JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF PUBLIC WORKS AND TERRITORIAL PLANNING
ROMANIA

THE FEASIBILITY STUDY

ON WASTEWATER TREATMENT
ALONG THE DANUBE RIVER DOWNSTREAM REACH
IN ROMANIA

FINAL REPORT

SUMMARY

January 2000

PACIFIC CONSULTANTS INTERNATIONAL
In association with
NIHONSUIDO CONSULTANTS CO.,LTD.

Foreign Currency Exchange Rates Applied in the Study

Currency	Exchange Rate/US$
Romanian Lei (ROL)	15,756
Japanese Yen (¥)	122.00
Euro	0.95266
German Mark (DM)	1.8838

(Average rate of June 1999)

Note: Following numerical notations are adopted in the Report:
Decimal marker : "." (Period)
Digit separator : "," (Comma)

PREFACE

In response to a request from the Government of Romania, the Government of Japan decided to conduct the Feasibility Study on Wastewater Treatment along the Danube River Downstream Reach in Romania and entrusted the study to the Japan International Cooperation Agency (JICA).

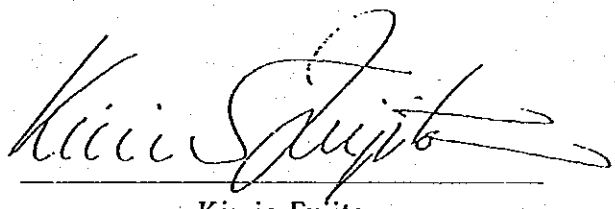
JICA selected and dispatched a study team headed by Mr. Akira Takechi of Pacific Consultants International (PCI) and composed of staff members of PCI and Nihon Suido Consultants Co., Ltd. to Romania, three times between January 1999 and January 2000. In addition, JICA set up an advisory committee headed by Mr. Osamu Fujiki, Osaka Prefectural Government, between January 1999 and January 2000, which examined the Study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Romania, and conducted field surveys in 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 team.

January, 2000



Kimio Fujita
President
Japan International Cooperation Agency

THE FEASIBILITY STUDY ON WASTEWATER TREATMENT
ALONG THE DANUBE RIVER DOWNSTREAM REACH IN ROMANIA

January, 2000

Mr. Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

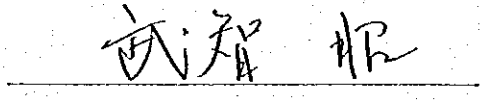
We are pleased to submit to you the final report entitled "The Feasibility Study on Wastewater Treatment along the Danube River Downstream Reach in Romania". This report has been prepared by the Study Team in accordance with the contracts signed on 18 January 1999 and 13 May 1999 between the Japan International Cooperation Agency and the Joint Study Team of Pacific Consultants International and Nihon Suido Consultants Co., Ltd.

The report examines the existing conditions of the seven cities in the study area, presents the results of feasibility studies on wastewater treatment plants in Tulcea, Galati, and Braila, and presents the results of basic studies on wastewater treatment plants in Calarasi, Giurgiu, Turnu Magurele, and Drobeta Turnu Severin.

The report consists of the Summary, Main Report, and Supporting Report. The Summary summarizes the results of all studies. The Main Report contains the existing conditions, results of the feasibility studies, results of basic studies for the four cities, and conclusions and recommendations. The Supporting Report includes technical details of contents of the Main Report.

All members of the Study Team wish to express grateful acknowledgement to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction, and Embassy of Japan in Romania, and also to Romanian officials and individuals for their assistance extended to the Study Team. The Study Team sincerely hopes that the results of the study will contribute to the implementation of wastewater treatment plants along the Danube River downstream reach, and that friendly relations of both countries will be promoted further by this occasion.

Yours faithfully,



Akira Takechi
Team Leader

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ABBREVIATIONS

Organizations

EBRD	European Bank for Reconstruction and Development
ISPA	Instrument for Structural Policies for Pre-accession
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
MOF	Ministry of Finance
MPWTP	Ministry of Public Works and Territorial Planning
MWFEP	Ministry of Water, Forestry and Environmental Protection
DLPA	Department of Local Public Administration

General

LIBOR	London Inter-bank Offered Rate
WTP	Willingness to Pay
ROL	Romanian Lei

Technical Terms

WWTP	Wastewater treatment plant
EIA	Environmental Impact Assessment
BOD_5	Biochemical oxygen demands, 5-day, 20℃
COD	Chemical oxygen demands
Cl^-	Chlorine ion
DO	Dissolved oxygen
SS	Suspended solids
T-N	Total nitrogen
T-P	Total phosphorous

Units

mm	millimeter
cm	centimeter
m	meter
km	kilometer
m^2	square meter
km^2	square kilometer
ha	hectare
ml	milliliter
l	liter
m^3	cubic meter
mg	milligram
g	gram
kg	kilogram
t	ton (1,000 kg)
W	watt
kW	kilowatt
m^3/d	cubic meter per day
m^3/h	cubic meter per hour
m^3/s	cubic meter per second
l/s	liter per second
mg/l	milligram per liter
lcd	liter per capita per day

1. INTRODUCTION

Seven (7) cities located along the Danube River, namely Tulcea, Galati, Braila, Calarasi, Giurgiu, Turnu Magurele and Drobeta Turnu Severin, were selected as higher priority cities in the nationwide development of wastewater treatment from the viewpoints of the government policies to fulfill the EU Environmental Directives as one of EU applicant countries, and of a priority action required in the Strategic Action Plan for the Danube River Basin. While wastewater collection systems are considerably developed in the selected cities, none of them have proper treatment facilities. They are discharging wastewater to the Danube River without proper treatment.

These situations have been well recognized, thus most of the cities have prepared a plan for the construction of wastewater treatment facilities. Both the state and municipal governments have been keen to realize the plans, however, they have not succeeded it mainly because of lack of financial sources in the both governments. The realization is considered to be possible only by utilizing financial instruments from foreign financial agencies judging from budget constraints of responsible organizations. Foreign financial agencies strictly require a feasibility of the project implementation in many aspects, such as technical, financial, economic, social, and environmental aspects, at least. However, the present plans are not provided with enough information to confirm the feasibility in these aspects.

On these backgrounds, this study entitled "the Feasibility Study on Wastewater Treatment along the Danube River Downstream Reach in Romania" (hereinafter "the Study") was conducted to provide feasibility studies, which can confirm the feasibility in those aspects, and the methodology to enable the cities to access the international financial instruments.

The objectives of the Study are;

i) to conduct a basic study on wastewater treatment in the selected seven (7) cities,

ii) to conduct a feasibility study for wastewater treatment of the targeted three (3) cities, namely Tulcea, Galati and Braila, among the selected seven cities, and

iii) to carry out technology transfer to the Romanian counterpart personnel in the course of the Study.

The study area is shown in *Figure 1*.

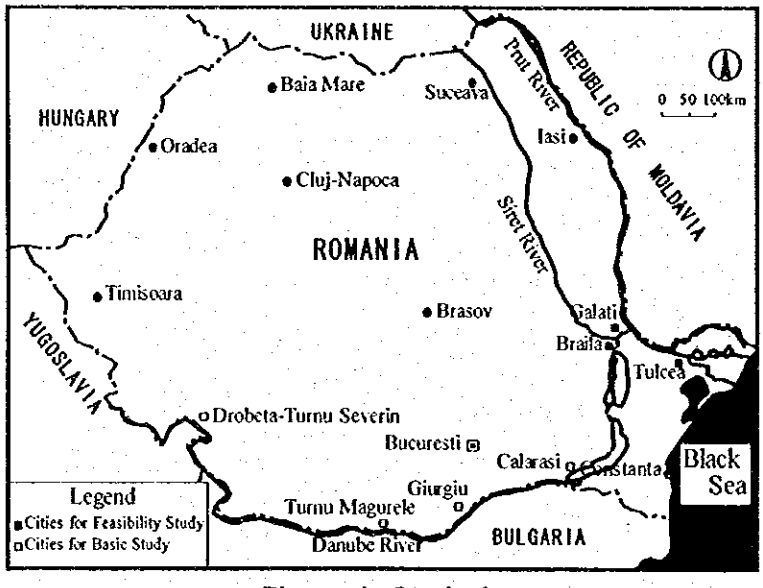
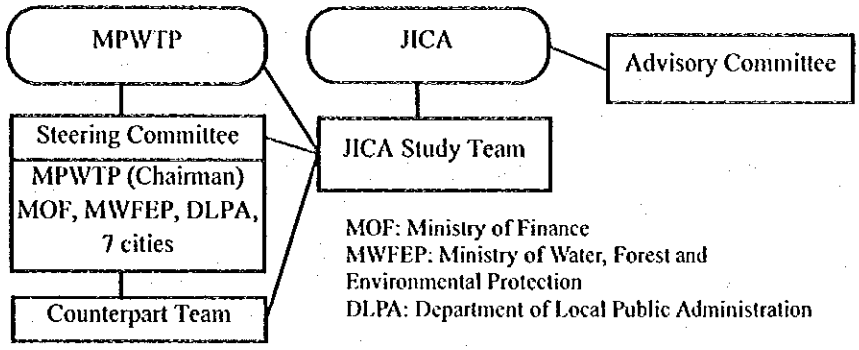


Figure 1 Study Area

The whole organizational scheme is given below. Japan International Cooperation Agency (JICA) set up a study team to conduct the Study and organized an advisory committee to examine the Study. Ministry of Public Works and Territorial Planning (MPWTP), the Romanian executing agency of the Study, organized a steering committee consisting of relevant ministries and the seven cities and chaired the Committee. The Steering Committee organized a counterpart team to work with the JICA Study Team.



The Study was commenced in February 1999 and completed in January 2000 with submission of this Final Report. Overall time schedule of the Study is presented below.

Study Stage	I			II	III			IV		V	VI	
Work Items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Preparation Work													
Basic Survey													
Preparation of Progress Report													
Preliminary Study of F/S for the Targeted Cities													
Environmental Impact Assessment (EIA)													
Preparation of Technology Transfer Seminar													
F/S for Targeted Cities													
Guidelines for Development of Wastewater Treatment													
Preliminary Design for Remaining 4 Cities													
Presentation of Draft Final Report													
Technology Transfer Seminar													
Preparation of Final Report													
Report	IC/R				P/R				IT/R		DF/R		F/R

Legend:
IC/R: Inception R., P/R: Progress R., IT/R: Interim R., DF/R: Draft Final R., F/R: Final R. ■: In Romania □: In Japan

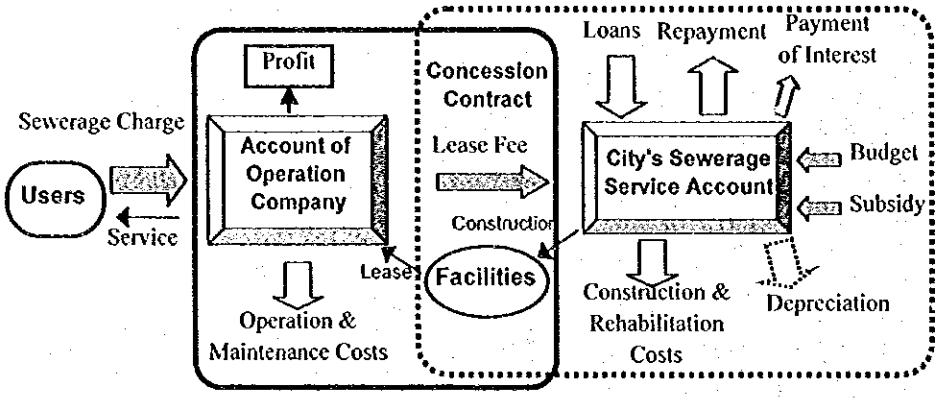
The Final Report presents whole results of the Study and comprises Main Report, Supporting Report and Summary.

2. INSTITUTIONAL CONSIDERATION

Recently there were important changes in the institutional framework, such as issuance of new local public finance law and privatization of wastewater management undertaker. Under the new regime, public works administration procedures and financing procedures for public works were thoroughly reviewed. As results of the review, followings were concluded.

2.1 PROPOSED OPERATIONAL STRUCTURE OF SEWERAGE SERVICE

Based on the most likely prospect of the privatization process, an operational structure of the sewerage service, as shown in the figure below, was proposed and adopted for a financial analysis of the present feasibility studies.



In the proposed structure, a private operation company, which is supposed to be established on the present commercial company or Regia Automona by selling shares to the State Ownership Fund and finally to private sectors, renders operation and maintenance of the sewerage service based on a concession contract with a city council, and collects sewage charges from users. The concession contract may cover transfer and lease of various rights such as of trade, ownership, operation and management. Since details of the concession contract to be applied in each city have not become clear, it is set out that the concession contract in the proposed structure covers the lease of facilities necessary for the operation of sewerage services, and that the lease fees are paid from the operation company to the city council.

2.2 PROPOSED FINANCIAL ARRANGEMENT

In the present regime, it is possible for the city councils to utilize both external loans contracted by themselves or through the state. The utilization of the external loans contracted by themselves would be more preferable from a viewpoint of local council's initiatives in local public works, which is one of aims of the local public finance law. However, it seems practically difficult for the councils to access those loans. Usually in external loans without state guarantee, lending terms for a private sector could be applied and the terms would be too heavy financial burden to the city councils. This is the reason why it is assumed that the councils apply an external loan through the state. In case of the external loan through the state, the repayment capability of the council must be proved with such a manner that the total annual installments never exceed 20% of the current revenue.

On the other hand, the sound financial condition of the operation company is crucial for success of the project.

Thus, the financial feasibility of the project was evaluated from financial conditions of both the city council and the operation company.

3. CONCEPTS OF PRELIMINARY ENGINEERING

3.1 PURPOSE AND SCOPE OF PRELIMINARY ENGINEERING

Purpose of the preliminary engineering in the Study is defined to give a technical basis to evaluate a feasibility of the wastewater treatment plant (WWTP) project. Scope of the preliminary engineering is set out to include WWTPs and interceptors or trunk mains, if they are required to transfer wastewater from the existing sewer networks to the WWTPs.

3.2 DETERMINATION OF DESIGN BASIS

Such design bases as wastewater flow and characteristics, which are essential factors of preliminary engineering, have existed in each city and they have been used in the past feasibility studies and sewerage development plans. Since most of sewerage facilities designed and being constructed are based on those bases, it may cause discontinuity, if the design bases determined in the Study far differs from the existing one. It would be more practical to adopt the existing design bases, to keep compatibility with the existing facilities.

However, as long as information given to the JICA Study Team, some of those bases do not have enough justifiable background. Therefore, in the Study, the existing design bases were reviewed by using available data having solid bases, the results of field survey in the Study and data in literatures.

3.3 INTERCEPTORS

Interceptors planned in the Study are to transfer wastewater to WWTPs by collecting wastewater from existing outfalls or trunk mains. In the course of the Study, it was confirmed that there existed trunk mains that collect most of the wastewater from sewer networks in some cities, or construction of such trunk mains was going on. Therefore, the proposed projects utilize these existing or being constructed trunk mains as much as possible to transfer the wastewater to the WWTPs.

3.4 SELECTION OF TREATMENT PROCESS

(1) Targets

To make a plan realistic, two step water quality requirements were adopted in the selection of wastewater treatment process; the first step for BOD and SS and the second step for T-N and T-P. It is proposed that facilities to meet the first step requirements are constructed first, then additional facilities to meet the second step requirements will be constructed as modification or expansion of the first step facilities. The Study proposes a construction of the facilities to meet the first step requirements and verifies a technical possibility to modify the proposed facilities to meet the second step requirements. Water quality targets were set out as follows:

- For the present feasibility: BOD_5 = 20 mg/l or less, SS = 60 mg/l or less
- For future modification: T-N = 10 mg/l or less T-P = 1 mg/l or less

(2) Comparison of Process

For the first step requirements, a conventional activated sludge (CAS) method and an oxidation ditch method (OD) were compared. The comparison was carried out by designing imaginary plants with 100,000 m^3/day capacity and comparing required areas, operation and maintenance, and their costs.

For the second step, following three scenarios were compared. Comparison was carried out by same manner as for the fist step:

Scenario-1	BOD, SS and T-N removal;	Recirculation nitrification-denitrification, Step feed, multi-stage nitrification-denitrification
Scenario-2	BOD, SS and T-P removal;	Anaerobic-aerobic activated sludge
Scenario-3	BOD, SS, T-N and T-P removal;	Anaerobic-anoxic-aerobic.

(3) Conclusion

Following conclusions were obtained:

- The conventional activated sludge process (CAS) is selected as the most desirable process for the removal of BOD and SS, because of its superior pollutant removal efficiencies to other secondary treatment processes and long operational experience obtained in Romania;
- The biological removal of T-P may be difficult, because the aerated grit chambers and oil traps to be provided ahead of the biological treatment process cannot maintain the influent under anaerobic conditions which is necessary for biological removal of T-P. For this reason, the T-P removal will be performed by chemical precipitation process;
- T-N removals will be achieved by the recirculation nitrification-denitrification method.

4 FEASIBILITY STUDY ON WASTEWATER TREATMENT

4.1 PLANNING BASIS

Planning bases for three (3) targeted cities were set out as shown in *Table 1*.

Table 1 Planning Base for Tulcea, Galati and Braila Cities

ITEMS		TULCEA	GALATI	BRAILA
CITY POPULATION				
Present		96,300	330,300	234,800
2010		100,000	382,000	257,000
WATER SUPPLY POPULATION				
Present		96,000	335,630	234,800
2010		100,000	382,000	257,000
SEWERAGE SERVICE POPULATION				
Present		69,000	328,095	194,250
2010		73,000	377,000	221,600
WASTEWATER INFLOW				
Average Daily	(m^3/day)	37,000	200,000	98,000
Maximum Daily	(m^3/day)	43,000	235,000	115,000
Maximum hourly	(m^3/day)	53,000	285,000	140,000
Wet Weather flow	(m^3/day)	-	570,000	280,000
WASTEWATER QUALITY				
BOD_5	(mg/l)	130	130	150
SS	(mg/l)	140	150	180
T-N	(mg/l)	20	20	25
T-P	(mg/l)	3.5	3	4
WASTEWATER TREATMENT				
PLANT CAPACITY	(m^3/day)	43,000	235,000	115,000

4.2 INTERCEPTOR SYSTEM PLANNING

Interceptors were planned to convey wastewater from existing sewer systems to proposed WWTPs utilizing existing facilities as much as possible. Major facilities planned are summarized in *Table 2*, and outlines of each city are as follows:

TULCEA

Existing sewerage system has two (2) trunk mains and seven (7) outfalls. It was concluded that the two trunk mains were to be used as interceptors by connecting four (4) outfalls except outfalls No.5, No.6, and No.7 to the trunk mains and by diverting the flows to the proposed WWTP, as shown *Figure 2*. Wastewater from the outfall No.7 is not collected to the wastewater treatment plant because it is wastewater from the water purification plant. Major proposed facilities include construction of the new pumping station, and installation of a pressure sewer line from the new pumping station to WWTP.

GALATI

Existing sewerage system has seven (7) outfalls. It was concluded that an interceptor was to be installed from the outfall No.3 to the proposed WWTP as shown in *Figure 3*. The interceptor is of a gravity type and to collect wastewater from the existing outfalls. Wastewater from the outfall No.2 is not collected to the WWTP because it is wastewater from the water purification plant.

BRAILA

Existing sewerage system has 12 outfalls and the new trunk main is under construction. It was concluded that wastewater was to be collected from most down stream of the trunk main under construction, and transferred to the proposed WWTP via a newly installed interceptors by gravity flow as shown in *Figure 4*.

Table 2 Major Facilities of Planned Interceptors

	Tulcea	Galati	Braila
Interceptor	ϕ 1000 x 2, L=300m,EC=2m ϕ 600 , L=87m, EC=2m	ϕ 1500-2200, L=7400m, EC=1-8m	ϕ 1650, L=2740m, EC=1-7m
Pump equipment	Q=0.15m³/s x 3(1standby), H=30m		
Pressure pipe	ϕ 400, L=285m + 175m		
WWTP outfall sewer	ϕ 800, L=150m, EC=3.5m	ϕ 2800, L=3200m, EC=1.5m	ϕ 2000, L=1100m, EC=1.5m
Others	CSOs, Valves, Manholes, Connections	CSOs, Valve, Manholes, Connections	CSOs, Valve, Manholes, Connections, Pipe for excessive storm water

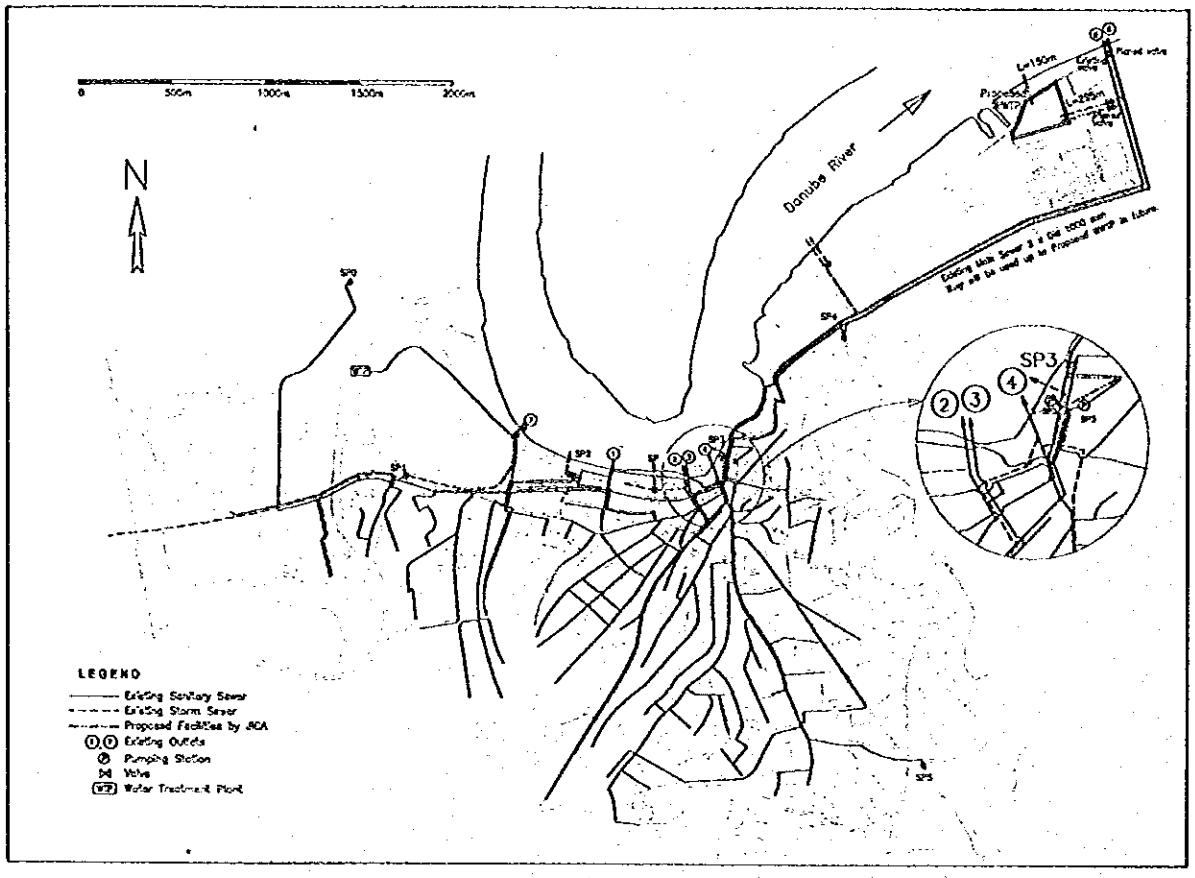


Figure 2 Proposed Interceptor System of Tulcea

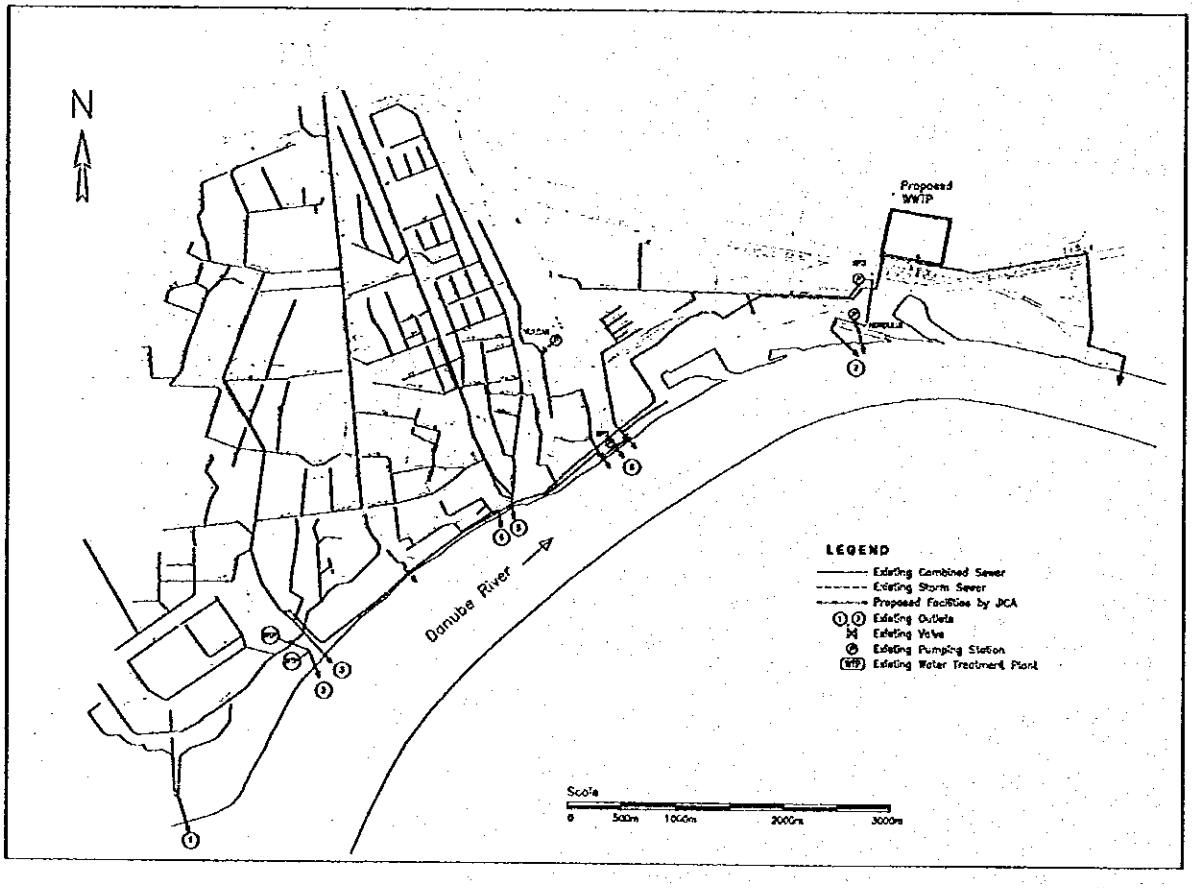


Figure 3 Proposed Interceptor System of Galati

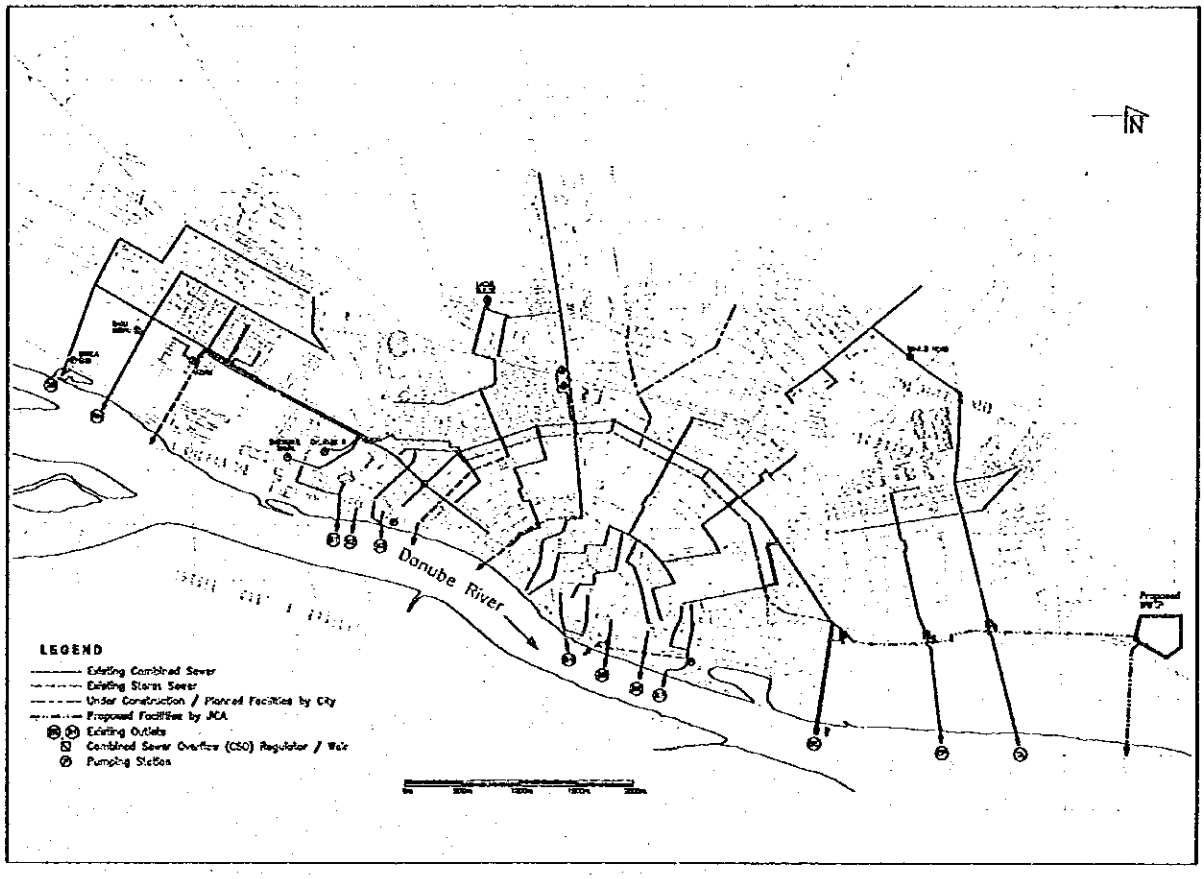


Figure 4 Proposed Interceptor System of Braila

4.3 WWTP PLANNING

(1) Treatment Flow

Treatment flow comprises wastewater treatment and sludge treatment as shown in *Figure 5*. Conventional activated sludge (CAS) was adopted as a wastewater treatment process and anaerobic sludge digestion process was adopted as a sludge treatment.

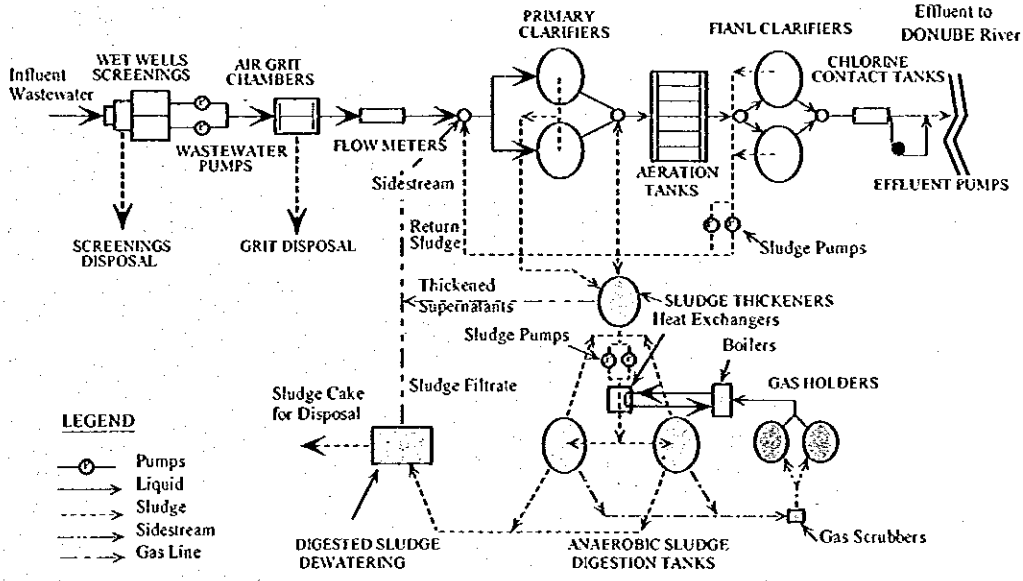


Figure 5 Process Flow of Proposed WWTPs

(2) Process Components

Major facilities of the WWTP of each city are as shown in *Table 3*.

Table 3 Major Facilities of Proposed WWTP

	Tulcea (Separate System)	Galati (Combined System)	Braila (Combined System)
Screen and Pump	Influent gate 2 (1.0×0.6) Coarse screen B=1.6, 2 Fine screen B=1.6, 2 Pumps ϕ350, Q=15m³/min, H=5.5m, Mp=21kw × 4	Influent gate 4 (1.0×1.0) (including for rain 2) Coarse screen B=1.6, 2+2 Fine screen B=1.6, 2+2 Pumps ϕ600, Q=50m³/min, H=16m, Mp=192kw× (2+2) ϕ900, Q=100m³/min, H=16m, Mp=370kw× (2+2)	Influent gate 4 (1.0×1.0) (including for rain 2) Coarse screen B=1.6, 2+2 Fine screen B=1.6, 2+2 Pumps ϕ450, Q=25m³/min, H=5m, Mp=70kw × (2+2) ϕ600, Q=50m³/min, H=5m, Mp=132kw × (2+2)
Grit chamber Oil separator	B 3m × L 8m × 2 channels	B 3m × L 22m × 8 channels	B 3m × L 22m × 4 channels
Parshall flume	306 - 12,380 m³/h × 1 unit	306 - 12,380 m³/h × 2 units	306 - 12,380 m³/h × 2 units
Primary Sedimentation	ϕ25 m, effective depth 2.0 m 4 tanks	ϕ35 m, effective depth 2.0 m 4 tanks	ϕ35 m, effective depth 2.0 m 4 tanks
Aeration Tank	B 5.5m × H 5.5m × L 49m 4 × 2 = 8 tanks (For advanced treatment + B 5.5m × H 5.5m × L 54m × 8)	B 5.5m × H 5.5m × L 67m 8 × 4 = 32 tanks (For advanced treatment + B 5.5m × H 5.5m × L 73m × 32)	B 5.5m × H 5.5m × L 76m 4 × 4 = 16 tanks (For advanced treatment + B 5.5m × H 5.5m × L 67m × 16)
Final sedimentation Tank	ϕ30 m, effective depth 3.5 m 4 tanks (For advanced treatment: + ϕ30 m, effective depth 3.5 m × 4)	ϕ45 m, effective depth 3.5 m 8 tanks (For advanced treatment: + ϕ40 m, effective depth 3.5 m ×8)	ϕ45 m, effective depth 3.5 m 4 tanks (For advanced treatment: + ϕ40 m, effective depth 3.5 m × 4)
Chlorination chamber	B 4.0m × H 4.0m × L 38m (Chlorination time 15 min)	B 4.0m × H 4.0m × L 204m (Chlorination time 15 min)	B 4.0m × H 4.0m × L 100m (Chlorination time 15 min)
Sludge Thickener	Inside diameter 9.5 m × H 4 m 2 tanks	Inside diameter 16 m × H 4 m 4 tanks	Inside diameter 12 m × H 4 m 4 tanks
Sludge Digester	Inside diameter 12.5 m × H 21 m V=2000 m³ 2 Tanks	Inside diameter 17.5 m × H 31 m V=5580 m³ 4 Tanks	Inside diameter 15 m × H 26 m V=3500 m³ 4 Tanks
Gas Holder	Inside diameter 12 m × H 9.5 m V = 650 m³ × 1 tank	Inside diameter 16 m × H 17 m V = 2,000 m³ × 2 tanks	Inside diameter 13m × H 13.57m V = 1,000 m³ × 2 tanks
Dewatering Equipment	130kg/m hr, B = 2 m 4 machines (building 24 m × 10 m)	130kg/m hr, B = 3 m 14 machines (building 56 m × 20 m)	130kg/m hr, B = 3 m 8 machines (building 32 m × 20 m)
Blower Equipment	Multi stage turbo blower ϕ200 / ϕ200 55 m³/hr, 3 (1) (building 18 m × 13 m)	Multi stage turbo blower ϕ350 / ϕ300 140 m³/hr, 5 (1) (building 26 m × 13 m)	Multi stage turbo blower ϕ350 / ϕ300 80 m³/hr, 5 (1) (building 26 m × 13 m)
Administration Building	30 m × 20 m = 600 m²	30 m × 50 m = 1,500 m²	30 m × 40 m = 1,200 m²

(3) Plant Layout

Plant layouts of Tulcea, Galati, and Braila WWTPs are shown in *Figures 6, 7,* and *8,* respectively.

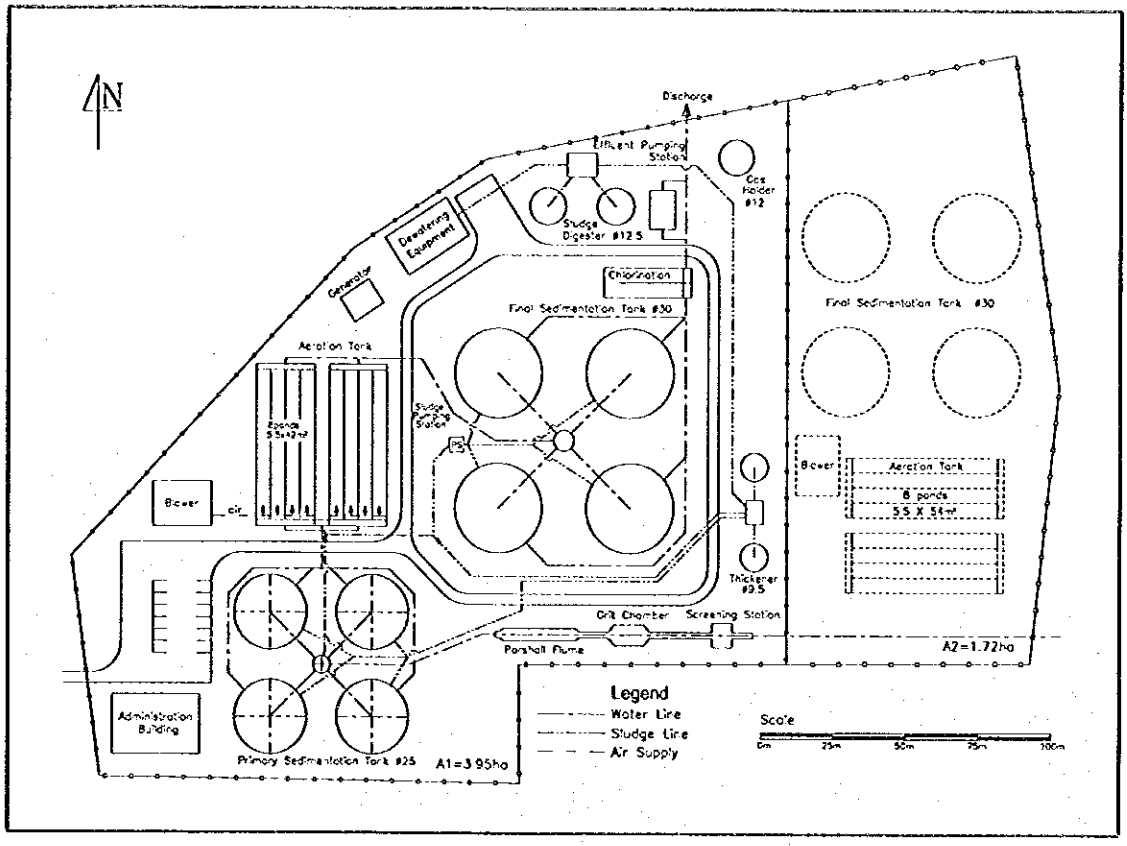


Figure 6 Layout of Proposed WWTP of Tulcea

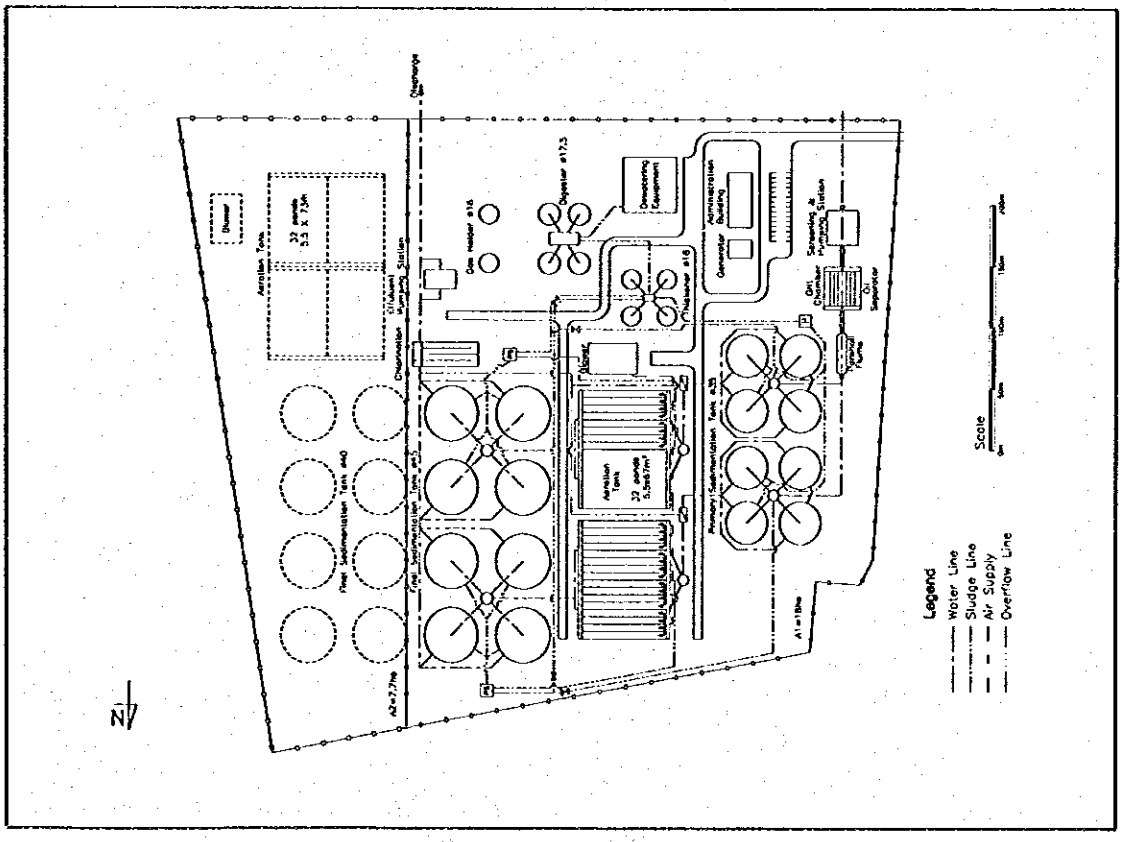


Figure 7 Layout of Proposed WWTP of Galati

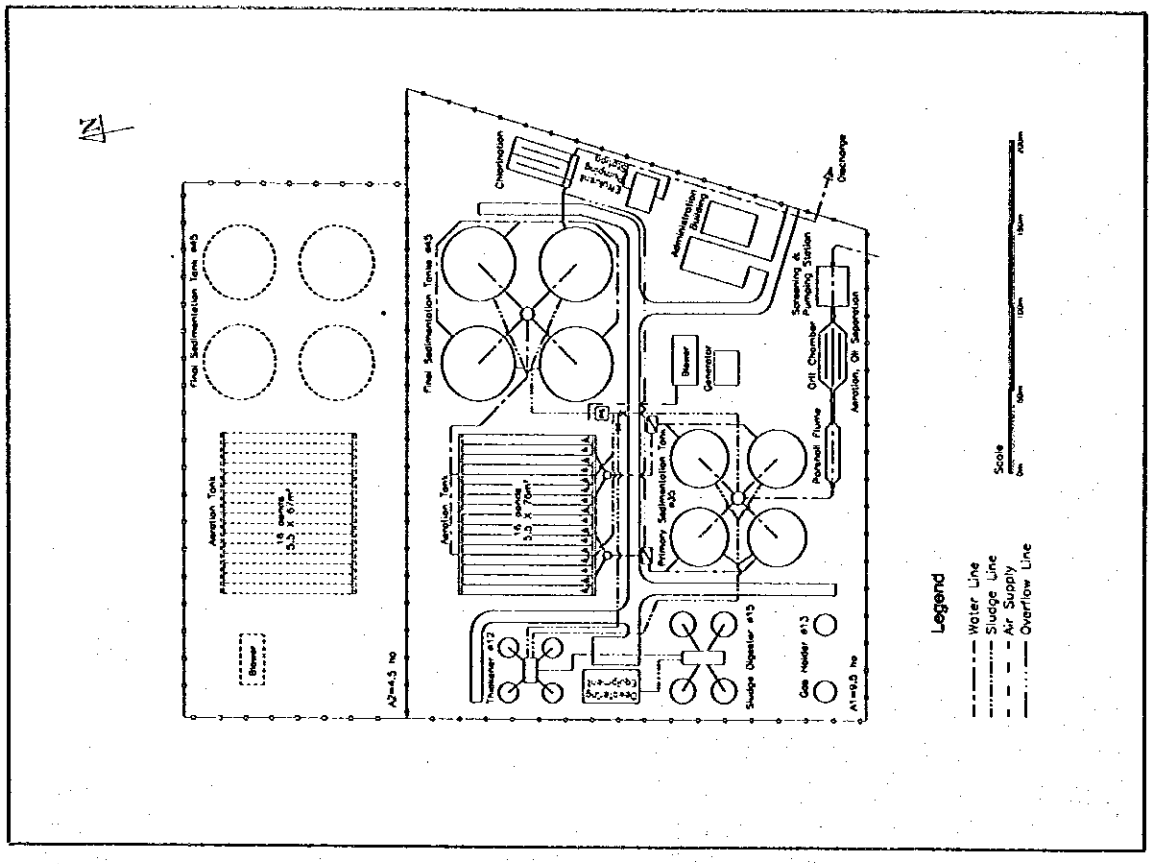


Figure 8 Layout of Proposed WWTP of Braila

4.4 CONSTRUCTION PLAN

The construction plan for the project is prepared based on the following considerations:

- Annual working days are estimated at 225 days based on the rainfall records in the past five (5) years and holidays in Romania. Daily working hour is assumed to be eight (8) hours.
- Construction machines are fully utilized for the smooth and economical implementation.

Required construction periods are estimated based on the construction volume and ordinary scale of inputs with the considerations mentioned above.

5. OPERATION/MAINTENANCE AND ORGANIZATION PLANS

Work items necessary for the operation and maintenance of the proposed WWTPs are summarized, as well as operational parameters necessary for operation.

Organization plan was prepared so as to enable the actual implementation of the above proposed operation and maintenance plan.

6. COST ESTIMATES

The project costs were calculated with following components:

	Item	Remarks
I	Construction Cost	
II	Engineering Service Cost	10% of (I)
III	Government Administration Cost	2% of (I)
IV	Contingency	10% of (I+II+III)
V	Project Cost	I+II+III+IV

Among them, the construction cost has further breakdown as shown below. "Main works" was calculated based on unit prices and quantity given by the preliminary engineering. The unit prices were prepared based on general price information available in Romania and Japan, and price inquiries to manufacturers and contractors in Romania, other European countries, and Japan.

	Item	Remarks
I	Construction Cost	Total of I-1 to I-6
I-1	Mobilization and demobilization	5 % of I-3
I-2	Preparatory works	5 % of I-3
I-3	Main works	Total of I-3-1 to I-3-4
I-3-1	Civil work	
I-3-2	Mechanical/electrical equipment	
I-3-3	Mechanical/electrical equipment installation	
I-3-4	Administration building	
I-4	Miscellaneous works	10 % of I-3
I-5	Site expenses	10 % of I-3
I-6	Overhead and profit	10 % of I-3

Operation maintenance costs were calculated from electric power charge for the equipment and cost for personnel. The project costs and operation and maintenance costs were estimated under the following conditions.

- All base costs are expressed under the economic conditions that prevailed in June 1999.
- The exchange rates of currencies are US$1 = ROL 15,756 = ¥122, Euro1 = ROL 16,539 and DM1 = ROL 8,364.
- Equipment cost for WWTP is classified into foreign and local currency portions and rates of them are 70 % and 30 % respectively.
- Price escalation is not counted.

Estimated costs for each city are as shown in *Table 4*.

Table 4 Estimated Project and O & M Costs

City	Project costs (million lei)			O & M Costs (million lei/year)
	Total	Local Portion	Foreign Portion	
Tulcea	321,054	107,265	213,789	3,820
Galati	1,684,237	504,061	1,180,176	16,518
Braila	837,376	268,416	568,960	9,296

7. IMPLEMENTATION PROGRAM

Implementation programs were prepared by setting out to start the projects from 2000, with one (1) year detail design and tendering stage followed by three (3) years (Tulcea) or four (4) years (Galati and Braila) of construction stages.

8. FINANCIAL PLAN

8.1 FINANCIAL SOURCES

Financial plans were prepared on conditions that investment costs for the construction of the WWTP are not affordable for the present city councils' financial capability.

As possible external financial sources, three (3) international financing organs, EBRD, JBIC and ISPA were adopted in the preparation of the financial plans. Terms of each financing organs were assumed as follows:

Financing Organs	Financing Ratio (%)	Loan/Grant	Interest Rate (%)	Repayment Period (Years)	Grace Period (Years)
EBRD	70	Loan	6.5	15	3
JBIC	70	Loan	2.7	30	10
ISPA	75	Grant	-	-	-

8.2 PREPARATION OF FINANCIAL PLAN

Following four (4) cases of financial arrangements were set out:

- Case I: EBRD 70% + Self Financing 30%
- Case II: EBRD 50% + ISPA 50%
- Case III: EBRD 30% + ISPA 70%
- Case IV: JBIC 70% + Self Financing 30%

For each case, two (2) cases of lease fee were set out as follows:

- Equivalent amount to a total of depreciation, repayment and payment of interest
- Its 50 %

Furthermore, three sewerage charge levels were set out as follow:

- Equivalent amount to people's willingness to pay in each city
- Intermediate of the willingness to pay and maximum affordability
- Equivalent amount to affordability (2% of average household income of each city - ratio of the present sewerage charge paid to the average household income)

In total, 24 alternative cases for each city were analyzed in the Study.

8.3 EVALUATION OF FINANCIAL PLAN

Cash flows calculated for the cases set out above were evaluated from two aspects:

- Soundness of the private company's financial operation (Sustainability-cumulated working capital, Profits)
- Affordability of city council's financial capability and the repayment criteria (Ratio of subsidy to budget size, Ratio of repayment to current revenue)

8.4 PROPOSED FINANCIAL PLAN

The financial plans were proposed by the financial arrangements as shown in *Table 5*, because the available financial arrangement could not be fixed in the Study.

Table 5 Proposed Financial Plans

City	Case	Financial Arrangement	Lease fee	Level of Sewerage Charge
Tulcea	I	70% EBRD + 30% Self-financing	50% of depreciation and repayment	Maximum Level (1.62% of household income)
	II	50% EBRD + 50% ISPA	100% of depreciation and repayment	Maximum Level (1.62% of household income)
	III	30% EBRD + 70% ISPA	50% of depreciation and repayment	Mean Level (0.96% of household income)
	IV	70% JBIC + 30% Self-financing	50% of depreciation and repayment	Mean Level (0.96% of household income)
Galati	I	70% EBRD + 30% Self-financing	100% of depreciation and repayment	Mean Level (1.12% of household income)
	II	50% EBRD + 50% ISPA	100% of depreciation and repayment	Mean Level (1.12% of household income)
	III	30% EBRD + 70% ISPA	50% of depreciation and repayment	Minimum Level (0.4% of household income)
	IV	70% JBIC + 30% Self-financing	50% of depreciation and repayment	Minimum Level (0.4% of household income)
Braila	I	70% EBRD + 30% Self-financing	50% of depreciation and repayment	Maximum Level (1.56% of household income)
	II	50% EBRD + 50% ISPA	50% of depreciation and repayment	Maximum Level (1.56% of household income)
	III	30% EBRD + 70% ISPA	50% of depreciation and repayment	Mean Level (0.96% of household income)
	IV	70% JBIC + 30% Self-financing	50% of depreciation and repayment	Maximum Level (1.56% of household income)

9. PROJECT EVALUATION

9.1 TECHNICAL FEASIBILITY

Proposed projects include the construction of the WWTPs and installation of interceptors necessary for conveying sewage from the existing sewered areas to the WWTPs, together with minor modification of the existing sewer system for connecting the existing system to the proposed interceptors. The wastewater treatment process applies a conventional activated sludge method, which can reduce the pollutant concentrations in the effluent at the levels required in the effluent standards, except T-N and T-P. For the removal of T-N and T-P, the study suggested the possible treatment methods and confirmed that the designated plant sites can accommodate required facilities for the methods. Therefore, wastewater currently

discharged to the Danube River without proper treatment in each city will be treated by the secondary treatment by implementing the proposed projects.

There is no existing WWTP with a secondary process in each city, and neither the city councils nor the service providers have experiences in the construction and operation of the WWTP, therefore the implementation of the projects may encounter some technical difficulties. However, proposed wastewater treatment process is a conventional activated sludge method, which is the most common method in Romania. There are several WWTPs with the conventional activated sludge methods all over the country under operation or under construction. Thus, such difficulties could be overcome by utilizing the experiences, know-how, and information accumulated in other city councils, institutes and service providers.

9.2 Economic Feasibility

Economic analysis was carried out by employing a CVM (Contingent Valuation Method) to quantify economic benefits of the projects. The economic benefits were quantified by the people's willingness to the contribution towards a government's policy to take an action for the nature conservation of the Danube Delta.

Based on the economic benefits above, three (3) economic criteria, a net present value (NPV), a benefit cost ratio (B/C) and an internal economic rate of return (EIRR) were calculated under following preconditions:

- Currency unit is ROL and the value of ROL is expressed at the June 1999 prices.
- Project Life: 30 years since the start of project implementation.
- Target Year: 2010. From 2010 on the values of O & M cost variables are assumed to keep the 2010 level.
- Implementation Period: four (4) years from 2000 to 2003 (Tulcea), five (5) years from 2000 to 2004.
- OCC (Opportunity Cost of Capital): 10%.
- Conversion factor : 98.4% to capital cost (initial and replacement cost) taking account of customs duty for foreign components.

The results of the calculation are as shown in *Table 6*. EIRRs of the three (3) cities exceed OCC (10%), thus the projects are judged economically feasible.

Table 6 Calculated Economic Criteria of the Project

	NPV (million ROL)	B/C	EIRR(%)
Tulcea	9,523	1.03	12.5
Galati	111,708	1.07	13.1
Braila	26,168	1.03	11.6

9.3 Financial Feasibility

Since the capital investment costs for the construction of the WWTP is too heavy financial burden to the cities that are responsible for the construction, the project would be feasible only on condition that the state provides financial and institutional support to the cities. Required supports from the state are as follows:

- Acceptance of the utilization of state guaranteed external loans.
- Exceptional provision for the aforementioned repayment criterion.
- Application of special subsidy to sewerage development projects.

9.4 Environmental Impact Assessment

Environmental impact assessment survey were carried out at the three (3) proposed WWTP sites for the items such as public health conditions, waste, hazards, topography and geology, groundwater, hydrological situation and fauna and flora, according to the Romanian procedures. It was confirmed that no major impacts would be caused by the proposed projects.

10. BASIC STUDY FOR THE FOUR CITIES

A basic study was carried out to provide a guide to a future feasibility study for the construction of WWTP for Calarasi, Giurgiu, Turnu Magrele and Drobeta Turnu Severin. The Study summarized the existing conditions related to the wastewater treatment as base data for the future feasibility study.

Indicative planning bases were estimated based on the presently available data as shown in *Table 7*. It is necessary to finalize them for the future feasibility study.

Preparative design of the WWTPs for the four (4) cities was carried out to show a possible wastewater treatment process, as shown in *Figures 9 to 12*, and to confirm that the plants could be accommodated in the designated plant site.

Necessary work items for the future feasibility and necessary activities for each item were given in a form of checklist.

Table 7 Indicative Planing Basis for the Four Cities

Item	Calarasi	Giurgiu	Turnu. Magurele	Drobeta Turnu Severin
Administrative (Total) Population				
Present(1998)	77,670	73,000	37,130	120,500
2010	NA	83,000	47,000	140,000
Sewerage Service Population				
Present(1998)	50,000	52,925	19,500	102,500
2010	54,060	140,000	21,000	138,000
Design Flow				
Average Daily Flow (m3/d)	42,600	71,900	17,000	53,800
Maximum Daily Flow (m3/d)	55,730	82,100	20,000	63,400
Maximum Hourly Flow (m3/d)	66,960	98,500	25,000	74,400
Wet Weather Flow (m3/d)	---------	---------	50,000	148,800
Design Influent Quality				
BOD_5 (mg/L)	230	240	130	130
SS (mg/L)	210	260	180	180
T-N (mg/L)	25	25	20	20
T-P (mg/L)	4	4	3	3

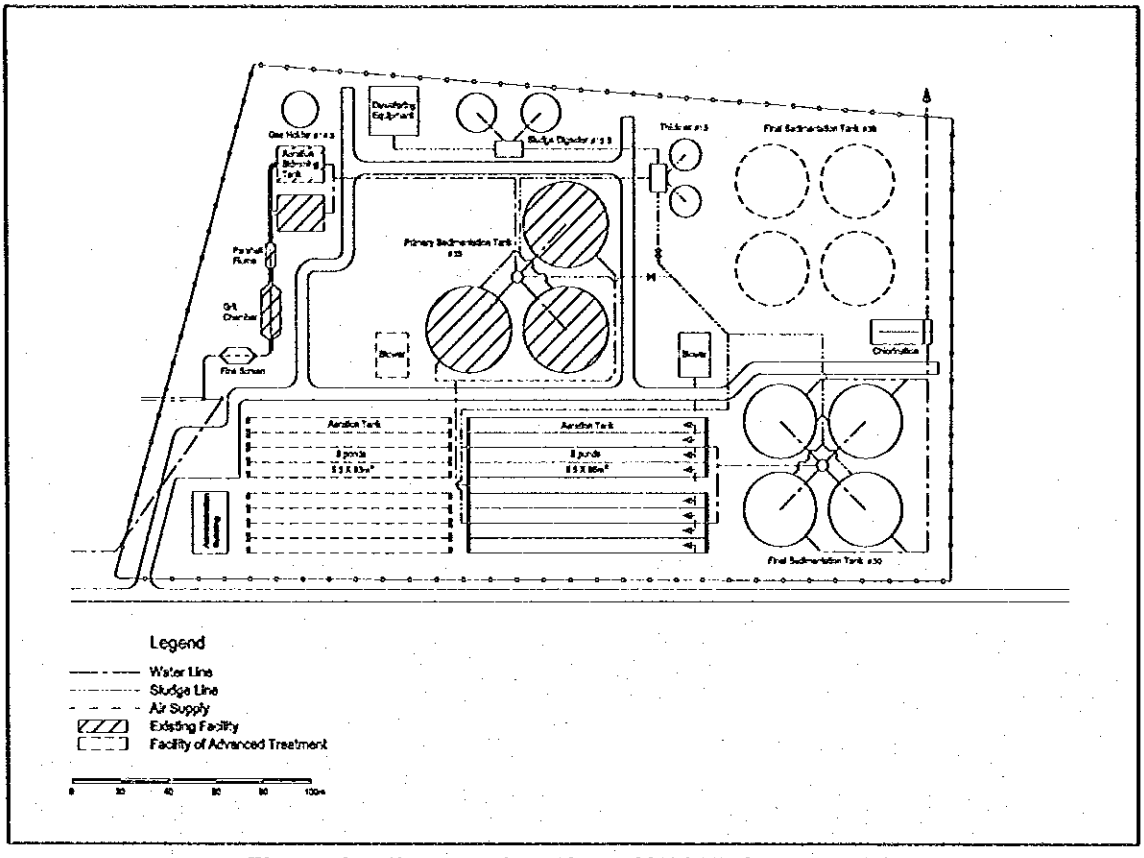


Figure 9 Preparative Plan of WWTP Layout of Calarasi

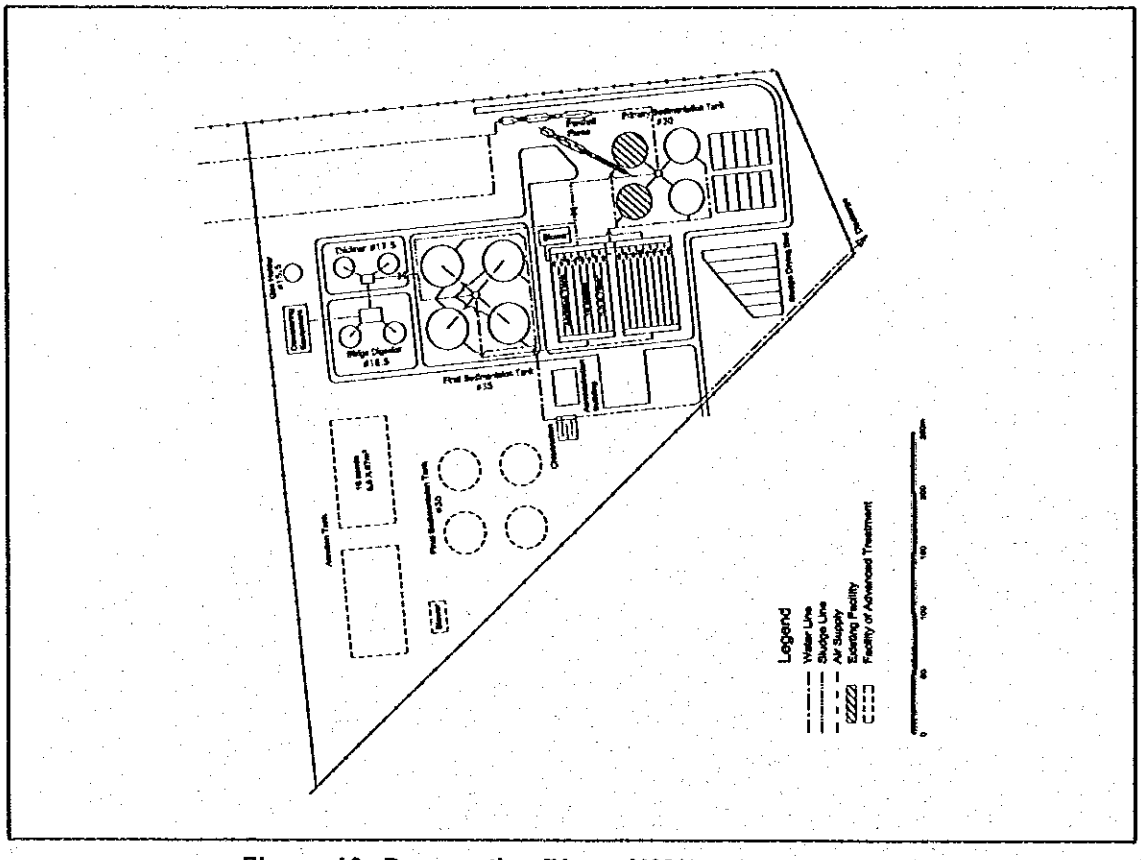


Figure 10 Preparative Plan of WWTP Layout of Giurgiu

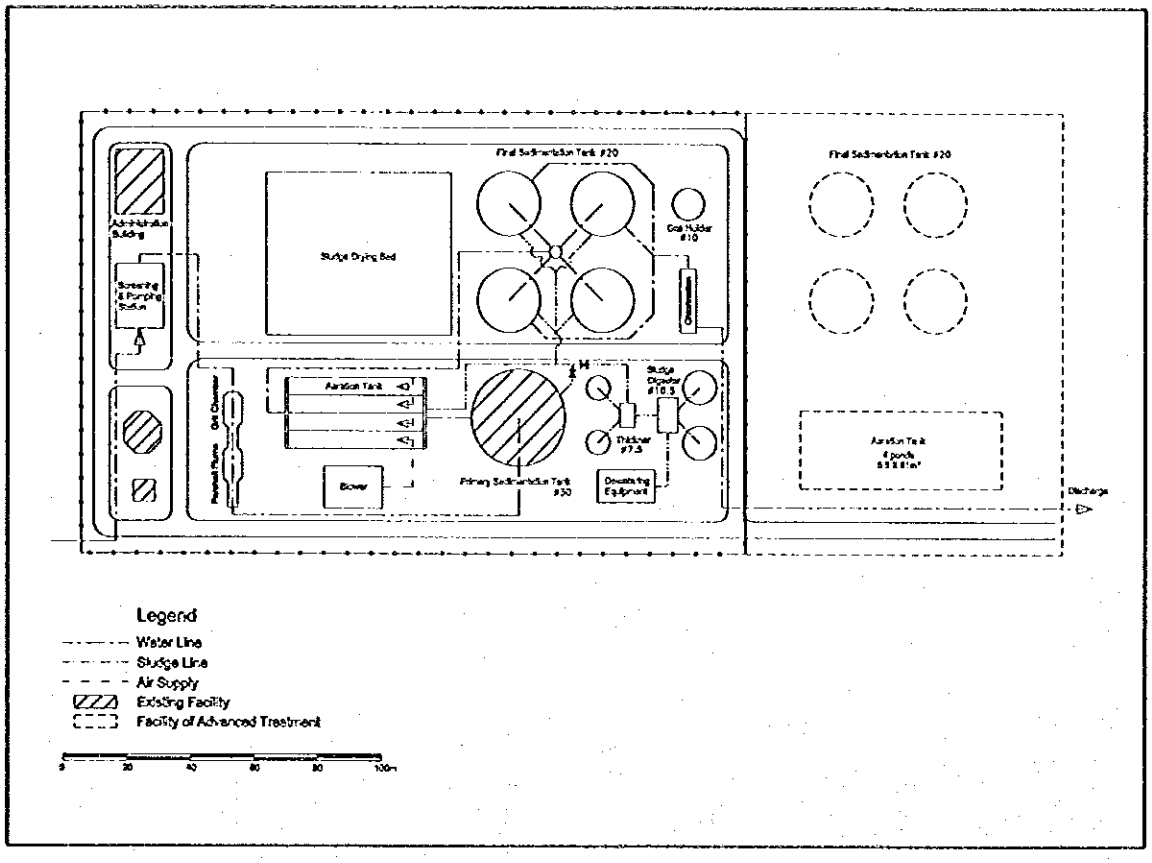


Figure 11 Preparative Plan of WWTP Layout of Turnu Magurele

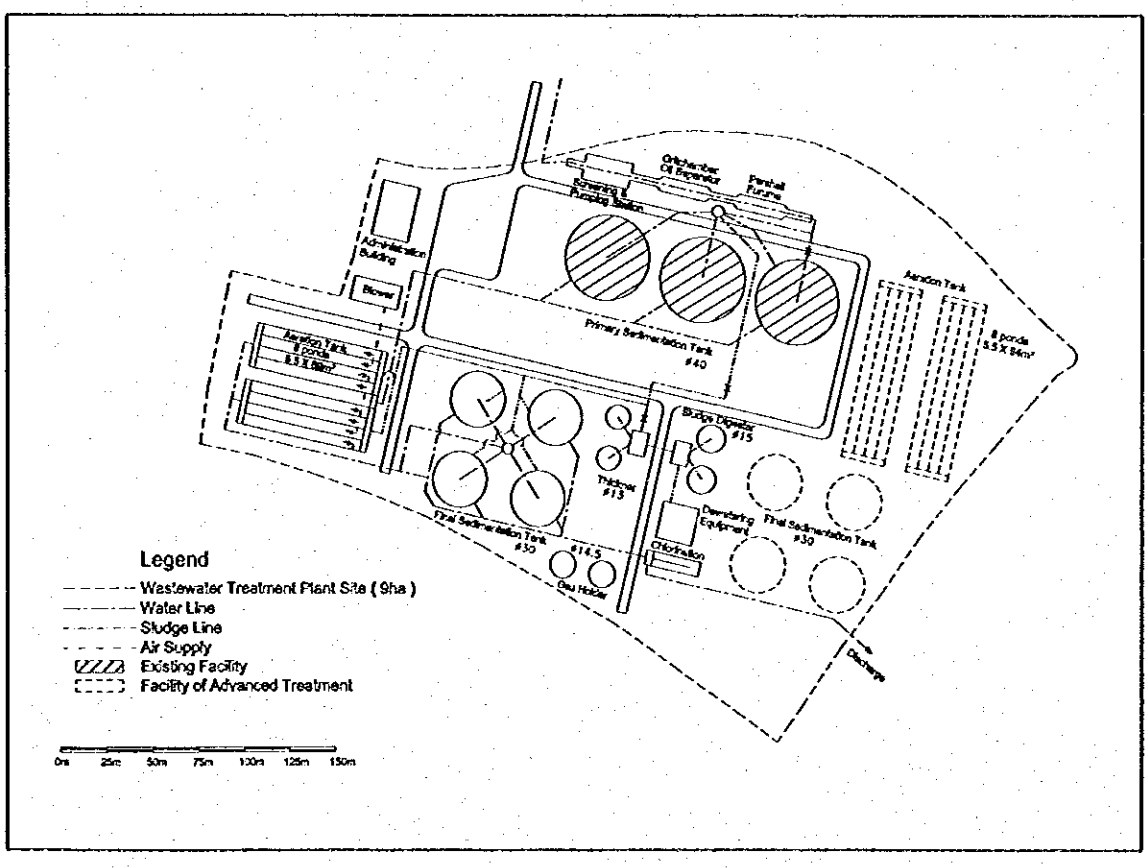


Figure 12 Preparative Plan of WWTP Layout of Drobeta Turnu Severin

11. CONCLUSION AND RECOMMENDATION

11.1 CONCLUSION

The study proposed the construction of the WWTP together with the installation of interceptors necessary to convey wastewater from existing sewered areas to the proposed WWTP. The proposed wastewater treatment employs a conventional activated sludge method, which is one of the basic biological treatments, and could treat the wastewater currently discharged into the Danube River without treatment, to the water quality levels to meet the international requirements, except T-N and T-P.

The feasibility study brought out the technical, economic, and environmental feasibility of the proposed projects, however, the Study revealed financial difficulty in the implementation of the projects. The initial investment cost for the construction of the wastewater is too heavy financial burden for the present city's financial conditions. Therefore, the Study evaluated the financial feasibility, premising the following financial and institutional supports from the state:

- Acceptance of the utilization of state guaranteed external loans.
- Exceptional provision for the aforementioned repayment criterion.
- Application of special subsidy to sewerage development projects

These supports seem to run counter to the spirit of the recent legislative reform that encourages financial independence of local public works from the state. It would be a quite right direction to expand the autonomy of local municipalities and to entrust local public works to the local municipalities' initiative as much as possible.

On the other hand, the state faces to necessity of the development of the wastewater treatment in the country to meet the EU Directives as the EU applicant country, and is internationally responsible for the development of the wastewater treatment along the Danube River. The development of the wastewater treatment could be one of the higher priority policies of the state. As revealed in the Study, the development of the wastewater treatment is too heavy financial burden for the local municipalities of which economy has not grown up enough. If the development is left in the local municipalities' initiative without any guidance and supports by the state, no considerable progress would be expected.

As long as the affordability of the local municipalities remains not enough to develop their wastewater treatment by themselves, the state should take the initiative in order to realize the state policy. Therefore, the Study considered it justifiable to provide the support as tools of the state initiative for the wastewater treatment development, despite of the sprit of the legislative reform.

11.2 RECOMMENDATION TO THE CITY COUNCIL

The Study concluded that the construction of the wastewater treatment plant is feasible. While the state support is essential, the city council should take the first action to realize the project.

The first action would be to take a decision of the implementation of the project. As mentioned above, the project would cause a heavy financial burden and would limit the implementation of other new projects. Every effort to squeeze out the self-financing sources should be done. Process and results of the efforts could be one of means to convince the state to provide the supports. While it is a matter of fact that the project would not work out without the state supports, it should be reminded that the project is not started by the state support but by the city council's initiative.

The Study proposed several options of financial plans by the financial arrangements. Availability of the foreign financial sources depends on the policy of the both recipient country and financing agency. To start seeking for possible finical source will be one of the city council's initiatives. It is suggested that ISPA fund may be the most preferable as it is a grant. The Study provided the city councils with information necessary for the application of such financial sources.

11.3 RECOMMENDATION TO THE STATE

As long as Romania is the EU applicant country, the state should take an initiative to develop the wastewater system in the country. The Study considers that the state supports in terms of financial and institutional assistance are essential for the city council to implement the proposed project, comparing required project costs and the city council's financial capability.

The state is required to provide an arrangement for the state guaranteed external sources, because terms of external loans without the state guarantee are far exceed the city councils' affordability. Also, the state is required to provide exceptions of repayment criterion that is one of conditions for the state guarantee external loans. As explained in the financial plan in this report, the Study proposed a sustainable financial plan that proves capability of a operation company to pay lease fee, which covers all repayment amount and depreciation, to a city council. The Study considers that it is possible to exempt the repayment criterion on security of the financial plan.

Furthermore, the state should provide a subsidy that supplements a self-financing portion of the investment cost. Even if the city council can utilize the state guaranteed external loan, most of the city councils would have a great difficulty in procuring the self-financing portion. A source of such subsidy may be very limited in the state budget. Therefore, the state should have a plan to prioritize city councils for the sewerage development. The proposed subsidy could work as a tool for the state to exert the initiative for the sewerage development. The seven (7) cities in the study area are to have higher priority in the development plan because of their location, which is along the Danube River.