1.3.7 INDUSTRIAL WASTEWATER

Most of factories have their own water sources. Small Factories located in residential areas discharge their wastewaters into the public sewerage system, while factories located in industrial areas discharge their wastewaters into the Danube River directly. *Table II.1.67* shows one of examples of industrial wastewater management in the city.

Table II.1.67 Industrial Wastewater Management in Turnu Magurele

Name of Factory	S.C."Conservturris"S.A.	S.C. "Imperial"S.A. + S.C."Bertexro"S.R.L	S.C."Mopan"S.A.
Main Products	Fresh vegetable, vegetable canning	Textile (Clothes and Knitwear)	Breads
Number of Workers	Total 350 employees including temporary 200	Permanent 280 employees only.	Permanent 110 employees only.
Water Comsuption	1,100 m^3/d	50 m^3/d	72 m^3/d
Wastewater Discharge	1,000 m^3/d to municipal sewerage system. Quality date is not available	50 m^3/d to municipal sewerage system. Quality data is not available.	45 m^3/d to municipal sewerage system. Quality data is not available.

1.3.8 SOLID WASTE

Solid wastes from flats are kept in a container (volume of $3m^3$) which is placed at each block of flats and are collected by three special tracks. While solid wastes from individual houses are collected by three tractors. Solid wastes collected are disposed of at the dumping site located in about 2 km east from the city center. The site has enough capacity at present based on the present planning criteria of per capita solid wastes production volume: 1.5 m^3/capita/year for people living flats, 2.5 m^3/capita/year for people living in individual houses. Total 21 staff works for the operation of solid wastes management. The present charges of solid wastes are 4,000 ROL/capita/month set for people living in flats and 9,000 ROL/capita/month for people living in individual houses.

1.4 DROBETA TURNU SEVERIN

1.4.1 GENERAL

The City of Drobeta Turnu Severin is in southwest of Romania and bordered on Yugoslavia by the Danube River. The city is the capital of Mehedinti Judet (County) and also plays an important role as the center of traffic, trade, industry and tourism. A general map of the city is shown in *Figure II.1.27*.

About 10 km west of the city, there is a famous dam and hydroelectric power station called "Iron Gate (Portile de Fier) having a 1,010 MW turbine plant; the gates on the Romania side are 310m long and 34m wide. This was constructed by a Romania-Yugoslav joint venture in 1960. On the top of the dam wall, a road runs linking between Romania and Yugoslavia. In the city, there are the ruins (two pillars) of old bridge called "Trajan bridge" constructed across the Danube River between 101 to 102 AD by the Roman Emperor Trajan. North-east of the bridge ruins lie the remnants of Castrul Drobeta, a 2nd to 6th century Roman fort that was built to protest the bridge following the Roman conquest of Dacia in 106 AD.

The present city was built during the 19th century when its port was constructed and then expanded to suburban villages where were developed during the construction of "Iron Gate". The present administrative area is 1,322 ha including agricultural area of 1,099 ha.

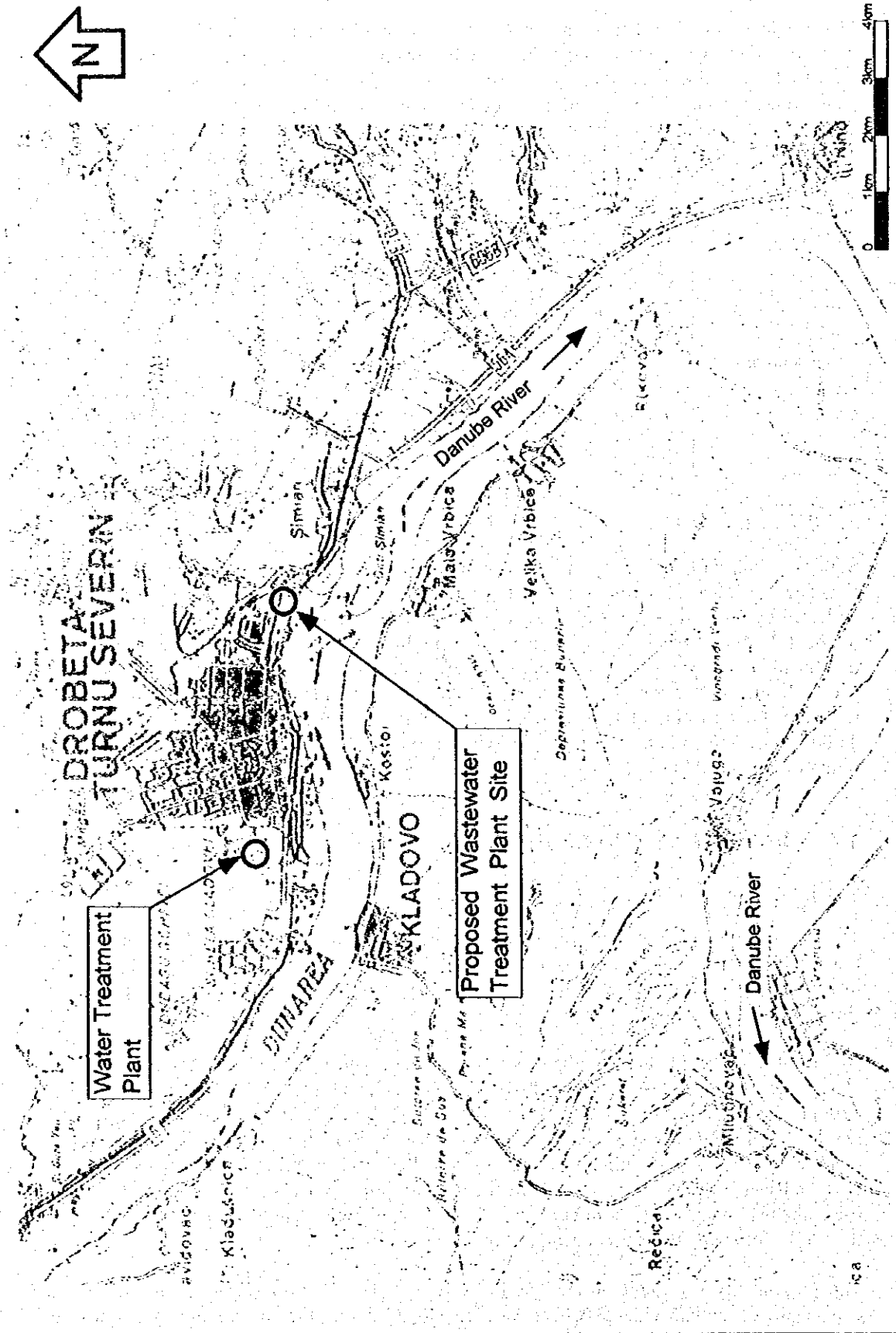

Figure II.1.27	General Map of Drobeta Turnu Severin City

1.4.2 NATURAL CONDITIONS

(1) Temperature and Wind

The annual average temperatures is 11.7℃, with the highest monthly temperature of 23℃ in July and the lowest in January at -1℃. The highest and lowest temperatures ever recorded are -26.6℃ and +42.3℃ respectively.

Prevailing wind directions are west, north-west, and south-east. The frequencies of the winds from west directions are 18 %, and those of the winds from north-west and south-east are 9.4% and 8.8% respectively.

(2) Precipitation

The annual average precipitation is about 675 mm. The monthly average precipitation is high as about 73mm in May, June and November. The dry periods are in August, September, February, and March. The maximum 24 hours rainfall ever recorded is 171.7 mm in July 1969. The average numbers of snowfalls days are 60 days during December and March.

(3) River Information on Flow, HWL, and LWL

The following information on the Danube River is available at two gauge stations.

Table II.1.68 Information of Danube at Drobeta Turnu Severin

Name of Station	Information		Remarks
CILDRO	Attention water level	44.27 m	43.53 m(*)
	Corresponded Flow	Q=11,000 m³/s	
	Flood water level	44.83 m	45.57 m(*)
	Corresponded Flow	Q=13,000 m³/s	
	Evacuation level	45.83 m	46.57 m(*)
	Corresponded Flow	Q=14,000 m³/s	
	Maximum flood flow record	Q=14,700 m³/s	(July 22nd, 1981)
	Maximum flood flow verifying evacuation	$Q_{0.01\%}$=22,300 m³/s	1/1,000 year
PF2	High Water Level (HWL)	41.00 m	
	Low Water Level (LWL)	39.40 m	
	Lowest Low Water Level (LLWL)	38.50 m	

Source: Drobeta Turnu-Severin City
Note) (*) shows Adriatic Sea Level, other figures are Black Sea Level. Adriatic Sea Level =Black Sea Level + 0.74 m

1.4.3 SOCIO-ECONOMIC CONDITIONS

(1) Population

It is estimated that the population of Drobeta Turnu Severin rose to the 100,000 level in 1989 or 1990. Since 1990, it traced an upward trend up to the middle of the 1990's, attaining the 118,000 level. Then, it has virtually maintained the same level up to 1998.

The population of the city in 1999 is estimated at 120,500. It is projected to increase to

140,000 in the target year od 2010. It means that the it will grow from now on at the average annual rate of 1.4%.

It is crucial to make a reasonable projection of the population since it forms the very basis on which to plan and design the future wastewater treatment plant.

The average number of members per household is 2.7, and the average number of bread earners per household is 2.0.

(2) Industries

As shown in the table below, the number of employees totaled 41,386 in 1996. It is on a downward trend these years. Out of it, the primary, secondary and tertiary sectors accounted for 1.6%, 57.1% and 41.4% respectively. The predominance of the secondary sector is to be noted. Especially, the number of workers in the manufacturing industry reached 16,989, occupying 41.1% of the entire workforce.

Table II.1.69 Number of Workers by Type of Activities

	1992	1993	1995	1996	%
Primary Industry	1,523	1,016	145	645	1.6
Secondary Industry	31,135	23,981	22,127	23,623	57.1
Mining Industry	1,697	0	0	0	0.0
Manufacturing Industry	20,558	18,576	16,644	16,989	41.1
Production & Distribution of Electricity, Gas and Water	3,025	1,441	1,491	1,868	4.5
Construction	5,855	3,964	3,992	4,766	11.5
Tertiary Industry	20,435	17,927	17,853	17,118	41.4
Total	53,093	42,924	40,125	41,386	100.0

Source: Drobeta Turnu-Severin City

Major products of the manufacturing industry are vehicles, metals, alcoholic drinks, alcohol and textile.

(3) Organization

The organization chart of Drobeta Turnu Severin city office is shown in *Figure II.1.28.*

Sewerage service is operated by S.C. SECOM S.A. S.C SECOM S.A. is a commercialized company. Now 99.94% of its share is owned by the State Ownership Fund.

S.C. SECOM S.A has 210 personnel in total and operates water supply and sewerage services. Technical part of the company consists of following sections.

- Water factory section with 104 personnel, and
- Water supply-sewerage network section with 57 personnel.

The organization chart of S.C. SECOM S.A is shown in *Figure II.1.29.*

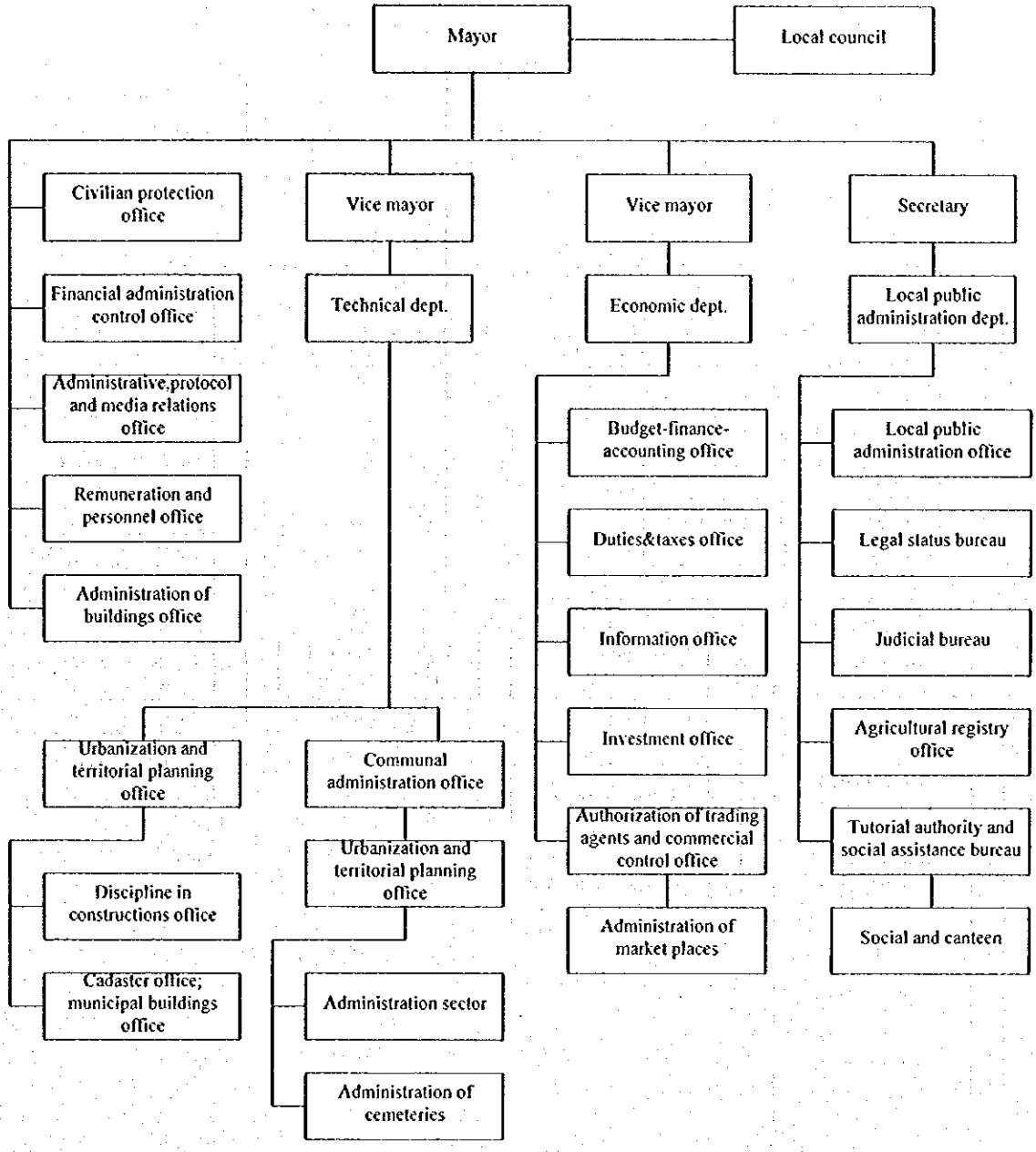

Figure II.1.28 | **Organization Chart of Drobeta Turnu Severin City Office**

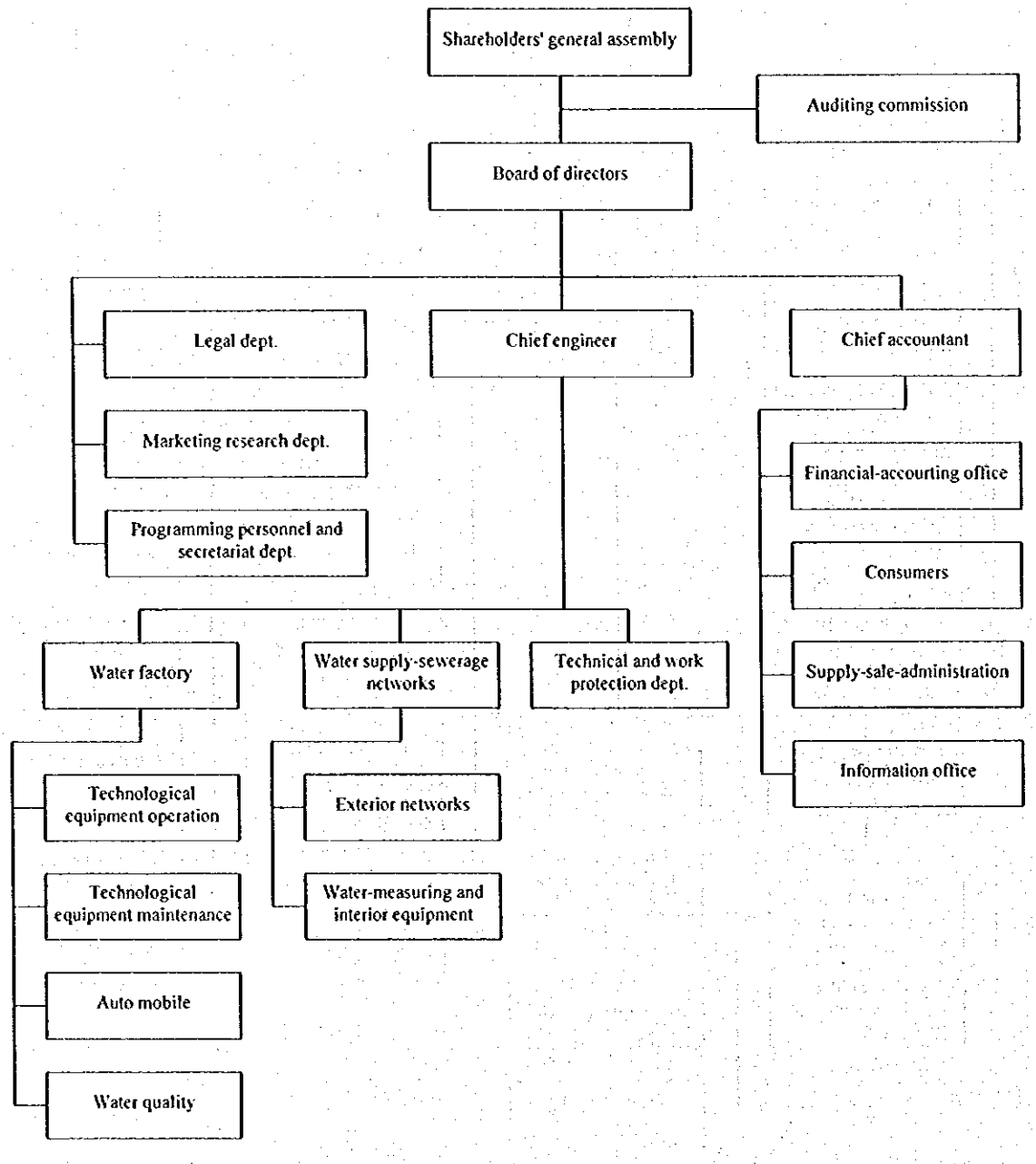

Figure II.1.29 | **Organization Chart of S.C. SECOM S.A.**

(4) Financial Conditions of the City

As shown in the table below, during7 years 1992 to 1999, the local budget of Drobeta Turnu Severin grew 433 times from ROL 183 million to ROL 79,320 million. Its average annual growth rate is calculated at 138.1%. During the same period, prices increased at the average annual rate of 76.9%. That is to say, the local budget increased in real terms by 34.6% per year on average.

Table II.1.70 Total Amount of Budget

1992	1993	1994	1995	1996	1997	1998	1999
183	675	4,514	17,715	25,648	50,281	56,229	79,320

Source: Drobeta Turnu Severin City (Unit:1,000,000 ROL)

The local budget of Drobeta Turnu Severin for 1999 totals ROL 79,320 million, which is by 41.1% greater compared with the budget for 1998, ROL 56,229 million.

Because of the new local finance law which was put into force in January, 1999, there is no subsidy from the central government any longer. Under the law, 31.5% of the tax on salaries goes directly to the local government. Also, 45% of this tax is allocated for the state income budget, of which a part is transferred to the local government through the county as the quota. This quota is different from the direct transfer from the state, but by nature is an addition to the above direct local tax on salaries. It occupies the majority of the transfer from the state income budget. That is, in principle, almost all the income of the local budget now derives from its own sources. It in turn gives freedom to the local authorities to use the income in whatever way they deem proper.

As shown in the table below, out of the city's total income budget of ROL 79,320 million in 1999, 49.3% came from its own sources, and the balance of 50.7% was the transfer from the central government (most of which consists of the above-mentioned quota).

Regarding the expenditure budget, capital expenditure, which is spent for the economic development of the city accounted for 28.6%.

54.0% or the majority of the expenditure budget went to "Services and Public Development, Dwellings, Environment and Water" which includes the sewerage sector. 22.0% was allocated for "Socia-Cultural".

Table II.1.71 Breakdown of Local Budget for 1999

Item	Amount	Ratio (%)
Total Income	79,320,372	100.0
1. Own Income	39,110,962	49.3
2. Money from State Income Budget	40,209,410	50.7
3. Subsidy	0	0.0
Total Expenditure	79,320,372	100.0
1. Current Expenditure	54,537,857	68.8
1) Personnel	5,187,036	6.5
2) Services and Materials	38,353,986	48.4
3) Subsidies	8,630,595	10.9
4) Transfer	2,306,240	2.9
5) Interest	60,000	0.1
2. Capital Expenditure	22,660,181	28.5
3. Financial Operations	1,972,334	2.5
4. Reserves	150,000	0.2

Source: Drobeta Turnu Severin City (Unit: 1,000 ROL)

Table II.1.72 Breakdown of Local Expenditure for 1999

Item	Amount	Ratio (%)
Total Expenditure	79,320,372	100.0
1. General Public Services	12,152,740	15.3
2. Social-Cultural	17,439,526	22.0
3. Services and Public Development, Dwellings, Environment and Water	42,852,707	54.0
4. Economic Activities	1,571,725	2.0
5. Other Activities	130,000	0.2
6. Transfer	0	0.0
7. Payment of Interest, etc.	60,000	0.1
8. Repayment of Loans	1,972,334	2.5
9. Expenditure with Special Destination	2,800,700	3.5
10. Sanitary and Veterinary Office	190,640	0.2
11. Reserve Funds	150,000	0.2

Source: Drobeta Turnu Severin City (Unit: 1,000 ROL)

(5) Financial Conditions of S.C. SECOM S.A.

S.C. SECOM S.A. provides water supply and sewerage services to the citizens of Drobeta Turnu Severin.

Since the beginning of 1998 up to now water and sewerage tariffs were revised 6 times. It shows a serious endeavor on the part of S.C. SECOM S.A. to make ends meet in this sector. Water tariffs seem to be on the high side compared with sewerage tariffs.

As of July 14, 1999 the sewerage charges for domestic and industrial customers are ROL 125 and ROL 160 respectively.

Table II.1.73 Water and Sewerage Charges

Item	Water Supply		Sewerage	
	Domestic	Industrial	Domestic	Industrial
Jan. 1, 1998	960	1,805	75	120
Feb. 1, 1998	1,045	1,965	80	130
Apr. 1, 1998	1,140	2,140	85	140
Jul. 5, 1998	1,215	2,280	90	150
Oct. 14, 1998	1,285	2,280	95	150
Apr. 1, 1999	1,380	2,245	102	160
Jul. 14, 1999	1,655	2,245	125	160

Source: S.C. SECOM S.A. (Unit: ROL/m^3)

The total volume of wastewater discharged into sewerage was 10,275,000 m^3 in 1998. It occupied 70.0% of the total volume of water supply. The income from sewerage services came to ROL 1,462 million in the same year. It corresponded to 7% of the income from water supply.

Table II.1.74 Income from Water Supply and Sewerage Services for 1998

Item	Total Volume (1,000 m^3)	Total Income (1,000 ROL)
Water	14,678	21,383,510
Sewerage	10,275	1,461,791

Source: S.C. SECOM S.A.

The total volume of wastewater discharged into sewerage was 5,370,000 m³ in the 1st half of 1999. The volume of sewage was 72.7% of that of water in the same period. The income from sewerage services came to ROL 811 million. It corresponded to about 7% of the income from water supply.

Table II.1.75 Income from Water Supply and Sewerage Services for 1st Half of 1999

Item	Total Volume (1,000 m³)	Total Income (1,000 ROL)
Water	7,384	11,925,970
Sewerage	5,370	810,973

Source: S.C. SECOM S.A.

The following table shows the financial performance of S.C. SECOM S.A. The company earned ROL 811 million, while it spent ROL 758 million, begetting a surplus of ROL 53 million or 6.5% from the sewerage services in the 1st half of 1999. It also produced surpluses in the preceding three years. Financial management of sewerage services looks on the whole sound and stable. The same can be said with water supply, too.

Table II.1.76 Financial Performance of S.C. SECOM S.A.

Item		1996	1997	1998	1st Half, 1999
Water Supply	Income	5,820,830	15,833,938	21,383,510	11,925,970
	Expenditure	5,528,382	15,529,635	20,370,510	11,147,215
	Profit	292,448	304,303	1,013,000	778,755
	Profit Rate (%)	5.0	1.9	4.7	6.5
Sewerage	Income	561,873	1,179,503	1,461,791	810,973
	Expenditure	540,533	1,047,352	1,163,791	757,991
	Profit	21,340	132,151	298,000	52,982
	Profit Rate (%)	3.8	11.2	20.4	6.5
Total	Income	6,382,703	17,013,441	22,845,301	12,736,943
	Expenditure	6,068,915	16,576,987	21,534,301	11,905,206
	Profit	313,788	436,454	1,311,000	831,737
	Profit Rate (%)	4.9	2.6	5.7	6.5

Source: S.C. SECOM S.A. (Unit: 1,000 ROL)

The cost of sewerage services per m³ of sewage was ROL 113 as shown in the following table. Of it, "Materials" and "Depreciation" accounted for 48.7% and 28.3% respectively. They were followed by "Personnel" and "Electricity" with 14.2% and 7.1% respectively. The per m³ cost of water supply was more than 12 times greater than that of sewerage services.

Table II.1.77 Unit Expenditure for Water Supply and Sewerage Services (1998)

Item	Water	Sewerage
Materials	130	55
Electricity	730	8
Duties and Taxes	4	0
Personnel	292	16
Payment for Services by Other Companies	46	2
Depreciation	84	32
Others	102	0
Total	1,388	113

Source: S.C. SECOM S.A. Unit: ROL/ m³

The cost of sewerage services per m³ of sewage was ROL 141 in the 1st half of 1999. Of it, "Electricity" and "Personnel" accounted for 41.8% and 27.7% respectively. They were followed by "Materials" and "Depreciation" with 12.1% and 6.3% respectively. The per m³ cost of water supply was more than 10 times greater than that of sewerage services.

Table II.1.78 Expenditure for Water Supply and Sewerage Services (1st Half, 1999)

Item	Water	Sewerage
Materials	130	17
Electricity	666	59
Duties and Taxes	43	6
Personnel	444	39
Payment for Services by Other Companies	24	2
Depreciation	116	9
Others	87	9
Total	1,510	141

Source: S.C. SECOM S.A. Unit: ROL/ m³

From the above, it can be said that the four major cost items are "Electricity", "Personnel", "Materials" and "Depreciation" in the sewerage services. The same is true with water supply.

During the three years 1996 to 1999 the income budget of SECOM grew 3.7 times from ROL 6,422 million to ROL 23,750 million at the average annual rate of 54.6%. These four years it compiled the budget in such a way that it could make a certain amount of profit each year. It succeeded in it despite the fact that the collection efficiency of water and sewerage charges has been at the 70% to 80% level.

Table II.1.79 Planned Budget of S.C. SECOM S.A.

Item	1996	1997	1998	1999
Total Income	6,422,300	23,140,000	25,220,000	23,750,000
Total Expenditure	6,144,846	22,781,880	24,536,000	22,975,000
Materials	1,071,600	3,000,000	3,200,000	2,250,000
Energy	3,200,000	11,040,000	12,000,000	11,000,000
Depreciation	264,000	600,000	1,500,000	1,500,000
Services Provided by 3rd Companies	160,000	2,400,000	600,000	400,000
Salaries	800,000	3,400,000	4,500,000	5,000,000
Social Protection	240,000	720,000	1,400,000	1,750,000
Others	409,246	1,621,880	1,336,000	1,075,000
Profit	277,454	358,120	684,000	775,000
Profit Rate (%)	4.3	1.5	2.7	3.3

Source: S.C. SECOM S.A. (Unit: 1,000 ROL)

The collection efficiency of water and sewerage charges in recent years was 72.69% to 80%.

Table II.1.80 Water and Sewerage Charges Collection Efficiency

Item	1996	1997	1998	1st Half of 1999
Collection Rate	72.7%	75.5%	78.8%	80.0%

Source: S.C. SECOM S.A. (Unit: 1,000 ROL)

The following things are essential to work out a sustainable financial plan on sewerage services.

- Estimation of the willingness and affordability of the households to pay sewerage charge to clarify the extent and limit of household income allocable to it.

- Incorporation of the actual collection efficiency in formulating income budget and cost analysis to realize proper level of cost per unit volume of sewage.
- Preparation of funds statement and balance sheet besides income statement in order to assure a long term profitability and solvency.

1.4.4 WATER SUPPLY

(1) General

The City has a centralized piped water supply system. The present system provides services to Schela Cladovei Village as well as to the urban area of Drobeta Turnu Severin City. The present water system covers 100% of the residents in urban area. Thus, the present actual service population is more than 111,200.

(2) Present Supply Conditions

The main water source for the piped water supply system is the surface water from Danube River. There are two intake structures, called "Scelif" and "Romag" along the Danube River located about 5 km to the west from the city center. At present about 3,200 L/s (276,480 m³/d) of the surface water is taken directly from the Danube River, of which about 938 L/s (about 81,000 m³/d) is for domestic purposes, and 402 L/s (34,800 m³/d) is for commercial, institutional purposes and for industrial purpose for small factories.

And the remaining 1,860 L/s (160,700 m³/d) is taken for large factories; 1,500 L/s (129,600 m³/d) for a factory producing heavy water and 360 L/s (31,100 m³/d) for a factory producing semi-chemical pulp, called "CELROM".

Water quality of Danube River from 1987 to 1997 is summarized in the table below.

Table II.1.81 Water Quality of Danube River for Water Supply during 1987 - 1997

Parameter	Unit	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Turbidity		3.5	4	4	5	6	7	7	8	9	10	10
Colour		1	1	2	3	3	4	4	4	4	5	5
pH		8.2	8.2	8.1	7.9	7.9	7.8	7.8	7.8	7.8	7.7	7.7
$KMnO_4$ consumption	mg/L	10.8	11.1	11.7	12.3	14.1	13.5	14.7	15.3	15.9	16.8	18.3
Alkalinity		3.4	3.4	3.3	3.2	3.2	3.1	3.0	3.0	2.9	2.8	2.7
Total Hardness		9.6	9.6	9.8	9.2	9.2	9.4	9.6	9.6	9.4	9.6	9.8
Total Iron	mg/L	0.04	0.06	0.08	0.04	0.06	0.06	0.08	0.20	0.10	0.30	0.30
Manganese	mg/L	0	0	0	0	0	0.01	0	0.01	0.02	0.01	0.02
Nitrogen	mg/L	0.4	0.6	0.4	0.8	1.6	2.0	2.2	2.1	2.2	2.3	2.3
Phosphorus	mg/L	0.002	0.01	0.02	0.03	0.05	0.04	0.06	0.07	0.08	0.08	0.10
DO	mg/L	9.0	8.6	8.4	8.2	7.9	7.4	6.2	5.8	5.6	5.0	5.0
Phenols	μ g/L	5	7	8	7	10	12	13	12	18	23	25
Zooplankton	MPN/L	10	15	15	20	25	30	35	40	45	45	50
Phytoplankton	MPN/L	1	1	1	1	2	2	2	2	5	3	3

Source: S.C. SECOM S.A.

The surface water is conveyed by a raw water main to the water purification plant located at the northern part of Industrial Platform South-West. At the plant the water is treated by a rapid sand filtration method, which is composed of coagulation tanks, sedimentation tanks, rapid sand filters and chlorination tanks. The plant has the daily average production of 116,000 m³/d.

The treated water is kept once at the treated water reservoirs and distributed directly through pumps to the consumers. The treated water reservoirs have enough capacity to distribute the water but the distribution pumps are necessary to improve the capacity. The existing pumps having the design capacity of 1,870 L/s are very old now and its working efficiency becomes lower, and moreover some pumps are worn-out or damaged. Therefore, the present capacity is only 530 L/s, which is less than one-third of the design capacity. Rehabilitation of the pumps is planned including rearrangement of water distribution networks.

The treated water is distributed directly to the houses and flats in Schela Cladovei Village as well as to Drobeta Turnu Severin by pumps installed at the water purification plant.

About 140 km of water distribution networks has been established for urban area and the industrial platforms. Only 40 % of the supplied water is measured by some bulk water meters when the water is supplied to flats or institutions. There are no practices to install water meters to the individual households.

The water demand is estimated at about 1,870 L/s (161,600 m³/d). During the high water demand (consumption) hours between 6 to 8 hours in the morning and 18 to 20 hours in the evening, the water is not supplied enough.

According to S.C. SECOM S.A., total unaccounted system losses and leakage from the intake to individual house connections are estimated about 32 %. The breakdown is as follows: those from the intake to the water purification plant are about 13%, those of distribution net works are about 9% , and those of house-connections are 10%.

(3) Future Development Plan

A plan of introducing groundwater is in progress, about 30% of the construction work is completed. The wells are at Topolnita located 37 km far from the city center. The groundwater be taken about 52,000 m³/d, and conveyed by gravity flow with the raw water main having a diameter of 1,000 mm. The water quality is very good for drinking purposes. However, the implementation of the construction work has not progressed due to financial constraints.

After the groundwater source development is completed, the water system will be modified in the industrial area and its service conditions are expected to improve. At first, Industrial Platforms East will be supplied separately from the present urban water supply system. Second, the supply conditions to Schela Cladovei Village will be more reliable or stable than the present conditions as well as those in the urban area.

1.4.5 SEWERAGE SYSTEM

(1) General

The City has developed combined sewer networks in principle, to collect both wastewater and storm-water, except for some limited area of the city where separate sewer system is applied. All collected domestic wastewater is discharged to Danube River without any treatment.

The present sewerage facilities are constructed based on the project no 1582-ISPGC for the stage technical-economical study had approved in 1975. The facilities constructed are as follows: pumping station, named SP0 having capacity of 600 L/s, pressure pipeline of L=2.2 km, main collectors of L=13.0 km. These facilities were commissioned in 1979, but the planned wastewater treatment plant was not constructed.

A study was conducted in 1985 to improve the storm-water management by installing structures

for Combined Sewer Overflow (CSO), composed of seven (7) regulators and diversion structures and seven (7) CSO outlets. But actually the implementation of CSO structures was limited for only one facility due to financial constraints. And the CSO structure installed has a small outlet having only 300 mm in diameter even though it was designed to have a 1,000 mm diameter. Therefore, almost all of the combination of wastewater and storm-water are conveyed by the interceptor during wet weather conditions.

(2) Existing Sewerage Facilities

Combined sewer networks are developed for the most of urban area of the city, for the industrial area of East and South-East, for the area of Schela Cladovei, and for the industrial area of South-West. In urban area and industrial areas of East and South-East, both wastewater and storm-water are collected by gravity flow, conveyed by gravity flow with the interceptor, and finally discharged into the Topolnita River. The river joins the Danube River near the discharging point, but in the area of Schela Cladovei and the industrial area of South-West, both wastewater and stormwater are collected by collector sewers and discharged directly into the Danube River. Only some portions are conveyed to a pumping station, called SP0 and discharged directly into the Danube River. In the future, the wastewater and stormwater collected from the latter areas, will be intercepted and pumped up by 3 pumping stations to the existing interceptor. Thus all intercepted wastewater and stormwater be conveyed to the proposed wastewater treatment plant and treated, as shown in *Figure. II.1.30.*

Three pumping stations were planned, but only two pumping stations, called SP0 and SP1, were constructed. A pumping station called SP2 has never been constructed.

In the SP0, the following equipment was installed: three units of electrical vertical pumps including one standby, type MV303, capacity Q=900 m³/h (250 L/s), total head of 38 m, motor output; 2 units of 160 kw and one unit of 30 kw. The pipes are as follows: each suction pipe diameter is 500 mm, each discharge pipe diameter is 400 mm, and final combined discharge pipe diameter is 800 mm.

Concerning the SP1, the following information is available: Three units of electrical vertical pumps with one standby, type ACV200-15, capacity Q=500 m³/h (138 L/s), total head of 15 m, motor output of 45 kw and pipe diameter of 600 mm. However, the equipment had never been used after construction.

For the planned pumping station, SP2, any information on the design was not available during the basic survey.

Total length of sewer networks is 137 km with six main collectors. The following table shows the breakdown of sewers installed and indicates that the total length of sewers is 120 km, which is slightly different from those mentioned above.

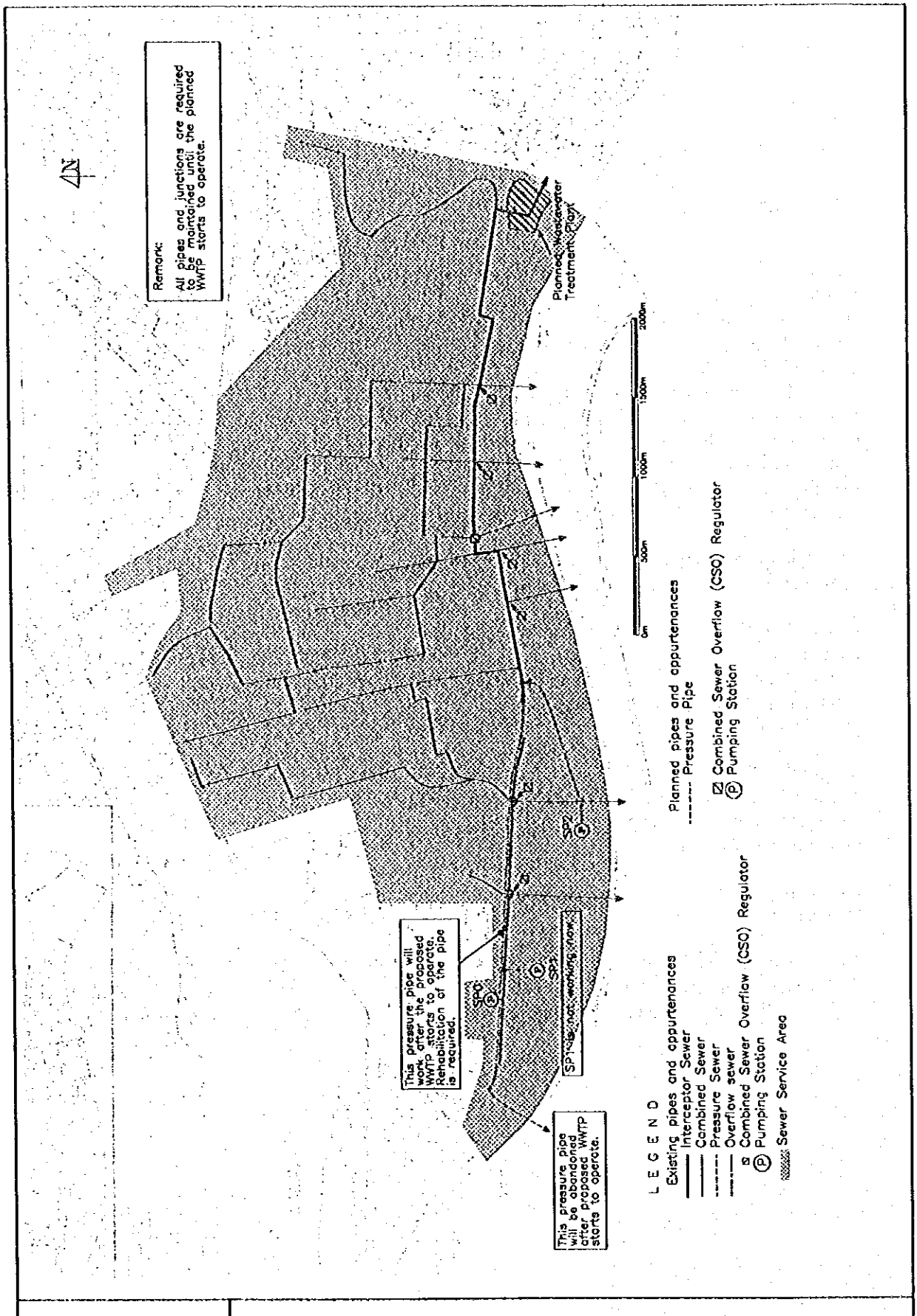

Figure II.1.30	Existing Sewerage System of Drobeta Turnu Severin

Table II.1.82 Existing Sewers in Drobeta Turnu Severin City

Type of Sewers (Material)	Diameter (mm)	Length (km)	Remarks
Collectors (Stone-ware)	150 < 300	8.0	
	300 < 400	5.2	
	400 < 500	1.5	
	more than 500	0.4	
	sub-total	15.1	
Collectors (PVC)	150 to 300	2.0	
Collectors (Concrete)	150 < 300	32.0	
	300 < 400	37.9	
	400 < 500	4.8	
	more than 500	3.7	
	sub-total	78.4	
	Total	95.5	
Main collectors (Concrete)	500 / 750	2.0	Bell shaped
	600 / 900	5.5	Bell shaped
	800 / 1200	4.8	Bell shaped
	900 / 1350	0.9	Bell shaped
	1000 / 1500	1.0	Bell shaped
	1000 / 1600	3.3	Bell shaped
	Total	17.5	
Interceptors (Concrete)	500 / 800	2.5	Bell shaped
	600 / 900	0.5	Bell shaped
	800 / 1200	0.9	Bell shaped
	1000 / 1500	3.1	Bell shaped
	Total	7.0	
Total Length of Sewers		120.0	

Source: S.C. SECOM S.A.

(3) Future Improvement Plan

The latest plan of wastewater management is the F/S conducted in 1981. In the 1981 F/S, the following wastewater treatment facilities were proposed to construct at the river mouth of Topolnita River in the eastern part of the city. All the wastewater conveyed by the interceptor be treated at a primary level. The components of system proposed are as follows: Screens, aerated grit chamber, and primary settling tanks are for the wastewater treatment and sludge thickening, anaerobic digester with a gas holder and sludge drying bed are for sludge treatment. The outline of proposed treatment facilities are as shown in *Table II.1.83*.

Table II.1.83 Outline of the Proposed Wastewater Treatment Facilities

Facilities	Main Features	Number	Remarks
Wastewater Treatment			
Screen	Width: 1.60 m, Depth: 2.00 m, Spacing: 20 mm	3 units	Mechanical screen removal equipment Design flow: 4,100 L/s
Horizontal Grit Chamber	Width: 3.15 m, Total Depth: 4.0 m, Length: 32.0 m	4 compartments	Design flow: 4,100 L/s Platforms for grits : 350 m^2
Skimming Tanks (Oil Separator)	Cross section: 6.75 m^2 each, Length: 30.0 m, Total volume: 810 m^3	4 units	Design Flow: 3,600 L/s, Retention time: 9.92 min.
Distribution Tank			
Primary Sedimentation Tank	Dia. = 45 m, circular type	2 units	Design Flow: 1,360L/s, Surface loading: 16$m^3/m^2/h$, Retention time: 1.39 hrs
Sludge Treatment			
Thickening Tank	Dia.: 20 m, circular type, Total Depth: 3.0 m, Total Surface Area: 320 m^3, Volume: 960 m^3	2 units	Equipped with sludge scraper and scum collector
Anaerobic Digester	Volume: 4,000 m^3 each	2 units	
Gas Storage Tank	Volume: 1,000 m^3	1 unit	
Drying Bed	Total Volume: 20,000 m^3		Volumetric loads: 3 $m^3/m^2/y$
Sludge pump house	Dia.: 4.0 m, Depth: 8.00 m	2 wells	
Equipment			
Blower	SRD 40 blowers	3 units including one standby	
Primary Sludge Pumps	Type EPEG 100-26, Q: 100 m^3/h, Total Head: 15.0 m, Motor Output: 11 kw.	2 units including one standby	Primary sludge: 440 m^3/d
Thickened Sludge Pumps	Type EPEG 80-30, Q: 100 m^3/h, Total Head: 25.0 m, Motor Output: 22 kw.	2 units including one standby	
Steam Generation Station			For heating anaerobic digester

Source: S.C. SECOM S.A.

1.4.6 On-site Sanitation

About 18,000 of population is not served by the public sewerage service. They use on-site sanitation system such as pit latrines and septic tanks. In the city, about 30 septic tanks are used for 100 inhabitants. The septage produced in the septic tanks is collected by a vacuum truck owned by the public corporation, R.A. Lotus, and desposed of at the municipal solid wastes dumping site.

1.4.7 Solid Waste

The city provides service of solid wastes collection and disposal. The service is operated by the SECOM S.A. All the collected wastes are disposed of at a dumping site located in the Simian commune.

The city has a plan of pre-F/S to construct a solid wastes landfill facility on the north-eastern

outskirts of the city, located at the Dudasu Cerneti, near the bank of Topolnita River. About 20 hectares are planned to develop the facility for ecological landfill, which has a capacity to cover 60 years' solid wastes production in the city. The facility be developed in three stages:

1st stage: A landfill facility having effective volume of 520,000m^3 (width x length x depth x units =50 m x 400 m x 9 m x 3) will be constructed. All collected solid wastes are planed to disposed of at the facility. Since the projected annual volume of collected solid wastes is about 50,000 to 60,000 m^3/year, the facilities will be able to work for seven to eight years.

2nd stage: The same scale of landfill facility will be constructed at this stage. Separate collection of solid wastes will be introduced to promote reuse of valuable materials in the wastes and to reduce the volume of solid wastes to be disposed off to the landfill facility. The city expects the landfill facility will last 30 years.

3rd stage: The same scale of landfill facility will be also constructed.

CHAPTER 2 PLANNING BASIS

2.1 DESIGN BASIS

Design bases are determined as shown in *Tables II.2.1* and *II.2.2*, based on the review of the existing studies and the results of wastewater quality survey conducted by the JICA Study Team during the Study.

Table II.2.1 Design Wastewater Inflow

Design Flow	Calarasi	Giurgiu	T. Magurele	D.T. Severin
Average Daily Flow (m^3/day)	42,600	71,900	17,000	53,800
Maximum Daily Flow (m^3/day)	55,730	82,100	20,000	63,400
Maximum Hourly Flow (m^3/day)	66,960	98,500	25,000	74,400
Wet Weather Flow (m^3/day)	--------	--------	50,000	148,800

Table II.2.2 Design Wastewater Quality

Design Influent Quality	Calarasi	Giurgiu	T. Magurele	D.T. Severin
BOD, (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

The review of the existing studies and the results of wastewater quality survey conducted by the JICA Study Team are explained below.

2.2 REVIEW OF THE 1995 F/S ON CALARASI WWTP EXPANSION

For expansion of the Calarasi wastewater treatment plant, a feasibility study was conducted based on the data supplied by S.C. APA CANAL S.A. in 1995. The followings are a summary of review of planning bases in the 1995 F/S taking into account of the present conditions of water supply and wastewater management.

2.2.1 TARGET YEAR

The target year for the 1995 F/S is not mentioned in the reports available. According to the city council, the target year for the 1995 F/S is the year of 2010.

2.2.2 POPULATION

(1) Administrative Population

In the 1995 F/S, the future administrative population is not studied, but the service population of water is studied as mentioned below.

The present population of the city is 77,666 as of 1998. During seven (7) years from 1992 to 1998, the population in the city was constant about 77,000 to 78,000.

(2) Service Population

Table II.2.3 summarizes the present and future service population of public water supply and sewerage services based on the information collected. The future service population is summarized from a calculation sheet for the future domestic drinking water consumption

prepared under the task of the 1995 F/S. The future service population of water supply is set at 1.2 times as large as the service population in the year 1995. The service population of sewerage is not mentioned in the 1995 F/S report.

Table II.2.3 Service Population of Public Water Supply and Sewerage Services

Service Category	Classification	Service Population	
		In 1998	In 2010*
1	Water distributed through street taps	327	0
2	Water distributed through yard taps	6,552	20,140
3	Houses with plumbing and sewer pipes	0	0
4	Houses with plumbing and sewers, with in-house water heating system	3,641	0
5	Houses with plumbing and sewers, with provisions of central water heating	49,340	54,060
	Water Supply Total	59,860	74,200
	Sewerage	50,000	Not available

Source: Calarasi City and S.C. APA CANAL S.A.
Note: * According to the 1995 F/S

The service category in the table is defined as the same as the Romanian Standards (STAS 1343). The standards are presented in *Table II.2.4*. The per capita water consumption for the 1995 F/S is set as the same as those of the standard except category 2 and 5. In both categories, the amount of 20 lcd is added to the standards considering local conditions. In the F/S report, the amount of institutional and commercial waters is not specified, but in the calculation sheet the waters are considered as the same as the standards. The per capita amount of those water is as shown in *Table II.2.4*.

Table II.2.4 Unit Water Consumption

Service Category	Classification	Domestic q_d (lcd)	Public and Commercial q_p (lcd)	Total q (lcd)	q_p to q_d Ratio
1	Water distributed through street taps	40	25	65	0.625
2	Water distributed through yard taps	80	30	110	0.375
3	Houses with plumbing and sewer pipes	140	30	170	0.214
4	Houses with plumbing and sewers, with in-house water heating system	210	85	295	0.405
5	Houses with plumbing and sewers, with provisions of central water heating	280	100	380	0.357

Source: STAS 1343
Note: The value of q_p can be increased depending local conditions, but not exceeds the followings by the city size;
- up to 15% for cities ranging in population from 300,000 to 1,000,000
- up to 25% for cities having the population more than 1,000,000

Table II.2.3 shows that the future service population of water supply is increased from 59,860 to 74,200 with the increment of 14,340. The total population of service category 1 and 2 is increased from 6,879 to 20,140, and the total population of service category 4 and 5 is increased slightly from 52,981 to 54,060.

Based on the present service population of water supply, the number of people receiving better service (category 4 and 5) is only increased by 1,070 and that of people receiving the minimum water supply service (category 1 and 2) is increased by 13,260. This means that the increased population have to use communal taps or yard taps and does not have any access to have the better water supply service. It is advisable to revise to increase the service population in

category 2 taking into consideration of present service population in that category.

2.2.3 DESIGN FLOW

(1) Water Supply

The present total water volume supplied by the public water supply system is 25,050 m^3/d (290 L/s). The supply volume is planned to increase by 11,410 m^3/d to 36,460 m^3/d (422 L/s). These are summarized in *Table II.2.5* with some more detailed information.

Table II.2.5 Water Supply Volume

Water Use	Present	Future Plan	Remarks
Domestic	18,290 m^3/d	26,180 m^3/d	
Institutional	2,030 m^3/d	4,720 m^3/d	A list of users is available.
Industrial	4,740 m^3/d	5,560 m^3/d	
Total	25,050 m^3/d	36,460 m^3/d	

The future domestic water consumption is estimated as shown in *Table II.2.6*. This estimation is based on the calculation sheet for the future domestic drinking water consumption prepared under the task of the 1995 F/S. The estimated domestic water consumption of 24,240 m^3/d in *Table II.2.6* is slightly different from the domestic water supply volume of 26,180 m^3/d in the future as shown in *Table II.2.5*.

Table II.2.6 Future Domestic Water Consumption

Service Category	Unit water consumption (lcd)	Future service population	Water consumption (m^3/d)	*Water demand at source (m^3/d)
2	130	20,140	2,620	3,170
5	400	54,060	21,620	26,160
Total		74,200	24,240	29,330

Note: * : Water demand at source = 1.21 x Water consumption

(2) Sewerage

The existing wastewater treatment plant receives the average inflow of about 20,600 m^3/d, ranging from 10,000 to 34,000 m^3/d, which is based on the flow records during six (6) months from June to August 1998 and December 1998 to February 1999.

A discharge flow from the existing wastewater treatment plant agreed upon between the National Water Company at the Constanta office and the Calarasi City is 23,600 m^3/d (272 l/s) in the average flow and 27,700 m^3/d (320 l/s) in the maximum daily flow.

For the future improvement of the WWTP, the following design flow is proposed in the 1995 F/S.

Table II.2.7 Design Flow Proposed for the Calarasi WWTP in the 1995 F/S

Design Flow	Flow (L/s)	Flow (m^3/d)
Average Daily	493	42,600
Maximum Daily	645	55,730
Maximum Hourly	775	66,960

Source: S.C. APA CANAL S.A.

However, the information on how to calculate the design flow is not available, thus it is difficult to evaluate the design flow. Compared with the future water supply plan as shown in *Table*

II.2.5, the design wastewater inflow is 6,140 m^3/d higher than the water supply volume of 36,460 m^3/d.

2.2.4 DESIGN INFLUENT QUALITY

The influent quality is measured at the WWTP. According to the quality records of August and September 1998 and January and February 1999, the COD and SS concentrations are about 45 mg/l and 140 mg/l, respectively.

A survey to measure flow rates and quality of influent to the existing WWTP was conducted by the JICA Study Team during February and March in 1999. The average concentrations of major quality parameters were as follows:

BOD_5 : 61 mg/l, SS: 60 mg/l, T-N: 13.8 mg/l, and T-P: 1.4 mg/l

These data shows that the pollutant concentrations to the WWTP are low. However, the design influent in the 1995 F/S is medium in pollutant concentrations. The quality set in the 1995 F/S is as follows: BOD_5 concentration of 230 mg/l, SS concentration of 210 mg/L, respectively. The design values are determined taking into consideration of the observed values by the WWTP laboratory and surveys conducted by a consulting company called ICIM.

The design influent quality is set at higher concentration than those observed data at the existing wastewater treatment plant after 1998.

2.3 REVIEW OF THE 1993 F/S ON GIURGIU WWTP EXPANSION

A feasibility study was conducted and completed in 1993 to extend and expand the existing Giurgiu wastewater treatment plant. The followings are a summary of review of planning bases in the 1993 F/S taking into consideration of the present status of water supply and sewerage services in the Giurgiu City.

2.3.1 TARGET YEAR

The target year is not mentioned in the 1993 F/S report prepared by PROED. However, it is confirmed by the city council that the target year is 2010.

2.3.2 POPULATION

(1) Administrative Population

The present population of the city is 72,995 as of 1st of July 1998. During these six (6) years from 1993 to 1998, the population of the city has been slightly decreased from about 74,000 to 73,000.

According to the city office, the population in the year 2010 is projected to grow to 83,000 with annual growth rate of 1.1%. Recently, the city revised the projection that the population will reach to 90,600 in the year 2010 with annual growth rate of two percent.

(2) Service Population

The present population served by municipal water supply is 52,925 as of 1998, which corresponds to about 73% coverage of the total population of 72,995. The categorized service population is not identified, even though the detailed information on the domestic water supply volume is available for flats and individual houses. The present number of population served by the public sewerage system is also not obtained.

Table II.2.8 presents the future service population of public sewerage services based on the 1993 F/S. The future service population is summarized from a calculation sheet for estimating future domestic water consumption and wastewater generation.

Table II.2.8 Service Population Planned in the 1993 F/S

No.	Name of District/ Others	Service Category				Total
		2	3	4	5	
1	Central	1,000	0	4,000	15,000	20,000
2	Eroilor	3,900	0	2,340	1,560	7,800
3	Gara	1,850	0	1,110	740	3,700
4	Bancasa	700	0	2,100	11,200	14,000
5	Oinac-Nord	0	550	1,650	8,800	11,000
6	Oinac-Sud	0	1,150	2,300	8,050	11,500
7	Negru Voda-Nord	0	1,000	2,000	7,000	10,000
8	Negru Voda-Sud	0	1,200	4,200	6,600	12,000
9	Future Development	-	-	-	50,000	50,000
Total		7,450	3,900	19,700	108,950	140,000

Followings are findings in the 1993 F/S regarding service population.

- The service population is based on the population served by the public water supply system. The total service population is planned 140,000, but it exceeds the total projected administrative population of 83,000 in the year 2010. Without considering the future development of 50,000, the service population of 90,000 is already above the recorded population of about 73,000 to 74,000 during 1993 to 1998 and also exceeds the total projected population of 83,000.
- In the 1993 F/S, it was planned that all the population served by the public water supply system also received the sewerage service. However, some residents receiving water through communal taps or yard taps generally do not have an access to the public sewerage system. The population served by the sewerage system can be smaller than that of public water supply system.
- The number of people of service category 2 in Central District and in Bancasa District is 1,000 and 700, respectively. But judging from inconsistency between the provided and the calculated unit per capita flow, those number of service population can be belong to the service category 3, because the calculated unit flow used is the same as that of the service category 3.
- An increase in service population is 50,000 for the user category 5. This increase is equivalent to about 55% of the total service population of 90,000 when it was planned. But the detailed information and background why the high future service population is adopted are not explained in the 1993 F/S report.

The above findings imply that the planning bases of the 1993 F/S are outdated and those might be better to revise considering the present situations of the city.

2.3.3 Design Flow

(1) Water Supply

1) Present Water Supply Conditions

The present water volume provided by the public water supply system is 41,170 m^3/d (476 l/s) including un-accounted water of 10,750 m^3/d (124 l/s). The breakdown is shown in *Table II.2.9*.

Table II.2.9 Present Water Supply Conditions

Item	Water Volume	
	(m^3/d)	(l/s)
Domestic water for flats	20,070	232
Domestic water for individual houses	2,470	29
Industrial water	7,880	91
Total distributed water	30,420	352
Un-accounted water	10,750	124
Total supplied water	41,170	476

From the above figure, the total domestic water volume of about 22,540 m^3/d (261 l/s) is distributed to the consumer of 52,925. Thus the per capita consumption in average can be calculated about 426 lcd. This value exceeds a standard water consumption rate of 380 lcd for the cagtegory 5, the highest grade, in the STAS 1343.

The city has a rehabilitation program to recover the original capacity of the water supply system. The total water supply volume will be increased by 21,470 m^3/d (248 l/s) to 62,640 m^3/d (725 l/s) in the near future by an installation of new distribution pumps.

2) Review of the 1993 F/S

According to the 1993 F/S, the water supply volume in the future is planned about 100,900 m^3/d as the maximum daily flow. For comparison, the information is summarized in *Table II.2.10*.

Table II.2.10 Water Supply Volume

Water	Present* (1998)	The 1993 F/S			Remarks
		Basis for the plan**	Report ***	Calculation Sheet ***	
Domestic	22,540	36,394	56,239	59,220	
Industrial	7,880	44,430	44,640	44,430	A list of users is available.
Unaccounted-for water	10,750	-	-	-	
Total	41,170	80,824	100,879	103,650	

(Unit:m^3/d)

Note: * presents the figures shown in the previous section as the present water supply volume
** presents the figures used for calculation of the future water supply in the 1993 F/S
*** presents the future water supply volume in the 1993 F/S.

The domestic water supply of 59,220 m^3/d is estimated as shown in *Table II.2.11*.

Table II.2.11 Domestic Water Supply Plan (Maximum Daily Flow)

Category	Unit water consumption* (lcd)	Future Service population	Water supply (m^3/d)
2	171 or 259	7,450	1,420
3	239 or 258	3,900	989
4	308 to 310	19,700	6,070
5	457 or 581	108,950	50,741
Total		140,000	59,220

Note: * the figures are calculated by the given water supply volume and the service population

(2) Sewerage

The existing WWTP is designed to treat 0.5 m^3/s (43,200 m^3/d) of wastewater but actually receives about 25,000 m^3/d as the average flow. This inflow rate is about 82% of the distributed water (30,420 m^3/d) and 61% of the supplied water (41,170 m^3/d).

In the 1993 F/S, the design flow of the WWTP, expressed as the maximum daily flow, is assumed at 80% of the water supply volume. Therefore, the maximum daily flow of wastewater is estimated about 82,100 m^3/d (=950 l/s). The maximum hourly flow of the wastewater is assumed to be 1.2 times as large as the maximum daily flow, then the maximum hourly flow is estimated about 98,500 m^3/d. These are summarized as shown in *Table II.2.12*. In the 1993 F/S, the wastewater treatment capacity was planned 1.9 times as large as the existing design capacity of 43,200 m^3/d.

Table II.2.12 Design Flow for the Giurgiu WWTP in the 1993 F/S

Design Flow	Flow (l/s)	Flow (m^3/d)
Average Daily	Not available	Not available
Maximum Daily	950	82,100
Maximum Hourly	1,140	98,500

Source: The 1993 F/S Report

The design flow for the domestic and industrial wastewater is summarized in the table below.

Table II.2.13 Design Flow for Domestic and Industrial Wastewater

Wastewater	Maximum Daily Flow		Maximum Hourly Flow		Present Distributed Water
	(l/s)	(m^3/d)	(l/s)	(m^3/d)	
Domestic	530	45,800	640	55,300	22,540 m^3/d
Industrial	420	36,300	500	43,200	7,880 m^3/d
Total	950	82,100	1,140	98,500	30,420 m^3/d

2.3.4 Design Influent Quality

The influent quality is measured and recorded at the WWTP. According to the quality records of the WWTP during January to December of 1998, the monthly average BOD_5 and SS concentrations are in the range of 14 to 31 mg/l and 99 to 295 mg/l, respectively.

A survey to measure flow rates and quality of influent to the existing WWTP was conducted by the JICA Study Team during February and March in 1999. The survey results showed that the strength of wastewater was weak. The average concentrations of major quality parameters were as follows:

BOD_5 : 77 mg/l, SS: 87 mg/l, T-N: 11.3 mg/l, and T-P: 1.0 mg/l

The design influent quality in the 1993 F/S is set at the medium strength as follows: BOD_5 concentration of 237 mg/l and SS concentration of 256 mg/l, respectively. The design values were determined by a pollutant loads analysis.

2.4 TURNU MAGURELE

Turnu Magurele City does not have any expansion plans of the existing Turnu Magurele WWTP. Therefore, the followings are a summary of basic information of the present status of water supply and wastewater management in the city.

2.4.1 POPULATION

(1) Administrative Population

The population of Turnu Magurele city increased from 32,969 to 35,372 during eight (8) years from 1982 to 1989 at the average annual growth rate of 1.0%. Since 1990, however, the population growth has stopped virtually, and the population has been maintained at about 36,000 to 37,000. The present population is about 37,100 as of 1998. According to the information provided by the city, the population is projected to grow to 47,000 in the year 2010 with a high annual growth rate of 2.0%.

(2) Service Population

According to the city council, the present service population of water supply is about 21,500, which is equivalent to 58% of the total population of 37,000. While, the population served by the existing sewerage system is about 19,500 and its service coverage is about 53% of the total population.

The city council is asking foreign aids for studying improvement measures of public water supply system. But it does not have any expansion plan of the existing sewerage system. Therefore, the any information on future development of water supply and sewerage services is not available now.

2.4.2 FLOW RATES

(1) Water Supply

The present daily water supply volume is 220 l/s (19,000 m^3/d), domestic water supply of 165 l/s (14,250 m^3/d) and non-domestic supply of 55 l/s (4,750 m^3/d).

According to R.A. SAGO, the present domestic water supply conditions are summarized in *Table II.2.14*.

Table II.2.14 Present Conditions of Domestic Water Supply as of 1998

Water Supply Modes		Service Population	Unit Consumption (lcd)	Estimated Water Consumption (m^3/d)
Flats	Water metered	10,200	530	5,400
	Non-metered	6,800		Not available
	Sub-total	17,000		
Individual Houses		4,500	433	1,950
Total		21,500		Not available

Source: R.A. SAGO

Based on the information of water metered in *Table II.2.14*, the total volume of water metered is 7,350 m^3/d (= 5,400 m^3/d + 1,950 m^3/d) and the service population is 14,700, thus the per capita water supply volume is estimated 500 lcd. While, an average per capita water supply volume of domestic water can be estimated 663 lcd based on the total domestic water supply volume and the total service population.

(2) Sewerage

The total service population is 19,500, of which 17,000 living in flats and 2,500 living in individual houses. All the population living in flats are enjoying the services of sewerage as well as piped water supply.

Based on the monthly flow records at the existing WWTP, the monthly average flow is 12,420 m^3/d. In addition, based on the flow records in July in 1998, the average daily flow is 12,440 m^3/d and the maximum daily flow is 14,950 m^3/d.

The influent average flow of 12,420 m^3/d corresponds to 65% of the total water supply volume of 19,000 m^3/d. Taking into considerations of water leakage, for example 25 to 30% of total water supply volume, the existing WWTP covers almost all of the wastewater generated from the water supplied by the public water supply system.

The design flows of the existing WWTP are 25,000 m^3/d as the maximum hourly flow under dry weather conditions and 50,000 m^3/d under wet weather conditions.

2.4.3 INFLUENT QUALITY

Influent wastewater quality is measured at the existing WWTP. The monthly records show that a range of average concentrations of BOD_5 is from 31 to 45 mg/l and that of SS concentration is from 79 to 114 mg/l. These data indicates the strength of wastewater is weak.

A survey to measure both flow rates and quality of influent to the existing WWTP was conducted by the JICA Study Team during February and March in 1999. The survey results are shown in *Table II.2.15*.

Table II.2.15 Survey Results of Wastewater Quality at the Existing WWTP

Parameters	Influent		Effluent
	Range	Weighted Average	Range
BOD_5 (mg/l)	21 - 107	54	14 - 67
SS (mg/l)	32 - 168	96	24 - 104
T-N (mg/l)	45 - 68	56	48 - 51
T-P (mg/l)	1.00 -3.27	2.24	0.64 - 2.67

The concentrations of BOD_5 and SS are as low as 54 mg/l and 96 mg/l, respectively. Higher concentration of T-N is one of characteristics of the influent, this may be due to industrial wastewater.

2.5 REVIEW OF THE 1981 STUDY ON DROBETA TURNU SEVERIN WWTP

Following is a summary of review of planning basis for the existing Drobeta Turnu Severin WWTP. The review is based on latest plan for the WWTP considering water supply and wastewater management conditions. The latest plan available for the wastewater treatment plant is the preliminary study on the extension of sewerage and wastewater treatment plant (hereafter referred to as "the 1981 study"). This study was conducted during 1980 to 1981 and prepared by ISLGC, Bucharest (present PROED).

2.5.1 TARGET YEAR

The 1981 study has a two stages implementation program: the first stage targeted by the year of 1985 and the final stage targeted by the year of 2000. Therefore, the target year of the plan must be set at the year of 2000.

2.5.2 POPULATION

(1) Administrative Population

Since statistical data of the administrative population of the city are not available, the past trend of population is not analyzed. According to the information provided by the city, the population was changed as follows: the population was about 100,000 level in 1990 and increased to 118,000 level in the middle of 1990's and maintained the same level until recently. The present population is estimated about 120,500 as of 1999.

In the 1981 study, the future population was projected as follows: 105,000 in the first stage by the year 1985 and 138,000 in the final stage by the year of 2000. But the detail information is not available, for example, how the future population was projected and what kind of data was used for the projection.

According to the city, the future population in the year 2010 is projected to increase to 140,000 with an annual growth rate of 1.4%.

(2) Service Population

Based on the information provided by the city, the present service population of water supply is more than 111,200 and that of present sewered population is 102,500 out of the total administrative population of 120,500. Thus the populations served ratios are as high as 92% in water supply and 85% in sewerage service, respectively.

In the 1981 study, the design flows are estimated for the first stage (1985). The domestic wastewater is estimated based on the following service population as shown in *Table II.2.16.*

Table II.2.16 Service Population in the 1981 Study

Area	Description	Service Category	Year 1985	Year 2000
Zone 1	Houses connecting to sewer networks without heated water supply	3	1,400	1,200
Zone 2	Houses connecting to sewer networks with local water heating systems	4	20,000	20,000
Zone 3	Houses connecting to sewer networks with central water heating system	5	83,600	116,800
Total			105,000	138,000

Since the service population presented in the above table is the same as the administrative population, the service population coverage is set at 100% for the target year in the 1981 study.

2.5.3 DESIGN FLOW

(1) Water Supply

For the public water supply, total water volume of 116,000 m^3/d is taken from the Danube River, of which about 81,000 m3/d for domestic and 34,800 m^3/d for non-domestic purposes.

The present average daily production of the existing water purification plant is 116,000 m^3/d, which is the same as the intake volume. According to S.C. SECOM S.A., total unaccounted loss and leakage from the intake to individual house connections are estimated about 32 %. Based on this estimation, about 78,800 m^3/d of water is distributed to the consumer. The existing distribution pumps having design capacity of 161,600 m^3/d can only deliver water at the rate of 45,800 m^3/d due to some pumps are worn-out or damaged.

The city has a plan to improve the water supply conditions by provision of groundwater at the rate of 52,000 m^3/d.

(2) Sewerage

The design flows in the 1981 preliminary study are summarized as shown in *Table II.2.17*.

Table II.2.17 Design Flows in the 1981 Study

	Average Daily	Maximum Daily	Maximum Daily
First Stage 1985			
Domestic	34,200 m^3/d	39,647 m^3/d	45,594 m^3/d
Industrial	5,658 m^3/d	7,356 m^3/d	9,563 m^3/d
Total	39,858 m^3/d	47,003 m^3/d	55,157 m^3/d
Final Stage 2000			
Domestic	46,124 m^3/d	53,389 m^3/d	61,398 m^3/d
Industrial	7,644 m^3/d	9,937 m^3/d	12,918 m^3/d
Total	53,768 m^3/d	63,326 m^3/d	74,316 m^3/d

The per capita wastewater generations rates used for estimating the design flows are summarized in *Table II.2.18*.

Table II.2.18 Per Capita Domestic Wastewater Generation Rates in the 1981 Study

User Category	Average Daily (A)	Maximum Daily (B)	Maximum Hourly (C)	Ratios of A:B:C
3 (Zone 1)	145 lcd	180 lcd	207 lcd	0.81:1.00:1.15
4 (Zone 2)	195 lcd	235 lcd	270 lcd	0.83:1.00:1.15
5 (Zone 3)	360 lcd	415 lcd	477 lcd	0.87:1.00:1.15

Note: The figures of maximum hourly flow are estimated based on the maximum daily flow multiplied with the flow variation factor of 1.15.

Concerning the industrial wastewater, the 1981 study does not give any information on how the industrial wastewater flow was estimated and decided.

2.5.4 Design Influent Quality

Any information of design influent quality is not available from the 1981 study. A survey to measure flow rates and wastewater quality was conducted by the JICA Study Team during February and March in 1999. Wastewater samples were taken every three (3) hours for 24 hours at two sites: one is a manhole at Street N. Cernaianu and the other is the existing outfall to the Topolnita River. The resulted four water quality parameters of BOD_5, SS, T-N, and T-P are presented in *Table II.2.19*.

Table II.2.19 Survey Results of Wastewater Quality

Parameters	Sampling Point No.1 at Street N. Cernaianu		Sampling Point No.2 The Outfall to Topolnita River	
	Range	eighted Average	Range	Weighted Average
BOD_5 concentration (mg/l)	12 - 37	28	19 - *1,050	358 (44)**
SS concentration (mg/l)	15 - 63	45	38 - *432	162 (56)**
T-N concentration (mg/l)	5.5 - 11.0	8.5	5.9 - *12.7	9.0 (7.9)**
T-P concentration. (mg/l)	0.34 - 2.83	1.25	0.13 - *1.23	0.94 (0.82)**

Notel: * 2 samples among 8 samples have very high concentrations due to influence of industrial wastewater.
**The figures in parentheses are the weighted average excluding the two influenced samples.

The wastewater taken at the sampling point No.1 was domestic origin because the service area of the sewers was residential area only. The strength of wastewater was weak and the BOD_5 and SS concentration were as low as 28 mg/l and 45 mg/l, respectively. While, the wastewater taken at the sampling point No.2 was strong in terms of BOD_5 and SS concentrations. However, the samples having high concentrations were influenced by some industrial wastewater. When the two stronger or strange samples are excluded from the calculation of weighted average concentration, the average concentrations are estimated as low as 44 mg/l in BOD_5 and 56 mg/l in SS. These data reveal that the strength of domestic wastewater is weak.

CHAPTER 3 PREPARATIVE PLANNING OF WWTP

3.1 GENERAL

Preparative designing of WWTPs has been carried out based on currently available information mainly obtained through the Study. Purposes of the preparative designing are to provide one example of possible WWTP to be constructed in each city and to confirm that the designated site caters the WWTP.

Preparative designing was prepared by selecting a treatment method according to the concepts described in Chapter 3 of Part I, and by calculating sizes of the facilities based on examined maximum daily wastewater flow. However, no alternative study has been conducted to determine types of each facility, and no topographic and hydrologic conditions have been considered in the preparation.

Therefore, this does not represent the best plan and design, and may not necessary be a base of further feasibility study. Preliminary engineering shall be thoroughly done based on the concepts described in Chapter 3 of Part I and by a manner to be presented in the next chapter, when each city conducts a feasibility study on wastewater treatment.

3.2 CALARASI

The preparative planning is shown in *Figure II.3.1.* New facilities are constructed as expansion of the existing plant and the existing facilities for a primary treatment are utilized as it is. The plan generally follows the design shown in the 1995 F/S. However, layout of additional facilities is rearranged so as to cater the site for an advanced treatment with in the designated site. Main equipment of the Calarasi WWTP is shown in *Table II.3.1.*

Table II.3.1 Main Equipment of Calarasi WWTP

Item	Specification
Screen and Pumps	Coarse screen : 3 Fine screen : 3 Pumps: No specification is available
Grit chamber/ Oil separator	B3m × L8.5m× 2 channel
Parshall flume	306-12,380m³/h × 1 channel
Primary Sedimentation Tank	ϕ35m × 3 tanks (utilizing existing 3 tanks)
Aeration Tank	B5.5 × H5.5 × L96m × 8 tanks (For advanced treatment:×L83m× 8 tanks)
Final Sedimentation Tank	ϕ30m × 4 tanks (For advanced treatment: ϕ30m × 4 tanks)
Chlorination Chamber	B4.0m × H4.0m × L49m
Sludge Thickener	ϕ13m× H4.0m× 2 tanks
Sludge Digester	ϕ15.5m× H27m× 2 tanks
Gas Holder	ϕ14.5m× H4.7m× 1 tank
Dewatering Equipment	130 kg/hr, B = 3m × 5 units
Blower Equipment	ϕ350 / ϕ300, 120m³/min × 2

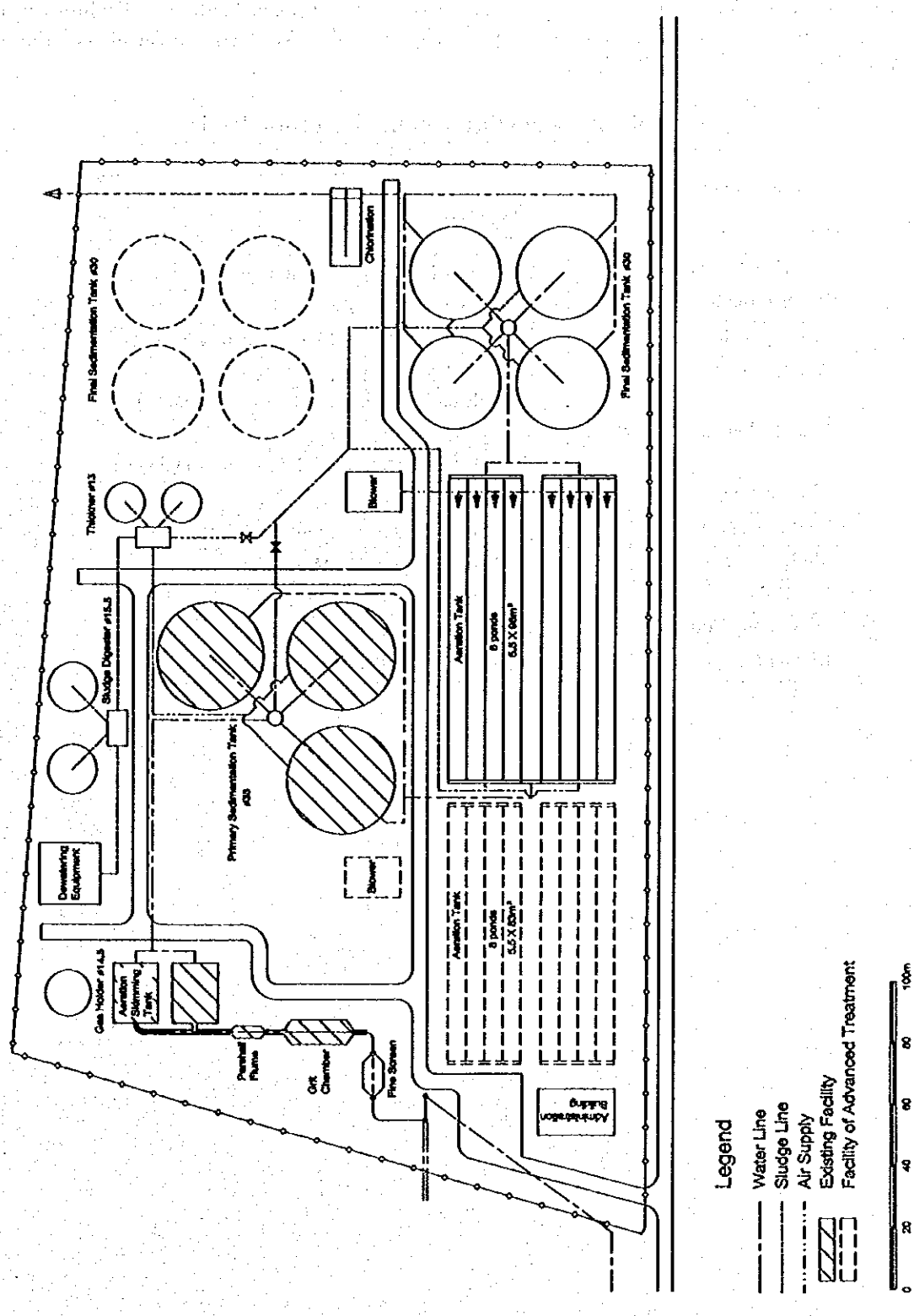

Figure II.3.1	Layout Plan of Calarasi WWTP

3.3 GIURGIU

The preparative planning is shown in *Figure II.3.2.* New facilities are constructed as expansion of the existing plant and the existing facilities for a primary treatment are utilized as it is. Layout plan was prepared by calculating sizes of additional facilities. Facilities were arranged in the extended site proposed by the city council. Main equipment of the Giurgiu WWTP is shown in *Table II.3.2.*

Table II.3.2 Main Equipment of Giurgiu WWTP

Item	Specification
Screen and Pumps	Coarse screen : 3 Fine screen : 3 Pumps: No specification is available
Grit chamber/ Oil separator	B3m × L16.0m × 2 channels
Parshall flume	306-12,380m³/h × 1 channel
Primary Sedimentation Tank	ϕ30m × 4 tanks (utilizing existing 2 tanks)
Aeration Tank	B5.5 × H5.5 × L76m × 16 tanks (For advanced treatment: ×L87m × 16 tanks)
Final Sedimentation Tank	ϕ35m × 4 tanks (For advanced treatment: ϕ35m × 4 tanks)
Chlorination Chamber	B4.0m × H4.0m × L72m
Sludge Thickener	ϕ17.5m × H4.0m × 2 tanks
Sludge Digester	ϕ18.5m × H33m × 2 tanks
Gas Holder	ϕ15.5m × H17.2m × 1 tank
Dewatering Equipment	130 kg/hr, B = 3m × 9 units
Blower Equipment	ϕ300 / ϕ250, 95 m³/min × 4

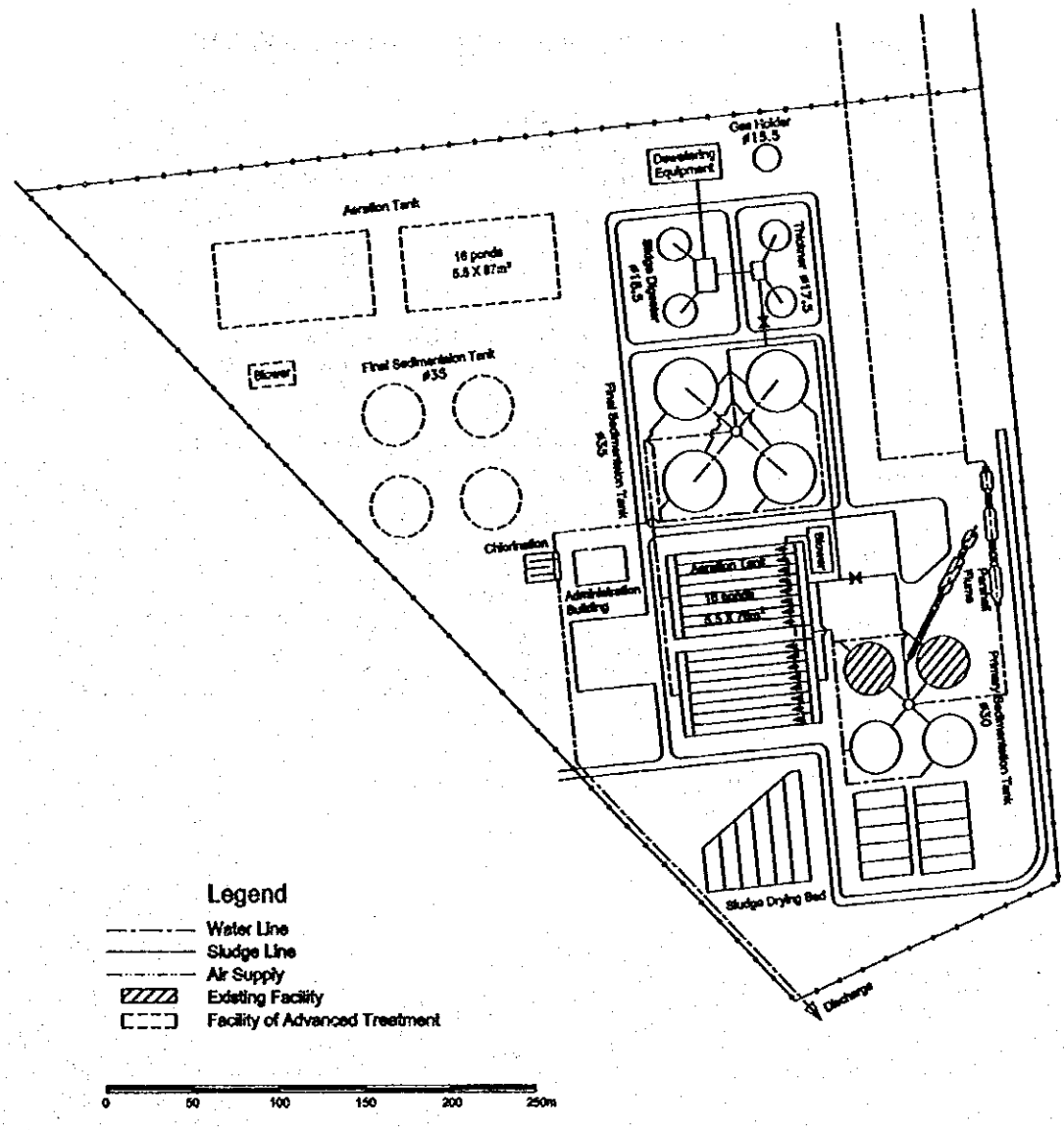

Figure II.3.2	Layout Plan of Giurgiu WWTP

3.4 TURNU MAGURELE

The preparative planning is shown in *Figure II.3.3*. New facilities are constructed as expansion of the existing plant and the existing facilities for a primary treatment are utilized as it is. Layout plan was prepared by calculating sizes of additional facilities. As far as a secondary treatment is concerned, all the facilities will be able to be catered in the existing plant site. In case of an advance treatment, the site is required beyond the existing site, but is able to be catered in the area proposed by the city council as a site extension. Main equipment of the Turnu Magurele WWTP is shown in *Table II.3.3*.

Table II.3.3 Main Equipment of Turnu Magurele WWTP

Item	Specification
Screen and Pumps	Coarse screen : 2 Fine screen : 2 Pumps: ϕ300× 4 (1 standby)
Grit chamber/ Oil separator	B3m × L8.0m× 2 channels
Parshall flume	306-12,380 m³/h × 1 channel
Primary Sedimentation Tank	ϕ30m × 1 tank (utilizing existing 1 tank)
Aeration Tank	B5.5 × H5.5 × L44m × 4 tanks (For advanced treatment:×L61m× 4 tanks)
Final Sedimentation Tank	ϕ20m × 4 tanks (For advanced treatment: ϕ20m × 4 tanks)
Chlorination Chamber	B4.0m × H4.0m × L18m
Sludge Thickener	ϕ7m× H4.0m× 2 tanks
Sludge Digester	ϕ10.5m× H17m× 2 tanks
Gas Holder	ϕ10.0m× H9.0m× 1 tank
Dewatering Equipment	130 kg/hr, B = 2m × 3 units
Blower Equipment	ϕ200 / ϕ200, 25m³/min × 2

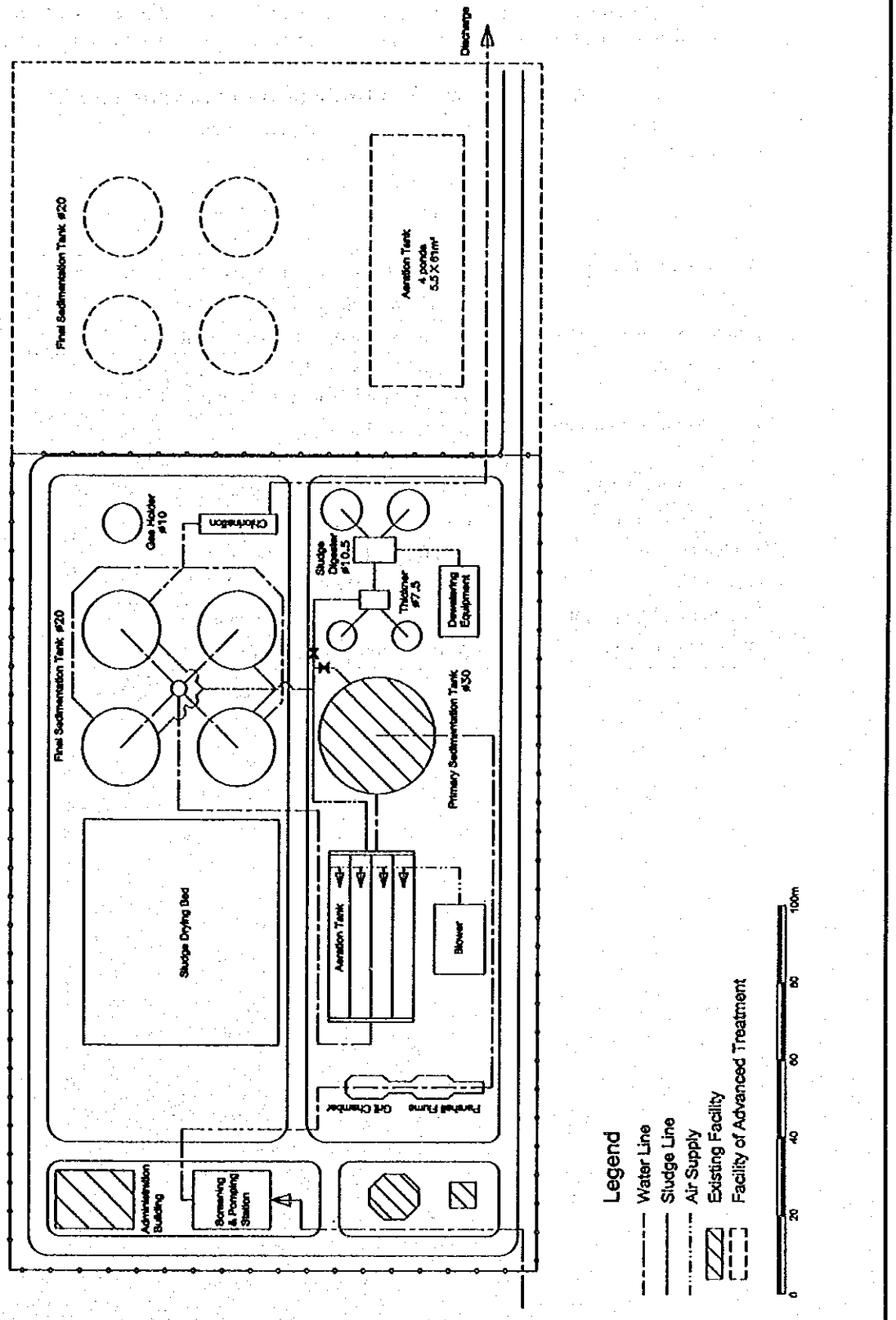

Figure II.3.3	Layout Plan of Turnu Magurele WWTP

3.5 DROBETA TURNU SEVERIN

The preparative planning is shown in *Figure II.3.4.* New facilities are constructed in the site proposed by the city council. Layout plan was prepared by calculating sizes of additional facilities. Main equipment of the Drobeta Turnu Severin WWTP is shown in *Table II.3.4.*

Table II.3.4 Main Equipment of Drobeta Turnu Severin WWTP

Item	Specification
Screen and Pumps	Coarse screen : 3 Fine screen : 3 Pumps: ϕ400 × 4 ϕ500 × 4
Grit chamber/ Oil separator	B3m × L22m× 2 channels
Parshall flume	306-12,380m³/h × 1 channel
Primary Sedimentation Tank	ϕ40m × 2tanks (utilizing existing 2 tanks)
Aeration Tank	B5.5 × H5.5 × L69m × 8 tanks (For advanced treatment: ×L94m× 8 tanks)
Final Sedimentation Tank	ϕ30m × 4 tanks (For advanced treatment: ϕ30m × 4 tanks)
Chlorination Chamber	B4.0m × H4.0m × L55m
Sludge Thickener	ϕ13m× H4.0m× 2 tanks
Sludge Digester	ϕ15.0m× H26m× 2 tanks
Gas Holder	ϕ14.5m× H14.7m× 1 tank
Dewatering Equipment	130 kg/hr, B = 3m × 5 units
Blower Equipment	ϕ200 / ϕ200, 40m³/min × 4

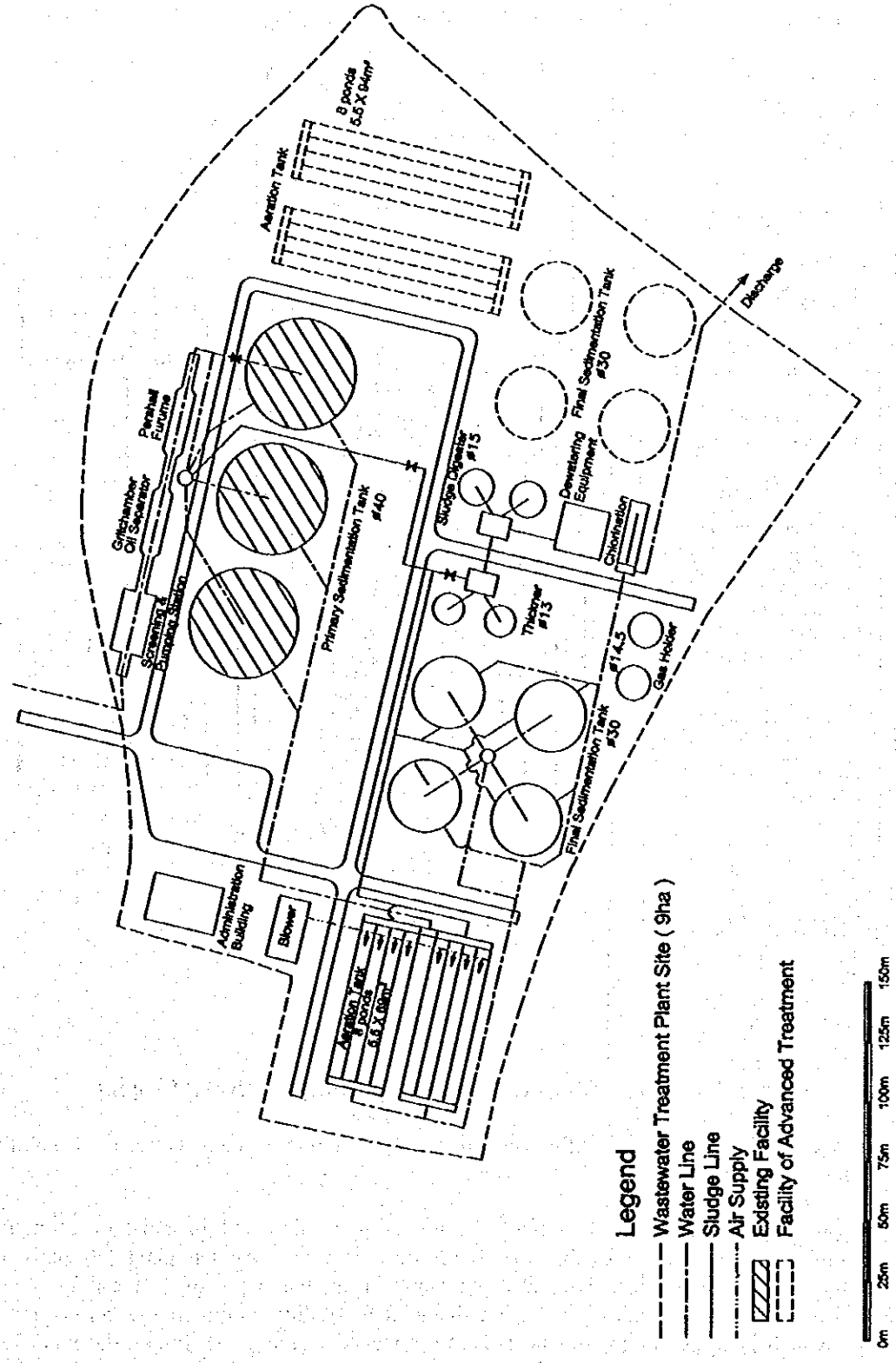

Figure II.3.4	Layout Plan of Drobeta Turnu Severin WWTP

CHAPTER 4 OUTLINES OF THE GUIDELINES

The guideline for the wastewater treatment is given as a form of checklist of necessary work items through feasibility study work. *Figure II.4.1* shows workflow of the feasibility study. Checklist is given as shown in *Table II.4.1* by each work item in *Figure II.4.1*.

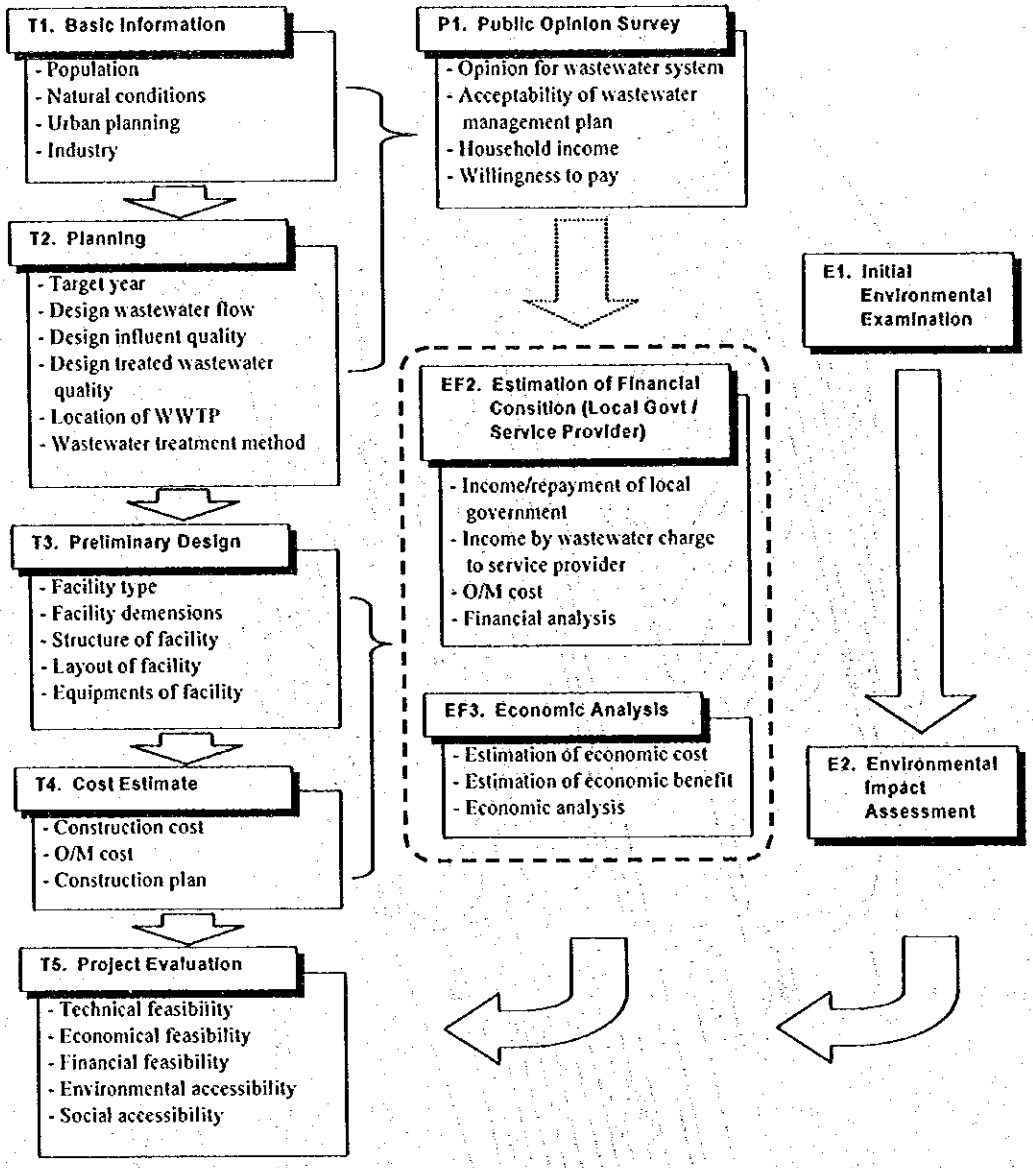

Figure II.4.1 Flow Chart for Feasibility Study of WWTP Project

Each city council can use the checklist when they prepare terms of reference for the feasibility study on their WWTP.

In general, there is imbalance between an engineering portion and financial or economic portions in existing Romanian feasibility study for the wastewater treatment plant. Usually the feasibility studies are provided with in-depth engineering, but depth of cost estimates and financial plans are not enough to evaluate a financial feasibility. Furthermore, an economic analysis, which justifies the investment, is hardly attached thereto. Therefore, the workflow shown in *Figure II.4.1* stresses a flow for these analyses. In addition, to highlight those points, trial financial and economic analyses adopting project cost estimated by cost functions will be presented as a part of the guidelines.

Table II.4.1 Checklist for Feasibility Study on WWTP Project (1/6)

Item	Purpose	Required Data	Required Activities	Remarks for Four Cities .
T1. Basic Information				
Population	To evaluate service level improvement in term of population. To formulate bases for estimating domestic wastewater generation.	- Statistical data of the administrative population - Future population projection - Present water supply service population - Present sewerage service population - Plan of future water supply service population	1) Determination of future service population of sewerage	- Calarasi City: Future administrative population is not projected and the future service population is set at 1.2 times of that in the year 1995. - Giurgiu City: Future service population exceeds the future administrative population. An adjustment is required. - Turnu Magurele City: Future administrative population is projected. But there is no future water supply and sewerage plan. - Drobeta Turnu Severin City: Future administrative population is not projected. The existing plan is targetted at the year 2000.
Natural Conditions	To collect basic information for planning and design of sewerage system.	- Climate - Topography - Geology Major characteristics of receiving water bodies		
Urban Planning	To formulate a sewerage plan linked to a city development plan.	- Urban development plan - Land use map(present and future)	.1) Identify service area of public water supply and sewerage system in a topographic map 2) Identify population by landuse pattern, if any	- Existing future plans consider the service population and its service level for each district or zone.
Industry	To estimate how much industrial wastewater will be generated in the future. To prepare how much industrial wastewater will be received by sewerage system.	- List of major factories including water consumption, wastewater generation and present status of wastewater management - Wastewater monitoring data -	1) Prepare a list of major factories discharging wastewater to the sewerage system 2) Estimate the wastewater quantity and quality to be discharged	- Lists of major factories including water supply volumes and wastewater generations are prepared in the existing plans of Calarasi city and Guiugiu city. - There was a case that institutional wastewater was included in the list of industrial wastewater.

Table II.4.1 Checklist for Feasibility Study on WWTP Project (2/6)

Item	Purpose	Required Data	Required Activities	Remarks for Four Cities
T2. Planning				
Target Year	To determine the planning basis.	- Upper plan (national, regional, or municipal development plan) - Guideline for infrastructure plan	1) Determine the target year for the planning	- Target year is not mentioned in any reports of existing plans.
Design Wastewater Flow	To determine the wastewater to be managed by the sewerage system. To prepare basic data for O/M plan and financial plan.	- Service population by service category - Per capita water consumption and wastewater generation - Commercial and institutional water consumption/wastewater generation - Industrial wastewater to be received by the sewerage system - Groundwater level in the sewered area - Time variation coefficients	1) Determine how much the domestic wastewater will be generated and received by the sewerage system 2) Determine how much the commercial and institutional wastewater will be generated and received by the sewerage system 3) Determine how much the industrial wastewater will be discharged and received by the sewerage system 4) Estimate the amount of groundwater infiltration 5) Determine design flows such as average daily flow, maximum daily flow and maximum hourly flow	- Description of how to estimate the domestic, commercial and institutional wastewaters is not enough to understand. - There are no explanations why the per capita water consumption and the per capita wastewater generation are applied. - Except the plan of Calarasi city, amount of commercial and institutional wastewaters is not mentioned in the reports of future plans. - Future allowance for industrial wastewater is not mentioned clearly in the reports. - All future plans do not consider amount of groundwater infiltration in the design flow and do not provide any reasons why groundwater infiltration is not considered. - Average daily flow is an essential component for evaluating O/M and efficiencies of sewerage system, but this flow was not mentioned as the design flow in the reports of future plan.
Design Influent Quality	To determine facility plan	- Present raw wastewater quality - Design flows - Laws/Regulations of industrial wastewater to be received by public sewerage system - List of pollutants loads from major factories	1) Evaluate the present wastewater quality data and information 2) Project future influent quality and pollutant loads	- No data are provided how to determine the design influent quality.

Table II.4.1 Checklist for Feasibility Study on WWTP Project (3/6)

Item	Purpose	Required Data	Required Activities	Remarks for Four Cities.
Design Treated Wastewater Quality	To determine facility plan	- Laws/Regulations on effluent quality - Present data on water quality and flowrates of receiving water body	1) Determine the treated wastewater quality	
Location of Wastewater Treatment Plant	To determine facility plan	- Candidate sites for WWTP - Topographic Map - Geological data and information - Social data and information - Other natural conditions	1) Conduct alternative study for each candidate site 2) Conduct supplemental investigations for topographic, geological, and environmental data and information 3) Determine the most appropriate site for WWTP	- No explanation if any alternative studies on WWTP sites have been conducted.
Wastewater Treatment Method	To determine facility plan	- Design flows - Influent Quality - Design treated wastewater quality - Topographic map of available sites	1) Select possible wastewater treatment methods with consideration of influent and treated wastewater quality 2) Conduct alternative study of possible wastewater treatment methods taking into account of costs (capital and O/M), site availability, required O/M level, etc., 3) Determine the most appropriate wastewater treatment method	- No explanation if any alternative studies on wastewater treatment and sludge treatment methods are conducted. - No explanation why the wastewater treatment process was selected as the most appropriate method.
T3. Preliminary Design				
Facility Type	To present a basis of preliminary study	- Plant site availability - Efficiency of treatment - Cost		
Facility Dimensions	To estimate construction volume / cost	- Design wastewater amount		
Structure of Facility	To estimate construction volume / cost	- Design standard - Structural Data - Geological Data	1) Design calculations 2) Examination of facility foundation	
Layout of Facility	To determine facility arrangement	- Site survey map - Dimensions of structures	1) Examination of facility arrangement	

Table II.4.1 Checklist for Feasibility Study on WWTP Project (4/6)

Item	Purpose	Required Data	Required Activities	Remarks for Four Cities
Equipments of facility	To determine equipment capacity and electric power		1) Calculations of equipments capacity 2) Calculation of required electric power of equipments	
T4. Cost Estimate				
Construction Cost	To present project cost for economic / financial analysis	- Personnel cost - Material cost for construction - Equipment cost for Construction - Mechanical and electrical equipment cost for treatment plant - Exchange rate - Economic indicator - Formula for WWTP/interceptor construction (if available) - other necessary data	1) Calculation of work volume and necessary mechanical / electrical equipment to construct WWTP based on engineering design 2) Examination of unit price / cost for construction of WWTP and determination of them 3) Estimation of construction cost based on estimated work volume and unit cost 4) Estimation of Project cost by adding necessary cost for construction 5) Determination of cost disbursement schedule based on construction plan	
O/M Cost	To present project cost for economic / financial analysis	- Nos. of personnel for O/M works - Personnel cost - Cost for water, electricity, fuel, chemical etc. - Cost for spare parts - other necessary data	1) Estimation of personnel cost for OM works 2) Estimation of material cost for OM works 3) Estimation of repairing work volume for OM works 4) Estimation of other necessary cost for OM works 5) Calculation of total annual OM cost for the project	

Table II.4.1 Checklist for Feasibility Study on WWTP Project (5/6)

Item	Purpose	Required Data	Required Activities	Remarks for Four Cities
Construction Plan	To present construction plan for economic / financial analysis	- Meteorological data - Work volume - Capability of construction company - Material and equipment availability for construction - Available method for the project - other necessary data	1) Estimation of workable days and hours using 2) Estimation of construction period 3) Determination of sequence of works	
T5. Project Evaluation				
Technical Feasibility	To evaluate project	- Result of preliminary design		
Economical Feasibility	To evaluate project	- EIRR - B/C - NPV - Economical indicators		
Financial Feasibility	To evaluate project	- Estimated cash flow - FIRR		
Environmental Acceptability	To evaluate project	- Result of EIA - Lows related to Environment		
Social Acceptability	To evaluate project	- Result of EIA - Result of public opinion survey		
P1. Public Opinion Survey				
Opinion for Wastewater System	To present data on public awareness on wastewater system	- Current situation of wastewater system - Required water quality		
Acceptability of Wastewater Management Plan	To present data on public awareness on wastewater system	- Current situation of wastewater management system - Future wastewater management plan		
Household Income	To present a data for economic / financial analysis		1) Preparation of interview survey 2) Conducting of interview survey 3) Data processing of survey result 4)	

Table II.4.1 Checklist for Feasibility Study on WWTP Project (6/6)

Item	Purpose	Required Data	Required Activities	Remarks for Four Cities
Willingness to Pay	To present a data for economic / financial analysis		1) Preparation of interview survey 2) Conducting of interview survey 3) Data processing of survey result 4)	
EF2. Estimation of Financial Condition				
Income/repayment of Local Govt.	To present a data for financial analysis	- Local government budget - Income from water company - Repayment to central gov't.		
Income by Wastewater Charge to Service Provider	To present a data for financial analysis	- Balance sheet/cach flow of water company - Water tariff - Wastewater tariff - Collection ratio of wastewater charge		
O/M Cost	To present a data for financial analysis	- Annual O/M cost of water company - Prices of water, electric fuel etc.		
Financial Analysis	To present a data for project evaluation	- Construction cost - O/M cost - Income by wastewater charge - Repayment to Central gov't	1) Estimation of cashflow 2) Calculation of FIRR	
EF3. Economic Analysis				
Estimation of Economic Cost	To present a data for economic analysis	- Construction Cost - O/M cost - Ratio of F.C and L.C. - Standard Conversion Factor (SCF)		
Estimation of Economic Benefit	To present a data for economic analysis	- Willingness to pay to the project-		
Economic Analysis	To present a data for project evaluation	- Economic benefit - Economic Cost - Implementation program - Project life	1) Calculation of EIRR, B/C, NPV, etc.	
E1. Initial Environmental Examination				
E2. Environmental Impact Assessment