社会開発調査部報告書

No. 62

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF WATERS, FORESTS AND ENVIRONMENT PROTECTION
ROMANIA

THE STUDY ON THE MASTER PLAN FOR WATER ENVIRONMENT MANAGEMENT ON THE PRAHOVA RIVER BASIN

FINAL REPORT

VOL. I : SUMMARY REPORT

MARCH 1999

CTI ENGINEERING CO., LTD.
IN ASSOCIATION WITH
CENTRAL CONSULTANT INC.

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The cost estimates in this Study are based on the price levels indicated below and expressed in Romanian Lei according to the following exchange rates:

US$1.00 = Romanian Lei 8800 = Japanese Yen 141.5

As of August 1998

PREFACE

In response to a request from the Government of Romania, the Government of Japan decided to conduct the Study on the Master Plan for Water Environment Management on the Prahova River Basin and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Naohito Murata, CTI Engineering Co., Ltd. and composed of members from CTI Engineering Co., Ltd. and Central Consultant Inc., to Romania, three times between December 1997 and March 1999. In addition, JICA set up an advisory committee headed by Mr.Kenichi Tanaka, development specialist, Institute for International Cooperation, JICA, between December 1997 and March 1999, which examined the study from special and technical points of view.

The Team held discussions with the officials concerned of the Government of Romania 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 Romania for their close cooperation extended to the study.

March, 1999

Kimio Fujita
President
Japan International Cooperation Agency

March, 1999

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Sir:

LETTER OF TRANSMITTAL

We are pleased to submit herewith the Final Report for the Study on the Master Plan for Water Environment Management on the Prahova River Basin, Romania. The report contains the advice and suggestions of authorities concerned of the Government of Japan and the Japan International Cooperation Agency (JICA), as well as the formulation of the water environmental management plan for the Basin. Also included are the comments made by the Ministry of Waters, Forests and Environment Protection, and Self-managed Public Company Romanian Waters during the technical discussion on the Draft Final Report.

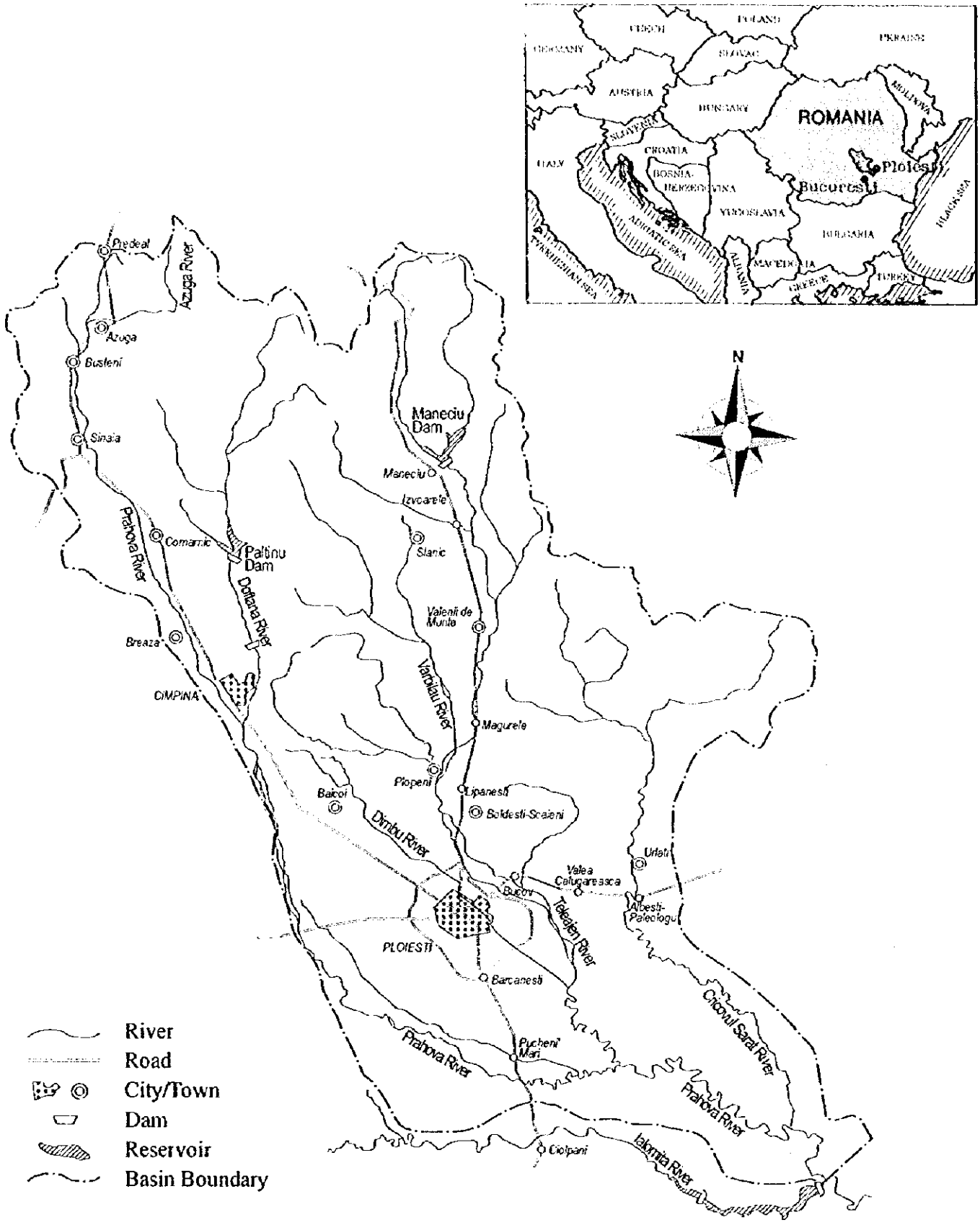
The Final Report presents the Master Plan for Water Environment Management on the Prahova River Basin. In view of the urgency and necessity of the water environmental improvement in the Basin, it is recommended that the Government of Romania should proceed with the feasibility study or project implementation of the priority projects selected in the master plan at the earliest possible time.

Finally, we wish to take this opportunity to express our sincere gratitude to the Government of Japan, particularly, JICA, the Ministry of Foreign Affairs, Environment Agency, Ministry of Construction and other offices concerned. We also wish to express our deep appreciation to the Ministry of Waters, Forests and Environment Protection, Self-managed Public Company Romanian Waters and other authorities concerned of the Government of Romania for their close cooperation and assistance extended to the JICA Study Team during the Study.

Very truly yours,

NAOHITO MURATA
Leader
JICA Study Team

Encl. : a/s



LOCATION MAP

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ABSTRACT

1. INTRODUCTION

The Prahova River Basin covers an area of 3,738 km^2 with a total population of 755,000 in 1997. The River, a secondary tributary of the Donau River, runs through the Prahova County located to the north of Bucharest City, the capital of Romania. It is much contaminated by organic and toxic pollutants, especially oil waste. The promotion of integral water environmental management is essentially necessary to solve the current water pollution problems.

In response to the request of the Government of Romania (GOR), the Japan International Cooperation Agency (JICA) of the Government of Japan conducted the Study on the Master Plan for Water Environment Management on the Prahova River Basin from December 1997 to January 1999. The objectives of the Study are:

(1) to formulate the master plan for water environment management on the Prahova River Basin for the target year 2015; and,

(2) to carry out technology transfer to the counterpart personnel of the GOR in the course of the Study.

2. RIVER WATER USE AND POLLUTION PROBLEMS

2.1 Existing Water Use and Supply

The total existing water use in the Basin is estimated at 212.5 million m^3/year with the following breakdown: domestic use of 80.1 million m^3/year, industrial use of 118.8 million m^3/year and agricultural use of 13.5 million m^3/year.

To meet the above water uses, the surface water of 160.0 million m^3/year and groundwater of 86.0 million m^3/year are extracted. The major water supply systems of the Basin are two (2) reservoirs, four (4) intakes, and the related water transmission mains and canals as shown in Fig. 1. They supply approximately 80% of the total extracted surface water to Ploiesti City and its surrounding areas for mostly drinking and industrial uses.

However, a large quantity of water loss is observed in the transmission mains of Romanian Waters (Voila-Ploiesti and Valenii de Munte-Ploiesti). It is roughly estimated at 32 million m^3/year or 30% of the total extracted water.

2.2 Pollutant Sources and Effluent Loads

The wastewater in the Basin is discharged into the rivers from 15 sewerage systems, 86 industrial sources and non-point sources. The sewerage systems collect the wastewater of 322,000 people or 43% of the total basin population and 82 industrial sources. There are 189 industrial pollutant sources in the Basin of which 86 sources are discharged into the rivers, 82 are discharged into the sewerage systems and the remaining 21 are disposed in the other ways.

The effluent pollution load will much increase according to the economic developments in the future if no water pollution control measures are taken. The total existing and future effluent pollution load to the rivers in the Basin are estimated as follows.

Source	Existing (1997)		Future (2015)	
	Wastewater Discharge (l/s)	Pollution Load BOD (ton/day)	Wastewater Discharge (l/s)	Pollution Load BOD (ton/day)
Sewerage	2,191	8.8	2,781	15.7
Industry	1,794	10.0	3,005	25.1
Non-point		14.0		14.4
Total	3,985	32.8	5,786	55.2

2.3 River Water and Wastewater Quality Standards

The Romanian national standards classify river water quality into three (3) categories by water use as shown below.

Category	Permissible Quality BOD (mg/l)	Scope of Water Use
I	5	Drinking water and other water requiring same quality level
II	7	Industrial water and other water requiring same quality level
III	12	Irrigation water and other water requiring same quality level

The other Romanian national standards stipulate that the quality of all wastewater discharged into river and sewerage system must be below 20 mg/l in BOD and 300 mg/l in BOD respectively.

All the drinking water and most of the industrial water in the Basin are extracted from the upper reaches of the rivers or underground where the water quality has no problem. The existing water uses in the middle and lower reaches affected by water pollution are all irrigation water except some industrial water in the middle reaches of the Prahova Main River. The river water quality of the Basin should maintain Category I in the upper reaches, Category II in the middle reaches of Prahova Main River and Category III in the other river sections.

2.4 Existing and Future River Water Quality

The river water quality in 2015, in case of with no water pollution control project, at the principal stations in the Basin is projected as follows, compared to the existing one. This future river water quality will be improved as also shown below when all the sewerage and industrial wastewater in the Basin are treated up to 20 mg/l in BOD in compliance with the national standards. For location of the principal stations, see Fig. 1.

(BOD mg/l)

Station	Location	Existing	Future W/O Project	Future W/ Project	Water Use	Standard
Cimpina	Exit of Prahova Valley	4.3	6.2	3.6	Recreation*	< 5
Nedelea	Upstream of Nedelea Weir	7.4	12.4	7.4	Industry/Agricul.	< 7
Prahova	Prahova Main Downstream	15.2	29.6	9.9	Agriculture	< 12
Moara	Teleajen Downstream	18.2	30.1	12.4	Agriculture	< 12
Ciorani	Cricovul Sarat Downstream	11.0	10.6	10.3	Agriculture	< 12
Adincata	Upstream of Ialomita Junction	14.2	23.5	10.1	Agriculture	< 12

*: Water contact recreation

3. PROPOSED MATER PLAN

The proposed master plan is targeted for the year 2015. It includes the following structural and non-structural proposals.

3.1 Development of Sewerage System and Industrial Wastewater Treatment

The proposed sewerage development includes the rehabilitation/development of treatment plants and the extension of sewer networks in 15 municipalities, and construction of a new sewerage system including treatment plant in one (1) municipality. The wastewater will be treated up to 20 mg/l in BOD. The sewerage served population of the Basin in 2015 is estimated as follows, comparing with the existing one.

Item	Existing (1977)	Future (2015)
Total Basin Population	755,000	815,000
Sewerage Served Population	322,000	394,000
Service Ratio (%)	42.6	48.3

Among the existing 189 industrial pollutant sources in the Basin, 24 sources do not need to be treated and 86 sources will satisfy the wastewater quality standards with no improvement of the existing treatment plants until 2015. Hence, necessary rehabilitation/extension of the existing treatment plants, and construction of new plants are proposed for the remaining 79 pollutant sources. The wastewater will be treated to meet the wastewater quality standards of not only organic substances but also toxic materials.

The total development cost and annual O&M cost of sewerage system and industrial wastewater treatment are estimated as follows.

Item	Development		Operation &Maintenance	
	Number of System/Source	Cost (US$ million)	Number of System/Source	Annual Cost (US$ million/year)
Sewerage System	16	46.7	16	2.6
Industrial Wastewater Treatment	79	49.8	165	14.5
Total	95	96.5	181	17.1

3.2 Strengthening of Monitoring System and Prevention of Accidental Water Pollution

There are a number of point sources in the Basin. The target river water quality of the Basin cannot be attained until the wastewater of all these point sources is treated to meet the quality standards.

The water quality monitoring system including reconstruction of the existing laboratory, water quality sampling/analysis and inspection of wastewater discharge should be strengthened to attain a satisfactory water management of the Basin.

The Basin has been affected by accidental water pollution 18 times since 1989. The most serious accident was the diesel oil leakage from the old pipeline running along the Doftana River. This kind of accident has been repeated eight (8) times over the entire distance of the pipeline, sometimes affecting the drinking water use in the downstream areas. For the pipeline route, see Fig. 1.

Replacement of this old pipeline for the important section with 15.7 km distance is proposed to prevent this accidental water pollution.

The total development cost and O&M cost of the monitoring system and accidental water pollution are estimated as follows.

Item	Development Cost (US$ million)	Annual O&M Cost (US$ million/year)
Monitoring System	1.82	0.95
Accidental Water Pollution	4.70	-
Total	6.52	0.95

3.3 Beneficial Effects and Financial Evaluation

The proposed water pollution control projects will produce the beneficial effects including (i) recovery of the existing water environment losses, (ii) prevention of the tourism income loss in the Prahova valley, (iii) cost saving of the industrial water use in the middle reaches of the Prahova Main River and (iv) prevention of agricultural production loss in the downstream.

When the marginal efficiency of the sewerage development project is assumed to be the financial internal rate of return (FIRR) = 10%, the sewerage beneficiaries of the Basin can bear one-third of the development cost and all the O&M cost. The remaining development cost must be borne by the central and local governments.

When the marginal efficiency of the industrial wastewater treatment project is assumed to be FIRR=10%, the industrial sector of the Basin should annually appropriate 0.7% of the sales amount for the development, and operation and maintenance of the industrial wastewater treatment.

4. RECOMMENDATIONS

4.1 Strengthening of Monitoring System

The Romanian Waters should perform more intensive monitoring on the quality of the wastewater effluents as well as river water to attain a satisfactory water environmental management of the Basin according to the Water Law.

However, the existing monitoring capacity of the Romanian Waters Prahova Office is insufficient in manpower and laboratory equipment. In addition to the manpower increase, urgent improvement of the laboratory is necessary to meet the increasing analytical works of

water quality.

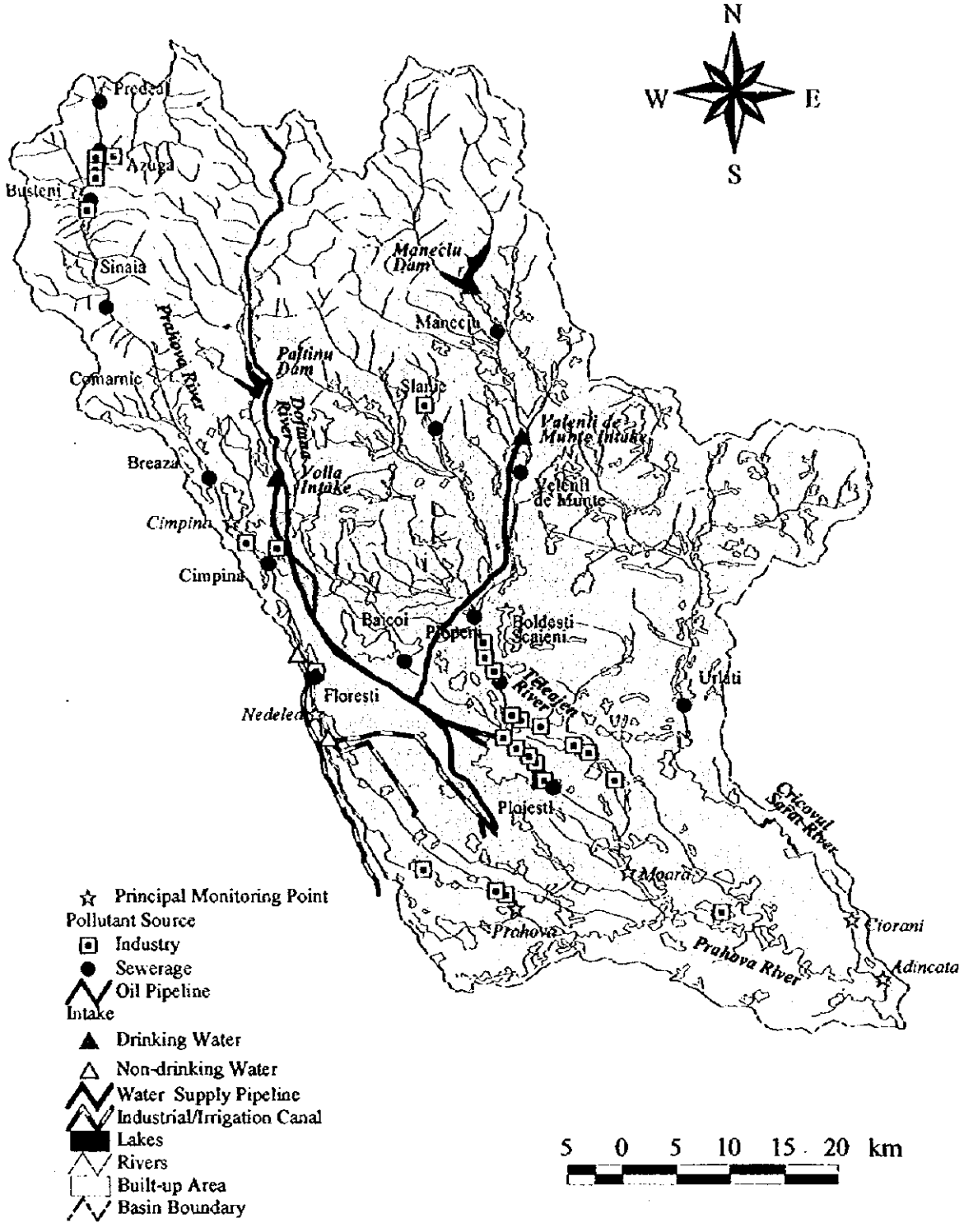
4.2 Project Implementation and Feasibility Study

(1) Feasibility study for the promotion of water management in the Basin should be conducted at the earliest time. The study includes establishment of an advanced laboratory, accidental water pollution control by replacing the oil leaking pipeline along the Doftana River, and prevention of water leakage in the transmission mains of the Romanian Waters.

(2) The Ploiesti City sewerage is the largest sewerage polluter of the Basin. It discharges 73 % of the total sewerage pollution loads or 34 % of the total sewerage and industrial pollution loads of the Basin in BOD. Feasibility study for the development of wastewater treatment has been completed. Early financial arrangements for the detailed design and for construction are necessary.

(3) The petroleum industry is the largest industrial polluter of the Basin. It discharges 73 % of the total industrial pollution loads or 39 % of the total sewerage and industrial pollution loads of the Basin in BOD. Early implementation of the feasibility study for the development of wastewater treatment is necessary.

(4) The sewerage developments of Cimpina City and Prahova valley are also necessary in view of the importance of the water uses in the Prahova Main River. Early implementation of the feasibility study for the developments of wastewater treatment is recommended.



STUDY ON THE MASTER PLAN FOR WATER ENVIRONMENT MANAGEMENT ON THE PRAHOVA RIVER BASIN	Fig.1 Water Supply System and Pollutant Source
JAPAN INTERNATIONAL COOPERATION AGENCY	

THE STUDY ON THE MASTER PLAN FOR WATER ENVIRONMENT MANAGEMENT ON THE PRAHOVA RIVER BASIN

SUMMARY

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ABBREVIATIONS & GLOSSARIES

AGENCIES/ORGANIZATIONS

Apele Romane	:	Self-Managed Public Company Romanian Waters
EBRD	:	European Bank of Recovery Development
EPA	:	Environmental Protection Agency
EU	:	European Union
ICIM	:	Environmental Engineering Research Institute
ICPT	:	Cimpina Institute for Oil Research and Technology
JICA	:	Japan International Cooperation Agency
MNE	:	Ministry of National Education
MWFEP	:	Ministry of Waters, Forests and Environment Protection
NCEF	:	National Commission for Economic Forecasting
NCSD	:	National Center for Sustainable Development
NGO(s)	:	Non-Governmental Organization(s)
PHARE	:	Poland Hungary Assistance for Restructuring Economy
ROMSILVA	:	Romanian Forestry
UNDP	:	United Nations Development Programme

ACRONYMS

Ave.	:	Average
BOD	:	Biochemical Oxygen Demand
C.A.	:	Size of Catchment Area
COD	:	Chemical Oxygen Demand
EIA	:	Environmental Impact Assessment
FIRR	:	Financial Internal Rate of Return
El., EL.	:	Elevation
Fig.	:	Figure
GDP	:	Gross Domestic Product
GIS	:	Geographic Information System
HG	:	Government Decision
L.S.	:	Lump Sum
Max.	:	Maximum
Min.	:	Minimum
NTPA	:	Romanian Standard
O&M	:	Operation and Maintenance
SS	:	Suspended Solids
STAS	:	The national standards of Romania
VAT	:	Value Added Tax
Vol.	:	Volume
W.L.	:	Water Level

MEASUREMENTS/SYMBOLS

Units of Length

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer

Units of Weight

g, gr.	:	gram
kg	:	kilogram
t, ton	:	metric ton

Square Measure

m^2	:	square meter
ha, has	:	hectare, hectares
km^2	:	square kilometer

Units of Capacity / Cubic Measure

l, lt., ltr	:	liter
m^3	:	cubic meter
MCM	:	million cubic meter

Time

s, sec	:	second
min.	:	minute
hr	:	hour
yr	:	year

Compound Units

mm/hr	:	millimeter per hour
m/s	:	meter per second
km/hr	:	kilometer per hour
mg/l	:	milligram per liter
kg/d	:	kilogram per day
m^3/s	:	cubic meter per second
l/s	:	liter per second
m^3/yr	:	cubic meter per year
$m^3/s/km^2$	:	cubic meter per second per square kilometer
l/c/d	:	liter per capita per day

Others

MW	:	megawatt
%	:	percent
°C	:	Celsius
¥	:	Japanese Yen
$, US$	:	US Dollar

SUMMARY

1. INTRODUCTION

The Prahova River, with an aggregate drainage area of 3,738 km^2, runs through the Prahova County located to the north of Bucharest City, the capital of Romania. It is a secondary tributary of the Donau River, entering the Ialomita River. The River is much contaminated by organic and toxic pollutants, especially oil waste. The scarce flow of the River further worsens the river water quality. The promotion of integral water environmental management is essentially necessary to solve the current water pollution problems.

In response to the request of the Government of Romania (GOR), the Japan International Cooperation Agency (JICA) of the Government of Japan conducted the Study on the Master Plan for Water Environment Management on the Prahova River Basin from December 1997 to January 1999. The objectives of the Study are:

(1) to formulate the master plan for water environment management on the Prahova River Basin for the target year 2015; and,

(2) to carry out technology transfer to the counterpart personnel of the GOR in the course of the Study.

2. STUDY AREA

2.1 River System and Hydrology

The River drains an area of 3,738 km^2, covering 79% of the total administrative area of the Prahova County. The main river, originating on the Carpatian mountain range which has a peak elevation of more than 2,000 m, flows down the Prahova valley resort area in the upper reaches, the Ploiesti industrial area in the middle reaches, the agricultural area in the lower reaches and finally enters the Ialomita River at the southern end of the Prahova County.

The Prahova river system is illustrated in Fig. 1. The salient features of the Prahova Main River and the major tributaries are summarized below.

River	Drainage Area (km^2)	River Length(km)	Riverhead El. (m)	Lower-end El (m)
Azuga	89	23	1,600	940
Doftana	414	51	1,400	360
Teleajen	1,656	122	1,760	80
Dimbu	188	39	340	100
Cricovul Sarat	607	94	600	60
Prahova	3,738	193	1,100	60

Three (3) types of climate characterize the Basin: mountain, hill and plain. The average annual precipitation is 1,000-1,400 mm in the mountain area, 500-1,000 mm in the hilly area and 550-600 mm in the plain area. Seasonal variation of precipitation is not striking although a comparatively large rainfall intermittently occurs in the summer season.

The flow rate of the Prahova River at Adincata (lowermost end of the River: 3,682 km^2) is estimated to be 11.67 m^3/s in drought time (95 % flow), 14.31 m^3/s in low flow time (75% flow) and 24.23 m^3/s on average. The specific discharges of drought, low and mean flows are calculated to be 0.32 $m^3/s/100\ km^2$, 0.39 $m^3/s/100\ km^2$ and 0.66 $m^3/s/100\ km^2$, respectively.

2.2 Existing Socio-economy

The Basin extends over 96 municipalities consisting of two (2) cities, 12 towns and 82 communes. The existing basin land consists of current agricultural land (19.4%), fallow land (7.8%), pasture/hay (18.2%), forest (48.9%), orchard (4.5%), urban/built-up area (1.0%) and water body (0.2%).

The population of the Basin was 755,000 in 1997, equivalent to 87% of the total population of the Prahova County.

Industry is the largest economic sector in the County, sharing more than 50% of the GDP. The petrochemical industry produced 52% of the total industrial production in monetary term, followed by machines/equipment industry (11%), chemical/synthetic fibers (7%) and food/beverage (5%) in 1995. It has been suffering from the privatization process in the recent years.

Major agricultural products are wheat, maize, sugar beat, sunflower, potato and grape. The agricultural product has been increasing on the whole since 1991. However, the production in livestock farming has significantly decreased during the same period.

The Basin has plenty of tourism resources in the northern mountain areas, especially in the Prahova valley. In 1996, 295,000 tourists visited the Prahova valley.

2.3 Projection of Socio-economic Growth

The annual growth rate of the future socio-economy in the Basin is projected as follows.

Index	Until 2000 (%)	2001-20015 (%)	2015/Present
Population	0.0	0.5	1.08
GDP	0.0	4.2	1.85
Industrial Production	0.0	3.5	1.68
Livestock Production	0.0	0.0	1.00
Tourist Number to Prahova Valley	0.0	5.0	2.08

The population of the Basin will increase from 755,000 in 1997 to 815,000 in 2015. The industrial production is projected to grow from US$1.5 billion in 1997 to US$2.5 billion in 2015. The number of tourists to the Prahova valley will increase from 295,000 in 1997 to 612,000 in 2015.

3. WATER DEMAND AND SUPPLY BALANCE

3.1 Water Demand

(1) Existing Water Use

The Basin has a total population of 763,000 including piped water served population outside the Basin. Among them, 509,000 people (67%) are served by piped water and the remaining 254,000 people (33%) use shallow well water individually.

Petroleum refinery is the largest industrial water user followed by electricity/gas supply industry. These two (2) industries share 89% on gross water use basis (including reuse) or 64% on real water use basis (excluding reuse) of the total industrial water use. In the Basin, reuse of industrial water has much advanced, reaching 86% on average due to the high reuse rate in the petroleum refinery and electricity/gas supply industries.

The existing agricultural water use includes irrigation, livestock farming and inland fishery.

The total existing water use of the Basin is estimated at 923.1 million m^3/year of which the real water use (excluding industrial water reuse) is estimated to be 212.5 million m^3/year. The real water use by area and by category in the Basin is summarized below.

(unit: million m^3/year)

Area	Domestic Water	Industrial Water	Agricultural Water	Total Water Use
Ploiesti City & Surroundings	50.1	80.0	2.3	132.5
Floresti	0.2	6.0	0.0	6.2
Cimpina City	7.0	7.1	0.0	14.0
Prahova Valley	8.8	9.3	7.5	25.7
Others	14.0	16.4	3.6	34.1
Total	80.1	118.8	13.5	212.5

(2) Future Water Demand

The future water demand for domestic, industrial and agricultural purposes are estimated based on the following assumptions:

(a) Domestic water demand will increase in proportion to the growth of population and per capita water use. The trans-basin piped water supply in the future is included.

(b) The reuse rate of the industrial water in the Basin has already reached 86% on average. Further promotion of the reuse rate is considered not easy. Hence, the industrial water demand is assumed to increase in proportion to the growth of industrial production.

(c) Future irrigation water demand is estimated by assuming retrieval of the irrigation systems that have been out of operation since 1989. No water demand increase is assumed in livestock farming and inland fishery.

The total water demand (including industrial water reuse) of the Basin in 2015 is estimated at 1,531.0 million m^3/year, of which the real water demand (excluding

industrial water reuse) is estimated to be 340.6 million m^3/year. The real water demand by area and by category is summarized below.

(unit: million m^3/year)

Area	Domestic Water	Industrial Water	Agricultural Water	Total Water Use
Ploiesti City & Surroundings	66.7	134.8	4.5	206.0
Floresti	0.7	10.0	0.0	10.7
Cimpina City	9.2	11.9	0.0	21.1
Prahova Valley	13.3	16.8	7.5	37.6
Others	31.8	24.2	4.2	60.2
Outside of Basin	4.5	-	0.4	4.9
Total	126.2	197.8	16.7	340.6

3.2 Water Supply

(1) Existing Water Supply

To meet the existing water use of 212.5 million m^3/year, the surface water of 160.0 million m^3/year and groundwater of 86.0 million m^3/year are extracted.

The major water supply systems of the Basin are shown in Fig. 1. They supply approximately 80% of the total surface water supply volume of 160.0 million m^3/year. The functions of the systems are summarized below.

(a) Water developed by Paltinu and Maneciu reservoirs is extracted from the Voila intake in Doftana River and Valenii de Munte intake in Teleajen River, and transported by the two (2) routes of transmission mains to Movila Vulpii station (located in the northern suburbs of Ploiesti City) for distribution to Ploiesti City and two (2) large factories; S.C. Petrobrazi S.A. and S.C. Petrotel Ploiesti. On the mid-way to the Movila Vulpii station, the water is also distributed to the local municipalities.

(b) Water is extracted from Prahova Main River at Nedelea intake and conveyed to S. C. Petro Brazi S.A. and F.E. Ploiesti for industrial use, and to the farmlands on the left bank of the Prahova Main River for irrigation purpose.

(c) Water is withdrawn from Prahova Main River at Calinesti intake for irrigation of the farmlands on the right banks of the Prahova Main River.

A large quantity of water loss is observed in the transmission mains of Romanian Waters (Voila-Ploiesti and Valenii de Munte-Ploiesti). It is roughly estimated at 32 million m^3/year or 30% of the total extracted water. On the other hand, the existing water loss rate in the municipalities is not so large, averaging 15%.

(2) Future Water Supply

The balance of the total water demand in 1997 and 2015 is estimated to be 128.2 million m^3/year. This balance will be met by the additional extractions of surface water (111.4 million m^3/year) and groundwater (16.8 million m^3/year). The allocation of surface and ground water is based on the following assumptions:

(a) In the areas where surface water is supplied at present, additional water demand is met by only surface water development. No groundwater development is considered.

(b) In the areas where only groundwater is supplied at present, additional water demand is met by only groundwater development.

The additional surface water demand of 111.4 million m^3/year will be met by the following developments:

Developments	Volume (million m^3/year)
Extraction from Voila and Valenii de Munte Intakes	47.0
Extraction from Other Intakes	32.0
Water Leakage Prevention of Transmission Mains	32.4
Total	111.4

On the other hand, the water supply development potentials of Paltinu Dam (active storage capacity: 53 million m^3) and Maneciu Dam (active storage capacity: 50 million m^3) are large enough to meet the additional water demands at the Voila and Valenii de Munte intakes for the downstream areas although they cannot meet the water demand in the Prahova valley due to the large head difference.

4. POLLUTANT SOURCES AND LOAD

4.1 Sewerage

Among 96 municipalities in the Basin, 15 municipalities are provided with sewerage system. The municipalities served by sewerage system are listed below. Location of the sewerage systems is shown in Fig. 1.

Municipality	Name of Municipality
City	Cimpina, Ploiesti
Town	Predeal, Azuga, Busteni, Sinaia, Breaza, Baicoi, Plopeni, Slanic, Valenii de Munte, Boldesti Scaieni, Urlati
Commune	Floresti, Maneciu

Twelve (12) sewerage systems except Ploiesti, Azuga and Busteni are provided with activated sludge treatment plants. The wastewater of Ploiesti is treated only by sedimentation tank. Azuga and Busteni have no treatment plant. Operation of the treatment plants is insufficient due to the financial limitation and damage of the equipment.

The existing served population of the sewerage systems is estimated to be 322,000 or 43% of the total population of 755,000 in the Basin. The remaining 433,000 or 57% is provided with septic tank or latrine.

The sewerage system receives domestic wastewater (including wastewater of offices, shops/restaurants, public facilities, etc.), industrial wastewater and groundwater infiltration. The existing total wastewater discharge of the sewerage systems in the Basin is estimated at 2,191 l/s with a total effluent BOD load of 8,808 kg/day.

The domestic wastewater influent discharge to the sewerage system is assumed to increase in proportion to the growth of served population and per capita wastewater. The industrial wastewater influent discharge is also assumed to increase in proportion to the growth of industrial production. On the other hand, treatment efficiency of the existing plant will lower according to the increase of influent sewerage discharge.

The total wastewater discharge of the sewerage systems in the Basin in 2015 is estimated at 2,781 l/s with a total effluent BOD load of 15,726 kg/day in case of without project.

The existing and future (without project) BOD load effluent of the sewerage systems in the Basin are as shown below.

Area	Existing		Future (without project)		Ratio
	BOD Load (kg/d)	(%)	BOD Load (kg/d)	(%)	
Ploiesti City	6,466	73.4	11,603	73.8	1.79
Cimpina City	521	5.9	1,102	7.0	2.11
Prahova Valley	1,108	12.6	1,836	11.7	1.66
Other Area	714	8.1	1,185	7.5	1.66
Total	8,808	100.0	15,726	100.0	1.79

4.2 Industrial Wastewater

There are 189 pollutant sources of 164 industrial establishments in the Basin. The pollutant sources include not only factories but also livestock farms and other industrial activities. Among the 189 sources, 86 discharge into the rivers, 82 discharge into the domestic sewerage, 7 discharge into the industrial sewerage (and finally, into river or domestic sewerage through the treatment systems of the other industrial establishments; hence, duplicated), and 14 dispose underground. Location of the major pollutant sources discharging into the river is shown in Fig. 1.

Among the 86 pollutant sources discharging into the rivers, 73 are each provided with a treatment plant and the remaining 13 have no treatment system. Most of the pollutant sources discharging into the sewerage system are each provided with a pre-treatment system. Operation of the existing treatment plants and pre-treatment plants is unsatisfactory due to the financial limitation and damage of the equipment.

The existing total industrial wastewater discharged into rivers in the Basin is estimated at 1,794 l/s with total effluent loads of 10,063 kg/day in BOD and 2,746 kg/day in Oil. Most of the total industrial pollution load is discharged from three (3) major oil refineries: S.C. Petrobrazi S.A., S.C. Petrotel S.A. Ploiesti and S.C. Astra Romana S.A.. They share approximately 70% in BOD and about 80% in Oil of the total effluent pollution load to rivers in the Basin.

The industrial wastewater discharge is assumed to increase in proportion to the growth of industrial production. On the other hand, treatment efficiency of the existing plants will lower according to the increase of the wastewater discharge.

The total industrial wastewater discharged into rivers in the Basin in 2015 is estimated at 3,005 l/s with a total effluent BOD load of 25,183 kg/day in case of without project.

The existing and future (without project) BOD load effluent of the industrial establishments in the Basin are as shown below.

Area	Existing		Future		Ratio
	BOD Load (kg/d)	(%)	BOD Load (kg/d)	(%)	
Ploiesti City & Surroundings	8,908	88.5	22,206	88.2	2.49
Cimpina City	537	5.3	1,442	5.7	2.69
Prahova Valley	268	2.7	747	3.0	2.79
Other Area	349	3.5	788	3.1	2.26
Total	10,062	100.0	25,183	100.0	2.50

4.3 Total Existing and Future Effluent Pollution Load in the Basin

There are non-point pollutant sources in addition to the sewerage and industrial wastewater. The major non-point sources in the Basin are household wastewater outside sewerage service area, livestock wastewater of individual small farms and wastewater from lands.

The total effluent pollution load to rivers will increase in BOD from 32,843 kg/l in 1997 to 55,229 kg/l in 2015 in case of without project. The existing and future BOD load effluents to rivers by pollutant source are shown below.

(Existing)

(unit: kg/day)

Source	Prahova Main	Dimbu	Teleajen	Cricovul Sarat	Total	(%)
Point (sewerage)	1,700	6,649	408	50	8,806	26.8
Point (industry)*	6,212	2,056	1,763	1	10,032	30.6
Sub-total	7,912	8,705	2,170	51	18,838	57.4
Non-point (household)	1,565	1,002	1,409	502	4,477	13.6
Non-point (livestock)	2,496	338	1,752	761	5,347	16.3
Non-point (land)	1,864	676	1,144	498	4,180	12.7
Subtotal	5,925	2,015	4,304	1,760	14,005	42.6
Total	13,837	10,720	6,474	1,811	32,843	100.0

*: including factories, major livestock farms and other industrial activities

(Future without Project)

(unit: kg/day)

Source	Prahova Main	Dimbu	Teleajen	Cricovul Sarat	Total	(%)
Point (sewerage)	3,045	11,900	695	86	15,723	28.5
Point (industry)*	15,278	5,517	4,345	3	25,143	45.5
Sub-total	18,323	17,417	5,037	89	40,866	74.0
Non-point (household)	1,690	1,082	1,522	542	4,835	8.8
Non-point (livestock)	2,496	338	1,752	761	5,347	9.7
Non-point (land)	1,864	676	1,144	498	4,180	7.5
Sub-total	6,050	2,096	4,418	1,801	14,362	26.0
Total	24,373	19,512	9,454	1,890	55,229	100.0

*: including factories, major livestock farms and other industrial activities

5. EXISTING AND FUTURE RIVER WATER QUALITY

5.1 River Water Quality Standards

The Romanian national standards classify river water quality into three (3) categories by water use. Applicable water uses by category in the standards are summarized below.

Category	Permissible Quality (mg/l)			Scope of Water Use
	BOD	Oil	CN	
I	5	0.1	0.01	• centralized potable water supply • central water supply for food industry requiring potable water quality • others
II	7	0.1	0.01	• water supply for industrial technological processes • others
III	12	0.1	0.01	• water supply for irrigation • water supply for cooling system • others

All the drinking water and most of the industrial water in the Basin are extracted from the upper reaches of the River or underground where the water quality has no problem. The existing water uses in the middle and lower reaches affected by water pollution are all irrigation water except some industrial water in the middle reaches of the Prahova Main River. The river water quality of the Basin should maintain Category I in the upper reaches, Category II in the middle reaches of Prahova Main River and Category III in the other river sections.

5.2 Wastewater Quality Standards

The wastewater quality standards in Romania were published in November 1997 by the Government Decision (NTPA-001 and NTPA-002). The quality of all wastewater discharged into the river and sewerage system must be below 20 mg/l in BOD and 300 mg/l in BOD, respectively.

5.3 Standard River Flow Rate for Water Quality Assessment

River flow rate fluctuates throughout the year and river water quality also always varies depending on river flow rate. Hence, it is necessary to determine a proper standard river flow rate for the assessment of river water quality. If the standard river flow rate is determined too low, dilution effects of the river water is under-estimated. As a result, the water pollution control cost required to attain the target river water quality will be over-estimated, although the river water quality with a high reliability can be assured.

The standard river flow rate of the Prahova River is determined in due consideration of the target river water quality, assurance rate of the target river water quality, improved river water quality by wastewater treatment and required wastewater treatment cost.

On the other hand, the Government Decision (NTPA-001) stipulates that the standard flow rate is the yearly minimum monthly mean discharge with a 95% probability. However, this standard flow rate is so small that it cannot be practically applied for the Basin. The standard flow rates at the principal stations in the Basin are shown below. The river water quality in 2015 assessed under these standard flow rates is far from the target quality even if all the sewerage and industrial wastewater are treated up to 20 mg/l in BOD as also shown below.

Station	Location	Standard Flow Rate (m^3/s)	Future Quality BOD (mg/l)	Target Quality BOD (mg/l)
Prahova	Prahova Main Downstream	3.32	21	12
Moara	Teleajen Downstream	2.79	34	12
Ciorani	Cricovul Sarat Downstream	0.11	73	12
Adincata	Upstream of Ialomita Junction	7.38	25	12

All the sewerage and industrial wastewater must be treated up to 5 mg/l in BOD by applying a high-level treatment process in order to attain the target river water quality in 2015. The total required development cost and annual O&M costs are estimated as follows, comparing with the normal costs required to treat up to 20 mg/l in BOD.

Case	Development Cost (US$ million)	Annual O&M Cost (US$ million/year)
Treatment up to 5 mg/l	134.7	43.5
Treatment up to 20 mg/l	96.4	17.1

In this Study, more practical standard river flow rate is proposed as described below.

Three (3) alternative standard river flow rates; i.e., mean daily flow rates of 50% (183 days flow rate), 75% (274 days flow rate) and 95% (347 days flow rate) are assumed. The future river water quality in 2015 at the principal stations under the above three (3) standard river flow rates will be controlled as shown below by treating all the sewerage and industrial wastewater up to 20 mg/l in BOD.

(unit : BOD mg/l)

Station	Location	50 % Flow (183 days flow)	75 % Flow (274 days flow)	95 % Flow (347 days flow)	Target Quality
Prahova	Prahova Main Downstream	10	13	14	12
Moara	Teleajen Downstream	12	16	16	12
Ciorani	Cricovul Sarat Downstream	10	13	17	12
Adincata	Upstream of Ialonita Junction	10	12	14	12

In this Study, a mean daily flow rate of 50% is proposed as the standard flow rate, considering that:

(1) The water use in the middle and lower reaches of the Basin is mostly for agricultural purpose and a higher assurance of target river water quality is considered unnecessary.

(2) It is unpractical to enforce a wastewater treatment higher than the normal level (BOD: 20 mg/l) for the municipalities and industrial establishments under the existing water use situation of the Basin.

5.4 Existing and Future River Water Quality

The future river water quality in 2015, in cases of both with and without projects, are estimated based on the projected pollution load effluents from the point and non-point sources. The future river water quality at the principal stations in the Basin is summarized as follows, compared to the existing one. In the following table, the future river water quality with project is the one when all the sewerage and industrial wastewater are treated up to 20 mg/l in BOD in compliance with the national wastewater quality standards.

(BOD mg/l)

Station	Location	Existing	Future W/O Project	Future W/ Project	Water Use	Standard
Cimpina	Exit of Prahova Valley	4.3	6.2	3.6	Recreation*	< 5
Nedelea	Upstream of Nedelea Weir	7.4	12.4	7.4	Industry/Agricul.	< 7
Prahova	Prahova Main Downstream	15.2	29.6	9.9	Agriculture	< 12
Moara	Teleajen Downstream	18.2	30.1	12.4	Agriculture	< 12
Ciorani	Cricovul Sarat Downstream	11.0	10.6	10.3	Agriculture	< 12
Adincata	Upstream of Ialomita Junction	14.2	23.5	10.1	Agriculture	< 12

*: Water contact recreation

6. PROPOSED MASTER PLAN

The proposed master plan is targeted for the year 2015. It includes the following structural and non-structural proposals.

6.1 Development of Sewerage System

The proposed sewerage development includes rehabilitation/extension of the existing treatment plants and extension of the existing sewer networks in 15 municipalities, and construction of a new sewerage system including treatment plant in Comarnic Town. The activated sludge treatment process is applied for all the extension of the existing plants and construction of a new plant. The wastewater will be treated up to 20 mg/l in BOD.

The sewerage served population of the Basin in 2015 is estimated as follows, comparing with the existing one.

Item	Existing (1977)	Future (2015)
Total Basin Population	755,000	815,000
Sewerage Served Population	322,000	394,000
Service Ratio (%)	42.6	48.3

The total development cost is estimated to be US$46.66 million and the total annual O&M cost at the time of full operation in 2015 is estimated to be US$2,639 thousand with the following breakdown.

Item	Cost (US$ 1,000)
Development Cost	
Treatment Plant Rehabilitation	6,024
Treatment Plant Construction	32,512
Sewer Construction	8,124
Total	46,660
Annual O&M Cost	
Treatment Plant	2,375
Sewer	264
Total	2,639

Note : 1) Costs are estimated at the prices in August 1998.
2) Exchange rate: 1 US$ = 141.5 Yen = 8,800 Lei

6.2 Development of Industrial Wastewater Treatment

Among the existing 189 pollutant sources, 24 sources do not need to be treated. Then, the objective sources for wastewater treatment are 165 of which 86 sources will satisfy the wastewater quality standards with no improvement measures until 2015. The wastewater of the remaining 79 sources should be improved. They are grouped into 23 industrial categories as follows:

Activity	No.	Activity	No.	Activity	No.
Basic Metals	1	Hotel/Restaurant	4	Petroleum Refinery	8
Chemical/Chemical Products	1	Land transport	1	Post/Telecommunication	1
Construction Material	7	Livestock Farm	5	Public Administration	1
Education	3	Machinery/Equipment	8	Rubber/Plastic Products	1
Electrical Machinery	2	Metal Products Fabricated	2	Tanning Leather	1
Electricity/Gas Supply	1	Mining/Quarrying	1	Textiles	1
Food/Beverage	13	Non-metallic Mineral	3	Wood	5
Health/Social Work	7	Paper/Paper Products	2	Total	79

Necessary rehabilitation and extension of the existing treatment plants, and construction of new plants are proposed for the above 79 pollutant sources. The optimum wastewater treatment process among activated sludge, coagulation settling and sand filter methods is applied for each pollutant source. The wastewater will be treated to meet the wastewater quality standards of not only organic substances but also toxic materials.

The total development cost for 79 sources is estimated to be US$49.8 million with the following breakdown. The total annual O&M cost for 165 sources at the time of full operation in 2015 is estimated to be US$14,463 thousand.

Item	Cost (US$ 1,000)
Development Cost	
Treatment Plant Rehabilitation	6,084
Treatment Plant Construction	43,677
Total	49,761
Annual O&M Cost	
Treatment Plant	14,463

Note : 1) Costs are estimated at the prices in August 1998.
2) Exchange rate: 1 US$ = 141.5 Yen = 8,800 Lei

6.3 Strengthening of Monitoring System and Prevention of Accidental Water Pollution

(1) Strengthening of Monitoring System

There are approximately 180 major point sources in the Basin of which about 100 sources are discharged into the river and the others are disposed to the sewerage system. The target river water quality of the Basin cannot be attained until the wastewater of all these point sources is treated to meet the quality standards.

The water quality monitoring system should be strengthened to attain a satisfactory water management of the Basin. Monitoring location, frequency and quality parameter in the river and pollutant sources should be increased. Further, the existing laboratory in Romanian Waters Prahova Office should be reconstructed to meet the increasing requirements of laboratory analysis.

The reconstruction cost of the laboratory is estimated at US$1,823 thousand. The annual water quality monitoring cost including sampling and laboratory analysis is estimated at US$95 thousand/year.

(2) Prevention of Accidental Water Pollution

The Basin has been affected by accidental water pollution 18 times since 1989. The most serious accident was the diesel oil leakage from the old pipeline of Petrotrans Ploiesti company running along the Doftana River. This kind of accident has been repeated eight (8) times over the entire distance of the pipeline, affecting the river water quality of the Doftana River. In 1995 and 1996, the leaked diesel oil entered the water purification plant from Voila intake, causing the suspension of drinking water supply to a wide area in the downstream. The number of the affected people reached 232,000.

The frequency of the oil leakage will further increase as the pipeline becomes older. Once the oil is leaked in the near upstream of the Voila intake, it is difficult to prevent intrusion of the oil into the water purification plant. This old pipeline should be replaced for a 15.7 km distance upstream of Voila intake.

The total replacement cost of the pipeline is estimated at US$4,701 thousand.

6.4 Legal and Institutional Recommendations

(1) The standard flow rate for the assessment of river water quality (a yearly minimum monthly mean discharge with a probability of 95%) designated in NTPA-001 is so small that it cannot be practically applied. It should be replaced by the flow rate with a lower probability.

(2) The water quality management of the Basin including water quality sampling, laboratory analysis, licensing procedures, inspection on wastewater discharge, wastewater quality assessment, penalty assessment and accident preparedness should be more active to cope with the existing and future increasing water pollution problems. For this purpose, inspection personnel and laboratory analysts in Romanian Waters Prahova Office should be increased.

(3) The owner of a wastewater treatment plant shall be obligated to monitor the functioning of the plant through laboratory analysis by the Water Law. However, the municipalities in the Basin will not be able to afford establishing the laboratory with a required technical level due to financial and manpower limitation.

It is advisable to avoid the unnecessary overlapping of investment. The proposed new laboratory shall serve not only Romanian Waters but also the municipalities in the Basin under joint cooperation. If required, the laboratory analysis for the industrial units may be entrusted on payment basis to the new laboratory.

(4) The performance of the existing Water Fund is poor, because of the limitation of constituting sources of permit/license fees and penalties. Sources other than those stipulated in the Water Law should be added to expand the Fund. The constituting sources shall include credits and government subsidy for the specific technological development as listed below.

(a) Study and development of advanced monitoring equipment such as oil detector and toxic substance detector;

(b) Study and development of technologies for energy-saving wastewater treatment and wastewater recycle use; if required, installation of model plants or model projects.

6.5 Promotion of Public Participation in Water Environment Management

The existing point sources in the Basin are too many for the Romanian Waters Prahova Office to monitor. Also, non-point sources are generally out of reach of the Romanian Waters' regular monitoring activities. Furthermore, riverside residents can notice water pollution accidents earlier than anyone else.

Therefore, the systemized public participation in water environment management can supplement scarce governmental resources on monitoring, inspection and enforcement, which will eventually save governmental costs. In fact, the results of the questionnaire survey show that people in the Basin are willing to act more for environmental improvement.

The communication between the public and the Romanian Waters should be extended and strengthened with cooperation of the local environmental NGOs. There are 13 environmental NGOs in the Basin. They will be able to contribute more to the public awareness of water environment management. Moreover, there are legal bases of NGO participation as an information provider or authorized representative in the Water Law.

The following methods of communication are recommended in order to reach the general public: (i) distribution of water reports and educational kits, (ii) opening of water exhibitions, workshop and training, (iii) advertisement and campaign for water environment improvement, etc.

7. PHASING AND EVALUATION OF MASTER PLAN

7.1 Phased Program

(1) General

The proposed developments of the sewerage system, industrial wastewater treatment, water quality monitoring system and accidental water pollution control will be implemented in three (3) phases: first phase (2001-2005), second phase (2006-2010) and third phase (2011-2015) based on the following policies.

The sewerage and industrial wastewater control of the Basin will be leveled up step by step, reaching the target in 2015. All the wastewater will be treated up to 20 mg/l in BOD by 2015. Oil and other pollutants will be treated along with BOD to meet their standards by 2015.

The implementation program is prepared also in due consideration of the financial capability of the local governments and industrial establishments in the Basin.

(2) Sewerage System

(a) The rehabilitation of the existing treatment plants is urgent and will be completed by 2005.

(b) The Ploiesti City sewerage is the largest sewerage polluter of the Basin. It discharges 73 % of the total sewerage pollution loads or 34 % of the total sewerage and industrial pollution loads of the Basin in BOD. The development of Ploiesti treatment plant is given the highest priority. It will start in 2001.

(c) The extension of Cimpina treatment plant and construction of the new treatment plants in Azuga, Busteni and Comarnic are given the second highest priority, in view of the importance of the water uses in the Prahova Main River. They will start in 2006.

(d) The extension of the plants in the other municipalities will be done during the third phase.

(e) The extension of the sewer networks will be implemented step by step during the second and third phases.

(3) Industrial Wastewater Treatment

(a) The petroleum industry is the largest industrial polluter of the Basin. It discharges 73 % of the total industrial pollution loads or 39 % of the total sewerage and industrial pollution loads of the Basin in BOD. On the other hand, the economical efficiency of the development of its wastewater treatment is very high, compared to those of the other industries. Hence, the wastewater treatment of the petroleum industry is given the top priority. It will start in 2001.

(b) Such industries discharging wastewater with a high concentration as livestock farms are given the second priority. The development of the treatment plants will start in 2006.

(c) The wastewater treatment development of all the other industries will be performed during the third phase.

(4) Monitoring System and Accidental Water Pollution

(a) The reconstruction of the exiting laboratory in Romanian Waters Prahova Office will be performed during the first phase in view of the urgent necessity of strengthening the existing monitoring system.

(b) The replacement of the pipeline of Petrotrans Oil Company running along the Doftana River will be executed during the first phase, in view of the fact that the drinking water of the Basin is exposed to serious danger of oil contamination.

(5) Disbursement Schedule of Investment Cost

The disbursement schedule of the development costs for the above projects are summarized below. The required O&M costs are also estimated as shown in the same table.

Project	Phase I (2001-2005)	Phase II (2006-2010)	Phase III (2011-2015)	Total	Annual O&M* (2016 -)
Development Cost (US$ 1,000)					
Sewerage System	12,714	15,910	18,036	46,661	
Industrial wastewater treatment	9,616	13,738	26,407	49,761	
Monitoring / Accidental Pollution	6,524	-	-	6,524	
Total	28,854	29,648	44,443	102,946	
O & M Cost (US$1,000)					
Sewerage System	5,892	7,661	9,742	23,295	2,641
Industrial wastewater treatment	48,793	56,514	68,445	173,752	14,463
Monitoring / Accidental Pollution	475	475	475	1,425	95
Total	55,160	64,650	78,662	198,472	17,199

*: US$1,000/year

7.2 Improvement of River Water Quality

The above phased program of the sewerage and industrial wastewater developments will gradually improve the water quality of the Prahova River, attaining the target quality in 2015. The river water quality (BOD) at the principal stations of the Basin in 2005, 2010 and 2015 are estimated as follows:

(unit: BOD mg/l)

Station Name	Station Location	Existing	2005	2010	2015
Cimpina	Exit of Prahova Valley	4.3	4.8	4.2	3.6
Nedelea	Upstream of Nedelea Weir	7.4	8.3	7.9	7.4
Prahova	Prahova Main Downstream	15.2	11.3	10.2	9.9
Moara	Teleajen Downstream	18.2	13.8	13.4	12.4
Ciorani	Cricovul Sarat Downstream	11.0	10.6	10.7	10.3
Adincata	Upstream of Ialomita Junction	14.2	11.2	10.7	10.1

7.3 Economic Benefits

Beneficial effects of a water pollution control project are mostly intangible. However, the economic benefits of the proposed master plan are estimated in monetary term to the possible extent as described below.

(1) Recovery of Water Environmental Losses

Many environmental losses are generated by the river water pollution at present. They include outbreak of waterborne diseases, decrease or extinct of aquatic lives, loss of recreational value, emission of foul smell, reduction of water and land use potential, etc. These losses were estimated as a whole through an interview survey. The proposed project will recover these losses.

(2) Prevention of Tourism Income Loss

The value of tourism resources in the Prahova valley will decrease according to aggravation of the river water quality, resulting in the decrease of tourism income in the future. The proposed project will prevent this income loss in the tourism industry.

(3) Cost Saving of Industrial Water Use

Some industrial water is extracted from the Nedelea Intake in the middle reaches of the Prahova Main River. The water source must be shifted to the Doftana River or Teleajen River due to the water pollution in the future, resulting in increase of the water supply cost. The proposed project will save the costs of this industrial water use.

(4) Prevention of Agricultural Production Loss

The water pollution of the Prahova River will cause damages on the agricultural production in the downstream in the future. The proposed project will prevent this agricultural production loss.

The annual benefits in 2015 are estimated as follows.

Item	(US$ 1,000)
Recovery of Water Environmental Loss	4,016
Prevention of Tourism Income Loss	1,128
Cost Saving of Industrial Water Use	913
Prevention of Agricultural Production Loss	54
Total	6,111

7.4 Financial Analysis

(1) Development of Sewerage System

The existing sewerage systems in the Basin receive both domestic and industrial wastewater with different service charges.

The average affordable sewerage charge for domestic waste in the Basin under the existing economic situation is estimated to be 219 lei/m^3, based on the actual sewerage charges and the questionnaire survey of willingness to pay. It is equivalent to 0.4% of the average household income. The affordable sewerage charge will increase according to the growth of household income in the future.

The average affordable sewerage charge for industrial waste under the existing economic situation is determined to be 344 lei/m^3, considering the existing premium rate on the charge for domestic waste. The affordable sewerage charge will also increase according to the increase of the domestic waste charge in the future.

The expected annual sewerage revenue in the future is estimated below by applying the above unit charges.

Year	Unit Charge (lei/m³)		Volume (10^3 m³/yr.)		Annual Revenue
	Domestic	Industry	Domestic	Industry	(US$ million/yr.)
- 2000	219	344	40,659	11,880	1.48
2005	262	412	46,170	14,668	2.07
2010	314	494	51,680	17,455	2.83
2015	377	592	57,191	20,243	3.81
2016 -	377	592	57,191	20,243	3.81

Exchange rate: 1 US$=8,800 lei

The sewerage development of the Basin is evaluated in terms of financial internal rate of return (FIRR). The annual O&M cost is sufficiently covered by the expected annual revenue. The FIRR is calculated for various cases of cost coverage as shown below.

Cost Coverage	FIRR (%)
(1) All development cost and O&M cost	0.19
(2) 50 % of development cost and O&M cost	5.77
(3) 40 % of development cost and O&M cost	8.57
(4) 30 % of development cost and O&M cost	14.13

When the marginal efficiency of the project is assumed to be FIRR=10%, the beneficiaries can bear one-third of the development cost and all the O&M cost. The remaining development cost must be borne by the central and local governments.

(2) Development of Industrial Wastewater Treatment

The average affordable percentage of the industrial wastewater treatment cost to sales amount in the Basin is roughly assumed to be 0.7% based on the questionnaire survey. While, the total industrial production of the Basin is projected to increase from US$1,492 million at present to US$2,499 million in 2015. Then, the total affordable treatment cost of the Basin in the future is estimated as shown below.

Year	Annual Affordable Cost (US$ million/yr.)
- 2000	10.44
2005	12.41
2010	14.73
2015	17.50
2016 -	17.50

Exchange rate: 1 US$=8,800 lei

FIRR of the industrial wastewater treatment project is calculated at 12.35% by regarding the annual affordable cost as the revenue accrued from the project.

When the marginal efficiency of the project is assumed to be FIRR=10%, the industrial sector of the Basin should annually appropriate 0.7% of the sales amount for the development, and operation and maintenance of the industrial wastewater treatment.

7.5 Impact of Economic Growth Change on River Water Quality

(1) Change of Economic Growth Rate

The future river water quality and, as a result, the required water pollution control cost will vary depending on the projection of the socio-economic growth rates. In the proposed master plan, the following annual growth rates are assumed.

Item	Until 2000	2000-2015	2015/Present
Population	0.0 %	0.5 %	1.08 time
General Industry	0.0 %	3.5 %	1.68 time
Tourism Industry	0.0 %	5.0 %	2.08 time
Livestock Industry	0.0 %	0.0 %	1.00 time

Among the above assumed socio-economic growth rates, those of the general industry and tourism industry may vary to some extent, however, the variation range of the population and livestock growth rates is considered small. On the other hand, the tourism industry discharges only 1.4% of the total industrial wastewater in BOD load at present. Hence, different growth rates are considered for only general industry.

The National Commission for Economic Forecasting has predicted that the annual industrial growth rate of the country will reach 2.7% at the minimum and 4.3% at the maximum, averaging 3.5% in 2000. Based on this prediction, two (2) different cases of low growth (2.7%) and high growth (4.3%) are assumed for the general industry of the Basin during 2001-2015.

(2) Change of River Water Quality

The river water quality varies according to the change of the general industrial growth rate. The river water quality at the principal stations in 2015 for both cases of low and high growth rates are estimated as follows.

(BOD: mg/l)

Station	Location of Station	Proposed		Low Growth		High Growth	
		Without Project	With Project	Without Project	With Project	Without Project	With Project
Cimpina	Exit of Prahova Valley	6.2	3.6	5.9	3.4	6.6	3.7
Nedelea	Upstream of Nedelea Weir	12.4	7.4	11.1	7.0	14.1	8.0
Prahova	Prahova Main Downstream	29.6	9.9	25.5	9.3	34.9	10.4
Moara	Teleajen Downstream	30.1	12.4	27.3	12.2	33.9	12.8
Ciorani	Cricovul Sarat Downstream	10.6	10.3	10.5	10.3	10.6	10.3
Adincata	Upstream of Ialomita Junction	23.5	10.1	21.1	9.9	26.8	10.5

Note: Sewerage and industrial wastewater with project are treated up to the standards.

The river water quality in both cases scarcely differs from that of the proposed one.

(3) Change of Required Costs

The required development costs of sewerage system and industrial wastewater treatment in both cases of low and high growths are estimated as follows.

(US$ 1,000)

Project	Proposed	Low Growth	High Growth
Sewerage system	46,661	45,983	47,430
Industrial Wastewater Treatment	49,761	46,523	53,726
Total	96,422	92,506	101,156

The cost difference of both cases from the proposed one is small.

8. RECOMMENDATIONS

8.1 Strengthening of Monitoring System

There are a number of point pollutant sources consisting of sewerage, factories and other industrial establishments in the Basin. The wastewater treatment of these sources should be leveled up to meet the new standards regulated in the Government Decision at an early stage. The Romanian Waters should perform more intensive monitoring on the quality of the wastewater effluents as well as river water to attain a satisfactory water environmental management of the Basin according to the Water Law.

However, the existing monitoring capacity of the Romanian Waters Prahova Office is insufficient in manpower and laboratory equipment. In addition to the manpower increase, urgent improvement of the laboratory is necessary to meet the increasing analytical works of water quality.

The municipalities in the Basin are also obligated to monitor the quality of sewerage effluents to maintain proper operation of their treatment plants according to the Water Law. The existing capacity of their laboratories is insufficient as well due to financial and manpower constraints.

Integration of the existing laboratories of the Romanian Waters and related municipalities under joint cooperation may also be necessary to meet the current requirement of high-level water quality analysis such as for oil and toxic substances, and to avoid the unnecessary overlapping of investment.

8.2 Project Implementation and Feasibility Study

Early implementation or feasibility study for the following projects is recommended.

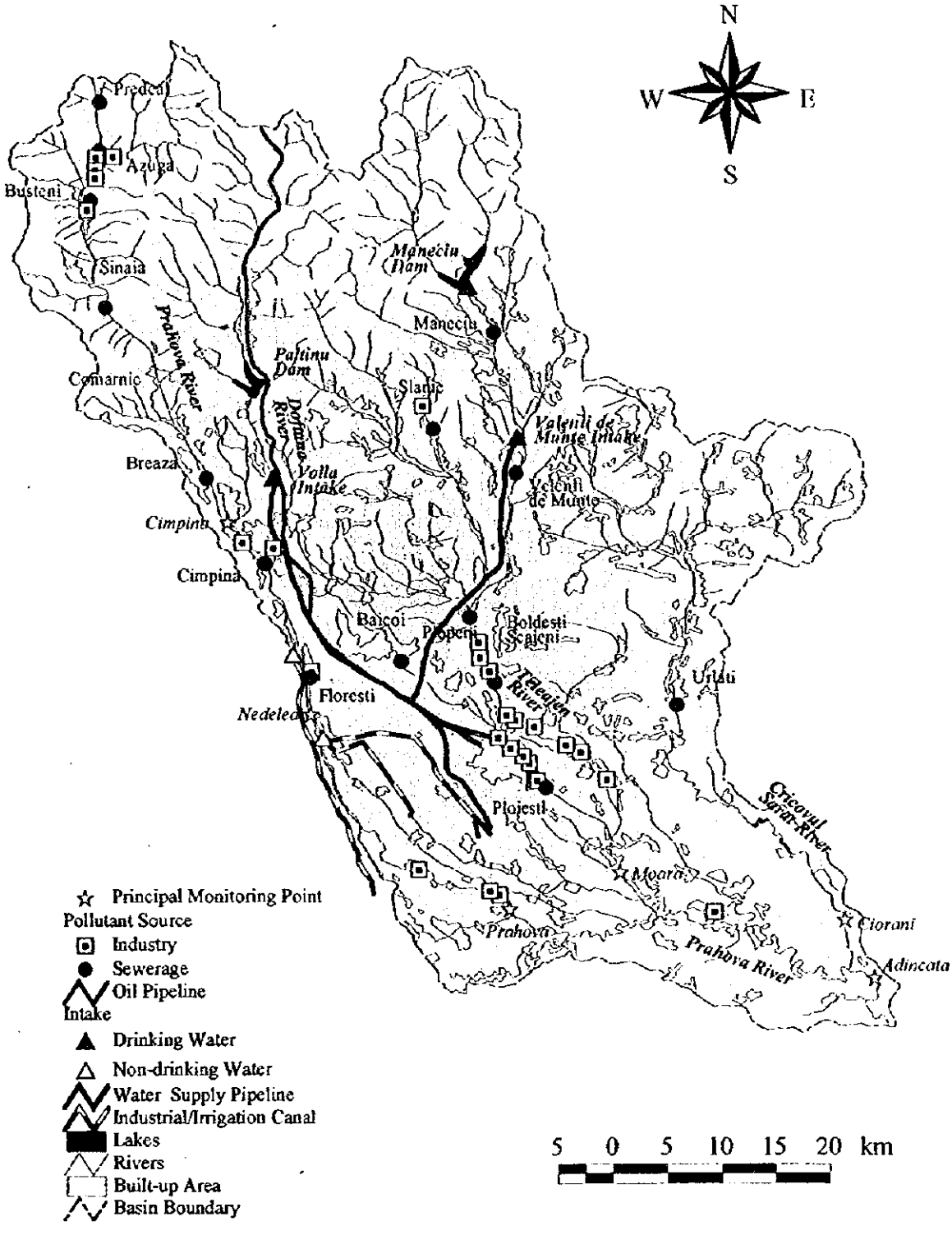
(1) Feasibility study for the promotion of water management in the Basin including establishment of an advanced laboratory under joint cooperation of the Romanian Waters and concerned municipalities, accidental water pollution control by replacing the oil leaking pipeline along the Doftana River, and prevention of water leakage in the transmission mains of the Romanian Waters.

(2) Feasibility study for the development of Ploiesti sewerage wastewater treatment has been completed by a local consultant. Early financial arrangements for the detailed design including review of the feasibility study and for construction are necessary.

(3) Feasibility study for wastewater treatment development of the petroleum industry.

(4) Feasibility study for the development of the sewerage wastewater treatment of Cimpina and Prahova valley including rehabilitation of Sinaia treatment plant, construction of the

new treatment plants in Azuga, Busteni and Comarnic, and rehabilitation/extension of Cimpina treatment plant.



STUDY ON THE MASTER PLAN FOR WATER ENVIRONMENT MANAGEMENT ON THE PRAHOVA RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig.1 Water Supply System and Pollutant Source