with average rate 0.5 m per year during 1982-1996 (see Figure 2.5.16). There was no decline of heads at the seaside.

The Upper Jurassic – Lower Cretaceous aquifer belongs both to the Danube and the Black Sea river basins. The boundary follows the groundwater divide with direction SW- NE. Within the Black Sea River Basin, the discharge is through large Devnia springs. At the seashore, artesian wells are discharging hot water. Another part of the groundwater flow goes to submarine discharge. The aquifer is highly heterogeneous.

There are no observational wells for GWL measurements in the recharge zone of the aquifer.

The most appropriate way to understand this complicated system is to apply groundwater modeling. Lack of systematic observations in the central parts of the aquifer where recharge occurs, hampers the overall research, as well as lack of real data on dynamics in groundwater abstraction and recharge from rivers. Modeling of a part of this aquifer showed high heterogeneity with huge transmissivity near its main discharge zone on the cross-section of many faults.

After long lasting groundwater level decline, some stabilisation has been observed as an evidence of a new equilibrium. During the year 2005, intensive recharge occurred, which is well expressed on Figure 2.5.17 that shows amplitudes of GWL variations.

Good management of the Upper Jurassic - Lower Cretaceous aquifer should be based on groundwater models. Much work is to be done to relate groundwater balance and dynamics in this karst reservoir that interacts with other aquifers from NE Bulgaria.

(d) Problematic Areas in terms of Groundwater Quantity

A map showing groundwater bodies at risk (quantity aspect) defined by River Basin Directorates is presented in Figure 2.5.18. Groundwater body at risk from the Black Sea River Basin is under risk of sea intrusion. For the Groundwater body at risk from WABD, the permissions for groundwater abstractions are close to the assessed groundwater resources. GWB at risk in EABD in Yambol-Elhovo region is defined due to the fact that related to it surface water body is at risk.

Groundwater Overdraft – Decrease of Baseflow

Depletion of groundwater owing to human activity is reported in other countries. In Bulgaria, water supply systems are widely ground on headwaters. The upper parts of watersheds are abundant in clear water.

Under pristine conditions, this is a resource for surface runoff as well as for groundwater recharge.

Under moderate rates of withdrawal, local surface waters and ecosystems are moderately affected. Reduction of recharge to groundwater occurs. The first and most direct impact is the decrease of baseflow. The last can trigger loss of riparian vegetation and depending ecosystems; gaining stream may become a losing stream.

Surface runoff has potential to convert into groundwater. Thus, every uptake of surface water has negative impact on groundwater.

The present state of the groundwater quantity at national level is analyzed based on the network of monitoring stations for the period 2000-2005 and before it.

In general, problems related to groundwater quantity aspects arise in cases of:

- Low groundwater resources;
- Strongly expressed seasonal scarcity of the groundwater resources;

- Groundwater levels close to the land surface (susceptible to swamping, and inundation);
- Very deep groundwater levels (hampered access to groundwater);
- Substantial change in groundwater levels due to natural or anthropogenic impacts (especially continuous falling of groundwater levels as a result of groundwater exploitation).

Low groundwater resources may be (or become) insufficient, with needs to apply artificial recharge or to search for alternative sources for water supply. Several zones of low groundwater resources may be seen on the maps of Bulgaria.

The main causes of low groundwater resources are:

- Low values of precipitation amount;
- Low values of evapotranspiration;
- Low permeability of outcropping rocks;
- Flat relief;
- Lack of substantial recharge from surface waters.

Some of the above mentioned factors simultaneously lead to low values of the river runoff in the same area. As an example, the Kalnitza River - right tributary of the Tundzha River, which is characterized with low values of both modules: of the river runoff (Bojilova, 2006) and of the groundwater flow.

Another unfavorable aspect for the areas with low values of the groundwater flow is related to generally low rates of groundwater flow, with inherent longer residence time and consequently groundwater enriched by salts and trace elements.

Under pristine conditions, many ecosystems along rivers used to be considerably dependent from water supply 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) Groundwater Quality and the Problematic Areas

The distribution of total dissolved solids (TDS) for groundwater in Bulgaria is presented in Figure 2.5.19 (T. Kehajov, 1972). The lowest values are registered for intrusive and metamorphic rocks within high mountains, and the highest - for clays and marbles in the lowest parts of the country.

(a) Shallow Groundwater

The groundwater quality of Bulgaria is characterized based on data from groundwater quality network from ExEA for 2000-2005, which have been analysed and visualised in GIS-maps. Where appropriate, additional information have been used. The used threshold values are from Regulation N 9 for drinking water.

The network of groundwater quality stations from ExEA is rather sparse, and thus unable to reflect all important features and spatial variability in chemical composition of groundwater in details. Monitoring does not cover large territories.

Nitrate

Excess nitrate is the most common problem in Bulgaria related to groundwater quality (see Figure 2.5.20). It is mainly due to over-fertilizing of crops in past time, animal breeding (lagoons, liquid waste) and lack of WWTP in many settlements. Zones with nitrate pollution in groundwater for South Bulgaria are related to specific soils (Vertisols) vulnerable to application of nitrate fertilizers.

In order to protect groundwater from nitrate pollution from agricultural activity, Nitrate Vulnerable Zones (NVZ) has been delineated in implementation of Regulation N 2 from 16.10.2000 (on the protection of water from nitrate pollution from agricultural sources). Geographical extent of these NVZ is rather wide. This Figure presents an initial designation of NVZ. Additional designation (or revised designation) should be made in Bulgaria before August 2008.

High concentrations of nitrate pose a serious problem for the drinking water supply. Shallow groundwater is the most affected. The registered maximal values of nitrate and other indicator parameters for the year 2000 are presented on Figure 2.5.21, and for the period 2000-2005 - on Figure 2.5.22. The average nitrate content in groundwater for the period 2000-2005 is given on Figure 2.5.23.

On the last map, the average values of the nitrate content are given in brackets. In the same map trends in nitrate content are presented. Increasing trend indicates progressive pollution of groundwater for the period 2000-2005 (with red arrows), and decreasing trend - improving of the groundwater quality (with blue arrows). The red arrows prevail over the blue ones. In average for the country, concentrations of nitrate in groundwater are predominantly below 30 mg/l (green colour) or in the range 30-50 mg/l (yellow colour) - see Figure 2.5.23.

Figure 2.5.22 shows that for many stations maximal nitrate concentrations over 50 mg/l (red colour) or even 100 mg/l (black colour) have been registered. On this map only stations with nitrate content above the threshold value (50 mg/l) are presented.

Comparing Figure 2.5.22 and 2.5.23 one can conclude that in many sites only temporary increase in nitrate content is registered. Simultaneously, enhanced average values of nitrate over 30 mg/l and increasing trend both undoubtedly testify to anthropogenic pollution.

Nitrate content in drinking water presents a real problem in some areas, ***problematic*** in respect of nitrate content:

1) Extremely vulnerable to pollution is area in Northeast Bulgaria, where shallow groundwater is related to Sarmatian limestone formation (fractured and karstified) that is weakly protected from pollution.

   This is a fragile environment, where groundwater receives its recharge from precipitation along with pollution load from widespread sources of contamination, including agricultural activities. Specific feature of this region is lack of perennial surface runoff. All temporary streams enter into the aquifer along with inherent pollutants.

Taking into account its strong vulnerability to pollution, this territory needs to be monitored and managed with particular care.

2) Groundwater in the Plovdiv-Pazardzhik area, which is characterized with high anthropogenic impact from different origins. This is the region with abundant groundwater in porous alluvial-proluvial Neogene and Quaternary sediments. The aquifer in Quaternary deposits is unconfined, close to the land surface with shallow GWL, and is vulnerable to pollution. The deeper Neogene aquifer is confined, and it is better protected from pollution.

   The different kinds of pollution include agricultural impact both from fertilizers and animal breeding, pollution from numerous towns and villages without WWTPs, and industrial activities.

3) Stara Zagora area is characterized with shallow groundwater in low permeable sands, with high levels of nitrate. It is considered that specific soils in the area (namely Vertisoils) are responsible to accumulation of nitrate in groundwater. This process is related to activity of specific bacteria. For these soils, over-fertilizing is fatal and leads to high nitrate in groundwater. The same soils are developed south to Yambol and in Bourgas region.

   Nitrate is mobile, and has tendency to be accumulated in water under evaporation.

   Uncontrolled use of nitrogen fertilizer in agriculture is especially dangerous for Vertisols and should be stopped. Good practices in agricultural activities within NVZs need to be applied.

Nitrite and Ammonium

Nitrite and ammonium testify to fresh pollution, mainly from wastewater. They occur episodically.

Phosphates

Phosphate in groundwater may be due to application of fertilizers, from industry and of geogenic origin. It is not a constant pollutant (see Figure. 2.5.21 and 22).

Main occurrences of phosphate minerals in Bulgaria are presented in Figure 2.5.24 (by A.Y.Kunov, 2005). The apatite (23) is most frequently found mineral. A significant part of the phosphates is concentrated in the Eastern Rhodopes, and less – in Central and Eastern Srednogorie Zone. Most of phosphates have been found during the investigation of ore mineralizations (Zn-Cu-Pb and other). Lately, the interest to geochemistry of the phosphorus is high in relation to possible process of eutrophication.

Heavy Metals

Heavy metal pollution of groundwater is usually related to the heavy metal pollution of soils. In the next introductory section, basic features of this pollution are presented.

Industrial Pollution of Soils (Konishev et al.):

This problem has become actual for Bulgaria since the early 1960s.

Heavy Metal Pollution of Soils:

The most regularly occurring metals in soils are copper, zinc, lead, and cadmium. Other heavy metals - nickel, chromium, and mercury - have been found at significant levels only rarely. Their heavy concentrations are usually related to ore mining or are concomitant emissions of the main pollutant (copper, zinc, and lead).

Bulgarian soils are low in organic matter and relatively high in clay. Clay minerals are highly reactive with different pollutants, and the heavy metals in particular. The most mobile forms of the heavy metals occur in relatively high concentrations in the acid soils and in lower concentrations in the calcareous soils.

Some important sources of pollution from metallurgy:

- ***Lead-zinc smelter*** at Plovdiv: operating since 1962; capacity about 50,000 - 60,000 t Pb/year;
- ***Iron smelter***, combined with floatation and coking operations, near the city of Sofia operating since 1962; emissions and effluents containing a wide range of pollutants.

Irrigation with Polluted Surface Waters:

Nearly all the country's rivers are affected, particularly in their middle and lower reaches. The rivers receive effluents from mining, ore processing, and metallurgy. Typically this results in high rates of heavy metal accumulation in irrigated lands. The affected area is estimated at between 8,000 and 10,000 hectares. The most significantly affected rivers are the Topolnitsa, Teamok, Ogosta, and Arda.

The registered maximal values of heavy metals in groundwater: lead (Pb), zinc (Zn), nickel (Ni), chromium (Cr), cadmium (Cd), arsenic (As) for the period 2000-2005 are presented in Figure 2.5.25. On this map only stations with heavy metal content above the threshold value are presented.

In Bulgaria there are numerous ore deposits that are developed (Pb-Zn, Cu, poly-metallic, etc.). Mines in operation and abandoned mine sites pollute groundwater. Principal ore mineralizations occur in mountain regions, where stations for groundwater quality network are almost lacking.

The widespread pollution by **lead** in the Plovdiv-Pazardzhik area is most likely related to the above mentioned lead-zinc smelter at Plovdiv operating since 1962. Other possible sources are from industry. As Topolnitsa River is polluted from mining and ore processing (as previously mentioned), the irrigated areas from this influent are polluted as well.

As was mentioned above, heavy metals occur in lower concentrations in the calcareous soils. Possibly, this is the cause of lower prevailing heavy metal pollution in porous groundwater and generally no problems in carbonate terrains. Unfortunately, there are exclusions. For the stations 130, 84 and 224 from NE Bulgaria, concentrations of lead above threshold have been registered.

Copper is below the threshold value of 2 mg/l everywhere.

Chromium in groundwater naturally occurs in Bulgaria. It is known that enhanced values of Cr are common in North Bulgaria within the Danube plain and near Bourgas. Figure 2.5.25 gives only slight idea of these features. In Southern Bulgaria, in the region of the Eastern Rhodopes, there are small ore mineralizations of Cr that are not extracted.

Iron and **manganese** are naturally occurring in groundwater. The main production of Fe is from Sofia region.

The occurrence of manganese in groundwater in Bulgaria is presented in Figure 2.5.26 (Kehajov, 1986). Bulgaria is rich in manganese ores. The most well known ore mineralizations are near Varna.

The occurrence of Fe and Mn in groundwater is governed by redox potential (Eh value). The other limiting factor is the low solubility of carbonates. Thus, Fe and Mn are more usual for porous groundwater, not for karstic (Figure 2.5.27 and 28). Iron smelter near the city of Sofia may be responsible to pollution of groundwater.

In general, the analyzed groundwater quality network do not represent adequately the general features of groundwater that are well known from the data of Water Supply Companies based on long-term chemical analyses.

Pollution from Old Mine Tailings:

Monitoring does not cover large territories in Bulgaria, especially in mountain regions. Nevertheless, these regions contain numerous ore mineralizations, and produce both natural and anthropogenic geochemical anomalies related to mining activities including abandoned mines.

Some of “hot spots” related to groundwater quality are due to old tailings from past mining activities, and remobilisation of pollutants. Evidently, abandoned mine lands need specific management.

Pollution from Ore Mineralizations and Abandoned Mine Sites - Hot Spots:

Mines in operation and abandoned mine sites pollute groundwater. Remaining tailings continue to impact the environment. Remobilization of pollutants may occur. Two hot spots are presented below.

1) In the Chiprovtsi area, NW Bulgaria, tailing impoundment waste is the main pollutant for the environment (soil, water and vegetation). Chiprovtsi was ore mining settlement already in XIII–XVI centuries. Nowadays, this is abandoned mine that still pollutes environment. The basic pollutant for waters is **arsenic** (As), and for soils – arsenic and lead (Pb). Some remediation of the area has been made, but it did not stop pollution of waters from waste piles. The pollution is registered downstream, in the Ogosta reservoir, which is used for irrigation. The threat is related to drifting away of pollutants all around.

2) **Arsenic** in drinking waters in Poibrene village (EABD) has been registered soon. It is situated downstream from mining area, with rich copper deposits, some of them with high arsenic content. During last years mineral processing is not in operation in this area. The most possible source of the groundwater pollution is from old tailing. The pollution appeared after heavy rainfall events.

   Evidently, waste materials present a threat to environment. Abandoned mine sites' inventory, investigation and remediation are necessary. There are known cases of low quality rehabilitation of mining areas. An appropriate cleanup program will improve water quality and enhance public safety.

Balkan Endemic Nephropathy (BEN) Zone:

Balkan endemic nephropathy (BEN) is a dangerous chronic disease. It was first described in Serbia and in Bulgaria (NW part of the country). In Bulgaria, BEN was described in 1956.

Etiology remains the major problem of BEN. There are different hypotheses of risk factors for this disease, such as environmental pollution in endemic settlements, including groundwater pollution.

Pesticides

Registered content of pesticides in groundwater for the period 2000 – 2005 is presented in Figure 2.5.29.

The total number of stations with available data from ExEA on pesticides in groundwater is 116 (for the period 2000 - 2005). In the table below, only 17 stations are included, which showed registered content of pesticides in groundwater >0.05 µg/l.

Stations with the Highest Registered Values of Pesticides in Groundwater (µg/l) – by Station for the Years 2000-2005

St. N	2000	2001	2002	2003	2004	2005	Total – max	Year/ max	RB
389	**>0.1**	**<0.1**	**No data**	**>0.1**	**>0.1**	**No data**	**2.189***	2003	D
379	**<0.1**	**>0.1**	**>0.1**	**>0.1**	**=0.1**	**No data**	**0.244**	2003	D
280	**No data**	**No data**	**>0.1**	**>0.1**	**No data**	**<0.1**	**0.191**	2002	D
188	**No data**	**No data**	**>0.1**	**<0.1**	**<0.1**	**<0.1**	**0.143**	2002	D
391	**<0.1**	**<0.1**	**No data**	**>0.1**	**<0.1**	**No data**	**0.141**	2003	D
29	**<0.1**	**<0.1**	**=0.1**	**>0.1**	**<0.1**	**No data**	**0.108**	2003	D
330	**	**No data**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**0.093**	2002	EA
174	**<0.1**	**No data**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**0.091**	2002	EA
25	**<0.1**	**No data**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**0.090**	2000	D
385	**<0.1**	**No data**	**No data**	**No data**	**No data**	**No data**	**0.078**	2000	WA
81	**	**<0.1**	**	**<0.1**	**No data**	**No data**	**0.073**	2001	EA
11	**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**No data**	**0.073**	2001	EA
223	**	**No data**	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**0.072**	2002	EA
226	**	**No data**					**0.069**	2002	EA
334	**	**No data**	**No data**	**No data**	**<0.1**	**No data**	**0.062**	2004	EA
24	**	**<0.1**	**	**<0.1**	**<0.1**	**No data**	**0.053**	2001	EA
23	**	**No data**	**<0.1**	**<0.1**	**No data**	**<0.1**	**0.051**	2002	EA

* Extremely high value of total content of pesticides. For the station N 389, the registered value of Ametryn is 0.904 in 2003 and 0.6 in 2004.
** Simazine, Atrazine and Propazine not measured.

Some of the stations were sampled 1 or 2 times during this period, so there is a lack of data for some years. “No data” is usual for the years 2001 and 2005. During 2000, there were many stations with data lack concerning the most important pesticides: Simazine, Atrazine and Propazine.

The number of stations with registered content of pesticides in groundwater above the indicator level (0.1 µg/l, according to the Drinking Directive) is 7 for the country.

Number of Stations with Registered Content of Pesticides >0.05 µg/l

River basin	**>1 µg/l**	**>0.1 µg/l**	**0.05 - 0.1 µg/l**	Total >0.05 µg/l
Danube RB	**1**	**6**	**1**	7
Black Sea RB	**0**	**0**	**0**	0
WARB	**0**	**0**	**1**	1
EARB	**0**	**0**	**9**	9
Total for Bulgaria	**1**	**6**	**11**	17

Pesticides have been found in groundwater within lowlands along the Danube River, in the Sofia kettle, in NW part of the country. In southern part of the country, in Plovdiv-Pazardjik region, many stations showed the value close to the threshold value of 0.1 µg/l.

There are other data on pesticides in groundwater besides from ExEA stations. Unfortunately, there are registered values of 0.5 µg/l for Razgrad in NE Bulgaria (project – Ministry of Health). Stations from ExEA did not cover this territory at all.

(b) Deep Groundwater and Springs

Deep groundwater is characterized generally with enhanced temperature. The temperature value of groundwater at 500 m depth (Figure 2.5.30 – from Atlas, 2002) shows many positive anomalies, and one large negative anomaly in NE Bulgaria. The last is generated by descending groundwater flows and refers to the most productive and deep transboundary aquifer (shared between Bulgaria and Romania). It is related to carbonate Upper Jurassic - Lower Cretaceous sediments. The aquifer is largely used for water supply.

Along flow paths to the east, TDS content changes from 0.4 g/l up to 3.5 g/l. In the same direction, the systematic change of the groundwater chemistry and increase of temperature are registered that testify to longer residence time of groundwater. Near the seashore, groundwater is rich in H_2S, showing reducing conditions.

Deep aquifers from the Northern part of the country (the Moesiane platform) have inherent high TDS content and enhanced temperature.

In Bulgaria there are many thermo-mineral occurrences that are not described here.

The most common problems associated to water quality for karst springs are pollution from nitrate, nitrite and ammonium along with possible bacterial pollution, especially for highly karstified terrains with sinkholes or for springs fed additionally from river runoff. The same problems are inherent to shallow groundwater in lowlands that are subject to inundations. One specific problem related only to karst springs is water turbidity during high spring flows.

(c) Problematic Areas of Groundwater Quality

Groundwater in Bulgaria shows evident features of anthropogenic pollution. Shallow groundwater is the most concerned. Groundwater bodies at risk by River Basin Directorate (quality aspect) is available on Figure 2.5.31. Evidently, there was no adequate coordination between the River Basin Directorates and universal methodical approach.

To characterize groundwater problematic areas, other information besides GW quality network has to be involved. The groundwater quality data for 2000-2005 have been analysed and visualised in GIS-maps.

The primary problematic areas in terms of groundwater quality are indicated (see Figure 2.5.32):

- 1. North-East Bulgaria - Sarmatian limestone formation - nitrates.
- 2. Groundwater in the Plovdiv-Pazardzhik, Haskovo and Sofia Areas – nitrates, heavy metals, iron and manganese.
- 3. Stara Zagora; south from Yambol and Bourgas Areas – nitrates (Vertisols).
- 4. 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.

Such areas with risk from flooding are situated along the river courses, especially in their lower reaches (available in Figure. 3.10 in p. 261, Geography of Bulgaria, 2002). In general, they frequently coincide with areas with extremely shallow groundwater level. On Figure 2.5.7 such areas with shallow GWL are presented based on limited data from the NIMH groundwater network.

Especially dangerous is flooding with polluted waters. The example is Topolnitsa dam polluted from mine activities. Flooding occurs on the Plovdiv-Pazardzhik Area, which is characterized with high anthropogenic impact from different origins.

Inundation presents a critical period. 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.

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References to Section 2.5.2:

Common Implementation Strategy for the Water Framework Directive (2000/60/EC) Guidance Document No. 15. Guidance on Groundwater Monitoring

Guideline on: Groundwater monitoring for general reference purposes (Utrecht, 2006) (http://igrac.nitg.tno.nl/docs/WG1-Guideline.pdf)

Monitoring Report. Worldwide review on groundwater monitoring practice based on data from the questionnaire. IGRAC(http://igrac.nitg.tno.nl/gpm_practices.html)

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References to Section 2.5.3 (1)

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References to Section 2.5 3 (2):

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2.6 Water Quality

2.6.1 Current Water Quality Conditions

For the monitoring networks for surface water, ExEA and NIMH have different monitoring networks in the country. In this Study, current conditions of water quality in the rivers were analyzed based on the available data of ExEA from Year 2000 to 2005. Data of physico-chemical monitoring and hydro-biological monitoring were collected and analyzed.

(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 measured with frequency of 4, 6 or 12 times per year.

Number of Current Physico-chemical Monitoring Points of ExEA

DRBD	BSBD	EABD	WABD	Total
201	107	151	50	509

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 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.

Proposed New Surface Water Quality Classification by MoEW in 2005

Class limit values		**Reference class - High**	**TV-good**	**2 x TV**	**5 x TV**	**> 5 x TV**
	Unit	**I**	**II**	**III**	**IV**	**V**
Oxygen/nutrient regime						
Temperature	^{o}C					
Dissolved oxygen	mg/l	7	6	5	4	3
BOD_5	mg/l	<2	<3.5	<7	<18	>18
pH (acid)	-		>6.5	>6.0		
pH (alkali)	-		<8.5	<9.0		
NH_4 ammonium-N	mg/l	0.05	0.3	0.6	1.5	>1.5
NO_2 nitrite-N	mg/l	0.01	0.06	0.12	0.3	>0.3
NO_3 nitrate-N	mg/l	0.8	2	4	10	>10
PO_4 ortho-P	mg/l	0.05	0.1	0.2	0.5	>0.5
Total-P	mg/l	0.1	0.2	0.4	1	>1
Chlorophyl-a	µg/l	25	50	100	250	>250
Ions						
Sulphate (SO_4)	mg/l	80	150	250	300	>300
Chloride (Cl)	mg/l					
Metals (Dissolved)						
Zinc (Zn)	µg/l	bg	100	200	500	>500
Copper (Cu)	µg/l	bg	20	40	100	>100
Chromium (Cr-III + VI)	µg/l	bg	50	100	250	>250
Lead (Pb)	µg/l	bg	5	10	25	>25
Cadmium (Cd)	µg/l	bg	1	2	5	>5
Mercury (Hg)	µg/l	bg	0.1	0.2	0.5	>0.5
Nickel (Ni)	µg/l	bg	50	100	250	>250
Arsenic (As)	µg/l	bg	5	10	25	>25
Aluminum (Al)	µg/l	bg	5	10	25	>25
Biology						
Biotic index		≥4	>3	3	2 - 3	<2

Note: 1) TV: Threshold value:
2) There is no proposed water classification for COD up to now.
Data Source: MoEW; "National Report on Water Management at River Basin Level in the Republic of Bulgaria", 2005.

Figure 2.6.1 to 2.6.4 show 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 figures, it can be said that the water quality in the country is moderate (Class III) to bad (Class V) conditions in general with many stretches of poor (Class IV) to bad conditions. Organic pollution especially pollution by untreated domestic wastewater, industrial wastewater and wastewater from animal breeding farms are the reasons for these wide spread pollution in the country.

(2) Hydro-biological Water Quality

ExEA has the hydro-biological monitoring network covering the whole country with sampling points of about 2000. However, many points have only descriptive location without exact coordinates. 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.

Biotic Index (BI) and the Classification of Ecological Status

Biotic Index (BI)	National Classification	Ecological Status
5; 4-5	Class I	High
4; 3-4	Class II	Good
3	Class III	Moderate
2-3; 2	Class IV	Poor
1-2; 1	Class V	Bad

Mainly based on the ExEA's data of 2004 as well as referring to the data from 2000 to 2005 (the Struma River based on 2002), hydro-biological water quality map for the whole country was prepared in this Study as shown in Figure 2.6.5. Based on this map, it can also be said that 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 order to know the current water quality conditions in the rivers in EABD and WABD, Supplemental Water Quality Survey was conducted at 24 points in EABD and 12 points at WABD with a total at 36 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. Figure 2.6.6 shows the locations of the survey, and Table 2.6.1 shows the results. Based on the results, it can be said that many locations have problem of organic pollution with water quality class more than Class III. Furthermore, in may 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 analyzed based on the ExEA's data from 2000 to 2005. Figures 2.6.7 and 2.6.8 show the water quality class of the maximum values of these heavy metals for the most recent years of 2004 and 2005. The major rivers, where high values of these heavy metals are recorded during these 6 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 discharge from mines under operation and closed ones as well as wastewater and emission to the air from the ferrous and non-ferrous metal industries etc. Figure. 2.6.9 shows the metal and non-metal mines of under operation and closed ones. 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, following actions are recommendable to be taken.

Recommendation for the Actions against Heavy Metal Pollution:

1) The possibility of heavy metal pollution problem firstly has to be proved by MoEW before reporting to the Government. In order to make clear the problems and to formulate necessary programme of measures, not only the effort of MoEW, but also cooperation from various ministries will be necessary, because the problem might not only in the water, but also in the soils and crops in the affected area, health of people, and pollution sources such as mining. Therefore, after the above investigation by MoEW, it will be necessary to report to the Government about the possible problems of heavy metal pollution, and form inter-ministerial committee and working groups composed of the relating ministries such as MoEW, MoAF, MoH, MoRDPW and MoEE for the recommended actions below.

2) In order to overview the condition and mechanism as well as problem of the heavy metal pollution, to conduct a Preliminary Investigation of the river water, river bed materials, outlet of the mining wastewater etc., and soils and crops including sampling and analysis by different laboratories including the reliable laboratories in other EU member countries to check the accuracy of test results, and to prepare for the full-scale investigation/study mentioned below.

3) To conduct an Integrated Heavy Metal Pollution Study, under the assigned responsible Ministry or Joint Ministries appointed by the Council of Ministers:

- Investigation of pollution by heavy metals in the surface water, riverbed materials, water in the irrigation channels, soil in the irrigation areas, groundwater, crops in the possible contaminated areas, health problems of the local people and wastewater from the pollution sources such as mines. It is also recommendable to conduct laboratory test not only in Bulgaria but also in some other reliable international laboratories in the EU member countries etc. to get more reliable results.

- To study the mechanism of heavy metal pollution, and direction of controlling the pollution sources and improvement of the contaminated areas.

- To set operational monitoring stations for water and riverbed, wastewater from mines etc. and soil and conduct periodical observation.

- To formulate concrete programme of measures to improve the situation from the short-term, mid-term and long-term point of views.

- To take actions for implementing the proposed program of measures one by one.

2.6.2 Existing Urban and Municipal Wastewater Treatment Plants and National Plan

(1) Existing Urban or Municipal Wastewater Treatment Plants

There are 73 numbers of the existing urban or municipal wastewater treatment plants (WWTPs) in the country (see Table 2.6.3). Table 2.6.4 shows the new WWTPs under construction or committed for construction (under tendering or just contracted for construction based on international funding) in the country. Figure 2.6.10 shows the existing WWTPs, under constructed WWTPs and committed WWTPs for construction. In general. the existing WWTPs in EABD and WABD have the following problems.

1) Many of the WWTPs were 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. Furthermore, it can be often seen the deterioration of some of the concrete facilities.

2) Inflow concentration of BOD_5 to the existing WWTPs is generally very low with about 40 mg/l to 60 mg/l. This means that the sewage goes out from the sewer pipe to the ground and inflow of surrounding water into the sewer pipes.

3) Several WWTPs have problems of inflow of petrol or heavy metal from the industries, which cannot be treated by the urban or municipal WWTPs. Furthermore, this causes problem to the sludge, which includes heavy metal or oil.

4) Even in the case of no harmful substances in the sludge, the 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, about 360 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 Inhabitants 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.

2.7 Environmental and Social Conditions

2.7.1 Natural Environment

(1) Biodiversity, Protected Areas, Flora and Fauna

Although Bulgaria is relatively small country, it 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.

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"

2.7.2 Social Conditions

(1) Cultural Heritage

The Bulgarian lands have rich and most diverse cultural heritage. Inhabited since prehistoric times, they keep lasting traces from different ages with rich traditions such as ancient Thracians, Greeks, and Romans. Each important cultural heritages sites scattered through the whole country. On the other hand, Bulgaria has many natural heritages especially in the mountain areas.

In EABD area, there are many invaluable cultural heritage sites such as the "Kazanlak tomb", included in the list of the UNESCO-protected world cultural heritage. In WABD, there are also invaluable heritages. For example, the Pirin National Park is very famous and is in the UNESCO-protected world cultural heritage list as well.

(2) Waste

According to "Annual State of the Environment 2004, ExEA of Bulgaria", the non-hazardous total waste quantity in Bulgaria from economic activities was 196 million tons in 2004. The largest generator of non-hazardous waste is considered extraction industry with 94% of the total waste quantity, power engineering (3%), procession industry (2%). On the other hand, total domestic waste quantity in Bulgaria was 3,092 thousand tons in 2004. A 98% of the total waste quantity is disposed by land filling. Total waste quantity per capita in 2004 was 472 kg, which was the 94% of those in 2003.

Concerning the solid waste collection situations in the Study Area, the components of the household waste were collected separately in the municipalities of Dupnitsa, Nevestino, Bansko, Gotse Delchev and Kjustendil in WABD area and Chepelare, Smolyan, Sliven, Yambol, Kostenets, Pazardzik, Plovdiv, Asenovgrad and Stara Zagora in EABD area.

It is reported that the average quantity of household waste per capita is estimated at 476 kg in Bulgaria. The figures are the highest for the District of Pernik is estimated at 1,568 kg per capita, while these for the District of Plovdiv is 318 kg per capita. The share of the population served by municipal waste collection systems show a tendency of growth in the period 2001-2005 and a rise from 80.2% to 87.8% was reported according to the National Statistical Institute of Bulgaria. The rate is very high for the districts of Smolyan (98.4%) and Pazardzik (97.5%) in the EABD and for the districts of Kjustendil (96.7%) and Blagoevgrad (95.9%) in the WABD.

However, there are many waste management issues in the Study Area. For example, it is still observed many illegal waste dumping sites along the main rivers in the Study Area.

(3) Public Health Conditions (Water related Public Health)

In Bulgaria in 2002, the potable water quality was improved for chemical and permissible indicators and the standard compliance achieves more than 95%, but the adverse trend of wide diversion from standard keeps on for the micro-biologic indicator (approximately 14%); triple exceeding the WHO’s recommended level of 5%, according to “Annual State of the Environment 2002, ExEA of Bulgaria”.

Within the Study Area, it is also reported that surface water sources for drinking and household water supply (rivers, dams, lakes) are used mostly in the district of Blagoevgrad, Pernik, Plovdiv, Sliven, and Smolyan.

(4) Ethnic Group and Gender

It is reported that the major groups in Bulgaria’s population were Bulgarians. Bulgarians was 83.9%, Turks was 9.4%, and Roma was 4.7% of the total population, respectively in 2001. However, the actual Roma population was estimated at more than 7% of the country by 2006. Related to the location of the ethnic group, the Turkish population is concentrated in the southeastern parts of the country.

In terms of gender issues in Bulgaria, equal rights and the principle of non-discrimination are enshrined in the Bulgarian Constitution (1991). However, the Constitution does not explicitly provide specific regulations on gender equality.

2.8 Institution and Organizations for Basin Management

2.8.1 Institution for Basin Management

(1) The Water Act

In Bulgaria, the water institution is mostly contained in the Water Act, State Gazette No. 67/27, which was issued in 1999, and the related ordinances under the governance of the Act are promulgated. The Water Act is the first integrated legal document on water resources, water use, and water quality in Bulgaria. The Water Act has approximated the European Acquis (WFD 2000/60/EC).

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 very recently on August 2006, the Water Act was amended, although the Article 1 was exactly same as the previous Waster Act of the Article 1. However, the objective (Article 2) of the latest was totally changed. The objectives of the previous Water Act and the latest Water Act are shown in the following table.

<table>
<tr><th>Previous Water Act</th><th>Latest Water Act</th></tr>
<tr><td>The objective of this Act is 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:</td><td>(1) The objective of this 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:</td></tr>
<tr><td rowspan="3">1. Multiple-purpose and efficient use and reuse of water resources;
2. Development and conservation of water resources to meet the water needs of present and future generations;
3. Restoration of water quality and protection of waters against pollution, depletion and other adverse impacts on the regime thereof;
4. Conservation and protection of aquatic ecosystems and of environmental element related thereof;
5. Promotion of organized water use;
6. Prevention or elimination of water-related damage and loss.</td><td>1. Provide sufficient quantity and good quality of surface and underground waters for sustainable, balanced and fair extraction of water;
2. Reduce the pollution of waters;
3. Protection of surface and ground waters and the waters of the Black Sea;
4. Terminate pollution of the sea environment with natural or synthetic substances;
5. Reduction of discharge, emissions and release of priority substances.</td></tr>
<tr><td>(2) The objectives referred to in Paragraph (1) shall be achieved by some approaches, which include ecosystems approaches, reduction of the consequences of floods and droughts.</td></tr>
<tr><td>(3) The objective referred to in Paragraph (2) shall be achieved by some recent principles, which include river basin unit management principle, polluter pay and user pay principle.</td></tr>
</table>

Note: Above (2) and (3) are summarized for this Report from the original latest Water Act (English translation version).

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 territory of Bulgaria.

(2) EU-Water Framework Directive (EU-WFD)

The key European Legislation is laid down in the European Directives. Water management is mainly governed by the Water Framework Directive (WFD) 2000/60/EC binding with all other water-related directives. The EU-WFD is the overriding document in managing European water bodies. It introduces the following basic approaches and principles in water management making them statutory for EU member-states:

- The river basin unit principle for water management

Waters can only be managed within a river basin or river basin district. Setting up competent authorities to implement and enforce this approach is required.

- Sustainable water use

This is a key concept for long-term management and conservation of water resources.

- Ecosystems based approach in water assessment and management

This is also a concept for water quality monitoring, which should include biological parameters.

- “Polluter Pay” and “User Pay” principles

Cost recover for water quality improvement should be by polluter pay and user pay principles.

- “Self-recovery ” principles for water management

Water management requires all activities within a river basin to be a self-funded (self-recover principle). Central budget allocation is to be avoided.

- “Integrated Water Management ”

Integration is the fundamental concept on which all aspects such as i) environmental objectives, ii) all water resources, iii) all water uses, and iv) stakeholders and public participation of the EU-WFD.

(3) Time Schedule for required activities by the EU-WFD

Based on the EU-WFD requirements, Bulgaria is trying to follow the time schedule, which prescribed by the official EU manuals. The following table shows the time schedule and the present progress for required activities by the EU-WFD in the Study Areas (EABD and WABD).

Year	Required Activities	Present progress in the Study Area
2000	Adoption of the Directive	Completed
2003	Transposition into the Bulgaria National Legislation	Not totally completed
	Identification of river basins and competent authorities	Completed
2004	Overview of River Basin District 1) Initial characterization of River Basin District and water bodies 2) Pressure and impact analysis 3) Assessing the risk of water bodies, which not meet the environmental objective of “good status” 4) Economic analysis of water use 5) List up for the Protected Areas	Almost finished
2005	Report on River Basin Overview	Almost finished
2006	1) Monitoring program for water status operational for all waters 2) Publish a work program for preparing the River Basin Management Plan	Almost finished
2007	1) Summary Report on Monitoring Program 2) Discussing significant water management issues through public consultation and information	Almost finished (Public Consultation finished)
2008	Draft River Basin Management Plan including proposal for program of measures	Scheduled
2009	Finalizing the River Basin Management Plan and program of measures	Scheduled
2010	Report on the River Basin Management Plan	Scheduled
2012	1) Operating the program of measures 2) Discharges into surface waters are controlled according to the combined approach	Scheduled
2013	1) Report on the progress of implementation of the measures 2) Review Economic Analysis	Scheduled
2014	Publish Second Draft River Basin Management Plan	Scheduled
2015	1) Achievement of the target (good surface water status: environmental objective achievement) 2) Finalizing the Second River Basin Management Plan 3) Finalizing the revised program of measures	Scheduled

(4) Other Important Regulations and Orders

The following regulations are also directly related to basin management in Bulgaria:

- Official Gazette of MoEW, Regulations of activity, organization, and members of the Basin Directorates

This Gazette determines the detailed activities of each department, organization (functions of each department), and members of the “Basin Directorates” in the range of the regions of water basin management, specified by the Water Act.

- Order No. RD-848, Sofia, 18.08.2004

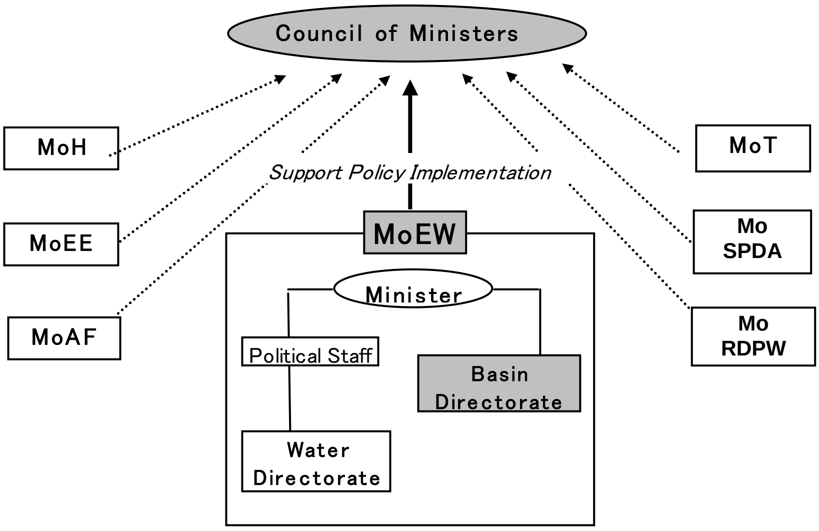
This order stipulates that “Inter Institutional Unit” within MoEW shall be established for coordination of the activities related to the requirements of the EU-WFD.

The other important recent water related regulations and orders, which are recent ordinances (Regulation No.1 to No.11) under the Water Act in Bulgaria. These are harmonized with the EU Directives. Table 2.8.1 shows the Bulgarian regulations and the relevant EU Directives.

2.8.2 Organizations for Basin Management

(1) Main Governmental Organizations for River Basin Management

According to the latest Water Act, there are three key organizations for basin management in Bulgaria. Basin management authorities at the national level are "the Council of the Ministers", "the Ministry of the Environment Water (the Minister)". In the regional level (river basin district level), "the four River Basin Management Directorates" has competent authorities and specific responsibilities and the relationships with the national level. The following figure shows the present relationships for basin management in Bulgaria among the relevant ministries.



Note 1: This figure shows the relationships concerning key basin management organizations only.
Note 2: Basin Dictorate is one of the "Direct Subordinates of the Minister".
Note 3: Water Dictorate is one of the "Specialized Administrations"

(a) The Council of Ministers

The Council of Ministers has the following main authorities and responsibilities in term of the water management in Bulgaria:

- 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.

MoEW for implementation of the above responsibilities supports the Council of Ministers.

(b) The Minister, Water Directorate of MoEW

MoEW is responsible for environmental protection, and use of natural resources, including water as the competent governmental body. MoEW is composed of nine

Directorates. As one of the main Directorate, "Water Directorate" is responsible for carrying out the national policy in integrated and sustainable water management.

MoEW (the Minister) 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.

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

(c) Basin Directorates

The Basin Directorates are one of the direct subordinations of the Minister of MoEW. The four water basin management directorates i) Danube River Basin Directorate (DRBD); ii) Black Sea River Basin Directorate (BSBD), iii) East Aegean Sea River Basin Directorate (EABD); iv) West Aegean Sea River Basin Directorate (WABD) within the Bulgaria territory are designated by the Article 152 of the latest Water Act.

The Director of Basin Directorate has the following main responsibilities within its 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.

Each Basin Directorate is divided into the six departments; i) Administrative-economic department; ii) Planning and management department; iii) Monitoring, prognosis, and information department; iv) Licenses and registers department; v) Water and water-economic cadastre department; vi) Control, public and press relations department, by "the Official Gazette of MoEW, Regulations of activity, organization, and members of the Basin Directorates".

However, the actual basin management responsibilities or tasks such as permission for water uses and the other many management tasks among the key management organizations within a river basin are not clear or dispersed.

The following table shows the current actual status in EABD and in WABD such as the numbers of the present staff, and each department priority activity, although each department is responsibility for many other activities.

Items	EABD	WABD
Actual number of the District Staff	Permanent: 54 persons Temporary: 5 persons	Permanent: 48 persons Temporary: 5 persons
Current priority activity by each department	• Prepare for river basin management plan (*Planning and Management Department*) • Prepare surface and ground water monitoring and investigate the monitoring points especially for chemicals (*Monitoring, prognosis, and information department*) • Prepare the licenses for water utilization (*Licenses and registers department*) • Prepare water usage map (*Water and water-economic cadastre department)* • Control over status of water bodies such as keeping up of minimum admissible river flow (*Control, public and press relations department*) • Engage with human resources development (*Administrative-economic department*)	• Develop river basin management plans to be the work instrument of water management for 2009-2015 (*Planning and Management Department)* • Assess the actual conditions of river basins (*Monitoring, prognosis, and information department*) • Issue permits for surface water usage, waste water disposal at surface water bodies (*Licenses and registers department*) • Delineate surface and ground water bodies (*Water and water-economic cadastre department*) • Control for adoption fees for water usage and water discharge to the stakeholders (*Control, public and press relations department*) • Engage with administrative arrangement (*Administrative-economic department*)

Also, the following organizations and actors are the supporting organizations for basin management in terms of specific tasks:

(d) Executive Environmental 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.

(e) 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.

(f) 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 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. For example, the numbers of the Basin Board in the EABD is 30 at present.

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

The Regional Environmental Inspectors implement some environmental protection policies at the regional level and support the Basin Directorates in their activities as bodies of MoEW. One 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.

(h) Municipalities

The municipalities are also direct actors in terms of the water management within the municipal property. For example, a municipality mayor could implement the policy related to activities involving operation, construction, remodeling, 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) 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:

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

The MoRDPW has two responsibilities with respect to river basin management; i) construction of drinking and wastewater facilities in the local areas; ii) management for public company in terms of drinking and wastewater.

(b) 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).

(c) Former Ministry of Agriculture, Forestry (MoAF), and State Agency for Forests (SAF)

The MoAF (now changed name to the Ministry of Agriculture and Food Supply) is managing irrigation facilities in Bulgaria through a public cooperation of the irrigation system. On the other hand, the service entity of the irrigation system is transferring to “Irrigation Association” by a 20 years (year 2000 – 2020) transferring plan.

On the other hand, the SAF is managing forestry and forest conservation entire Bulgaria’s territory as a national agency with total 1,065 employees and the 16 regional offices in the whole region. The SAF was established based on the former “National Forestry Board”, which had almost same management functions with the SAF on July 2007. But, the SAF is still in process for rearrangement for the internal sections. The SAF is close related to basin management in Bulgaria particularly in the upper regions of the river basins.

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

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

(e) 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.

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

The MoSPDA unites the existing agencies responsible for prevention, response, management and recovery in case of crises, which includes large-scale flood disaster in Bulgaria. However, the actual management actions and responsibilities of MoSPDA related to flood management are not clear, because MoSPDA was established recently.

(g) 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 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.

(h) Water companies

In Bulgaria, there are many water companies, which are conducting the provision, as well as the O/M for drinking water, collecting water tariff, and sewage system O/M, has operated since 1999 as public cooperation under the State own. The service entity of the some companies are transferring to the municipalities, the others are transferring to independent public cooperation.

(i) 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.

2.9 Protected Areas for EU-WFD

The Annex IV of the EU-WFD regulates the types of the protected areas for the EU-WFD as follows:

- **Type1**: Areas designated for the abstraction of water intended for human consumption under the Article 7 (Areas designated for the abstraction of drinking water providing more than 10 m^3 a day as an average or serving more than 50 persons, as well as water bodies intended future use);
- **Type2**: Areas designated for the protection of economically significant aquatic species (fish, shellfish);
- **Type3**: Bodies of water designated as recreational waters, including areas designated as bathing waters under Directive 76/160/EEC;
- **Type4**: Nutrient-sensitive areas, including areas designated as vulnerable zones under Directive 91/676/EEC and areas designated as sensitive areas under Directive 91/271/EEC; and
- **Type5**: Areas designated for the protection of habitats or species where the maintenance or improvement of the status of water in an important factor in their protection, including relevant Nature 2000[2] sites designated under Directive 92/43/EEC and Directive 79/409/EEC.

The Article 119a of the latest Water Act of Bulgaria also regulates “the water protection zones” with almost same of the above types of the protected areas, although each definition of types of the protected areas is not so concrete compared with the EU-WFD’s definitions. The registers of the protected areas for the EU-WFD in EABD as well as WABD are not completed yet, however, the Article 6 of the EU-WFD also regulates “the register is completed at the latest four years after the date of entry into force of this Directive”.

On the other hand, it could be shown the present candidate sites of the Protected Areas for EU-WFD based on the available information from the EABD area and WABD area (see Figures 2.9.1 and 2.9.2 respectively). On the other hand, each boundary of the candidate-protected area of the figures such as “mineral water” might be too large or has no clear justification.

Furthermore, based on the “Nature 2000” within the framework of the Project “Preservation of Species and Habitats in Bulgaria accession to EU”, the national ecological network of Bulgaria is expected to cover 14% of the total national territory until year 2007.

Therefore, it will be needed further studies based on the above information for identifying the areas more reasonably in order to register the protected areas for the EU-WFD in the finalized RBMPs.

[2] Natura 2000 is the centerpiece of EU nature and biodiversity policy. It is a EU-wide network of nature protection areas established under the 1992 Habitats Directive. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats.

2.10 National Parks

(1) National Parks and the Other Protected Areas in Bulgaria

The Protected Areas Act of Bulgaria designates the national parks and the other protected areas. Bulgaria has the following three national parks:

- Central (Tseritralen) Balkan National Park
- Rila National Park
- Pirin National Park

The total area of the protected areas by 31 December 2003 was 545,004 hectors or 4.9% of the total area of the country by the Protected Areas Act. Out of it 543,238 hectors are protected areas by the Article 5 of the Act, and another 1,766 hectors are miscellaneous protected areas such as natural monument, etc. (see Figure 2.10.1).

With respect to the nature park, the Bulgaria has the nine nature parks i) Strandzha Nature Park, ii) Zlatni Pyasatsi Nature Park, iii) Shumensko Plato Nature Park, iv) Sinite Kamani Nature Park, v) Persina Nature Park vi) Balgarka Nature Park, vii) Vrachanski Balkan Nature Park, viii) Vistosha Nature Park, ix) Rilski Manastir Nature Park at present.

(2) Responsible Organization and Management Plans for the National Parks

The main responsible organization for the protected areas management in Bulgaria is MoEW. All the “national parks” have own management bodies (Park Directorate), which are subordinate to MoEW. On the other hand, the 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 and includes i) the location and boundary, ii) the management body, iii) the management purposes and legal bases, iv) the zoning methods and the categories, v) present conditions of natural and socio economic environment, vi) specific values/considerations/issues of the park management, and others.

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;
- Public awareness, education tools, and activities with local authorities.

Also, the main management tool of the management plan is the “zoning” of the conservation area into several management zones in accordance with the park objectives. The main features of each management plan for the national park is shown in Table 2.10.1.

(3) EABD and WABD Areas

(a) EABD Area

The southern parts of the Central (Tsentraien) Balkan National Park and the eastern parts of the Rila National Park are located within EABD area. The Central Balkan National Park is located in the upstream of the Tundzha River, while the Rila National Park is located in the upstream of the Maritsa River. (See Figure 2.10.2). The parts of the Bulgaria Nature Park and the Sinite Kamani Nature Park are located in the northern parts of EABD area.

On the other hand, there are no national and nature parks in the Arda River Basin, although small-scale natural monuments are designated.

(b) WABD Area

There are many and the most diverse types of the protected areas exist in WABD area. For example, the whole Pirin National Park is located within WABD and divided into the two river basins (Struma River Basin and Mesta River Basin). The west parts of the Rila National Park with Rilski Manastir Nature Park located within WABD area. (See Figure 2.10.3).

The other protected areas such as natural monuments are scattering within the whole area of WABD.

2.11 Forest Management

(1) Characteristics of the Forest Areas in Bulgaria

The total area of forests in Bulgaria is approximately 4 million hectares (more than one third of the total territory) in Bulgaria. More than 3.6 million hectares of the forests are afforested. The deciduous forests spread out to more than 2.5 million hectares (almost 70% of the afforested areas) and the area of coniferous forests is more than 1 million hectares (almost 30% of the afforested areas).

State owned forests up to year 2005 are almost 80% of all the forest. Municipal owned and private forests have an area of almost 20% of the forest areas of national importance.

Approximately 24% of the forests in the country were developed through forestation mainly with coniferous species. The results of immense forestation for the past fifty years aim at increasing the area of forests and the prevention of soil erosion.

However, in the past few years, the rate of the development of the new forests through forestation is growing smaller and reached 5 to 7,000 hectares per year, although the planned rate is approximately 12,000 hectares, which will mitigate the forests deterioration from the fires and droughts. The decrease is caused by the lessened number of investments on forestation and by the priority given to natural rehabilitation.

Ecological functions of the forest areas and their damages

It is reported that Bulgarian forests provide approximately 85% of the water drainage in the country, or 3.6 billion cubic meters of clean drinking water. Also, forests have a significant role in the reduction of the green house gases emission. The forests are contributing to soil protection, water resources protection, and prevention of natural disasters such as floods. However, the uncontrolled grazing and forest fires are lead the deterioration of the ecological functions of the forests.

(2) Institutions of Forest Management in Bulgaria

The administrative responsibility on the issues related to the forests in Bulgaria is MoAF with the State Agency for Forests (SAF), which is responsible for the execution of the forestry policy. On the other hand, MoEW has responsibility for conserving the national parks and the other protected areas on forest territory. SAF is responsible for the wood processing and furniture industry by defining the policy, strategy, and monitoring of activities concerning their conformity of the laws.

SAF is recently established as a national state body in Bulgaria. SAF has the following organizations:

- Regional Forestry Boards - 16 units in Bulgaria
- State Forestry Estates - 142 units in Bulgaria
- State Game Breeding - 37 units in Bulgaria
- Others - 20 units in Bulgaria

(3) Forest Management Issues

(a) Common Issues of the Forest Management

Bulgaria has the following common management issues:

- Lack of the management knowledge and skills of the private owners for forest management;
- Illegal cutting of the timber woods related to increasing domestic demands; and
- Bulgaria has long tradition and experiences for the forestry, but recent forestry is mainly concentrated on the timber resources by the management and financial reasons.

(b) Water related Issues of the Forest Management

Bulgaria has the following management issues related to water management:

- Illegal cutting of the timber woods in sanitary protected areas
- Soil erosions and related water contamination in the river basins

(4) National Strategies for the Forestry Sector Development in Bulgaria

For tackling the above forest management issues, the strategic plan for the development of the forestry sector for 2007-2011 is being developed following 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; and,
- Improvement of the awareness, co-ordination and inter-sector cooperation for the forest conservation.

This plan was compiled with the execution of the EU Forest Action Plan, which aims at the provision of a co-coordinated framework of activities as regards as the EU and the separate member countries. MoAF, through SAF is responsible for organizing the execution of the strategic plan.

With related to the RBMPs, the final RBMPs should be taking into account of the above forest management plans and their related projects, particular in the upstream of the river basins to improve the ecological functions as well as economic and social values of the forests areas.

2.12 Status of Domestic Water Usage

The JICA Study Team has made "a Survey on Water Usage for Domestic Use" (hereinafter referred to as " Survey") for around 3 weeks from Oct.12 to Oct. 31, 2006 for making clear an actual status of water use in domestic households in the targeted areas of EABD and WABD. This chapter is for reporting its results.

2.12.1 Methodology

The Survey is made by means of "an Interview Survey" using questionnaire sheets by ordering with outside specialists for 300 sampling points taking account to be equally distributed in the whole targeted areas and river courses. Figure 2.12.1 indicates the sampling points.

2.12.2 General Information

(1) Status of Domestic Household with Family Scale

Average floor area of households (HHs) in the targeted areas is 98 m^2 with ranging from 32 m^2 to 576 m^2 in both the basins as shown in Figure 2.12.2.

Almost of all their houses are their own houses in the targeted areas as shown in the following table.

Ownership of Houses Interviewed

Target Area	Own House	Rented House	Total Number of
West and East Agean River Basins	296	2	298
Share Rate	99%	1%	100%

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

And, their family scale is 3.37 persons per HH in the whole targeted areas. The following table shows its detail by river basins.

Family Scale by River Basin

(persons/HH)

River Basin	Average Family
West Aegean River Basin	3.47
Mesta River Basin	3.67
Struma River Basin	3.23
Pirinska Bistritza River Basin	4.00
Dospat River Basin	5.50
East Aegean River Basin	3.34
Byala River Basin	3.00
Arda River Basin	3.36
Toundzha River Basin	3.41
Maritsa River Basin	3.35
West and East Agean River Basins	3.37

Source:
Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

(2) Status of Water Supply

Water, which is consuming, is mainly coming from the public water systems with 80% in average in the whole targeted areas consisting of 90% in the West Aegean River Basin and 77% in the East Aegean River Basin as shown in the following table.

Status of Water Supply by Water Source

River Basin	Public Water Supply	Only Private Water Source	Combi-nation	Others (No Answer)	Total Number of Samples
West Aegean River Basin	77	0	9	0	77
East Aegean River Basin	216	5	59	2	221
Both the Basins	293	5	68	2	298

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

(3) Occupation

Households interviewed are not limited to have certain profession. Some HHs has no any working person, but they are living on a pension only. According to the results of the Survey, around 13% of HHs is living on the pension in the West Aegean River Basin, 6% in the East Aegean River Basin, and 8% in both the targeted areas.

Among all the persons who are gaining incomes including pensioners, 19% of persons are getting pension income in whole the targeted areas. On the other hand, number of working HHs with pensioners shares at 13% to the total working HHs in the West Aegean River Basin, 21% in the East Aegean River Basin, and 19% in both the basins.

Occupation is consisting of i) Public Servant, ii) Private Office, iii) Commercial, iv) Workers in Factories, v) Employees in Hotels, and vi) Agriculture in the question set in the Survey. As a result, number of working persons engaging in agricultural sector is only 3% in the whole targeted areas. Numbers of workers per HH are 1.16 persons/HH in the West Aegean River Basin, 1.19 persons/HH in the East Aegean River Basin, and 1.18 persons/HH in both the basins as shown in the following table.

Number of Workers per Household

River Basin	Public Servant	Private Office	Com-mercial Business	Worker for Factory	Hotel	Agri-culture	Total Workers	Total Number of Samples	Number of Workers per HH
West Aegean River Basin	18	32	11	22	6	0	89	77	1.16
East Aegean River Basin	63	103	22	66	1	9	264	221	1.19
Both the Basins	81	135	33	88	7	9	353	298	1.18

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

(4) Income

In the questionnaire, it is set that income categories as i) less than 500 Lev/HH per month, ii) 500 – 750 Levs/HH per month, iii) 750 – 1,000 Levs/HH per month, iv) 1,000 – 1,250 Levs/HH per month, v) 1,250 – 1,500 Levs/HH per month, vi) 1,500 – 2,000 Levs/HH per month, vii) 2,000 – 3,000 Levs/HH per month, viii) more than 3,000 Levs/HH per month. The said income level is different by number of working persons in HH. Figure 2.12.3 show a number of each income category by the number of working persons.

Based on the above data, overall average income per HH per month is calculated at 592.48 Levs in the West Aegean River Basin, 493.33 Levs in the East Aegean River Basin, and 520.14 Levs in both the basins as shown in the following table.

Status of Income per HH by Number of Working Person of HH

(Lev/HH per month)

River Basin	Income/HH with One Working Person		Income/HH with Two Working Person		Income/HH with Three Working Person		Income with Pensioner Only	Overall Average
	Without Pensioner	With Pensioner	Without Pensioner	With Pensioner	Without Pensioner	With Pensioner		
West Aegean River Basin	601.34	625.09	832.26	854.43	-	-	166.27	592.48
East Aegean River Basin	474.51	533.23	574.70	595.21	425.00	-	196.88	493.33
Both the Basins	508.64	555.36	636.00	656.25	425.00	-	182.24	520.14

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

Income level of HH with pensioner(s) only is 166.27 Levs/HH per month in the West Aegean River Basin, 196.88 Levs/HH per month in the East Aegean River Basin, and 182.24 Levs/HH per month in both the basins.

(5) Expenditure

Expenditure for foods and drinks in the targeted areas are ranging from 60.00/HH per month to 1,000.00 Levs/HH per month with 283.60 Levs/HH per month in average in the West Aegean River Basin, 80.00 Levs to 700.00 Levs with 271.22 Levs in average in the East Aegean River Basin, and 60.00 Levs to 1,000 Levs with 274.39 Levs in both the basins (see Figure 2.12.4(A)).

Expenditure for fuel are ranging from 10.00/HH per month to 250.00 Levs/HH per month with 62.36 Levs/HH per month in average in the West Aegean River Basin, 7.00 Levs to 360.00 Levs with 62.83 Levs in average in the East Aegean River Basin, and 7.00 Levs to 360 Levs with 62.77 Levs in both the basins (see Figure 2.12.4(B)).

And, expenditure for water are ranging from 5.00/HH per month to 80.00 Levs/HH per month with17.07 Levs/HH per month in average in the West Aegean River Basin, 3.00 Levs to 150.00 Levs with 17.56 Levs in average in the East Aegean River Basin, and 3.00 Levs to 150 Levs with 17.47 Levs in both the basins (see Figure 2.12.4(C)).

The following table shows a summary of monthly income and monthly expenditure by items per HH by region together with share rates of expenditure to the total expenditure.

Average Income and Expenditure of Domestic Household per Month

(Lev/HH per month)

River Basin	Income/HH in Overall Average	Expenditure				
		Food and Drinks	Fuel	Water	Others	Total
West Aegean River Basin	592.48	283.60	62.36	17.07	229.45	592.48
		47.87%	10.53%	2.88%	38.73%	100.00%
East Aegean River Basin	493.33	271.22	62.83	17.56	141.73	493.33
		54.98%	12.74%	3.56%	28.73%	100.00%
Both the Basins	520.14	274.39	62.77	17.47	165.52	520.14
		52.75%	12.07%	3.36%	31.82%	100.00%

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

(6) Water Utilization

Question set in the Survey is consisting of (i) use for drinking, (ii) for cooking, (iii) for toilet flushing (sanitary purpose), (iv) cloth washing, (v) for bathing (or for showering), (vi) for gardening, (vii) for car washing, (viii) for swimming pool, and (ix) for others. The following table shows a summary of the answers.

Status of Water Utilization

(Number of Answers)

River Basin	Number of Samples in Total	Drink-ing	Cook-ing	Toilet Flushing (Sanitary Purpose)	Cloth Washing	Bathing (or Shower-ing)	Gardenin g	Car Washing	Swimm-ing Pool	Others
West Aegean River Basin	77	61	74	68	77	77	18	3	0	0
East Aegean River Basin	221	166	208	181	216	215	30	0	0	0
Both the Basins	298	227	282	249	293	292	48	3	0	0

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

There is purchasing "bottled mineral water". However, it is not included in the above table. As shown in the above table, the water use for car washing is only 3 HHs in the West Aegean River Basin, and there is no any HHs to use water for swimming pool.

(7) Sewerage System

Generally, sewerage system is consisting of (i) public sewerage system, (ii) septic tank, and (iii) pit latrine. Therefore, the question set of Survey is also the same composition. The following table shows a summary of the answers.

Status of Sewerage System

River Basin	Public Sewerage System	Septic Tank	Pit Latrine	No Answer	Total Number of Answers
West Aegean River Basin	64	0	13	0	77
East Aegean River Basin	161	12	47	3	220
West and East Agean River Basins	225	12	60	3	297

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

A diffusion rate of public sewerage system is 83% in the West Aegean River Basin, 74% in the East Aegean River Basin, and 76% in the whole targeted areas.

(8) Water Flushing of Toilet

Water flushing of toilet in the targeted areas has been diff used by 87% in the West Aegean River Basin, 80% in the East Aegean River Basin, and 82% in both the basins as of 2006. The following table shows a summary of answers.

Status of Water Flushing of Toilet

River Basin	With Flushing	Without Flushing	No Answer	Total Number of Answers
West Aegean River Basin	67	10	0	77
East Aegean River Basin	177	43	3	220
West and East Agean River Basins	244	53	3	297

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

2.12.3 Residents who are Customers of Public Water Supply System

(1) Consumption of Water Supplied by Public Water Supply System

Consumed water volumes in average are 15.00 m^3/HH per month in the West Aegean River Basin, 16.01 m^3/HH per month in the East Aegean River Basin, and 15.73 m^3/HH per month in both basins. However, the volumes of water consumed are depending upon seasons as summer season and winter season as shown in the following table.

Water Consumption of Public Water Users

River Basin	Water Consumption (m^3/HH per month)			Number of No Answers	Total Number of Answers
	Summer	Winter	Average		
West Aegean River Basin	17.55	12.45	15.00	3	74
East Aegean River Basin	18.77	13.25	16.01	33	190
Both the Basins	18.43	13.02	15.73	36	264

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

In summer season, the said water volume consumed is ranging from 5.00 m^3/HH per month to 50.00 m^3/HH per month with 17.55 m^3/HH per month in the West Aegean River Basin, from 3.00 m^3/HH per month to 200.00 m^3/HH per month with 18.77 m^3/HH per month in the East Aegean River Basin, and from 3.00 m^3/HH per month to 200.00 m^3/HH per month with 18.43 m^3/HH per month in both the basins.

On the other hand in winter season, the said water volume consumed is ranging from 2.00 m^3/HH per month to 30.00 m^3/HH per month with 12.45 m^3/HH per month in the West Aegean River Basin, from 2.00 m^3/HH per month to 60.00 m^3/HH per month with 13.25 m^3/HH per month in the East Aegean River Basin, and from 2.00 m^3/HH per month to 60.00 m^3/HH per month with 13.02 m^3/HH per month in both the basins (see Figure 2.12.5).

(2) Expenditure for Water Supplied by Public Water Supply System

Average unit water charge of Public Water Supply System is 0.91 Levs/m^3 in the West Aegean River Basin, 1.03 Levs/m^3 in the East Aegean River Basin, and 1.00 Levs/m^3 in both the basins.

Based on these unit water charge as mentioned above and consumed water volume mentioned in previous sub-clause, expenditure for water supplied by the Public Water Supply Systems may be calculated as 13.59 Levs/HH per month in the West Aegean River Basin, 16.52 Levs/HH per month in the West Aegean River Basin, and 15.75 Levs/HH per month in both the basins. The following table shows a summary of the calculation.

Average Expenditure for Water Supplied by Public Water Supply System together with Its Unit Water Charge

River Basin	Water Charge (Lev/HH per month)			Unit Water Charge of Public Water Supply (Lev/m^3)	Number of No Answers	Total Number of Answers
	Summer	Winter	Average			
West Aegean River Basin	15.99	11.19	13.59	0.91	0	77
East Aegean River Basin	19.13	13.92	16.52	1.03	8	215
Both the Basins	18.30	13.20	15.75	1.00	8	292

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

As mentioned in the previous sub-clause, consumed water volumes are depending upon the season. Therefore, the expenditure for water is also different by the season. Figure 2.12.6 illustrates a range of the expenditure by season and by the basins.

However, their expenditure for water excluding bottled mineral water is as 17.07 Levs/HH per month in the West Aegean River Basin, 17.56 Levs/HH per month in the West Aegean River Basin, and 17.47 Levs/HH per month in both the basins. Remaining amounts of 3.48 Levs/HH per month in the West Aegean River Basin, 1.04 Levs/HH per month in the West Aegean River Basin, and 1.72 Levs/HH per month in both the basins are for the other water sources such wells as shallow wells and/or deep wells. Almost all of that water is used for gardening or household plot for kitchen garden for agricultural products. The following table shows its detail.

Average Expenditure for Water Supplied by Public Water Supply System and Other Sources Together with Their Share Rate

River Basin	Expenditure for Water in Total without Bottled Mineral Water (Lev/HH.month)	Water Charge by Public Supply System (Lev/HH.month)	Other Water Source	
			Amount (Lev/HH .month)	Share Rate (%)
West Aegean River Basin	17.07	13.59	3.48	20.41%
East Aegean River Basin	17.56	16.52	1.04	5.93%
Both the Basins	17.47	15.75	1.72	9.85%

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

Usage of ground water is at share rates of around 20% in the West Aegean River Basin, 6% in the East Aegean River Basin, and 10% in both the basins.

(3) Satisfaction Level for Water Supplied by Public Water Supply System

Feeling of people on water supplied by Public Water Supply System, generally, consists of (i) quantity, (ii) water pressure, and (iii) quality. So, the question is also set on these 3 items in the Survey.

As a result, almost of 90% of the people has a feeling of “insufficient” and “water pressure” on the quantity, and almost of 50% of people has the other feeling of “not acceptable” on quality for the water supplied by the Public Water Supply System. Share rate of people who have the feeling of “good” on water supplied by the Public Water Supply System is only around 25% in the whole targeted areas.

(4) Bottled Mineral Water

Unit Prices of bottled mineral water are 0.39 Levs/ℓ in average in the West Aegean River Basin, 0.37 Levs/ℓ in the East Aegean River Basin, and 0.37 Levs/ℓ in overall average in both the basins. It means that the price of the mineral water is around 370 times to the water supplied by the Public Water Supply System in both the basins (= 0.37 Levs/ℓ × 1,000 ÷ 1.00 Lev/m^3. The bottled mineral water is quite expensive comparing with the water supplied by the Public Water Supply System. Nevertheless, they are purchasing it with a rate of around 80% of HHs interviewed.

The following table shows a summary of volume-bottled mineral water purchased and the amount of expenditure for purchasing it by river basins together with its unit prices in each basin.

Purchasing Volume of Bottled Mineral Water and Expenditure for Purchasing It together with Its Unit Prices by Basins

River Basin	Purchasing Volume	Unit Price of Bottled Mineral Water		Expenditure for Purchasing Bottled Mineral Water	Number of Answers
		Per Bottle	Per Litre		
	(ℓ/month)	(Lev/ 1.5 ℓ bottle)	(Lev/ℓ)	(Lev/HH per month)	
West Aegean River Basin	29.25	0.58	0.39	11.27	77
West Aegean River Basin	25.80	0.55	0.37	9.49	218
Both the Basin	26.59	0.56	0.37	9.85	295

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

Accordingly, total amounts of expenditures are 28.35 Levs/HH per month in the West Aegean River Basin, 27.05 Levs/HH per month in the East Aegean River Basin, and 27.32 Levs/HH per month in both the basins as shown in the following table.

Expenditure for Water in Grand Total

(Lev/HH per month)

River Basin	Expenditure for Water in Total without Bottled Mineral Water			Expenditure for Purchasing Bottled Mineral Water	Grand Total
	Total	Water Charge by Public Supply System	Other Water Source		
West Aegean River Basin	17.07	13.59	3.48	11.27	28.35
East Aegean River Basin	17.56	16.52	1.04	9.49	27.05
Both the Basins	17.47	15.75	1.72	9.85	27.32

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.

The amounts of expenditure for the bottled mineral water are almost of 83% of the amount of expenditure for water supplied by the Public Water Supply System in the West Aegean River Basin, 57% in the East Aegean River Basin, and 63% in both the basins in comparison, and share rates of it to the total expenditure for all the water is around 40 % in the West Aegean River Basin, 35% in the East Aegean River Basin, and 36% in both the basins as shown in the flowing table.

Status of Purchasing Bottled Mineral Water

River Basin	Rate	
	Against Expenditure for Water Supplied by Public Water Supply System	Share Rate against Expenditure for Water in Grand Total
West Aegean River Basin	82.97%	39.77%
East Aegean River Basin	57.43%	35.08%
Both the Basins	62.56%	36.06%

Source:
A result of "Water Utility Survey" made by JICA Study Team, 2006.

According to information of some people, introduction of the bottled mineral into Bulgaria is not so much old (introduction has been started only in several years ago), so that it may be curious for almost of the people in Bulgaria. Therefore, this trend of consumption of bottled mineral water may be reflective of this social background.

However, according to the information as indicated in the figure entitled as “Feeling of People on Water Supplied by Public Water Supply system” in this sub-clause above, around 50% of the people are dissatisfied with quality of water supplied by the Public Water Supply System.

Furthermore, they are dissatisfied about “taste”, “smelling”, “color”, “cloudy water” of the water supplied by the Public Water Supply System. Some of them gave a comment to interviewers as “because of health” for purchasing the bottled mineral water. The trend of consumption of bottled mineral water may be reflective of these feelings of people in the targeted areas.

Share rates of the amount of expenditures for the bottled mineral water against expenditures in grand total for water are depending upon the income classification as shown in Table 2.12.1. Figure 2.12.7 indicates relationships between the amount of expenditure for the bottled mineral water and the income class. Relation curves as indicated in Figure 2.12.7 mean that the amounts of expenditures may become great as the income class become high. In this case, numbers of HHs in the higher income class than the class "1,000 – 1,250 Levs/HH per month" are quite little as only 2 samples in the class of "1,250 – 1,500 Levs/HH per month" and only 2 samples in the class of "<3,000 Levs/HH per month", so that, these data may not be reliable. Therefore, the said relation curve is made from the data of "Pensioner(s) only" to the data of "1,000 – 1,250 Levs/HH per month".

(5) Willingness of People to Pay (WTP)

Question of willingness to pay is set as "Willingness to pay the water charge in case that the above problems are removed". It means that answers on this question are "water charge the people will pay in addition to current water charge they are paying under the existing status". The flowing table shows a summary of their answers.

Summary of Answers on Willingness to Pay

River Basin	Reason to Purchasing of Bottled Mineral	
	Number of Answers	Amount of Acverage Additional Willingnes s to Pay (Lev/HH per month)
West Aegean River Basin	53	2.72
East Aegean River Basin	179	2.02
Both the Basins	232	2.18

Source:
A result of "Water Utility Survey" made by JICA Study Team, 2006.

The answers of the said "additional WTP" differs depending upon income class as from 0.00 Lev/HH per month to 30.00 Levs/HH per month with 2.72 Levs/HH per month in average as indicated in the above table in the West Aegean River Basin, from 0.00 Lev/HH per month to 20.00 Levs/HH per month with 2.02 Levs/HH per month in average in the East Aegean River Basin, and from 0.00 Lev/HH per month to 30.00/HH per month with 2.18 Levs/HH per month in average in both the basin as indicated in Figure 2.12.8.

2.12.4 Status of Private Water Source

Rates of answers whop have private water source to total number of samples are 11.69% in the West Aegean River Basin (9 HHs among 77 samples), 30.32% in the East Aegean River Basin (67 HHs among 221 samples)), and 25.50% in both the basins (76 HHs among 298 samples). Among them, number of HHs who has private water source(s) only is 5 HHs in the East Aegean River Basin. According to information from some people interviewed, they use the water from the private water sources for irrigation for household plots (kitchen garden) except HHs who have private water source only.

Kind of private water sources consists of "Deep Well", "Shallow Well", "River, Canal, and Pond", "Hydrant" (Public Tap), and others (they call it as "Domestic Water"). The flowing table shows a summary of answers.

Summary of Answers on Private Water Sources

River Basin	Reason to Purchasing of Bottled Mineral Water								
	Number of Answers who Have Private Water Source	Number of HHs who Have Private Water Sources	Of which: Number of HHs who Have Private Water Source Only*	Rate of Answers who Have Private Water Source to Total Samples	Deep Well	Shallow Well	River, Canal, and Pond	Hydrant (Public Tap)	Domestic Water (domestic water for irrigation)
West Aegean River Basin	9	9	0	11.69%	6	1	2	0	0
East Aegean River Basin	67	64	5	30.32%	30	31	4	1	2
Both the Basins	76	73	5	25.50%	36	32	6	1	2

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.
(Note) *: Refer to Table 2.4.3.

As mentioned above, almost of water from the private water source is not for drinking but for irrigation for kitchen garden. For this purpose, around 80% of HHs are feeling as "sufficient", but only around 30% of HHs are feeling as "good" and around 30% of HHs as "acceptable" in water quality as a whole.

Main Report

Chapter 2

Tables

Table 2.2.1 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

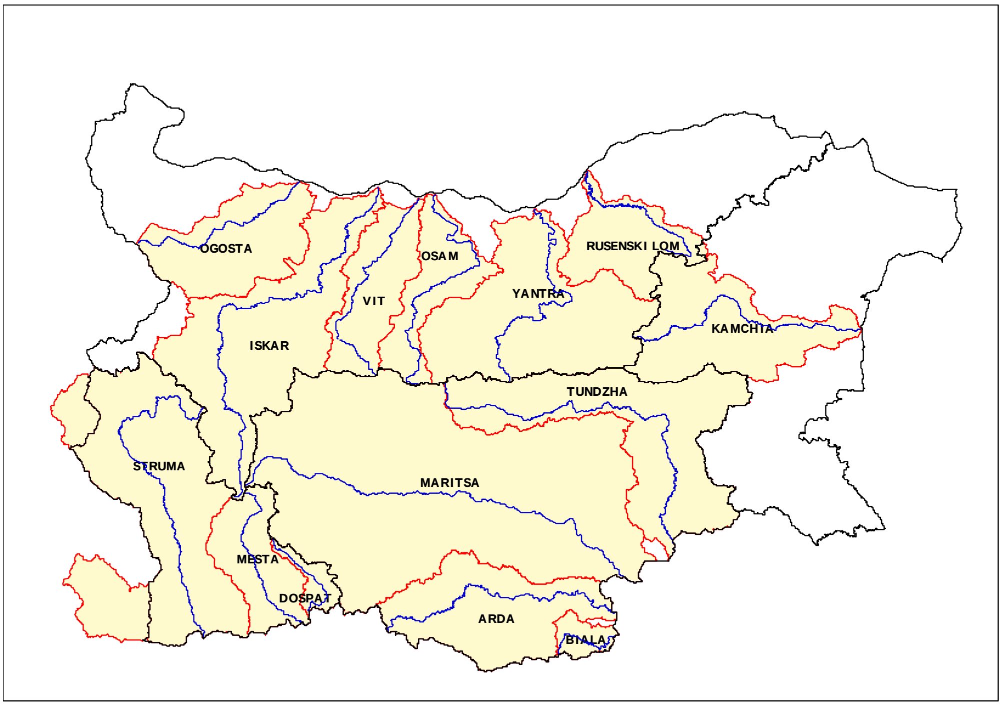


Table 2.2.2 Preliminary Water Balance across the Country in 2000-2005 under Assumption that Basin Storage is Negligible

Hydrological year				2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	Average in 2000-2005
	Precipitation Amount (*1)	(million m^3)	P	55,703	84,275	68,614	70,054	104,115	76,552
In (%)	Precipitation		P	100.0	100.0	100.0	100.0	100.0	100.0
	External Inflow (*2)	Inflow from Serbia	I_S	0.2	0.2	0.4	0.3	0.4	0.3
		Inflow from Macedonia	I_M						
Out (%)	Total Loss (*3)		L	84.9	84.8	66.6	75.5	66.4	74.8
	Outflow to Danuba & Black Sea (*2)	Outflow to Danuba	O_D	5.9	6.6	13.3	9.3	17.2	11.1
		Outflow to Black Sea	O_B						
	Outflow to Neighbouring Countries (*2)	Outflow to Turkey	O_T	9.3	8.8	20.5	15.6	16.8	14.4
		Outflow to Greece	O_G						
		Outflow to Serbia	O_S						
		Outflow to Romania	O_M						

(*1) It is calculated based on data in the selected 253 precipitation stations.
(*2) It is calculated based on observed discharge data in hydrometric stations. It is assumed that the runoff volume per unit area from ungaged catchment is same as the averaged one in gauged catchment.
(*3) It is assumed that total loss is equal to total inflow minus total outflow. However, this assumption would not be valid for water balance in single hydrological year. Therefore, the total loss could include basin storage.

Table 2.3.1 Population Projection in Bulgaria by Region, District and Municipality Since 2001

Region/District/Municipality	Index	2001	2002	2003	2004	2005
North West Region		531,149	521,951	512,593	503,065	493,708
Vidin	VID	128,050	125,158	122,609	120,192	117,809
Vratsa	VRC	223,358	219,830	216,388	212,656	209,124
Montana	MON	179,741	176,963	173,596	170,217	166,775
North Central Region		1,194,327	1,180,235	1,165,806	1,153,950	1,140,453
Veliko Tarnovo	VTR	291,121	289,229	287,011	285,677	283,599
Gabrovo	GAB	142,850	140,991	139,115	137,461	135,780
Lovech	LOV	167,931	165,456	163,342	161,190	159,214
Pleven	PVN	325,531	320,327	315,230	310,449	305,025
Ruse	RSE	266,894	264,232	261,108	259,173	256,835
North East Region		1,304,344	1,294,249	1,285,803	1,278,112	1,270,018
Varna	VAR	461,174	460,001	458,661	458,392	457,922
Dobrich	DOB	213,325	210,635	208,469	206,893	205,541
Razgrad	RAZ	144,818	143,129	142,388	140,743	139,094
Silista	SLS	140,784	138,994	137,424	135,701	134,093
Targovvishte	TGV	140,860	139,600	138,160	136,806	135,262
Shemen	SHU	203,383	201,890	200,701	199,577	198,106
South East Region		793,899	788,285	782,653	777,836	774,538
Burgas	BGS	422,458	421,049	419,925	418,925	418,750
Sliven	SLV	217,226	215,443	213,194	211,005	209,694
Yambol	JAM	154,215	151,793	149,534	147,906	146,094
South Central Region		1,969,595	1,956,913	1,944,382	1,933,271	1,921,178
Kardzhali	KRZ	163,341	162,332	161,002	159,878	158,541
Pazardzhik	PAZ	308,719	305,790	303,246	300,092	297,781
Plovdiv	PDV	714,779	712,702	710,958	709,861	707,570
Municipality Plovdiv	PDV22	340,122	340,475	340,320	341,464	341,873
Smolyan	SML	138,802	137,005	135,029	133,015	131,010
Stara Zagora	SZR	368,771	366,636	364,051	362,090	360,203
Haskovo	HKV	275,183	272,448	270,096	268,335	266,073
South West Region		2,097,781	2,104,208	2,110,036	2,114,815	2,118,855
Blagoevgrad	BLG	339,790	336,988	335,638	334,907	333,577
Municipality Blagoevgrad	BLG03	78,343	77,713	77,346	77,422	77,462
Kyustendil	KNL	160,702	158,746	156,376	154,468	152,714
Pernik	PER	148,251	146,431	144,104	142,251	140,981
Sofia Capital	SOF	1,178,579	1,194,164	1,208,930	1,221,157	1,231,622
Sofia	SFO	270,459	267,879	264,988	262,032	259,961
Whole the Nation of Bulgaria		7,891,095	7,845,841	7,801,273	7,761,049	7,718,750

(Note) Figures in each year are those at the end (Dec.31) of the year.
Source: "*Statistical Yearbook*", 2004, 2005, NSI, the Republic of Bulgaria.

Table 2.3.2 Economic Active Population in Whole the Nation of Bulgaria by Regions

(Unit: 1,000)

Region/Items	2001	2002	2003	2004	2005
North West Region					
Labor Force in Total	214	205	188	185	176
Employment	154	150	157	157	152
Unemployment	61	54	31	27	24
Unemployment Rate	28.26%	26.55%	16.48%	14.74%	13.62%
North Central Region					
Labor Force in Total	489	484	470	466	465
Employment	393	398	406	412	415
Unemployment	97	86	64	54	50
Unemployment Rate	19.76%	17.71%	13.52%	11.67%	10.78%
North East Region					
Labor Force in Total	564	561	543	552	555
Employment	428	438	438	455	481
Unemployment	136	123	105	97	74
Unemployment Rate	24.10%	21.91%	19.39%	17.59%	13.27%
South East Region					
Labor Force in Total	326	329	326	326	320
Employment	246	257	273	282	289
Unemployment	80	71	53	44	31
Unemployment Rate	24.59%	21.73%	16.31%	13.49%	9.60%
South Central Region					
Labor Force in Total	822	807	793	807	804
Employment	667	670	705	722	724
Unemployment	154	137	88	85	80
Unemployment Rate	18.76%	16.96%	11.09%	10.51%	10.00%
South West Region					
Labor Force in Total	947	947	964	987	995
Employment	811	826	856	894	920
Unemployment	136	121	108	92	76
Unemployment Rate	14.37%	12.81%	11.23%	9.32%	7.60%
Whole the Nation of Bulgaria					
Labor Force in Total	3,363	3,332	3,283	3,322	3,314
Employment	2,699	2,740	2,834	2,922	2,980
Unemployment	664	593	449	400	335
Unemployment Rate	19.74%	17.78%	13.68%	12.03%	10.09%

(Note) Figures in each year are those at the end (Dec.31) of the Year.
Source: NSI.

Table 2.3.3 International Balance of Trade by Main Trade Region

(mill. EUR)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Exports	3,837	3,744	4,256	3,747	3,734	5,253	5,714	6,063	6,668	7,985	9,454
EU countries - 15 1/	1,507	1,499	1,881	1,889	1,942	2,684	3,129	3,376	3,770	4,332	4,875
EU countries - 10 2/	109	100	147	207	141	172	195	218	240	322	470
Europe 3/	615	601	600	381	321	277	309	296	231	294	324
Balkan countries 4/	684	645	643	515	624	1,206	1,014	1,120	1,245	1,632	2,055
America	222	177	211	158	199	296	386	387	392	461	423
Asia	444	471	478	302	240	334	308	294	364	479	602
Other countries	256	251	296	296	267	286	373	371	426	465	705
Imports	4,112	3,935	4,307	4,416	5,140	7,085	8,128	8,411	9,611	11,620	14,682
EU countries - 15 1/	1,532	1,409	1,600	1,994	2,486	3,119	4,011	4,229	4,767	5,596	6,438
EU countries - 10 2/	137	130	176	199	267	378	436	450	552	688	846
Europe 3/	1,505	1,469	1,508	1,155	1,267	2,031	2,001	1,621	1,723	2,119	3,036
Balkan countries 4/	165	175	188	228	264	544	547	648	899	1,155	1,616
America	206	222	357	304	302	432	435	414	530	734	1,018
Asia	305	209	279	319	341	356	539	636	957	1,120	1,453
Other countries	263	321	198	219	213	225	159	413	182	207	275
Balance of Trade	-275	-190	-50	-669	-1,406	-1,832	-2,414	-2,348	-2,942	-3,635	-5,228

Source: Bulgarian National Bank.
(Note) 1/: Includes the EU member countries prior to May 1, 2004. 2/: Includes the new EU member countries accepted after May 1, 2004. 3/: Includes Russia, Ukraine, Switzerland, Gibraltar (GB), Moldova, Belarus, Norway, Lichtenstein, San Marino, Iceland and Monaco. 4/: Includes Turkey, Romania, Serbia and Montenegro, Macedonia, Albania, Croatia and Bosna and Herzegovina.

Table 2.3.4 International Trade by Category of Commodities

(mill. EUR)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Exports	3,837	3,744	4,256	3,747	3,734	5,253	5,714	6,063	6,668	7,985	9,454
Consumer goods	1,002	1,072	1,175	1,163	1,249	1,564	1,917	2,134	2,441	2,623	2,729
Raw materials	2,038	1,857	2,112	1,732	1,567	2,322	2,331	2,535	2,759	3,478	4,056
Investment goods	535	566	625	601	571	600	699	802	912	1,075	1,448
Mineral fuels, oils and electricity	263	249	345	252	346	767	767	591	557	809	1,222
Import	4,112	3,935	4,307	4,416	5,140	7,085	8,128	8,411	9,611	11,620	14,682
Consumer goods	366	270	291	628	693	864	1,140	1,253	1,476	1,895	2,259
Raw materials	1,566	1,538	1,851	1,792	1,886	2,557	3,130	3,266	3,849	4,602	5,284
Investment goods	775	734	731	943	1,407	1,729	2,038	2,110	2,466	3,085	4,047
Mineral fuels, oils and electricity	1,405	1,393	1,433	1,053	1,154	1,935	1,821	1,675	1,690	1,942	2,960
Other Imports *	0	0	0	0	0	0	0	107	129	96	133
Balance of Trade	-275	-190	-50	-669	-1,406	-1,832	-2,414	-2,348	-2,942	-3,635	-5,228

Source: Bulgarian National Bank.
* In accordance with changes in The Customs Tariff, since 1 January 2002.

Table 2.3.5 Balance of Payment of Bulgaria

(mill.EURO)

	2001	2002	2003	2004	2005
Current Account	-855	-402	-972	-1,131	-2,531
Trade Balance	-1,778	-1,878	-2,426	-2,953	-4,369
Exports, f.o.b.	5,714	6,063	6,668	7,985	9,454
Exports, f.o.b. (year over year percentage change)	8.78	6.10	9.98	19.75	18.40
Imports, f.o.b.	7,493	7,941	9,094	10,938	13,823
Imports, f.o.b. (year over year percentage change)	14.69	5.98	14.52	20.28	26.37
Capital and Financial Account	755	1,843	2,325	2,911	2,874
Financial Account	755	1,843	2,325	2,911	2,875
Foreign Direct Investment	903	980	1,851	2,727	1,789
Foreign Direct Investment/Current Account Deficit (%)	105.64	243.47	190.32	241.09	70.70
Portfolio Investment - Assets	-25	227	-69	-1	-8
Portfolio Investment - Liabilities	119	-326	-122	-562	-749
Other investments - Assets	-117	332	229	-753	124
Other investments - Liabilities	-115	659	460	1,983	1,652
BNB Foreign exchange reserves/imports of GNFS (in months)	5	6	6	6	5

Source: Bulgarian National Bank.
(Note) BNB means the Bulgarian National Bank.

Table 2.3.6 Output of Industrial Enterprises by Industrial Origin

(mill. Levs)

	2001	2002	2003	2004
Output				
Mining and Quarrying	1,017	996	1,037	1,329
of which "Private Sector"	569	598	611	923
Manufacturing	17,042	17,963	19,794	24,351
of which "Private Sector"	15,838	17,147	19,026	23,617
Electricity, Gas and Water supply	3,301	3,906	3,911	4,186
of which "Private Sector"	183	236	494	670
Total	21,360	22,865	24,742	29,866
of which "Private Sector"	16,590	17,981	20,131	25,210
Share Rates of Outputs				
Mining and Quarrying	4.76%	4.36%	4.19%	4.45%
of which "Private Sector"	3.43%	3.33%	3.04%	3.66%
Manufacturing	79.78%	78.56%	80.00%	81.53%
of which "Private Sector"	95.47%	95.36%	94.51%	93.68%
Electricity, Gas and Water supply	15.45%	17.08%	15.81%	14.02%
of which "Private Sector"	1.10%	1.31%	2.45%	2.66%
Total	100.00%	100.00%	100.00%	100.00%
of which "Private Sector"	100.00%	100.00%	100.00%	100.00%

Source: Statistical Yearbook of Bulgaria 2005.

Table 2.3.7 Output of Industrial Enterprises by Industrial Sub-Origin

(mill. Levs)

	2001	2002	2003	2004
Mining and Quarrying of Energy Producing Materials	434	433	474	532
Mining and Quarrying, except Energy Producing Materials	583	563	563	798
Manufacture of Food Products, Beverages and Tobacco	3,567	3,789	4,122	4,671
Manufacture of Textiles and Textile Products	1,340	1,774	2,061	2,358
Manufacture of Leather and Leather Products	198	221	257	210
Manufacture of Wood and Wooden Products	296	351	408	536
Manufacture of Pulp, Paper and Paper Products, Publishing and Printing	679	844	958	1,059
Manufacture of Coke, Refined Petroleum Products	n.a.	n.a.	n.a.	n.a.
Manufacture of Chemicals, Chemical Products and Man-Made Fibres	1,643	1,500	1,502	1,557
Manufacture of Rubber and Plastic Products	391	476	598	718
Manufacture of Other Non-Metalic Miniral Products	768	866	956	1,242
Manufacture of Basic Metals and Fabricated Metal Products, except Machinery	2,350	2,282	2,794	4,627
Manufacture of Machinery and Equipment, N.E.C.	1,225	1,348	1,479	1,755
Manufacture of Electrical and Optical Equipment	872	989	1,081	1,110
Manufacture of Transport Equipment	297	300	334	420
Manufacture, N.E.C.	n.a.	n.a.	n.a.	n.a.
Electricity, Gas and Water Supply	3,301	3,906	3,911	4,186
Total	21,360	22,864	24,742	29,866

Source: Statistical Yearbook of Bulgaria 2005.

Table 2.3.8 Water Sector Status by Regions and Districts in 2004

(1,000 m^3/year as of 2004)

Region/District	Index	Water Abstracted					Supplied Water Volume in Total	Water Loss Rate Including the Loss from Intake Point to Purification Point	Average Price of Drinking Water for Household (Levs/m^3)	
		Surface Water	Ground Water	Water Volume Sent to Other Public Water Works	Water Volume Received from Other Public Water Works	Total Available Water Volume			Net Unit Price without VAT	Gross Unit Price with VAT
North West Region		44,802	9,408	20,366	20,233	54,077	20,510	62.07%	0.82	0.99
Vidin	VID	5,657	1,825	0	174	7,656	4,116	46.24%	0.92	1.10
Vrtsa	VRC	7,420	5,131	0	18,856	31,407	10,262	67.33%	0.82	0.99
Montana	MON	31,725	2,452	20,366	1,203	15,014	6,132	59.16%	0.76	0.91
North Central Region		110,133	36,758	18,782	18,923	147,032	57,096	61.17%	0.84	1.02
Veliko Tarnovo	VTR	42,654	1,846	1,927	0	42,573	13,107	69.21%	0.89	1.07
Gabrovo	GAB	26,815	3,231	632	2,521	31,935	6,910	78.36%	0.97	1.17
Lovech	LOV	6,024	24,234	16,223	3,088	17,123	7,476	56.34%	0.77	0.92
Pleven	PVN	12,469	2,448	0	13,179	28,096	15,216	45.84%	0.92	1.11
Ruse	RSE	22,171	4,999	0	135	27,305	14,387	47.31%	0.70	0.84
North East Region		47,421	72,833	314	42,137	162,077	53,528	66.97%	0.98	1.17
Varna	VAR	7,932	21,914	0	42,120	71,966	25,039	65.21%	0.74	0.88
Dobrich	DOB	3,769	38,105	0	0	41,874	8,417	79.90%	1.20	1.44
Razgrad	RAZ	8,503	5,373	140	17	13,753	5,330	61.24%	1.33	1.60
Silista	SLS	7,449	2,755	0	0	10,204	4,286	58.00%	1.25	1.50
Targovvishte	TGV	8,188	971	174	0	8,985	2,610	70.95%	1.18	1.42
Shemen	SHU	11,580	3,715	0	0	15,295	7,846	48.70%	1.05	1.25
South East Region		129,695	16,407	45,423	2,868	103,547	40,260	61.12%	0.79	0.95
Burgas	BGS	100,378	2,700	42,258	2,380	63,200	26,965	57.33%	0.71	0.85
Sliven	SLV	27,759	3,281	3,165	488	28,363	7,378	73.99%	0.92	1.10
Yambol	JAM	1,558	10,426	0	0	11,984	5,917	50.63%	1.00	1.20
South Central Region		41,479	163,998	468	5,041	210,050	79,807	62.01%	0.78	0.93
Kardzhali	KRZ	9,166	561	0	0	9,727	5,394	44.55%	0.80	0.96
Pazardzhik	PAZ	4,464	26,448	74	283	31,121	11,841	61.95%	0.55	0.65
Plovdiv	PDV	13,628	79,127	0	1,261	94,016	33,284	64.60%	0.60	0.72
Smolyan	SML	2,640	6,230	0	0	8,870	4,328	51.21%	0.78	0.93
Stara Zagora	SZR	5,159	39,539	215	3,165	47,648	15,667	67.12%	1.08	1.29
Haskovo	HKV	6,422	12,093	179	332	18,668	9,293	50.22%	1.17	1.41
South West Region		303,376	21,022	5,169	16,453	335,682	137,654	58.99%	0.48	0.57
Blagoevgrad	BLG	15,898	5,679	690	885	21,772	16,716	23.22%	0.41	0.49
Kyustendil	KNL	12,467	1,118	78	1,724	15,231	5,688	62.66%	0.73	0.88
Pernik	PER	25,330	7,767	504	504	33,097	11,859	64.17%	0.58	0.70
Sofia Capital	SOF	242,553	23	3,897	8,067	246,746	92,218	62.63%	0.45	0.54
Sofia	SFO	7,128	6,435	0	5,273	18,836	11,173	40.68%	0.54	0.65
Whole the Nation of Bulgaria		676,906	320,426	90,522	105,655	1,012,465	388,855	61.59%	0.71	0.85

Source: Environmental Bulletin 2004 , Ministry of Environment and Water.

Table 2.3.9 Average Annual Income per Household and per Capita

(Levs/year)

	2000	2001	2002	2003	2004
Average per Household					
Ordinary Income	4,360	4,307	5,289	5,584	5,925
Wages ans Salaries	1,695	1,711	1,978	2,234	2,382
Other Earnings	230	218	226	214	232
Enterpreneurship	194	179	226	234	233
Property Income	33	30	34	32	43
Unemployment Benefits	49	50	43	30	27
Pensions	934	1,022	1,061	1,152	1,312
Family Allowance	35	29	26	32	39
Other Social Benefits	51	56	86	70	93
Households Plot	727	644	1,043	1,017	958
Property Sale	20	19	25	37	28
Miscellaneous	392	349	541	532	578
Interest Income	153	128	159	140	216
Loans and Credits	83	88	99	151	206
Loans Repaid	14	9	9	12	9
Total	4,610	4,532	5,556	5,887	6,356
Average per Capita					
Ordinary Income	1,574	1,589	1,985	2,129	2,298
Wages ans Salaries	612	631	742	852	924
Other Earnings	83	80	85	82	90
Enterpreneurship	70	66	85	89	90
Property Income	12	11	13	12	17
Unemployment Benefits	18	19	16	11	10
Pensions	337	377	398	439	509
Family Allowance	13	11	10	12	15
Other Social Benefits	19	21	32	27	36
Households Plot	262	238	392	388	372
Property Sale	7	7	9	14	11
Miscellaneous	141	128	203	203	224
Interest Income	55	47	60	52	84
Loans and Credits	30	32	37	58	80
Loans Repaid	5	4	3	5	4
Total	1,664	1,672	2,085	2,244	2,466

Source: Statistical Yearbook of Bulgaria 2005.

Table 2.3.10 Average Annual Income Level by Region in 2004

(Levs/year)

Income Source	Region						Whole
	North West	North Central	North East	South East	South Central	South West	Nation of Bulgaria
Average per Household							
Ordinary Income	6,747	5,905	5,848	5,640	5,831	5,960	5,925
o.w. Wages/Salaries	1,902	2,162	2,301	2,373	2,255	2,792	2,382
Interest Income	295	135	212	332	202	213	216
Loans and Credits	247	297	142	214	114	259	206
Loans Repaid	17	12	8	10	6	8	9
Total	7,306	6,349	6,210	6,196	6,153	6,440	6,356
Average per Capita							
Ordinary Income	2,757	2,321	2,186	2,230	2,154	2,405	2,298
o.w. Wages/Salaries	777	850	860	938	833	1,127	924
Interest Income	120	53	79	131	75	86	84
Loans and Credits	101	117	54	85	42	105	80
Loans Repaid	7	5	3	4	2	3	4
Total	2,985	2,496	2,322	2,450	2,273	2,599	2,466

Source: Statistical Yearbook of Bulgaria 2005.

Table 2.3.11 Average Annual Expenditure per Household and per Capita

(Levs/year)

	2000	2001	2002	2003	2004
Average per Household					
Current Expenditure	3,832	3,850	4,326	4,585	5,021
Consumable Good and Services	3,254	3,315	3,744	3,970	4,285
Food and Non-Alcoholic Beverage	1,691	1,727	1,836	1,854	1,972
Alcoholic Beverage and tobacco	147	142	169	186	211
Clothing and Footwear	154	137	158	161	168
Housing, Water, Electricity, Gas and Other Fuels	469	465	588	644	694
Furnishing and Maintenance of House	109	110	129	150	161
Health	139	150	176	199	226
Transport	198	204	222	245	266
Communications	98	128	182	214	243
Recreation, Culture and Education	124	124	141	162	174
Miscellaneous Goods and Services	125	128	143	155	170
Taxes	142	120	128	142	148
Household Plot	113	119	130	119	121
Other Expenditure	323	296	324	354	467
Saving	95	108	115	125	142
Purchase of Currency and Securities	2	1	1	5	3
Debt Paid Out and Loan Granted	89	84	114	146	166
Total	4,018	4,043	4,556	4,861	5,332
Average per Capita					
Current Expenditure	1,383	1,420	1,624	1,748	1,948
Consumable Good and Services	1,174	1,223	1,405	1,514	1,662
Food and Non-Alcoholic Beverage	610	637	689	707	765
Alcoholic Beverage and tobacco	53	52	63	71	82
Clothing and Footwear	56	51	59	61	65
Housing, Water, Electricity, Gas and Other Fuels	169	171	221	246	269
Furnishing and Maintenance of House	39	41	48	57	63
Health	50	55	66	76	88
Transport	72	75	83	93	103
Communications	35	47	68	81	94
Recreation, Culture and Education	45	46	53	62	68
Miscellaneous Goods and Services	45	48	55	60	65
Taxes	51	44	48	54	58
Household Plot	41	44	49	45	47
Other Expenditure	117	109	122	135	181
Saving	34	40	43	47	55
Purchase of Currency and Securities	1	1	0	2	1
Debt Paid Out and Loan Granted	32	31	43	56	64
Total	1,450	1,492	1,710	1,853	2,068

Source: Statistical Yearbook of Bulgaria 2005.

Table 2.4.1 Existing Water Supply Systems

No.	Name of Water Supply and Sewerage Company (WSS Co.)	Owner	Related Basin District	Water Supply System: Number of municip. supplied	Water Supply System: Served populat. by WS	Supplied Water: From surface water (1000 m^3/year)	Supplied Water: From groundwater (1000 m^3/year)	Supplied Water: From dam (1000 m^3/year)	Supplied Water: Total supplied water (1000 m^3/year)	Water Purification and Storage: Water Purifica. Plants (no.)	Water Purification and Storage: Pump Sts. (no.)	Water Purification and Storage: WS Reservoirs and Tanks (no.)	Water Purification and Storage: WS Reservoirs and Tanks (m^3)	Pipes for Water Supply: Asbestos cement (m)	Pipes for Water Supply: Steel (m)	Pipes for Water Supply: Cast iron (m)	Pipes for Water Supply: PVC + HDPE (m)	Pipes for Water Supply: Other (m)	Pipes for Water Supply: Total length (m)	Pipes for Water Supply: Informat. Necessary Improve. (m)	Sewerage System: Served populat. By SW	Sewerage System: WWTPs (no.)	Sewerage System: Sewer Pump Stations (no.)	Sewerage System: Sewer networks (m)	Sewerage System: Informat. Necessary Improve. (m)
1	Burgas	State	BSBD	14	424,080	0	4,453	62,572	67,025	2	243	447		2,471,360	923,855	75,547	32,752	201,486	3,705,000		280,940	5	39	462,420	3,395,215
2	Dobrich	State	BSBD	8	225,987	0	35,712	0	35,712	0	77	265		2,975,000	181,000	4,000	52,000	52,000	3,264,000		102,500	5	7	208,400	3,156,000
3	Shumen	State & Municp.	BSBD	10	214,880	0	7,570	12,030	19,600	0	151	252		1,857,607	442,894	33,496	3,550	0	2,337,547		132,098	0	0	189,000	2,300,501
4	Varna	State & Municp.	BSBD	12	461,126	0	59,935	31,168	91,103	0	136	322		3,207,775	432,270	212,556	14,692	833,707	4,701,000		327,980	13	18	686,217	3,640,045
			Sub-total	**44**	**1,326,073**	**0**	**107,670**	**105,770**	**213,440**	**2**	**607**	**1,286**		**10,511,742**	**1,980,019**	**325,599**	**102,994**	**1,087,193**	**14,007,547**		**843,518**	**23**	**64**	**1,546,037**	**12,491,761**
5	Pleven	State	DRBD	10	314,965	0	25,710	0	25,710	0	344	275		2,461,471	527,336	8,692	47,771	8,730	3,054,000		163,100	1	1	294,959	2,988,807
6	Razgrad	State	DRBD	5	133,122	0	24,400	0	24,400	0	88	134		1,271,700	306,720	6,200	5,480	0	1,590,100		65,442	2	0	104,000	1,578,420
7	Vidin	State	DRBD	11	149,382	796	7,627	0	8,423	0	50	147		1,432,572	100,621	29,636	92,968	0	1,655,797		69,623	0	3	68,424	1,533,193
8	Sofia-district	State	DRBD & EABD	21	218,509	5,200	9,800	5,300	20,300	3	161	311		2,289,400	751,400	16,600	32,400	206,200	3,296,000		148,600	2	0	424,900	3,040,800
9	Gabrovo	State & Municp.	DRBD	3	100,927	2,238	1,947	24,000	28,185	2	45	282		910,230	48,480	27,000	21,430	99,860	1,107,000		91,794	1	0	157,460	958,710
10	Isperih	State & Municp.	DRBD	3	47,727	555	2,215	0	2,770	0	23	33		500,900	171,100	31,800	0	31,200	735,000						672,000
11	Lovech	State & Municp.	DRBD	7	137,323	5,837	17,016	0	22,853	0	100	267		1,334,140	354,822	3,600	18,092	44,346	1,755,000		55,780	0	0	87,285	1,688,962
12	Montana	State & Municp.	DRBD	10	148,096	530	6,305	27,465	34,300	1	55	125		1,252,100	167,980	3,700	59,926	17,294	1,501,000		58,999	1	1	104,792	1,420,080
13	Russe	State & Municp.	DRBD	8	275,538	0	28,000	0	28,000	0	110	187		1,846,008	364,123	122,370	107,281	408,218	2,848,000		147,684	0	1	117,576	2,210,131
14	Silistra	State & Municp.	DRBD	7	142,786	0	11,943	0	11,943	0	137	147		1,707,308	47,280	24,661	72,555	0	1,851,804		56,461	0	1	105,118	1,754,588
15	Targovishte	State & Municp.	DRBD	3	99,205	0	1,832	7,500	9,332	1	120	221		1,313,615	65,576	2,156	2,559	22,094	1,406,000		54,685	0	0	123,923	1,379,191
16	Veliko Tarnovo	State & Municp.	DRBD	9	266,229	574	7,209	29,631	37,415	1	190	277		2,387,936	252,647	30,180	9,893	239,344	2,920,000		142,520	1	0	286,580	2,640,583
17	Vratsa	State & Municp.	DRBD	10	242,975	0	22,276	18,076	40,352	0	195	276		2,311,842	302,967	52,460	25,174	0	2,692,443		110,000	1	1	209,200	2,614,809
18	Berkovitsa	Municipality	DRBD	1	21,466	220	252	0	472	0	1	18		173	20,294	0	147		20,614		16,529	0	0	61,500	20,467
19	Botevgrad	Municipality	DRBD	1	41,203	1,356	293	1,120	2,769	1	2	25		282,943	32,191	0	2,300		317,434		29,516	1	0	59,247	315,134
20	Knezha	Municipality	DRBD	1	17,501	0	3,073	0	3,073	0	9	2		188,910	1,700	0	1,690		192,300		4,720	0	0	12,140	190,610
21	Kubrat	Municipality	DRBD	1	28,357	0	0	0	0	0	15	30		227,275	99,883	0	3,161		330,319		0	0	0	0	327,158
22	Sevlievo	Municipality	DRBD		*40,989*				0					551,755	38,388	0	6,811		596,954						590,143
23	Sofia City	Municipality	DRBD	1	1,177,577	26,300	284	264,000	290,584	2	11	48		878,000	1,105,000	812,000	455,000		3,250,000		1,094,410	1	0	1,550,000	
24	Svishtov	Municipality	DRBD	1	50,000	0	6,000	0	6,000	0	39	30		360,000	80,000	0	20,000		460,000		35,000	0	0	80,000	440,000
25	Troyan	Municipality	DRBD						0																
			Sub-total	**113**	**3,653,877**	**43,606**	**176,181**	**377,092**	**596,879**	**11**	**1,695**	**2,835**		**23,508,278**	**4,838,508**	**1,171,055**	**984,638**	**1,077,286**	**31,579,765**		**2,344,863**	**11**	**8**	**3,847,104**	**26,363,786**
26	Haskovo (*)	State	EABD	***9***	***194,895***		***16,874***		***16,874***	***1***	***86***	218	***96,461***	***1,861,319***	***229,800***	***3,027***	***7,176***	***20,606***	***2,121,928***	***27,420***	***142,706***	***0***	***1***	***211,000***	***1,380***
27	Pazardzhik	State	EABD	3	165,426	0	19,950	0	19,950	0	84	72		749,680	162,511	116	31,980	0	944,287		96,067	0	3	119,642	912,191
28	Plovdov	State	EABD	16	720,416	3,685	90,980	0	94,665	5	132	236		3,187,898	332,965	75,404	27,921	1,581,812	5,206,000		497,552	2	0	755,152	3,520,863
29	Smolyan	State	EABD	11	141,013	1,185	8,211	0	9,396	8	35	229		1,015,171	215,940	2,619	36,424	120,846	1,391,000		88,794	1	0	259,858	1,231,111
30	Stara Zagora	State	EABD	18	388,182	0	55,306	0	55,306	0	331	224		2,418,375	444,124	65,344	75,736	310,421	3,314,000		245,160	3	1	352,016	2,862,499
31	Yambol (*)	State	EABD	***5***	***145,948***	***0***	***23,527***	***0***	***23,527***	***0***	***199***	120	***52,689***	***1,420,653***	***311,865***	***0***	***34,488***	***26,369***	***1,793,375***		***69,027***	***0***	***4***	***132,328***	
32	Dimitrovgrad	State & Municp.	EABD	1	64,981	0	2,517	0	2,517	1	20	25		465,000	36,000	20,300	16,698	0	537,998		43,000	0	0	75,750	501,000
33	Kardzhali (*)	State & Municp.	EABD	***7***	***140,175***	***69***	***3,986***	***5,328***	***9,383***	***1***	***70***	103	***39,760***	***1,059,464***	***74,958***	***0***	***121,432***	***65,955***	***1,321,809***	***692,000***	***65,405***	***0***	***0***	***141,947***	***145,015***
34	Sliven	State & Municp.	EABD	4	234,000	158	18,767	7	18,932	0	74	152		1,301,000	537,000	10,000	17,000	14,000	1,879,000		125,000	2	0	161,151	1,838,000
35	Batak	Municipality	EABD	1	7,000	0	219	350	569	0	0	6		66,000	15,000	0	1,500		82,500		7,000	0	0	10,100	81,000
36	Belovo	Municipality	EABD	1	12,000	560	680	0	1,240	1	3	5		45,000	3,000	0	1,200		49,200		3,000	0	0	6,500	48,000
37	Bratsigovo	Municipality	EABD																						
38	Panagyurishte	Municipality	EABD	1	31,000	664	1,600	0	2,264	3	9	15		76,000	60,000	0	2,000		138,000		21,000	0	0	38,000	136,000
39	Peshtera	Municipality	EABD	1	25,000	718	525	0	1,243	1	4	9		95,000	25,000	4,000	3,000		127,000		22,000	0	0	50,000	120,000
40	Rakitovo	Municipality	EABD	1	16,200	110	650	0	760	0	0	5		32,000	1,200	0	2,100		35,300		14,000	0	0	27,200	33,200
41	Strelcha	Municipality	EABD	1	6,000	500	60	0	560	1	4	7		46,020	23,610	0	10,070		79,700		3,000	0	0	7,038	69,630
42	Velingrad	Municipality	EABD	1	41,450	3,261	2,733	0	5,994	1	9	31		250,236	2,070	41,031	4,800		298,137		36,000	0	0	96,470	252,306
			Sub-total	**81**	**2,333,686**	**10,910**	**246,585**	**5,685**	**263,179**	**23**	**1,060**	**1,457**	**188,910**	**14,088,816**	**2,475,043**	**221,841**	**393,525**	**2,140,009**	**19,319,234**		**1,478,711**	**8**	**9**	**2,444,152**	**11,752,195**
43	Blagoevgrad	State	WABD	10	219,629	12,145	8,681	348	21,174	2	15	115		947,639	416,836	9,226	35,055	19,244	1,428,000		167,180	0	0	374,001	1,364,475
44	Kyustendil (*)	State & Municp.	WABD	***8***	***103,211***	***1,620***	***1,100***	***553***	***3,273***		***78***	124	***50,815***	***1,159,066***	***276,962***	***27,348***	***31,753***	***184,740***	***1,679,869***	***1,479,600***	***54,052***	***1***	***0***	***153,730***	***58,000***
45	Pernik	State & Municp.	WABD	6	105,867	315	6,771	21,632	28,718	3	37	186		1,005,034	217,607	38,258	1,075	97,026	1,359,000		115,944	1	0	418,045	1,222,641
46	Breznik	Municipality	WABD						0																
47	Dupnitsa	Municipality	WABD	1	51,715	5,960	515	1,986	8,461	0	8	20		113,718	89,644	16,273	9,949		229,584		38,700	1	0	54,075	203,362
48	Kovachevtsi	Municipality	WABD																						
49	Kresna	Municipality	WABD																						
50	Petrich	Municipality	WABD	1	65,000	941	436	0	1,377	0	6	31		310,290	9,970	700	3,300		324,260		30,000	0	0	90,000	320,260
51	Sandanski	Municipality	WABD	1	43,943	1,980	3,161	0	5,141	0	1	33		301,594	37,373	0	3,214		342,181		34,195	0	0	60,445	338,967
			Sub-total	**27**	**589,365**	**22,961**	**20,664**	**24,519**	**68,144**	**5**	**145**	**509**	**50,815**	**3,837,341**	**1,048,392**	**91,805**	**84,346**	**301,010**	**5,362,894**		**440,071**	**3**	**0**	**1,150,296**	**3,507,705**
			Total	**265**	**7,903,001**	**77,477**	**551,100**	**513,066**	**1,141,643**	**41**	**3,507**	**6,087**	**239,725**	**51,946,177**	**10,341,962**	**1,810,300**	**1,565,503**	**4,605,498**	**70,269,440**	**2,199,020**	**5,107,163**	**45**	**81**	**8,987,589**	**54,115,447**

Data Source: 1) "Management and Development Strategy for Water Supply and Sewerage Sector in the Republic of Bulgaria", MoRDPW, 2004

2) WSS Companies with (*) mark and gray color are based on the answer to the questionnaires to the WSS Companies in EABD and WABD areas by the end of August 2007, which have been received by this Study.

DUMMY

Table 2.4.2 Potential Irrigation Area

Source: Irrigation Systems Ltd.

	Irrigation Branch	Total Potential Irrigation Area (ha)	Total Suitable Area (ha)	Total Potential Irrigation Area in EABD(ha)	Total Potential Irrigation Area in WABD(ha)
1	Burgas	19,922	17,841	3,247	0
2	Varna	17,246	14,313	0	0
3	Veliko Tarnovo	42,683	19,707	0	0
4	Vidin	20,737	12,458	0	0
5	Vratsa	47,224	37,427	0	0
6	Gotse Delchev	8,201	5,951	0	8,201
7	Dupnitsa	13,582	11,487	0	13,582
8	Montana	22,750	19,724	0	0
9	Pazardzhik	57,799	26,181	57,799	0
10	Pernik	16,045	13,380	0	15,052
11	Pleven	53,127	34,840	0	0
12	Plovdiv	106,159	72,083	106,159	0
13	Ruse	57,573	47,057	0	0
14	Sandanski	15,790	13,611	0	15,790
15	Sliven	34,232	25,698	34,232	0
16	Sofia	29,555	22,245	3,901	0
17	Stara Zagora	38,516	36,005	38,516	0
18	Targovishte	26,123	20,967	0	0
19	Haskovo	50,491	30,502	50,491	0
20	Shumen	37,398	32,885	0	0
21	Yambol	25,434	23,197	25,434	0
	Total	**740,584**	**537,558**	**319,778**	**52,625**

Table 2.4.3 Average Water Use and Abstraction by Irrigation System in 2001-2005

Source: Irrigation Systems Ltd.

#	Irrigation Systems PLC, Branch name	Toital Potential Irrigation Area (ha)	Areas watered as 1st step in irrigation period (ha)	Quantity of water used (10^3 м^3/ year)	Irrigation Water Delivered (Estimated Abstracted Water) (10^3 м^3/ year)	Percentage of Irrigated area agasint Total Potential Area (%)	Loss Rate (%)	Unit Water Used (m^3/ha/year)
		A	B	C	D	B/A x 100	(D-C)/D x 100	1000 x C/B
1	Burgas	19,922	210	278	850	1.05	67.3	1,325
2	Varna	17,246	649	943	5,404	3.77	82.6	1,452
3	Veliko Tarnovo	42,683	365	518	2,304	0.86	77.5	1,419
4	Vidin	20,737	497	562	1,722	2.40	67.3	1,132
5	Vratsa	47,224	691	1,050	2,014	1.46	47.8	1,520
6	Gotse Delchev	8,201	1,122	1,930	5,396	13.68	64.2	1,721
7	Dupnitsa	13,582	371	603	2,025	2.73	70.2	1,625
8	Montana	22,750	346	413	657	1.52	37.1	1,192
9	Pazardzhik	57,799	4,527	49,401	140,353	7.83	64.8	10,912
10	Pernik	16,045	219	323	1,238	1.37	73.9	1,471
11	Pleven	53,127	1,500	1,994	6,562	2.82	69.6	1,329
12	Plovdiv	106,159	9,177	61,295	152,219	8.64	59.7	6,679
13	Ruse	57,573	407	460	1,009	0.71	54.4	1,130
14	Sandanski	15,790	457	1,228	2,357	2.89	47.9	2,690
15	Sliven	34,232	2,287	4,218	12,289	6.68	65.7	1,845
16	Sofia	29,555	434	516	1,530	1.47	66.3	1,188
17	Stara Zagora	38,516	2,401	15,878	41,457	6.23	61.7	6,613
18	Targovishte	26,123	1,500	2,062	7,408	5.74	72.2	1,374
19	Haskovo	50,491	1,650	3,123	11,699	3.27	73.3	1,893
20	Shumen	37,398	900	1,282	5,524	2.41	76.8	1,424
21	Yambol	25,434	1,218	1,553	9,522	4.79	83.7	1,275
	Total	**740,584**	**30,928**	**149,629**	**413,539**	**4.18**	**63.8**	**4,838**

Table 2.4.4 Average Annual Water Balance at Downstream End (Country Border) of River Basin in 2001- 2005

Source: JICA Study Team

	Struma	Mesta	Dospat	Arda	Biala	Tundzha	Maritsa
Quasi-Natural Flow (NF) (m^3/s)	**71.32**	**30.79**	**6.46**	**61.72**	**4.46**	**39.57**	**116.44**
Potential Flow (PF) (m^3/s)	**69.89**	**27.47**	**2.35**	**53.95**	**4.46**	**29.60**	**126.10**
Disturbed Flow (DF) (m^3/s)	**71.35**	**27.69**	**2.41**	**53.95**	**4.47**	**21.99**	**108.12**
(PF-NF)/NF (%)	*-2.01*	*-10.77*	*-63.65*	*-12.60*	*0.00*	*-25.19*	*8.29*
(DF-NF)/NF (%)	*0.04*	*-10.04*	*-62.68*	*-12.60*	*0.19*	*-44.44*	*-7.14*
(DF-PF)/PF (%)	*2.09*	*0.82*	*2.68*	*-0.00*	*0.19*	*-25.73*	*-14.26*
Accumulated Abstracted Water for Irrigation (IRR) (m^3/s)	**0.152**	**0.169**	**0.000**	**0.020**	**0.000**	**8.563**	**20.698**
Accumulated Abstracted Water for Drinking Water (DWS) (m^3/s)	**1.698**	**0.094**	**0.000**	**0.468**	**0.000**	**0.471**	**0.699**
Accumulated Abstracted Water for Industrial Water (IWS) (m^3/s)	**1.871**	**0.262**	**0.000**	**0.594**	**0.000**	**0.055**	**3.218**
Accumulated Total Water Abstraction (TotalAbst) (m^3/s)	**3.721**	**0.524**	**0.000**	**1.083**	**0.000**	**9.089**	**24.614**
IRR/PF (%)	*0.22*	*0.62*	*0.00*	*0.04*	*0.00*	*28.93*	*16.41*
DWS/PF (%)	*2.43*	*0.34*	*0.00*	*0.87*	*0.00*	*1.59*	*0.55*
IWS/PF (%)	*2.68*	*0.95*	*0.00*	*1.10*	*0.00*	*0.19*	*2.55*
TotalAbst/PF (%)	*5.32*	*1.91*	*0.00*	*2.01*	*0.00*	*30.70*	*19.52*
Accumulated Domestic WasteWater Discharge (DWW) (m3/s)	**1.744**	**0.367**	**0.056**	**0.816**	**0.008**	**1.339**	**5.863**
Accumulated Industrial WasteWater Discharge (IWW) (m^3/s)	**3.440**	**0.384**	**0.007**	**0.265**	**0.000**	**0.134**	**0.774**
Accumulated Total WasteWater Discharge (TotalWW) (m^3/s)	**5.184**	**0.751**	**0.063**	**1.081**	**0.008**	**1.473**	**6.638**
DWW/DF (%)	*2.44*	*1.33*	*2.31*	*1.51*	*0.19*	*6.09*	*5.42*
IWW/DF (%)	*4.82*	*1.39*	*0.30*	*0.49*	*0.00*	*0.61*	*0.72*
TotalWW/DF (%)	*7.27*	*2.71*	*2.61*	*2.00*	*0.19*	*6.70*	*6.14*

- Quasi-Natural Flow (NF)
  - Flow without human disturbances such as abstraction, discharge, transfer
  - Likely natural, however, not exactly natural.
  - In the model, regime change of local reservoir is not taken into account.
- Potential Flow with Significant Reservoir (PF)
  - Flow with influence of significant reservoir, but no abstraction from reservoir
  - Potentially usable water amount after regime change by significant reservoir
- Disturbed Flow (DF)
  - Existing condition
  - It can be expressed as follows.
    - (Potential Flow) – (Total abstracted water) + (Total discharged water)

Table 2.4.5 Results of Interview Survey

No.	Problems and On-going / Near Future Projects	Municipality																										
		Pernik	Dupnitsa	Kyustendil	Blagoevgrad	Sandanski	Razlog	Bansko	Gotse Delchev	Dospat	Asenovgrad	Velingrad	Pazardzhik	Panagyurishte	Plovdiv	Hisarya	Karlovo	Stara Zagora	Galabovo	Dimitrovgrad	Haskovo	Svilengrad	Kazanlak	Sliven	Yambol	Elhovo	Smolyan	Ivaylovgrad
	Basin District	W	W	W	W	W	W	W	W	W	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
A.	**Water Supply Systems (WS)**																											
A-1	**Problems**																											
1)	Insufficient water quantity of water sources	x		x	x			x		x	x																	
2)	Water sources (shallow wells) are affected by surface water pollution														x													
3)	Manganese problem of water sources					x									x					x	P			x	x			
4)	Insufficient quality of tap water									P				x					x						x			
5)	Water regime due to insufficient water sources or quantity	x			x					x	P								x									
6)	Water regime due to high loss and frequent accidents of water pipes													x				x	x									
7)	Old or deteriorated pipes with asbestos cement and steel pipes with high loss and frequent accidents	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
8)	Lack or insufficient purification plant		x		x	x					x													x	x			
9)	Old or insufficient capacity of water purification plant	x		x																	x							
A-2	**On-going Projects**																											
1)	Replacement of water supply pipes			P		P	P	P										x						P			P	
2)	Construction of new WS system					P																						
3)	Construction of purification plant					x																		x				
B.	**Sewerage Systems (SW)**																											
B-1	**Problems**																											
1)	Insufficient coverage of SW	x		x								x	x	x		x	x				x	x					x	
2)	Insufficient capacity of sewer pipes																	x	x									
3)	Old or deteriorated sewer pipes	x					x			x				x									x		x		x	
4)	No municipal WWTP				x	x	x	x	x	x	x	x	x	x			x	x	x	x		x			x	x	x	x
5)	Insufficient capacity or deterioration of the existing WWTP			x												x								x				
6)	Inflow of industrial wastewater which cannot be treated by the WWTP		x												x								x					
7)	Insufficient or no industrial WWTP	x	x		x				x		x			x	x									x		x		x
8)	No treatment plants for animal breeding farms		x						x	x					x								x			x		
B-2	**On-going Projects**																											
1)	Construction or renovation of municipal WWTP			x	x		x						x					x		x	x			x			x	
2)	Replacement of sewer pipes			x	P	P												x		P				x			P	
3)	Construction of new sewer system		P	P		P				P				P			P		P					x				
C.	**Floods**																											
C-1	**Problems and Flood Damage**																											
1)	Floods in recent years	x																								x		
2)	Flood in 2005										x		x	x	x		x			x		x				x		
3)	Flood in 2006									x				x					x	x				x	x	x	x	x
4)	Floods by heavy rainfall										x			x					x	x								
5)	Floods by insufficient river capacity																			x		x						
6)	Floods by dam's problem												x	x					x									
7)	Flood by insufficient drainage						x													x				x				
8)	Damage to houses/buildings	x					x			x				x	x		x		x	x		x				x		
9)	Damage to town/village areas																								x	x		
10)	Damage to agricultural land/crops									x			x	x	x		x			x						x		
11)	Damage to roads / railroad incl. bridge	x								x	x		x	x	x		x		x			x			x		x	
12)	Damage to water supply system												x															x
13)	Damage to sewerage system													x	x		x					x						
14)	Damages to banks or protection dikes		x							x	x		x		x				x						x			
C-2	**Flood Warning and Evacuation**																											
1)	Warning to people was done.									x					x					x								
2)	Information by mass media only													x														
3)	Evacuation of people was done.													x	x				x	x						x		
C-2	**Response and Recovery**																											
1)	Strengthen/repair or temporally dikes														x		x			x		x						
2)	Removal of obstacles to flow													x	x		x		x									
3)	Draining of water																								x			
4)	Repair of road or bridge										x		x	x					x									
5)	Repair of water supply system												x															
6)	Repair of sewerage system																											
7)	Disinfection of flooded area																x											
8)	Discharge release from reservoirs																x											
C-3	**Mitigation Measures**																											
1)	River improvement including bank protection and dike									x					x													
2)	Drainage improvement																											

Notes:
1) Basin District: E - EABD, W - WABD
2) P: partial problem or partial areas have problems or some parts have been improved or repaired.

Source:JICA Study Team

Table 2.6.1 Results of the Supplemental Water Quality Survey by JICA - Physico-chemical Parameters and Bacteria

Point No.	EEA's Code	Latitude (N)	Longitude (E)	Altitude	River Basin	Temperature (°C)	pH	EC (μS/cm)	DO (mg/l)	SS (mg/l)	BOD5 (mg/l)	COD (mg/l)	TN (mg/l)	TP (mg/l)	Coliform (MPN / 100 ml)	Fecal coliform (MPN / 100 ml)
T1	30059243	42°39.400'	24°58.860'	739m	Tundzha	12.7	7.8	20.5	9.8	3.4	2.0	4.8	0.86	0.01	75	0
T2	30059311	42°32.719'	25°33.778'	314m	Tundzha	16.8	8.0	435.0	8.7	4.2	4.8	10.8	3.92	0.28	over 2400	0
T3		42°36.682'	26°11.940'	168m	Tundzha	17.9	8.1	402.0	10.2	2.4	2.4	5.5	1.73	0.02	43	0
T5	30059077	42°35.022'	26°19.360'	151m	Tundzha	18.4	7.8	553.0	7.1	8.0	5.5	12.0	5.56	0.40	over 2400	0
T8	30059152	42°31.372'	26°34.127'	129m	Tundzha	17.1	8.1	670.0	7.2	9.2	5.7	14.1	5.68	0.62	over 2400	0
T10		42°04.464'	26°33.993'	166m	Tundzha	18.0	8.0	507.0	8.8	7.2	1.3	4.8	3.43	0.06	1100	0
T11	30059328	42°03.147'	26°28.432'	81m	Tundzha	18.9	8.5	651.0	11.4	6.0	1.9	7.4	5.39	0.38	over 2400	11
MA2	30060085	42°14.418'	24°06.388'	254m	Maritsa	12.0	8.0	191.0	10.2	31.8	12.2	45.0	3.31	0.12	over 2400	15
MA4	30060156	42°12.600'	24°10.895'	238m	Maritsa	13.0	8.0	258.0	9.1	7.8	4.7	15.2	2.86	0.07	150	0
MA5	30060102	42°18.457'	24°22.293'	258m	Maritsa	19.0	8.0	838.0	11.0	33.6	3.5	10.6	6.12	0.04	120	0
MA8		42°17.877'	24°31.483'	215m	Maritsa	16.0	7.9	635.0	8.4	6.4	15.4	44.0	5.88	0.61	460	0
MA9	30060110	41°57.105'	24°51.542'	349m	Maritsa	11.0	8.7	280.0	9.8	4.2	3.6	13.8	3.12	0.12	over 2400	0
MA10	30060111	42°08.722'	24°52.570'	158m	Maritsa	16.8	7.8	451.0	8.0	10.2	4.2	11.2	4.55	0.05	over 2400	0
MA11		42°41.415'	24°34.215'	493m	Maritsa	14.5	7.6	83.4	9.7	8.8	2.4	6.7	1.35	0.04	over 2400	3
MA12	30060530	42°31.222'	24°50.815'	270m	Maritsa	16.6	7.9	241.0	10.0	10.2	3.7	8.6	3.95	0.05	over 2400	0
MA14		42°09.692'	24°56.862'	146m	Maritsa	18.1	7.9	370.0	8.2	14.2	5.5	18.8	3.26	0.22	over 2400	0
MA15	30060092	42°07.032'	25°12.805'	119m	Maritsa	18.7	8.0	413.0	7.5	10.6	19.6	58.8	3.65	0.18	over 2400	0
MA17		42°17.751'	25°52.333'	115m	Maritsa	16.7	7.7	543.0	1.0	10.6	13.8	30.0	4.79	1.05	over 2400	0
MA18		41°49.390'	25°52.292'	129m	Maritsa	18.0	8.1	616.0	9.1	8.4	13.8	38.4	2.95	0.04	over 2400	0
MA19	30060270	42°02.850'	25°52.225'	86m	Maritsa	18.8	7.9	802.0	5.8	24.4	13.2	38.0	4.52	0.64	over 2400	9
MA22	30060097	41°46.127'	26°11.610'	56m	Maritsa	18.9	8.2	514.0	8.7	24.6	17.5	61.2	4.22	0.25	1100	0
MA23		42°07.905'	26°05.787'	134m	Maritsa	18.1	7.6	671.0	9.6	1.4	<1,0	3.4	2.14	0.05	120	0
A1		41°39.242'	24°58.114'	883m	Arda	13.0	7.6	129.0	9.3	3.8	1.3	3.4	2.89	0.03	over 2400	0
A3	30061281	41°34.176'	25°23.262'	226m	Arda	23.0	8.6	344.0	10.6	19.4	1.5	5.6	1.80	0.04	1100	0
S1		42°30.267'	22°54.047'	637m	Struma	15.3	7.9	895.0	7.9	10.0	5.5	17.2	5.15	0.72	over 2400	0
S3		42°16.973'	22°47.213'	462m	Struma	17.8	8.5	612.0	15.2	3.6	3.6	10.8	1.72	0.14	210	0
S4		42°11.890'	23°03.100'	418m	Struma	22.3	9.3	555.0	12.3	11.6	5.2	15.2	3.61	0.35	240	0
S5		41°52.895'	23°07.138'	295m	Struma	20.0	8.5	441.0	10.8	24.8	4.5	12.8	2.56	0.21	over 2400	0
S6		41°42.652'	23°09.575'	154m	Struma	19.2	8.5	441.0	10.3	26.4	3.8	11.2	2.65	0.22	over 2400	0
S7		41°30.263'	23°15.155'	101m	Struma	19.4	8.5	442.0	11.3	26.2	4.8	13.6	2.64	0.18	over 2400	0
S8	30065649	41°24.377'	23°24.320'	125m	Struma	15.2	8.1	138.0	10.0	84.4	3.7	13.2	1.43	0.05	over 2400	9
S9		41°24.320'	23°20.550'	79m	Struma	21.5	8.4	447.0	10.1	30.2	7.1	20.0	2.30	0.18	over 2400	0
M3		41°53'570'	23°32.500'	769m	Mesta	15.0	8.2	272.0	8.3	20.0	5.1	14.4	3.50	0.16	over 2400	9
M4		41°46.880'	23°40.563'	668m	Mesta	15.5	9.0	235.0	11.2	10.2	4.6	15.0	2.93	0.06	over 2400	0
M6		41°28.177'	24°00.567'	425m	Mesta	16.9	8.2	272.0	9.6	23.8	5.6	14.8	2.85	0.10	over 2400	9
D1	30063626	41°33.518'	24°08.273'	1044m	Dospat	12.6	7.9	137.0	9.5	13.8	6.5	18.0	4.20	0.14	over 2400	0

Note: Gray color indicates relatively high values (such as more than Class III) of BOD5, COD, TP as well as high values of TN, Coliform and Fecal coliform.

Table 2.6.2 Results of the Supplemental Water Quality Survey by JICA - Hydro-biological Survey with The Most Dominant Species

Point No.	Macrophytes: Hydrophytes (submerged and emergent aquatic plants)	Phytobenthos	Benthic Invertebrate Fauna: The most dominant species	Benthic Invertebrate Fauna: Irish Biotic Index (IBI)	Fish fauna: The most dominant species	Fish fauna: Biomass (kg/ha)	Remarks
T1	Fontinalis anthipyretica	Gomphonema	Cryptochironomus gr. defectus	4-5	Salmo trutta fario Linnaeus, 1758	55	
T2	Ceratophyllum demersum	Nitzschia	Gammarus arduus	3-4	Barbus cyclolepis Heckel, 1840	300	
T3	Potamogeton natans	Nitzschia	Gammarus sp.	4	Barbus cyclolepis Heckel, 1840	252	
T5	Potamogeton natans	Navicula	Cryptochironomus gr. defectus	2-3	Barbus cyclolepis Heckel, 1840	145	
T8	Potamogeton natans	Navicula	Tanytarsus gr. gregarius	4	Rutilus rutilus (Linnaeus, 1758)	280	
T10		Rhoicosphenia	Gammarus sp.	4-5	Barbus cyclolepis Heckel, 1840	71	
T11	Potamogeton natans	Navicula	B. lutheri	4	Barbus cyclolepis Heckel, 1840	581	
MA2	Vallisneria spiralis	Reimeria	Tanytarsus gregarius	3	Barbus cyclolepis Heckel, 1840	57	
MA4	Ceratophyllum demersum	Nitzschia amphibia	Chironomus riparius	3	Rhodeus sericeus (Bloch, 1782)	329	
MA5		Nitzschia	Chironomus gr. plumosus	2-3	Leuciscus cephalus (Linnaeus,1758)	145	
MA8	Potamogeton pusillus	Navicula	B. fuscatus	3	Carassius gibelio Bloch, 1782	250	
MA9		Nitzschia	Chironomus gr. plumosus	5	Barbus cyclolepis Heckel, 1840	140	
MA10		Navicula	H. cf. instabilis	2	Rhodeus sericeus (Bloch, 1782)	134	
MA11		Reimeria	B. rhodani	4-5	Phoxinus phoxinus (Linnaeus, 1758)	37	
MA12	Ceratophyllum demersum	Reimeria	B. fuscatus	3-4	Barbus cyclolepis Heckel, 1840	363	
MA14	Ceratophyllum demersum	Nitzschia	Chironomus riparius	3	Carassius gibelio Bloch, 1782	144	
MA15		Nitzschia	Calopteryx splendens	3	Barbus cyclolepis Heckel, 1840	353	
MA17	Cladophora sp.	Navicula	Tubifex tubifex	1-2	Carassius gibelio Bloch, 1782	2	Very bad smell of water
MA18		Nitzschia amphibia	Chironomus riparius	3-4	Rhodeus sericeus (Bloch, 1782)	60	
MA19		Nitzschia	Tanytarsus gregarius	2-3	Carassius gibelio Bloch, 1782	40	Very bad smell of water
MA22	Ceratophyllum demersum	Nitzschia	C. pseudorivulorum	4	Rhodeus sericeus (Bloch, 1782)	346	
MA23		Fragilaria	Limnodrilus sp.	2-3	Leuciscus cephalus (Linnaeus,1758)	142	
A1		Navicula	Chironomus riparius	4	Salmo trutta fario Linnaeus, 1758	24	
A3	Cyperus flavescens	Nitzschia	Chironomus riparius	4	Barbus cyclolepis Heckel, 1840	286	
S1	Potamogetonpectinatus	Rhoicosphenia	G. balcanicus	3-4	Rhodeus sericeus (Bloch, 1782)	185	
S3	Ceratophyllum demersum	Nitzschia	G. balcanicus	4	Barbus cyclolepis Heckel, 1840	340	
S4	Cladophora	Nitzschia amphibia	Cryptochironomus gr. defectus	2-3	Barbus cyclolepis Heckel, 1840	265	
S5	Ceratophyllum demersum	Nitzschia amphibia	C. pseudorivulorum	3-4	Barbus cyclolepis Heckel, 1840	350	
S6		Nitzschia	C. pseudorivulorum	3-4	Barbus cyclolepis Heckel, 1840	231	
S7	Ceratophyllum demersum	Nitzschia	C. pseudorivulorum	4	Barbus cyclolepis Heckel, 1840	169	
S8	Fontinalis anthipyretica	Nitzschia	B. rhodani	3-4	Barbus cyclolepis Heckel, 1840	125	
S9		Nitzschia	Chironomus riparius	3	Alburnoides bipunctatus (Bloch, 1782)	263	
M3	Cladophora sp.	Navicula	B. rhodani	3-4	Barbus cyclolepis Heckel, 1840	65	
M4	Fontinalis anthipyretica	Navicula	B. rhodani	3-4	Barbus cyclolepis Heckel, 1840	215	
M6	Equisetum palustis	Nitzschia	B. fuscatus	4	Barbus cyclolepis Heckel, 1840	230	
D1	Potamogeton pectinatus	Nitzschia	Tipula sp.	3-4	Phoxinus phoxinus (Linnaeus, 1758)	5	

Table 2.6.3 Existing Municipal Wastewater Treatment Plants in Bulgaria (1/2)

No.	Municipal WWTP	Outflow to	Municipality	Maintained by	Const. / Rehabili. Year	Treatment Level	Population		Discharge Volume (m3/day)		Remarks
							Inhabitants	Population Equivalent	Design	Actual	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	**Ogosta River Basin**										
1-1	Vratsa	Dabnika River	Vratsa	W&S Co. Vratsa	1985	Secondary	69,423	104,135	43,200	40,608	
1-2	Varshets	Ogosta River	Varshets	W&S Co. Montana	1971	Secondary	7,271	10,907	3,800	5,180	
2.	**Iskar River Basin**										
2-1	Borovets Resort, Rila Hotel	Iskar River	Samokov	W&S Co. Sofia-Region	1992	Secondary		4,000		1,800	
2-2	Borovets Resort, Yaitzeto	Iskar River	Samokov	W&S Co. Sofia-Region		Secondary		6,000	2,880		Not received permission for operation.
2-3	Samokov ERM	Iskar River	Samokov	W&S Co. Sofia-Region	1973	Secondary	27,664	58,500	17,280	12,960	Up-graded in 2001
2-4	Sofia ERM	Iskar River	Sofia	W&S Co. Sofia	1984	Secondary	1,173,811	2,037,000	500,000	450,000	
2-5	Kremikovtsi	Lesnovska River	Sofia	W&S Co. Sofia	1978	Secondary	16,232	48,696	31,100	10,800	
2-6	Elin Pelin	Lesnovska River	Elin Pelin	W&S Co. Sofia	1962	Primary	3,930	6,000		518	
2-7	Botevgrad	Kalnitsa River	Botevgrad	W&S Co. Botevgrad	1963	Secondary	21,653	32,480	7,128	5,184	
2-8	Pravets	Malki Iskar River	Pravets	W&S Co. Sofia	1993	Secondary	4,773	7,160	4,060	1,240	
3.	**Vit River Basin**										
3-1	Pleven	Vit River	Pleven	W&S Co. Pleven	1988	Secondary	122,149	183,224	141,500	72,591	1991 - sludge treatment
4.	**Osam River Basin**	No									
5.	**Yantra River Basin**										
5-1	Veliko Tarnovo ERM	Yantra River	Veliko Tarnovo	W&S Co. Tsarevets	2002	Secondary	66,998	95,000	45,619	37,500	
5-2	Gabrovo	Yantra River	Gabrovo	W&S Co. Gabrovo	1985	Secondary	67,350	101,025	79,200	40,000	
5-3	Strazhitsa	Strazhishka R	Strazhitsa	W&S Co. Gabrovo	2001	Primary	5,309	10,000	4,500		
5-4	Gorna Oryahovitsa	Yantra River	Gorna Oryahovitsa			Secondary	44,904	102,535	16,178		Will be received permission for operation.
6.	**Rusenski Lom River Basin**										
6-1	Razgrad	Beli Lom	Razgrad	W Co. Dunav	1974	Secondary	39,036	60,000	35,810	18,600	
7.	**Dobrudzhanski Rivers and Dry Valleys**										
7-1	Dobrich	Suha River	Dobritch	W&S Co. Dobritch	1986	Secondary	100,379	150,569	57,000	25,532	
7-2	General Toshevo	Dry Valley	General Toshevo	W&S Co. Dobritch	1996	Secondary	8,159	12,239	899	186	
7-3	Tervel	Dry Valley	Tervel	W&S Co. Dobritch	1993	Primary	7,328	10,992	560	288	
7-4	Kubrat	Dry Valley	Kubrat	W&S Co Meden Kladenets	2004	Primary	9,045	10,939	839		
7-5	Dulovo	Dry Valley	Dulovo	Soch Ltd.- Dulovo		Primary	7,001	8,400	825		Not received permission for operation.
7-6	Isperih	Dry Valley	Isperih	W&S Co Isperih	2001	Primary	9,953	11,944	400		
8.	**Black Sea Coast**										
8-1	Shabla	Shablensko lake	Shabla	W&S Co. Dobritch	1991	Secondary	4,002	6,003	346		
8-2	Rusalka Resort	Black Sea	Kavarna	WS Rusalka	1968	Primary		5,000			
8-3	Kavarna	Black Sea	Kavarna	W&S Co. Dobritch	1999	Secondary	11,588	17,382	16,500		
8-4	Balchik	Black Sea	Baltchik	W&S Co. Dobritch	1970	Primary	12,629	70,000	1,100	1,500	
8-5	Albena Resort	Black Sea	Baltchik	Albena 2000 JSC	1972	Secondary		13,500	22,500	15,000	
8-6	Zlatni Pyastsi Resort	Black Sea	Varna	W&S Co. Varna	1983	Secondary		14,000	14,536	9,130	
8-7	Saint Konstantin Resort / Elena Grand Hotel	Black Sea	Varna	Grand Hotel Varna	1982	Secondary		5,000		1,500	
8-8	Saint Konstantin Resort / Elena Druzhba II	Black Sea	Varna	W&S Co. Varna	1959	Primary		5,000		1,500	
8-9	Varna	Varnensko Lake	Varna	W&S Co. Varna	1985	Secondary	322,204	420,000	156,000	95,000	
8-10	Asparuhovo	Varnensko Lake	Varna	W&S Co. Varna	1966	Primary	23,771	48,406	3,200	3,500	
8-12	Kamchiya	Kamchiya River before Black Sea	Avren	W&S Co. Varna	1983	Secondary		11,000	12,500	4,500	
8-13	Obzor -Biala	Dvoinitsa River before Black sea	Nesebar	W&S Co. Burgas	2004	Secondary	4,086	40,000	10,000		
8-14	Elenite Resort	Black Sea	Nesebar	Elenite Rezort	1986	Secondary		5,000	4,560	584	
8-15	Ravda-Sunny Beach Resort	Black Sea	Nesebar	W&S Co. Burgas	1976	Secondary	10,357	65,000	27,200	35,000	
8-16	Pomorie	Black Sea	Pomorie	W&S Co. Burgas	1998	Secondary	13,710	20,565	16,000		
8-17	Burgas	Vaya Lake	Burgas	W&S Co. Burgas	1986	Secondary	193,316	289,974	120,000	50,630	1989 - sludge treatment
8-18	Meden Rudnuk	Chanel after Mandra dam	Burgas	W&S Co. Burgas	1977	Primary	56,849	90,000	10,886	4,752	1986 -new facilities
8-19	Duni Resort	Gabera Dam	Sozopol	Duni Resort	1986	Secondary		5,000	760	445	
8-20	Kiten - Primorsko	Karaagach River before Black Sea	Tsarevo	W&S Co. Burgas	1980	Secondary	3,323	25,000	13,900	27,650	

Table 2.6.3 Existing Municipal Wastewater Treatment Plants in Bulgaria (2/2)

No.	Municipal WWTP	Outflow to	Municipality	Maintained by	Const. / Rehabili. Year	Treatment Level	Population		Discharge Volume (m3/day)		Remarks
							Inhabitants	Population Equivalent	Design	Actual	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
8-21	Lozenets	Karaagach River	Tsarevo	Sotcialen Otdih	1988	Secondary		5,000	2,000	1,700	
8-22	Tsarevo	Popska River	Tsarevo			Secondary	5,956	25,000	15,750		Not received permission for operation.
9.	**Kamchiya River Basin**										
9-1	Loznitsa	Loznishka River	Loznitsa	W Co. Dunav	1976	Secondary	2,769	4,154	1,100	1,730	
9-2	Smyadovo	Smyadovska River	Smyadovo	Smyadovo Hydropower JSC	1982	Secondary	4,493	6,740	3,124		
9-3	Dalgopol	Golyama Kamchiya River	Dalgopol	W&S Co. Varna	1982	Secondary	5,445	8,168	1,730	470	
9-4	Shumen	Poroina R	Shumen	W&S Co. Shumen	2002	Primary	89,054	151,841	86,400		
9-5	Dolen Chiflik	Cheir Dry River	Dolen Chiflik	Wood Processing Plant "Ticha"	1980	Secondary	6,965	10,448	1,200	800	
10.	**Provadiiska and Devnenska River Basin**										
10-1	Provadia	Provadiiska River	Provadia	W&S Co. Varna	1970	Primary	14,361	21,542	9,150	3,200	
10-2	Devnya	Devnenska River	Devnya	W&S Co. Varna	1975	Secondary	8,799	13,199	15,550	16,000	
10-3	Wetrino	Zlatina R	Wetrino	W&S Co. Varna	1995	Secondary	1,168	1,402	173	118	
10-4	Beloslav	Beloslavsko Lake	Beloslav	W&S Co. Varna	1976	Secondary	8,099	12,149	3,400	1,600	
11.	**Struma River Basin**										
11-1	Pernik	Struma River	Pernik	W&S Co. Pernik	1984	Secondary	86,133	129,200	60,000	49,248	Rehabilitated primary
11-2	Radomir	Struma River	Radomir	Radomir METALS JSC	1986	Secondary	15,835	23,753	9,936	6,912	
11-3	Zemen	Struma River	Zemen	Zemen Municipality	1996	Secondary	2,203	3,305	256	196	
11-4	Kovachevtsi	Svetlianska R	Pernik	Municipality Comp. Kovatchevtsi 96 Ltd.	1982	Primary		3,000	423	253	Not under operation
11-5	Dupnitsa	German River	Dupnitsa	W&S Co. Dupnitsa	1982	Secondary	38,323	57,485	62,208	39,744	
11-6	Kyustendil	Banishitsa River	Kyustendil	W&S Co. Kyustendil	1976	Secondary	50,243	75,365	50,112	27,648	
12.	**Mesta River Basin**										
12-1	Razlog - Pirin Hart JSC	Iztok River	Razlog	Pirinhart JSC Razlog	1974		12,809	20,926	53,200	25,000	Not under operation
13.	**Maritza River Basin**										
13-1	Ihitiman Leyarkomplekt	Mati vir River	Ihtiman	"Chugunoleene" JSCo	1983	Secondary	13,711	20,567	28,512	10,900	
13-2	Pamporovo Resort	Chepelarska River	Smolyan	W&S Co. Smolyan	1985	Secondary		7,000		3,200	
13-3	Plovdiv	Maritza River	Plovdiv	W&S Co. Plovdiv	1984	Secondary	340,638	662,590	213,000	149,000	Renovated in 2000
13-4	Hisaria	Sinia reka dam	Hisar	W&S Co. Plovdiv	1963	Primary	8,544	12,816	9,371		
13-5	Nova Zagora	Blatnitsa River	Nova Zagora	W&S Co. Sliven	1983	Secondary	25,453	38,180	17,546	14,250	
13-6	Radnevo	Sazliyka R	Radnevo	W&S Co. Stara Zagora	1970	Secondary	14,538	21,807	4,200	3,300	Under renovation in 2006
14.	**Tundja River Basin**										
14-1	Sliven	Asenovska River	Sliven	W&S Co. Sliven	1984	Secondary	100,695	106,000	74,304	47,520	Not works properly
14-2	Pavel Banya	Tundja River	Pavel Banya	W&S Co. Stara Zagora	1987	Secondary	3,097	4,646	1,640		
14-3	Kazanlak	Tundja River	Kazanlak	W&S Co. Stara Zagora	2000	Secondary	54,021	80,000	27,000		
15.	**Arda River Basin**	No.									

Total number of WWTPs = 69

Notes: 1) Data Sources: (1) to (4) and (6) to (11) from MoEW, and (5) from the WWTPs.
2) ERM: Enlargement, modernization and rehabilitation
3) Population (item (7)) is based on the census data on Dec. 31, 2001.
4) Population equivalent is based on the WWTP projects or equal percentages to the population (150% or 120 %) depending on the population.

Table 2.6.4 Status of the Construction of New WWTPs

	River valley	Town	Constructed	Designed	Implementation
1	Arda	Smolyan		EU ISPA	
2	Arda	Rudozem		EU PHARE	
3	Arda	Zlatograd		EU PHARE	
4	Black Sea Coast	Obzor-Byala	Constructed (up to secondary treatment)		
5	Black Sea Coast	Baltchik		EU ISPA	
6	Black Sea Coast	Tsarevo	Constructed (up to secondary treatment)		
7	Black Sea Coast	Varna-ERM		EU ISPA	
8	Black Sea Coast	Sozopol			under construction
9	Black Sea Coast	Ahtopol		ok	
10	Black Sea Coast	Primorsko-Kiten-ERM			under construction
11	Black Sea Coast	Asparuhovo-Varna		ISPA	
12	Black Sea Coast	Meden Rudnik - Bourgas		ISPA	tender procedure
13	Dobrudzha Plane Rivers	Isperih			under construction
14	Dobrudzha Plane Rivers	Dulovo			under construction
15	Iskar	Samokov	Constructed (up to secondary treatment)		
16	Iskur	Sofia-ERM		Phare etc.	
17	Kamtchiya	Shoumen	Primary treatment		
18	Kamtchiya	Veliki Preslav			under construction
19	Maritza	Stara Zagora			under construction
20	Maritza	Dimitrovgrad			under construction
21	Maritza	Haskovo			under construction
22	Maritza	Pazardjik			under construction
23	Maritza	Plovdiv-ERM		Cohision fund	
24	Maritza	Panagyurishte			
25	Ogosta	Montana		ISPA	tender procedure
26	Osum	Troyan	Primary treatment		
27	Osum	Lovetch		ISPA	tender procedure
28	Rossenski Lom	Razgrad-ERM			
29	Rossenski Lom	Popovo		ISPA	tender procedure
30	Struma	Blagoevgrad			under construction
31	Tundza	Kazanluk	Constructed (up to secondary treatment)		
32	Tundza	Sliven-ERM		Cohision fund	
33	Yantra	Veliko Turnovo -ERM	Constructed (up to secondary treatment)		
34	Yantra	Strazhitsa	Primary treatment		
35	Yantra	Gorna Oryahovitsa			Completed
36	Yantra	Sevlievo		ISPA	tender procedure

Table 2.8.1 Bulgarian Regulations and the relevant EU Directives

Relevant EU Directives	Bulgarian Regulations
Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances, amended by Directive 91/692/EEC	**Regulation No.1** of 7 July 2000 on the Exploration, Use and Protection of Groundwater (State Gazette No. 57/14.07.2000)
	Regulation No.2 of 16 October 2000 on the Protection of Waters against Pollution Caused by Nitrates from Agricultural Sources (State Gazette No 57/14.07.2000)
	Regulation No.3 of 16 October 2000 on the Terms and Procedures for the Exploration, Design, Approval and Operation of Sanitary Protected Areas Around Water Sources and Installations for Drinking and Domestic Water Supply and Around Water Sources of Mineral Waters Used for Therapeutic, Preventive, Drinking and Hygienic Purposes (State Gazette No. 88/27.10.2000)
Directive 78/695/EEC on the quality of fresh waters needing protection or improvment in order to support fish life, Directive 79/923/EEC on the quality required of shellfish waters, amended by Directive 91/692/EEC standardizing and rationalizing reports on the implementation of certain Directives relating to the environment	**Regulation No.4** of 20 October 2000 on the quality of waters supporting fish and shellfish organisms' life (State Gazette No. 88/27.10.2000)
Directive 91/271/EEC concerning urban waste-water treatment, amended by Directive 98/15/EC with respect to certain requirements established in Annex I	**Regulation No.5** of 8 November 2000 on the Procedure and Manner for Establishment of Networks and on the Operation of the National Water Monitoring System (State Gazette No. 95/21.11.2000, effective 21.11.2000)
	Regulation No.6 of 9 November 2000 on the Limit Values for Admissible Contents of Dangerous and Harmful Substances in the Waste Water Discharged in the Water Bodies Promulgated (State Gazette No. 97/28.11.2000)
	Regulation No.7 on the Terms and Procedure for Discharge of Industrial Waste Waters into Settlement Sewer Systems Promulgated (State Gazette No. 98/1.12.2000)
	Regulation No.8 of 25 January 2001 on the quality of coastal marine waters (State Gazette No. 10/2.02.2001)
Directive 98/83/EC on the quality of water intended for human consumption	**Regulation No.9** of 16 March 2001 on the Quality of Water Intended for Human Consumption (State Gazette No. 30 of 28 May 2001)
Directive 91/271/EEC concerning urban waste-water treatment, amended by Directive 98/15/EC with respect to certain requirements established in Annex I	**Regulation No.10** on Issuing Permits for Waste Water Discharge into Water Bodies and Setting Individual Emission Limit Values for Point Sources of Pollution (State Gazette No.66/27.07.2001, effective 27.07.2001)
Directive 76/160/EEC concerning the quality of bathing water	**Regulation No.11** of 25 February 2002 on the quality of bathing water (State Gazette No.25/08.03.2002)

Table 2.10.1 Main Features of the National Parks in Bulgaria

Main Features	Pirin National Park	Central (Tseritralen) Balkan National Park	Rila National Park
Zoning Categories and each area and ratio for total area ( )	There are the following zoning categories; 1) Reserve Zone: 5,991.8 ha. (14.8%) 2) Zone for limited human impacts: 8,198.5 ha. (20.3%) 3) Zone of conservation of forest ecosystems and recreation: 18,245.0 ha. (45.2%) 4) Zone of sustainable use of open areas and recreation: 6,808.8 ha. (16.9 %) 5) Tourism Zone: 891.8 ha. (2.2 %) 6) Zone for building facilities: 222.1 ha. (0.6 %)	There are the following five zoning categories based on the IUCN zoning categories and separate orders in Bulgaria. 1) Reserve Zone 2) Zone for limited human impacts 3) Tourism Zone 4) Zone for building facilities 5) Zone for multi-purpose The Park contains strictly protected zones of more than 28% of the all the Park area.	There are the following five zoning categories based on the IUCN zoning categories and separate orders in Bulgaria. 1) Reserve Zone 2) Zone for limited human impacts 3) Tourism Zone 4) Zone for building facilities 5) Zone for multi-purpose The Park contains strictly protected zones of about 20% of the all the Park area.
Characteristics of Present Conditions	1)Very variable ecological conditions by combination of southern latitude and high altitude. 2) Exceptional plant diversity and high percentage of the endemic species. 3) Special aesthetic features (landscape) 4) 118 lakes within the Park	1) Unique landscape (skyline of high peak, rock and cliff formation) 2) Diversified geomorphologic element 3) Many types of cultural heritages are also located within the Park 4) Rich in water sources	1) About 95% of these are natural forests averaging 90 years in age. 2) One of the Europe's largest national parks. 3) 10 monuments of culture for national significance in the Park. 4) About 120 lakes within the Park
Specific Values	1) High level of biological diversity (e.g. vascular flora is 1,315 species: about 30% of Bulgaria's flora) 2) The Park is one of the sites for NATURE 2000 3) The Area is significance for habitat conservation as global level. 4) National center for education and scientific activities.	1) One of the global representative areas for bird species. 2) A major potential part of the "Pan-European ecological networks ". 3) A significant faunal group of coniferous forests of Bulgaria 4) A natural complex of six typical vegetation belts of Bulgaria.	1) One of the global representative ecosystems of spruce and fir. 2) Serves as an important part of the ecological corridor concerning the European, Mediterranean and Pre-Asian flora and fauna. 3) The tallest spruce trees in Bulgaria (more than 60 m)
Specific Management Issues	1) Mass deforestation 2) Water pollution 3) Forest Fires 4) Ineffective legislation for the park management	1) Insufficient conservation activities for vulnerable ecosystems 2) Forest fires 3) Insufficient contributions to the local economy by the tourism activities in the Park.	1) Illegal tree cutting 2) Waste problems 3) Insufficient control for many tourists 4) Change of river hydrology by human pressures

Table 2.12.1 Share Rate of Expenditure for Bottled Mineral Water to Expenditure for Water in Grand Total

(Lev/HH per month)

River Basin/ Income Class	Expenditure for Water Supplied by Public Water Supply System	Expenditure for Bottled Mineral Water	Total Amount of Expenditure for Water	Calculated Share Rate of Expenditure for Bottled Mineral Water against Total Amount of Expenditure for Water (%)	Modified Share Rate of Expenditure for Bottled Mineral Water against Total Amount of Expenditure for Water (%)
West Aegean River Basin					
Pensioner(s) Only	19.73	3.15	22.88	13.78%	10.25%
>500	15.19	4.93	20.12	24.48%	28.24%
500 - 750	20.71	9.75	30.46	32.02%	38.76%
750 - 1,000	13.67	14.56	28.23	51.59%	46.23%
1,000 - 1,250	10.00	11.57	21.57	53.63%	52.02%
1,250 - 1,500	0.00	0.00	0.00	0.00%	56.75%
1,500 - 2,000	15.00	3.86	18.86	20.45%	60.76%
2,000 - 3,000	0.00	0.00	0.00	0.00%	64.22%
<3,000	24.00	21.20	45.20	46.91%	67.28%
East Aegean River Basin					
Pensioner(s) Only	11.37	3.43	14.80	23.19%	21.18%
>500	15.21	6.24	21.44	29.09%	30.12%
500 - 750	20.45	9.27	29.71	31.19%	35.35%
750 - 1,000	18.53	11.49	30.02	38.28%	39.07%
1,000 - 1,250	21.67	18.39	40.05	45.91%	41.95%
1,250 - 1,500	0.00	0.00	0.00	0.00%	44.30%
1,500 - 2,000	60.00	14.71	74.71	19.69%	46.29%
2,000 - 3,000	0.00	0.00	0.00	0.00%	48.01%
<3,000	0.00	0.00	0.00	0.00%	49.53%
Both the Basins					
Pensioner(s) Only	14.90	3.28	18.18	18.03%	16.39%
>500	15.20	5.89	21.09	27.91%	28.61%
500 - 750	20.49	9.35	29.84	31.32%	35.76%
750 - 1,000	17.02	12.33	29.35	42.01%	40.83%
1,000 - 1,250	18.75	16.67	35.42	47.07%	44.76%
1,250 - 1,500	0.00	0.00	0.00	0.00%	47.98%
1,500 - 2,000	37.50	9.26	46.76	19.81%	50.69%
2,000 - 3,000	0.00	0.00	0.00	0.00%	53.05%
<3,000	24.00	20.38	44.38	45.92%	55.12%

Source: A result of "Water Utility Survey" made by JICA Study Team, 2006.