CHAPTER 2 REVIEW OF EXISTING PLANS

2.1 EXISTING DESIGN BASES

Existing design basis and criteria applied to the present Galati wastewater management system plan have been duly reviewed and updated as necessary, so that the bases for planning and design of the wastewater management facilities are established.

The review work includes:

- Administrative population and served populations with the water supply and wastewater systems;
- Wastewater generations and design wastewater flows; and
- Wastewater characteristics.

The above factors have been reviewed in light of the latest data and information provided by the Galati City, APATERM S.A. of Galati, and other concerned agencies, together with the result of field surveys conducted under the present study.

The pre-feasibility study on Galati WWTP program, established by the PROED in September 1992 (1992 Pre F/S), elaborated a preliminary engineering design and feasibility study on interceptor sewers and WWTP. The Pre F/S proposed that new interceptor sewers be constructed along the Danube River to collect and transport the wastewater to the WWTP at the eastern end of the City.

During the past several years since the Pre F/S was established, however, there have been considerable social and economic changes in the region and the nation as a whole, which apparently affected to the design and planning basis for the wastewater management system. In view of these, the basic factors for the wastewater planning have been reviewed and, where found necessary, updated so as to meet the present situations.

2.1.1 POPULATION

(1) Administrative Population

The Galati City's population numbered 330,276 in December 1998 according to the statistic data by the Bureau of Statistics in Galati. The 1992 Pre F/S predicted future population based on the assumption that the population would increase at annual growth rates of 1.18 percent from 1991 to 2000 and 0.59 percent from 2000 to 2010, reaching 382,000 in 2010.

Before 1991, the City's population grew at an average rate of 1.67 percent per annum, while after 1991 the growth became nearly constant with populations ranging between 324,000 and 330,000.

The estimated 2010 population of 382,000 in the 1992 Pre F/S was developed based on the 1991 population. The 2010 population estimated by the 1992 Pre F/S apparently shows a mean value among other population forecasts by the different institutions.

The Bureau of Statistics in Galati has a view that the projected 2010 population of 382,000 appears appropriate on account the fact that the present population of 335,962 as of 25th of June, 1999 would increase at an average annual growth rate of 1.2 percent.

In view of the above, the Galati City's population of 382,000 in 2010 is considered to be appropriate and hence this figure will be used for the planning of the present feasibility study.

(2) Sewer Service Population

Service population proposed in the 1992 Pre F/S is reviewed based on the latest available data. The following table shows the results indicating that the proposed service population in the Pre F/S is already outdated, in which the number of user category 1 is increased and that of user category 4 is decreased. Therefore, the number of future service population was updated through discussions with the authorities concerned. As shown in *Table II.2.1*, the total number of beneficiaries of the sewerage services will increase from the present 328,100 as of June 1999 to 377,000 in 2010.

Table II.2.1 Water Supply and Sewerage Service Populations by Users Category

User Category by Norm	Per capita water demand (lcd)	Present population (June 1999)	1992 Pre F/S (2010)	JICA F/S (2010)
1	65	95	6,500	0
2	110	7,443	6,500	5,000
3*)	170	0	0	0
4*)	295	20,967	0	8,000
5*)	380	307,128	369,000	369,000
Water supply		335,633	382,000	382,000
Sewerage		328,095	369,000	377,000

Note: *) Users with sewer service.

2.1.2 DOMESTIC WASTEWATER FLOWS

(1) Estimation Method

The present and future wastewater generations are estimated based in principle on the rules set by the Romanian Standards STAS 1343 (Water supply - determination of water supply volumes) and STAS 1846-90 (Sewerage - calculation of the wastewater flow), and available water supply data provided by the APATERM S.A.

(2) Estimated Domestic Wastewater Flow

The estimated wastewater generations by water user category are shown in *Table II.2.2*.

Table II.2.2 Estimated Wastewater Generations by Water User Category

Category	Per capita water consumption	Present service population	Water consumption (m^3/d)	(**) Water demand at source (m^3/d)	(***) Waste water generation (m^3/d)
1	65	95	6	7	6
2	110	7,443	819	989	791
3*)	170	0	0	0	0
4*)	295	20,967	6,185	7,471	5,977
5*)	380	307,128	116,709	140,984	112,787
Total		335,633	123,719	149,451	119,561
Sewerage		328,095	122,894	148,455	118,764

Note: *) With sewer service
**) Water demand at source = Kp x Ks x Water consumption, where Ks=1.05, Kp=1.15, KpxKs=1.208.
***) Wastewater generation =Kw x water demand at source, where Kw=0.8

According to the 1998 data by the APATERM S.A. the daily quantities of water intake and water consumption are 167,300 m^3/day and 129,870 m^3/day, respectively, which agree with those estimated in the above.

(3) Per Capita Water Consumption

The per capita water consumption comprises domestic, commercial, and institutional uses at the different ratios depending on the water user category, the ratios of commercial and institutional water to domestic water range from 21 percent to 40 percent. These ratios reasonably reflect the water supply conditions as these are established based on the actual water consumption trends observed in the water supply system management.

(4) Domestic Wastewater Inflows

The average daily domestic, commercial and institutional wastewater inflows to the public sewerage system in 2010 are as shown in *Table II.2.3.*

Table II.2.3 Average Daily Wastewater Inflow by User Category

User Category by Norm	Service population by 1992 Pre F/S	Average flow by 1992 Pre F/S (m^3/d)	Service population by JICA F/S (m^3/d)	Design average flow by JICA F/S (m^3/d)
3	0	0	0	0
4	0	0	8,000	2,280
5	369,000	125,860	369,000	135,510
Total	369,000	125,860	377,000	137,790

The maximum daily and maximum hourly flows of domestic, commercial and institutional wastewaters are then calculated by using the coefficients defined in the Romanian Standards (STAS 1343/1) as shown in the following table.

Table II.2.4 Maximum Daily and Maximum Hourly Flows

Wastewater flow	Design flow (m^3/d)	Estimate by JICA (l/s)	Coefficient (STAS 1343/1)	1992 Pre F/S (l/s)
Average daily flow	137,790	1,595	-	1,457
Maximum daily flow	151,680	1,755	1.10 to 1.15*)	1,675
Maximum hourly flow	174,550	2,020	1.15	1,928

Note: *) 1.15 and 1.10 for Category 4 and 5, respectively.

2.1.3 Industrial Wastewater Flows

(1) Industrial Wastewater Generation

Presently 51 factories are discharging industrial wastewater to the public sewers after pre-treatment. The S.C. APATERM S.A. estimates that the total daily industrial wastewater discharged to the River through collectors was 12,068,000 m^3 in 1998, of which 9,683,652 m^3 came from the factories discharging more than 1,000 m^3 /year wastewater, as shown in *Table II.2.5.*

It is also assumed that the annual working days of the factories are from 250 to 365 days, with an average of 300 days. In addition, a survey of house-to-house visits and delivery of questionnaires was conducted at major factories in the Study. About 30 companies replied to the questionnaires have been discharging about 14,100 m^3/day wastewater with qualities generally in agreement with those surveyed by S.C. APATERM S.A.

Table II.2.5 Industrial Wastewater Discharge Estimated by S.C. APATERM S.A.

Discharge quantity	Annual discharge (m^3/yr)	Daily discharge range (m^3/d)	Average daily discharge (m^3/d)
More than 1,000 m^3/yr	9,683,652	26,530 – 38,735	32,280
- Listed companies	*3,704,858*	*10,150 – 14,820*	*12,350*
- Non-listed companies	*5,978,794*	*16,380 – 23,915*	*19,930*
Less than 1,000 m^3/yr.	2,384,343	6,530 – 9,535	7,950
Total	12,068,000	33,060 – 48,270	40,230

Source: S.C. APATERM S.A.

(2) Industrial Wastewater Inflows to Sewers

Quantities of industrial wastewater discharging into sewerage system in 2010, both from point and non-point sources, are also reviewed by using the collected data and questionnaire surveys. The review results are summarized as follows.

- Average daily flow ; 62,000 m^3/day
- Maximum daily flow ; 83,000 m^3/day
- Maximum hourly flow ; 110,000 m^3/day

2.1.4 WASTEWATER CHARACTERISTICS

(1) Present Domestic Wastewater Characteristics

The table below shows the average wastewater quality monitored in 1998 at the outfalls. The concentrations of BOD_5 and SS range 18 mg/l to 47 mg/l, and 54 mg/l to 109 mg/l, respectively.

Table II.2.6 Wastewater Quality at Outfall

No	Name of Collector	Number of Samples	BOD_5 (mg/l)	SS (mg/l)
1	Micro 21	36	47	109
3	Popasul de la Dunare	37	39	88
4	Libertatea	37	33	79
5	Valurile Dunarii	37	36	83
6	SP 13 Iunie	41	29	86
7	SP3	34	18	54

Note: Data obtained from S.C. APATERM S.A.

Further wastewater quality survey was conducted by the Study in February through March 1999, sampling wastewater at Micro 21 and SP 13 Iunie outfalls, the results of which are presented below.

As residential districts dominate and almost no factories exist within the tributary to the Micro 21 outfall, characteristics of the wastewater from this collector are considered to represent typical domestic wastewater. Within the tributary of the SP 13 Iunie collector, apartments, offices, restaurants, factories, etc. coexist, thus the wastewater is a mixture of domestic, commercial, institutional and industrial wastewater, as indicated in *Table II.2.7*.

Table II.2.7 Wastewater Quality at Outfalls Micro 21 and SP 13 Iunie

Parameters	Micro 21		SP 13 Iunie		Remarks
	Range	Weighted average	Range	Weighted average	
BOD_5 (mg/l)	19-164	71	30-70	49	*47, 29
SS (mg/l)	35-132	83	99-172	145	*109, 86
T-N (mg/l)	5.3-19.2	11.7	6.1-12.8	9.9	
T-P (mg/l)	0.31-3.93	1.56	0.53-1.32	0.93	

Note: * the average concentration of BOD_5 and SS shown in previous table.

The pollutant loads discharged to the Danube River through the outfalls are then estimated as summarized below.

Table II.2.8 Estimated Pollutant Load at Outfalls Micro 21 and SP 13 Iunie

Sampling Location	Average Flow (m^3/d)	Weighted Average Concentration (mg/l)				Pollutant Loads (kg/d)			
		BOD_5	SS	T-N	T-P	BOD_5	SS	T-N	T-P
Micro 21	1,344	71	83	11.7	1.56	95	112	15.7	2.10
SP 13 Iunie	96,096	49	145	9.9	0.93	4,709	13,934	951.4	89.37

As the wastewater measured at Micro 21 outfall is predominantly domestic in nature, the estimated pollutant loads could be used to estimate per capita unit pollutant loads. The results of the calculations indicate that the per capita wastewater flow is 112 lcd, with per capita BOD_5 and SS loads as low as 8 gcd and 9 gcd, respectively.

Table II.2.9 Wastewater Measured at Micro 21 Outfall

Parameters	Micro 21
Average Flow (m^3/d)	1,344
Service Population *	12,000
Per Capita Wastewater Generation (lcd)	112
Loads (kg/d)	
BOD_5	95
SS	112
Total Nitrogen (T-N)	15.7
Total Phosphorus (T-P)	2.1
Per Capita Unit Loads (gcd)	
BOD_5	8
SS	9
Total Nitrogen (T-N)	1.3
Total Phosphorus (T-P)	0.18

Note: * shows that the service population is based on the information provided by SC APATERM SA

(2) Present Industrial Wastewater Characteristics

Characteristics of the industrial wastewater measured at 48 manufacturers and companies in 1998 are available. Data collected by the S.C. APATERM S.A. and a questionnaire survey by the Study Team with cooperation of the S.C. APATERM S.A., are analyzed for estimating the industrial wastewater qualities.

The results of the analyses of the industrial wastewater, including the SC INTFOR SA, indicate that the average concentrations of BOD_5 and SS are about 60 mg/l and 140 mg/l, respectively. If the wastewater of such metallurgy products industry were not included in the estimation, the average concentrations of BOD_5 and SS would increase to about 130 and 190 mg/l, respectively.

(3) Design Wastewater Quality in 1992 Pre F/S

In the 1992 Pre F/S, design wastewater BOD_5 and SS were set at 115 mg/l and 400 mg/l, respectively. In the following table, the influent quality each of domestic and industrial wastewater was estimated by the per capita loads and service population, and design flows. The influent domestic wastewater BOD_5 and SS levels were estimated at 170 mg/l and 196 mg/l, respectively.

The estimated design strengths of domestic wastewater BOD_5 and SS were of typical medium strength wastewater, although the present domestic wastewater strength was quite weak as discussed previously. It also assumed that the industrial wastewater quality was 44 mg BOD_5/l and 649 mg SS /l. Such a high SS concentration evidently exceeds the permissible limit of 300 mg/l in the Romanian Standards, however, no information was available on how these values were estimated.

Table II.2.10 Design Wastewater Quality in 1992 Pre F/S

Parameter	Wastewater	Per Capita Loads (gcd)	Loads (kg/d)	Design Flow (m^3/d)	Influent Quality (mg/l)	Remarks
BOD_5	Domestic**	65	*24,830	146,060	**170	
	Industrial	-	5,170	117,505	**44	
	Total		30,000	263,565	114	≈ 115
SS	Domestic**	75	*28,650	146,060	**196	
	Industrial	-	76,300	117,505	**649	
	Total		104,950	263,565	398	≈ 400

Note: * The domestic wastewater also includes commercial, institutional wastewaters.
** The figures which are calculated that the per capita loads multiplied with the sewerage service population of 38,200 in 2010.
*** The figures calculated that the loads are divided by the design flow.

Source: The 1992 Pre F/S Report prepared by PROED, on September 1992.

(4) Estimation of Future Domestic Wastewater Quality

As the design wastewater influent quality parameters, BOD_5, SS, T-N, and T-P are estimated, taking into account the present wastewater concentrations, present pollutants loads, future increments of pollutants loads, and data and information available from some references.

As previously discussed the pollutant concentrations of the present domestic wastewater are low and so too are the per capita unit waste loads. The unit loads were estimated based on the service population, and hence, the average concentration of each quality parameters were used, instead of the per capita loads, to estimate the equivalent per capita loads, as shown below.

Table II.2.11 Equivalent Per Capita Load

Quality Parameter	*Average concentration (mg/l)	Design average flow (m^3/d)	Pollutant loads (kg/d)	Planned service population	Equivalent per capita loads (gcd)
BOD_5	71	138,000	9,798	377,000	26
SS	83		11,454		30
T-N	12		1,656		4.4
T-P	1.6		220.8		0.6

Note: * shows the data of Micro 21.

The equivalent per capita loads were used for the present domestic influent estimation. With the assumption that the per capita unit loads for commercial and institutional wastewater were to be 30% of the domestic one, the present domestic influent quality was estimated as follows.

Table II.2.12 Present Domestic Influent Quality

Quality Parameter	Per capita load (gcd)			Loads (kg/d)	Influent quality (mg/l)
	Domestic	Commercial & institutional	Total		
BOD_5	26.0	7.8	33.8	12,743	92
SS	30.0	9.0	39.0	14,703	107
T-N	4.5	1.4	5.9	2,224	16
T-P	0.60	0.18	0.78	294.1	2.1

Based on the assumption to increase the per capita loads by 30%, the design domestic influent quality was calculated as shown in *Table II.2.13*.

Table II.2.13 Design Domestic Influent Quality

Quality Parameter	Planned Service Population	Per Capita Loads (gcd)	Loads (kg/d)	Design Average Flow (m^3/d)	Influent Quality (mg/l)	Remarks
BOD_5	377,000	44	16,588	138,000	120	
SS		51	19,227		140	
T-N		7.7	2,903		21	
T-P		1.01	381		2.8	

Note: The Domestic wastewater includes commercial and institutional wastewater.

(5) Estimation of Industrial Wastewater Quality

The listed 51 factories are categorized by their products and the present industrial wastewater discharges by product categories are summarized as shown in the following table:

Table II.2.14 Industrial Category by Wastewater Discharge

Category	Present Discharge Flow (m^3/d)	Share (%)	Remarks
Food Processing	3,024	24.5	Meat products, dairy products, bread, vegetable oil, etc.
Beverage	2,237	18.1	Beer, wine, distillery, soft drinks, etc.
Textile	612	5.0	Cotton fiber, textile fiber, etc.
Metal Products	2,175	17.6	Metal semi-finished products, etc.
Other Manufactures	747	6.0	Machinery, chemical products, furniture, feed stuff, etc.
Others	3,553	28.8	Service industries
Total	12,348	100.0	

The share of each category for the target year was assumed to be the same as the present one. The design discharge flow to the sewerage system was calculated by the design flow of 18,000 m^3/day multiplied by the share of each category, as shown in *Table II.2.15*.

Table II.2.15 Design Industrial Discharge Flow

Category	Share (%)	Design discharg flow (m^3/d)	Remarks
Food Processing	25.0	4,500	
Beverage	18.0	3,240	
Textile	5.0	900	
Metal Products	18.0	3,240	
Other Manufactures	6.0	1,080	
Others	28.0	5,040	
Total	100.0	18,000	Design Average Flow

For the design purpose, the industrial wastewater quality to be discharged by each category is set as shown in *Table II.2.16*.

Table II.2.16 Design Industrial Wastewater Quality

Category	Quality Parameters (mg/l)			
	BOD_5	SS	T-N	T-P
Food Processing	300	200	40	10
Beverage	300	300	30	10
Textile	200	300	30	20
Metal Products	80	100	10	5
Other Manufactures	100	100	20	2
Others	100	200	5	1

The maximum permissible concentrations of BOD_5 and SS are set at 300 mg/l, which is same as the national effluent quality standards for the wastewater discharge to public wastewater systems. However, the concentration of total nitrogen and total phosphorus, the national effluent standards are not applied. Because the national standards do not provide any maximum permissible concentration of total nitrogen but that of ammonium nitrogen of 30 mg/l and provide that of total phosphorus of 5.0 mg/l.

The design loads from the listed 51 companies are estimated, with the average concentrations of BOD_5 of 187 mg/l, SS of 199 mg/l, T-N of 21 mg/l, and T-P of 6.6 mg/l. The design overall industrial wastewater quality are then estimated as shown in the following table. In the table, the design quality of industrial wastewater from the non-listed factories as well as the non-point source is assumed to be the same as the domestic, commercial and institutional wastewater.

Table II.2.17 Design Overall Industrial Wastewater Quality

Wastewater	Design Flow (m^3/d)	Loads (kg/d)				Concentration (mg/l)			
		BOD_5	SS	T-N	T-P	BOD_5	SS	T-N	T-P
Point source									
- Listed factories	18,000	3,373	3,582	383	118.8	187	199	21	6.6
- Non-listed factories	24,000	2,880	3,360	504	67.2	120	140	21	2.8
Non-point source	20,000	2,400	2,800	420	56.0	120	140	21	2.8
Total loads (kg/d)	62,000	8,653	9,742	1,307	242.0				
Average concentration (mg/l)						140	157	21	3.9

Combined with the design quality of the domestic, commercial, and institutional wastewater with the industrial wastewater discharged to the public sewerage system above, the overall influent quality to the wastewater treatment plant are as follows.

Table II.2.18 Overall Influent Quality to the Wastewater Treatment Plant

Wastewater	Design Flow (m^3/d)	Loads (kg/d)				Concentration (mg/l)			
		BOD_5	SS	T-N	T-P	BOD_5	SS	T-N	T-P
Domestic, Commercial, & Institutional	138,000	16,588	19,227	2,903	381	120	140	21	2.8
Industrial	62,000	8,653	9,742	1,307	242	140	157	21	3.9
Total (average)	200,000	25,241	28,969	4,210	623	126	145	21	3.1
Design wastewater quality (mg/l)						130	150	20	3

The design wastewater quality is thus determined to be 130 mg/l in BOD_5, 150 mg/l in SS, 20 mg/l in T-N, and 3 mg/l in T-P.

2.2 WASTEWATER COLLECTION SYSTEM

The sewerage system of Galati collects both dry weather flows (DWF) and wet weather wastewater flows (WWF) through the existing sewer reticulations and then discharges to the Danube River through seven major outfalls. Most of the wastewater flows down to the River directly through outfalls by gravity, but when the river water elevation rises, through the pumping stations.

The Galati City has established a comprehensive sewerage system improvement plan to intercept all the DWF, and during rain storms the WWF twice as much the DWF, through new interceptor sewers, and transport them to a centralized WWTP to be located in the eastern part of the City.

The plan includes the construction of interceptor and pressure sewers of about 9.7 km long. Each of the existing seven major outfalls will be intercepted near the Danube River with a provision of stormwater overflow chamber to divert the excess wastewater commingled with stormwater runoffs. According to the plan, all the wastewater could inflow by gravity to the interceptor sewers. The interceptor sewers range from 1,500 mm to 2,200 mm in diameters.

2.3 CITY'S PROPOSED WWTP

Under the City's sewerage improvement plant, a pre-feasibility study on the WWTP was made by PROED in 1990 and 1993, which proposed a plant to have a treatment capacity of dry weather flow (DWF) rate of 285,120 m^3/day and wet weather flow (WWF) of 570,240 m^3/day. In the study, the treatment plant facility capacities were calculated based on the predicted future City population of about 382,000 and wastewater quantities in the year 2010.

The selected WWTP site is located at the eastern end of the City area about 10 km downstream of the central part of the City. As the proposed site is located far removed from the sewer networks, the City has now been contemplating to find out other possible alternative WWTP sites closer to the existing sewer networks.

During the wet weather flow, up to the DWF will be treated by the secondary process while the wastewater in excess of the DWF will receive the primary treatment.

The major features of the WWTP are as summarized below:

Hydraulic Conditions

Maximum daily wastewater inflow rate:	3,050 l/sec or 11,000 m^3/hour
Maximum hourly wastewater inflow rate:	3,300 l/sec or 12,000 m^3/hour
Minimum hourly wastewater inflow rate:	2,300 l/sec or 8,300 m^3/hour
Peak flow Rate (2 x dry weather flow):	6,600 l/sec or 24,000 m^3/hour

Served Population/Per Capita Waste Loads

Total Population Served in 2010:	382,000 persons
Per capita Suspended Solids:	75 g/capita/day
Per Capita Biochemical Oxygen Demands(BOD_5):	65 g/capita/day
Total Domestic Suspended Solids(SS):	28,700 kg/day
Total Domestic BOD_5:	24,830 kg/day
Total Industrial Wastewater Suspended Solids:	76,300 kg/day
Total Industrial Wastewater BOD_5:	5,170 kg/day

Total Suspended Solids Inflowing Loads to WWTP:	105,000 kg/day
Total BOD_5 Inflowing Loads to WWTP:	30,000 kg/day

Wastewater Qualities

Influent wastewater quality:	BOD_5	115 mg/l
	SS	400 mg/l
Effluent wastewater quality;	BOD_5 (removal 75 %)	30 mg/l
	SS (removal 90 %)	40 mg/l

Treatment Process

The conventional activated sludge process to treat the maximum daily DWF is proposed. During wet weather, flows up to 2 times the dry weather flow will be led to the plant, of which up to one DWF flow rate will be biologically treated, the rest having been treated to the primary and chlorination treatment level. No advanced treatment is considered.

Proposed Facilities

The proposed activated sludge process facilities consist of the following:

- Primary treatment process
  Screenings; coarse and fine screenings
  Grit removal; aerated grit chambers
  Primary settling tanks
- Biological treatment process
  Aeration tanks
  Final settling tanks
- Chlorine contact tanks
- Sludge digesters and gas storage tanks
- Sludge dewatering
- Chlorination contact tanks
- Outfall Pumping System

2.4 CONCLUSIONS

Results of the review on the 1992 Pre F/S and other information indicate that the existing plan is in general appropriate to adopt to the present feasibility study.

The proposed conventional activated sludge process will be able to produce stable and high quality effluents that meet the stringent discharge quality requirements to the Danube River. The preliminary engineering design of the WWTP were made in principle based on the Romanian National Guidelines (STAS 4162), some parameters of which appear to be more stringent than other comparable standards.

It should be noted, however, that some of the basic factors in the Pre F/S, such as population and wastewater qualities/quantities, need to be updated in view of the recent changes of socioeconomic situations.

Flexibility to the improvement and upgrading of the WWTP should also be considered at the final design stage so that the WWTP could meet more stringent water quality requirements if and when such are enforced in the future. In the preliminary engineering design, a consideration is to be given to the future expansion and upgrading requirements so as to meet the possible requirements of more stringent water quality of the River water and increase of wastewater inflow.

CHAPTER 3 PLANNING BASIS

3.1 SERVED POPULATION

Of the Galati's 382,000 population in 2010, about 377,000 will be served by the sewerage system in 2010, with the breakdown shown in *Table I.3.1*.

Table I.3.1 Present and Future Served Populations

Water users category	Present (June 1999)	Future (2010)
3	0	0
4	20,967	8,000
5	307,128	369,000
Total	328,095	377,000

The design flows for the interceptor sewers and WWTP were determined by the served population of 377,000.

3.2 WASTEWATER FLOWS

The dry weather flows (DWF) and wet weather wastewater flow (WWF) to the WWTP in 2010 are as summarized in the following:

Table I.3.2 Wastewater Flow Rates in 2010

Wastewater category	Average daily flow	Maximum daily flow	Maximum hourly flow	Wet weather flow
Domestic/commercial/ institutional wastewater	138,000	152,000	175,000	-
Industrial wastewater	62,000	83,000	110,000	-
Total	200,000	235,000	285,000	570,000

(Unit : m^3/day)

For the DWF hydraulic and organic load designs of the WWTP facilities, the maximum daily wastewater flow rate of 2.72 m^3/sec. or 235,000 m^3/day is used. During rain events, the wastewater flow (commingled with stormwater) up to twice the DWF will be conveyed to the WWTP. Out of the WWF of 6.6 m^3/sec. or 570,000 m^3/day, only one DWF flow will receive the secondary treatment, the rest being treated up to the primary treatment level.

3.3 WASTEWATER CHARACTERISTICS

The wastewater characteristics in the year 2010 are estimated based on the review and analysis of the various field wastewater data collected by the City and the present study, as summarized in the following.

BOD_5	130 mg/l
SS	150 mg/l
T-N	20 mg/l
T-P	3 mg/l

CHAPTER 4 INTERCEPTOR SYSTEM

4.1 EXISTING SEWERAGE SYSTEM

The sewerage system in Galati is the combined system which collects both the wastewater and storm water together. Presently the system has no wastewater treatment plant and collected wastewater is directly discharged to the Danube River and the Siret River from seven outfalls. The existing sewerage system together with the site of wastewater treatment plant (WWTP) proposed in the Study is shown in *Figures II.4.1.*

The outfall No. 1 discharges the wastewater into the Siret River, whereas the outfalls No.2 to No.7 discharge the wastewater into the Danube River. The outfall No. 6 discharges the wastewater through the pumping station SP2 (13 Iunie) while the Danube water level rises so high that the wastewater could not be discharged by gravity. The outfall No. 7 discharges wastewater through pumping station SP3. Other outfalls discharge the wastewater by gravity.

Because the outfall No. 2 discharges wastewater collected only from a water purification plant which is supposed to manage the wastewater treatment, this outfall is excluded from the Study.

4.2 PROPOSED INTERCEPTOR SYSTEM

4.2.1 OVERALL PLANNING

Among the six (6) candidate sites, the WWTP site is selected at the eastern part of the City near the existing pumping station SP3 as shown in *Figure II.4.1,* based on the alternative study. It is planned that wastewater from existing outfalls be collected and transmitted to the WWTP by installing an interceptor sewer. The interceptor sewer system is planned to collect up to twice as much as the maximum hourly dry weather wastewater flow (2Q). The combined sewer overflow (CSO) regulators and connection sewers are to be installed to divert the wastewater flow into the interceptor sewer. The excess wastewater overflowing the planned CSO regulators is discharged to the River through the existing outfalls.

The interceptor sewer is planned to run along the Danube River, from near the outfall No.3 to the planned WWTP. The interceptor sewer will collect the wastewater from the existing outfall sewers No.3 to No.7 through the CSOs, as illustrated in *Figure II.4.2.* The wastewater from the outfall sewer No.1 is to be diverted into the existing sewer network which will be connected to outfall No. 3.

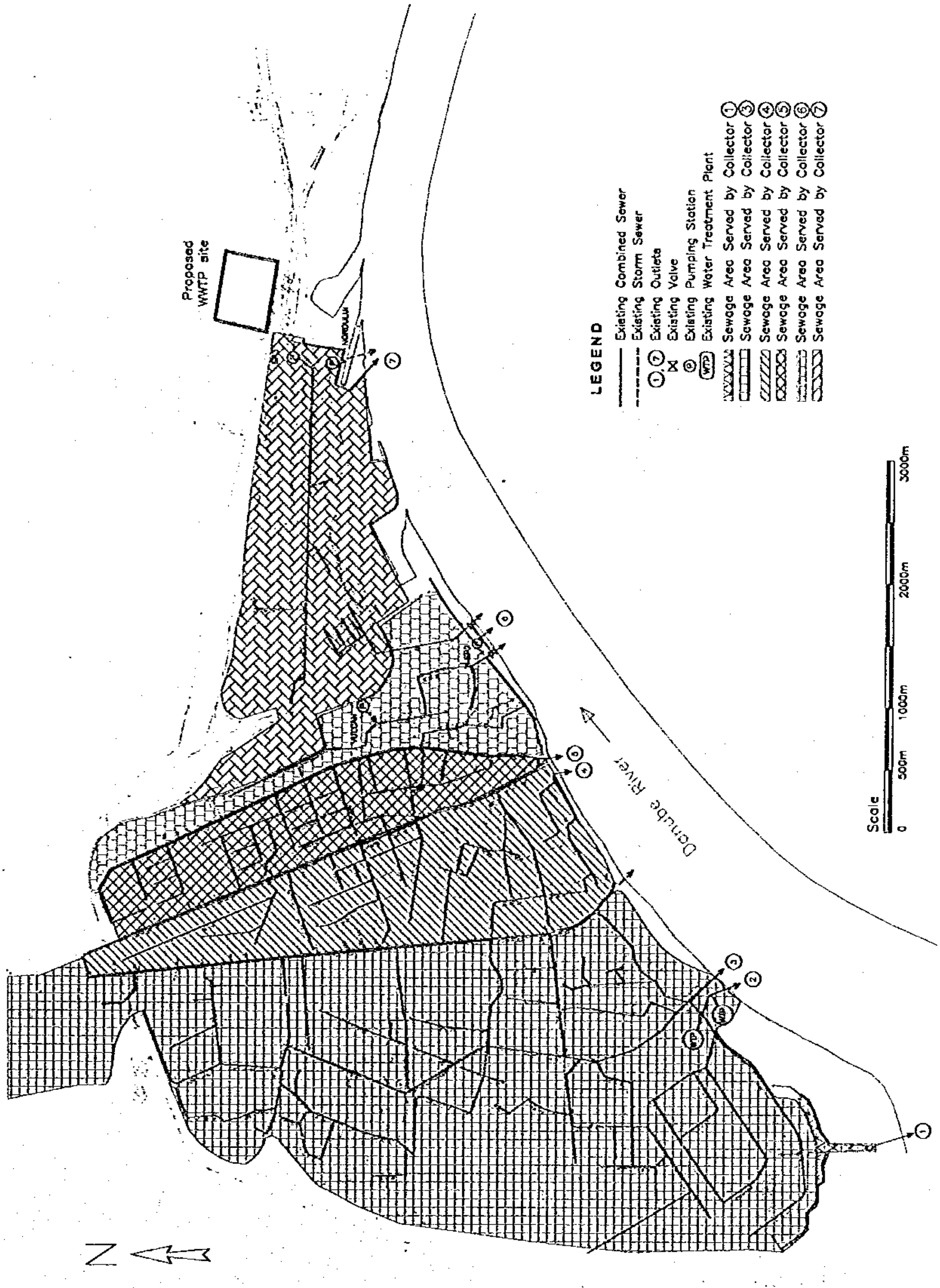

Figure II.4.1	Existing Sewerage System of Galati City

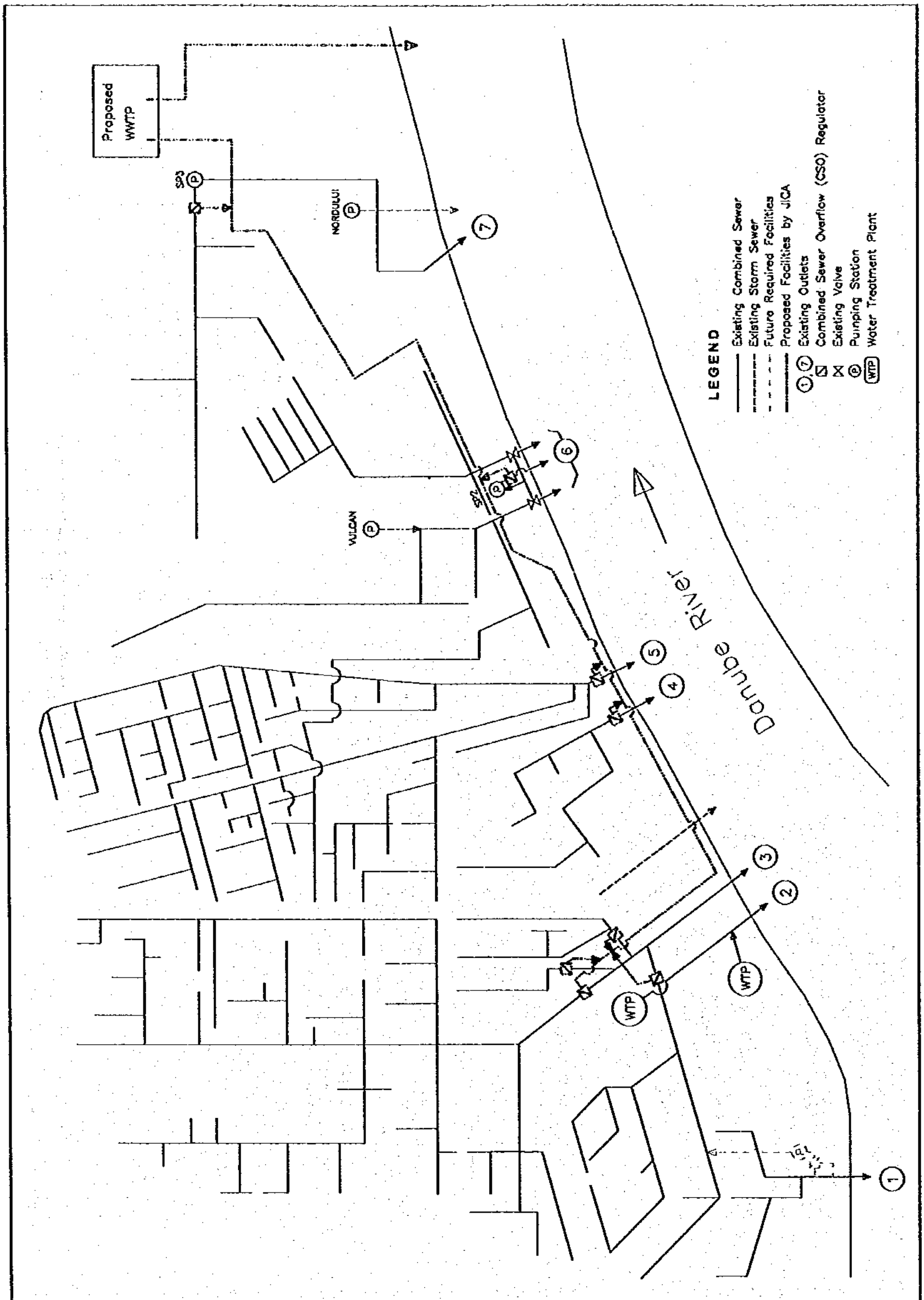

Figure II.4.2	Proposed Plan of Interceptor System of Galati City

4.2.2 Design Wastewater Flow

To design the interceptor sewer, design wastewater flows were determined as shown in *Table II.4.1*. Total maximum hourly flow was given by the planning basis in the Study and the maximum hourly flow of each outfall was estimated by distributing it proportionally to the wastewater flow of each outfall, which is estimated based on the information given by S.C. APATERM S.A.

Table II.4.1 Wastewater Flows from Existing Outfalls

Code and name of outfall		Wastewater flow * (m^3/day)	Max. hourly flow (Q) (m^3/day)	2Q (m^3/day)	Max. hourly flow (Q) (L/s)	2Q (L/s)
1	Micro 21	6,377	11,971	23,942	0.139	0.278
2	Water purification plant	0	0	0	0.000	0.000
3	Popasul de la Dunare	108,211	203,131	406,262	2.351	4.702
4	Libertatea	7,097	13,322	26,644	0.154	0.308
5	Valurile Dunarii	17,909	33,618	67,236	0.389	0.778
6	SP 13 Iunie	7,952	14,927	29,854	0.173	0.346
7	SP3	4,278	8,031	16,062	0.093	0.186
Total		151,824	285,000	570,000	3.299	6.598

*: Estimation in the Study based on data from S.C. APATERM S.A.

4.2.3 Facility Design

A route of the interceptor sewer is planned to collect wastewater from the existing outfalls as downstream as possible and to connect them along the existing roads as long as possible. The layout of proposed interceptor in Galati is shown in *Figure II.4.3*.

The interceptor sewer is designed to adopt gravity flow. Of the five (5) outfall sewers to be connected to the interceptor sewer, four (4) outfall sewers convey the wastewater by gravity, whereas wastewater of No.6 outfall sewer is pumped up to the interceptor sewer by the existing pumping station SP2. Sizes of the interceptor sewer were determined to have a capacity to convey 2Q of wastewater from connecting outfall sewers.

4.2.4 Proposed Facilities

Planned facilities comprise the combined sewer overflow (CSO) regulators, the connection sewers, the interceptor and manhole, as listed in *Table II.4.2*. Major features of these facilities are described in the following:

(1) Interceptor Sewer

Installation of the interceptor sewer starts near the outfall No.3 and ends at the entrance of the proposed WWTP. The total length of the sewer is 7,762 m, with diameters from 1,500 mm to 2,200 mm.

The sewer will generally be laid down by open cut excavation method, but where the earth coverage exceeds 5 m, a shield-tunneling method will be applied.

The open cut excavation method will be applied from GI1 through GI5-3, and the shield-tunneling method will be applied from GI5-3 through the WWTP. Lengths of the open cut and shield tunneling methods are 5,048 m and 2,714 m, respectively.

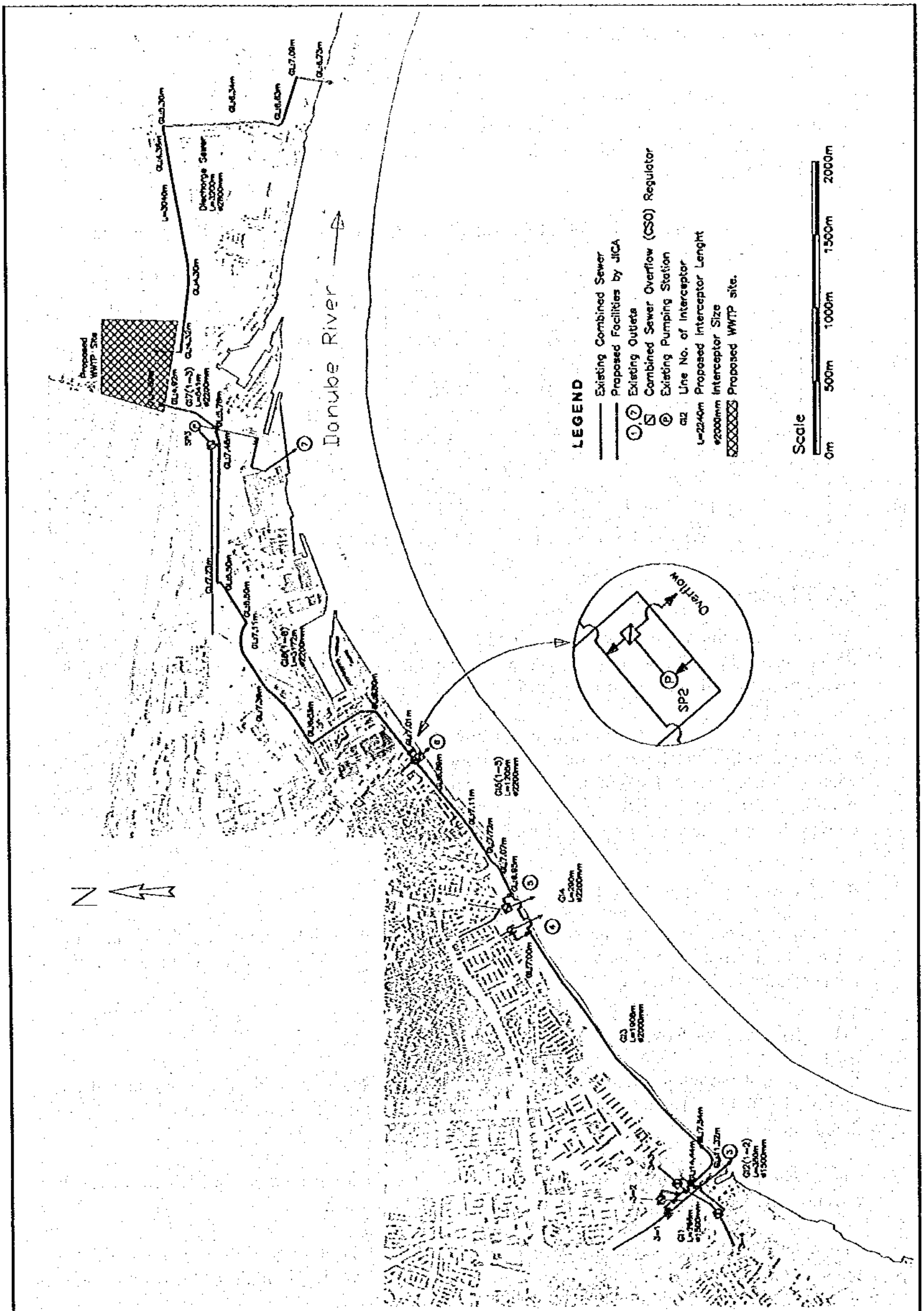

Figure II.4.3	Layout of Proposed Interceptor System of Galati City

(2) CSO Regulators

CSO regulators are installed in the main sewers to transfer up to 2Q of the wastewater to the interceptor sewer through connection sewers, and to divert the excess wastewater overflowing from weirs to the existing outfalls.

Two (2) different types of CSO regulators, large and small types, are applied in the Study. These are classified with overflow rates, diameters of the combined sewers, and hydraulic heads of overflow weir. In total eight (8) CSOs will be constructed, consisting of four (4) large and four (4) small CSO regulators.

(3) Connection Sewers

Seven (7) connection sewers are to be installed to carry 2Q of wastewater from the CSO regulator to the interceptor sewer. Generally the length of the connection sewer is around 20 m and the earth coverage is 1 to 3 m. However, length of connection sewer from one of the branches of outfall sewer No.3, which comes from southeast part of Galati, is estimated 300 m in order to keep the potential head.

(4) Manholes

28 manholes will be installed along the interceptor sewer generally at intervals of 200 m, and also at the junctions of sewers and roads.

Table II.4.2 Proposed Facilities of Interceptor System of Galati City

1. Interceptor Sewer

Diameter (mm)	Length by earth covering (m)				Total length (m)	Construction Method	Remarks
	1-3 m	3-5 m	5-7 m	7-9 m			
1500	282	14			296	Open cut	
2000	2258				2258	Open cut	
2200	517	1957			2474	Open cut	
2200		20			20	Open cut	Under railway
2200		144	1533	1036	2714	Shield method	

2. CSO Regulator

Type	Quantity
Small Type	4
Large Type	4

3. Connection Sewer

Diameter (mm)	Length (m)	Earth covering (m)
300	20	1-3
400	40	1-3
500	40	1-3
700	300	1-3
800	20	1-3

4. Manhole

Diameter (mm)	Quantity by earth covering				Total
	1-3	3-5	5-7	7-9	
1500	3				3
2000	10				10
2200	4	9	1	1	15

CHAPTER 5 WWTP FACILITY PLANNING

5.1 PLANNING PRINCIPLE

5.1.1 HYDRAULIC / ORGANIC LOADING ON FACILITIES

As the hydraulic and organic capacities of the plant component facilities, the maximum daily wastewater flow of 234,400 m^3/day or 2.72 m^3/sec is employed. Each component facility is checked both for the average daily and maximum hourly flow conditions.

All piping and channels for the secondary treatment process are designed to carry the maximum hourly flow of 3.3 m^3/sec, but for the primary treatment process the hydraulic maximum flow of 6.6 m^3/sec. (wet weather flow) are used.

5.1.2 PLANNING BASES

Plant Design and Operation: The plant design and operation will be such as to minimize any real or perceived nuisance to the surrounding community, and flexible so that any unanticipated future changes in the effluent requirements could be accommodated. The plant design will contain elements of flexibility, which will ensure changes in operation, for the plant performance enhancement and which could be implemented with ease.

Process Control: With the objective of simplicity of operation, the process control using sensors will be kept to a minimum and only used in such areas where it will have visible financial pay back. The process must be robust and hence not easily upset.

Flow Division Control: The design will provide for flow division control facilities to insure organic and hydraulic loading control to various process units. Convenient, easy and safe access, change, observation, and maintenance should be considered in the design of such facilities.

Plant Bypass and Unit Bypass: The wastewater treatment plant design calls for accepting the daily maximum DWF of 2.72 m^3/sec and the WWF of 6.6 m^3/sec. Flows in excess of 6.6 m^3/sec will be bypassed to the nearby waterways through stormwater overflow chambers on the way to the WWTP. A minimum of two units in the liquid treatment process train is to be provided for all unit processes and operations in the plant. The bypass design will facilitate plant operation during unit maintenance and emergency repair so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode.

Pipe Cleaning and Maintenance: Fittings, valves, and other appurtenances should be provided for pipes subject to clogging, to facilitate proper cleaning through mechanical cleaning or flushing. Pipes subject to clogging, such as pipes carrying sludge, shall be lined with a material that creates a smooth and non-adhering surface.

Grading and Landscaping: The plant site will be graded and landscaped upon completion of the plant. Concrete or asphalt paved walkways will be provided for access to all units. Steep slopes are to be avoided to prevent erosion.

Mechanical Equipment: Selected equipment must be readily available, can be serviced locally, and also supported by uncomplicated and understandable operation and maintenance manuals. Equipment replacement parts must be available without major delays.

Emergency Power Facilities: The plant shall have an alternate source of electric or mechanical power to allow continuity of operation during power failures. Auxiliary power for minimum aeration of the activated sludge is required to protect downstream uses.

Plant Sanitary System: An adequate supply of potable water under pressure shall be provided for use in the laboratory and for general cleanliness around the plant. Potable water from the municipal water supply may be used directly at points above grade for hot and cold supplies in lavatory, water closet, laboratory sink (with vacuum breaker), shower, drinking fountain, eye wash fountain, and safety shower. Toilet, shower, lavatory, and locker facilities shall be provided in convenient locations to serve the expected staffing level at the plant.

Flow Measurement: Flow measuring equipment should be provided so as to continuously indicate, totalize and record volumes of the incoming and outgoing liquid and sludge flows in the major facilities.

Laboratory: The WWTP should include a laboratory for making the necessary analytical determinations and operating control tests. The laboratory size, bench space, equipment and supplies shall be such that it can perform analytical work for all self-monitoring parameters required by discharge permits, and the process control necessary for good management of each treatment process included in the design

5.2 WWTP SITE DEVELOPMENT

5.2.1 SITE SELECTION

(1) Candidate Sites

As the possible WWTP site(s), the following six candidate lands have first been selected as shown below in *Table II.5.1*, then each of the sites is evaluated on its socioeconomic aspects, topography, environs, expandability, and the magnitude of treatment plant capacity the land can accommodate.

Table II.5.1 Alternative WWTP Sites

Alternative Sites	Land area (ha)	Remarks
Alternative 1	7.3	Flat agricultural and wasteland near the Siret River mouth.
Alternative 2	2.5	2.5Located southeast to the stadium.
Alternative 3	1.8	Located close to the Danube River.
Alternative 4	9.45	Located close to the stormwater pump station.
Alternative 5	>20	About 300 m north to Alt.4 site.
Alternative 6	>7	North to Free Economic Zone close to the Danube River.

(2) Affordable Treatment Capacities by Available Land Areas

The WWTP capacity that could be provided within the limit of each land area is estimated. The plant capacities corresponding to the alternative sites are as follows:

Table II.5.2 Maximum Capacity of WWTP by Land Area

Alternative Sites	Land area (ha)	*Maximum plant capacity (m^3/day)	Remarks
Alternative 1	7.3	60,000	Land is fully usable.
Alternative 2	2.5	11,000	Land is fully usable.
Alternative 3	1.8	6,000	Land is fully usable.
Alternative 4	9.45	40,000	About 40 % land area may be unusable.
Alternative 5	>20	300,000	Further expansion may be possible.
Alternative 6	>7	60,000	More land can hardly be acquired.

Note: Calculated from an equation in the form $A = 4.78Q^{0.633}$ by the Ministry of Construction, Japan, based on the data obtained from 117 conventional activated sludge WWTP.

(3) Evaluation of Alternative Lands

To treat the DWF of 235,000 m^3/day in a centralized WWTP, a land area of 18 to 20 hectares is required. All the six alternative plant sites are first checked for their appropriateness as WWTP sites. The analysis elaborates that Alternatives sites 1, 5 and 6 could be of the possible WWTP sites. The WWTP program options thus selected include:

- One centralized WWTP to treat all the wastewater at Alternative 5(20 ha) site; and
- Two separated WWTPs each at Alternative 6 site (12 ha.) and Alternative 1 site (14 ha.).

1) Cost comparison

An economic analysis is made of all costs accruing to each program over a 25-year period, and the future costs are discounted at 5 percent per annum to the present worth values. Results are as summarized in the following:

Table II.5.3 Construction and Costs of Alternative Plans

(US$ 1,000 at 1999 price level)

Alternative Plans	Capital Costs	O/M Costs (per year)
Option 1	65,643	3,854
Option 2	79,294	4,982

Note: These cost estimates are order-of-magnitude, or reconnaissance level only, and are not adequate for detailed financial planning.

Table II.5.4 Economic Costs of Alternative Plans

(US$ 1,000 discounted at 5 % per annum)

Alternative Plans	Capital Costs	O/M Costs	Total Costs
Option 1	67,432	38,944	106,380
Option 2	78,399	50,691	129,091

Option 1 would be less costly management program than Option 2 because of a concentrated WWTP has a merit of economy of scale. As it is presumed that at the initial stage of the implementation only limited fund would be available, Option 1 program would be the more realistic plan in terms of the project financing.

2) Intangible considerations:

Important non-quantifiable considerations have been identified and evaluation made of the degree to which each is responded to by the alternatives analyzed, including:

- Flexibility;
- Speed of project implementation; and
- Community/environmental impact.

Option 1 would require high initial investments for a large WWTP and conveyance facilities. Such major investments would dictate the course of regional wastewater management for many years to come, and would render the alternative inflexible. Option 2 is more flexible program than Option 1, because after initial construction of the system, it would be possible to start operation at a relatively early stage.

In Option 1, the large interceptors and WWTP would surely require considerable time to complete the construction. Option 2 has smaller interceptors than that of Option 1, and that can be laid in a relatively short time.

Option 1 will have no significant community impact because the treatment facilities involved would be located in an area presently devoted to agricultural land. The site is separated from residential area, but the land is to be acquired, taking some time to secure a sufficient land for the WWTP. As the west WWTP site of Option 1 is located close to the residential area, it requires considerations for minimizing hazards and nuisance. In view of these, Option 2 is superior to Option 1 in terms of community and environmental impacts..

3) Conclusions

From the comparative analysis, it is concluded that Option 1 represents satisfactory long-range regional wastewater management program from the economical and technical viewpoints of wastewater management plan, hence this should be adopted as the plant site for the wastewater management system.

5.2.2 Site Development

(1) Property

Presently available land for the centralized WWTP is about 20-hectare agricultural land, located about 500 m to north of the Danube River bank. This land is considered sufficient to provide all the necessary facilities for the preliminary, primary and secondary treatment in 2010, with a space for future plant expansion. The vicinity of the site is agricultural lands and neither residences nor major structures exist within 2km m from the site.

(2) Site Access

Access to the site can be made through the major road DN 2B, running from west toward east along the railway lines.

(3) Danube River Water Surface Elevations

The treatment plant structures and all related equipment shall be protected from physical damage by the 100-year flood. The treated plant effluent will be disposed of to the Danube River at a point about 10 km downstream from the central part of the City. The river water surface elevations at the different return periods are as given in the following table:

Table II.5.5 Danube River Water Surface Elevations at Galati by Probability

Water surface conditions	Surface elevations (in meters above MWL)
River water elevation (Highest recorded)	7.44
River water elevation (Average)	3.87
River water elevation (Lowest)	0.38
River water elevation (2% return period)	7.20

Source: "The Development of Sewerage System for Used Water from Galati City, September 1992."

(4) Ground Preparation

The land surface is relatively flat with natural ground elevations ranging from +3.8 m to +4.0 m M.W.L. The finished ground surface elevation of + 7.5 m M.W.L is appropriate for developing the site. The groundwater table in the present ground is relatively high and may affect to the deep underground structures.

5.3 PROCESS DESIGN

5.3.1 PRELIMINARY TREATMENT

The process units and structures associated with the preliminary treatment are the influent gates, screens (coarse/ fine), aerated grit removal, flow measurement, and influent pumping.

(1) Influent Gate

At the entrance to the plant, influent gates are to be provided to control or bypass the influent flows. The design data of the gates are as follows:

- Number of gates	4 units
- Type	Sluice gate (manually operated)
- Gate size	1.2 x 1.2 m
- Maximum head loss	about 100 mm

(2) Screening System

Coarse Screens: Manually-cleaned coarse bar screening facilities are to be provided ahead of fine screens. The criteria for the coarse screens are:

- Number of screens	4 units
- Channel width	1.6 m
- Clear bar spacing	100 mm
- Slope from vertical	60 degrees

Fine Screens: The fine screens are to be mechanically cleaned type. The criteria for the fine screens are:

- Number of screens	4 units
- Channel width	1.6 m
- Clear bar spacing	20 mm
- Slope from vertical	75 degrees

Screenings Disposal: Screenings must be disposed of at least daily. All collected screenings will be dumped to one common belt conveyor and sent to hopper for storage and final disposal to sanitary landfill.

(3) Influent Pumping Station

Type of Pumping Station: The pumping station is of dry-well type, being separated completely from wet-wells. Provision is to be made to facilitate easy removing of pumps, motors and other auxiliary equipment. The wet-well size is to be determined considering the required space between pumps and proper pump suction conditions. Adequate ventilation should be considered for the wet- and dry wells.

Pump Equipment and Operation Control: Totally 8 units of pump are planned, 4 pumps each for the wastewater and stormwater, including two standbys. The pumps are designed to have the same capacity and size where practicable. In case of power failure, the standby diesel engine operated pump will accomplish the pumping station operation.

The pump sizes, numbers and capacities of the wastewater pumps are as follows:

Wastewater Pumps

- No.1 Pump Units

Type of pumps	: Vertical centrifugal mixed flow pump
Pump diameter	: 600 mm
Pump discharge capacity	: 50 m^3/min
Total dynamic head (TDH)	: 16.0 m
Number of pump unit	: 4 units
Motor output	: 192 kW

- No.2 Pump Units

Type of pumps	: Vertical centrifugal mixed flow pump
Pump diameter	: 900 mm
Pump discharge capacity	: 100 m^3/min
TDH	: 16.0 m
Number of pump units	: 2 units (1 standby)
Motor output	: 370 kW

Stormwater Pumps

Type of pumps	: Vertical centrifugal mixed flow pump
Number of pumps	: 2 units (1 standby)
Pump diameter	: 900 mm
Pump discharge capacity	: 100 m^3/min
Pump total dynamic head	: 16.0 m
Number of pump units	: 2 units
Engine output	: 554 ps

Piping and Valves: Pipes are sized so that the velocity in the suction line should not exceed 1.5 m/sec, and the discharge piping 2.4 m/sec. Valves are to be provided on the suction and discharge sides of each pump.

Hoisting Equipment: An overhead bridge traveling crane is to be provided in the motor room, which will be used for handling equipment and materials.

(4) Aerated Grit Removal

Type of Grit Chamber: Grit settled at the bottom of the grit chambers is removed by sand pumps to grit separators and then transported by screw conveyors to grit hoppers.

Configuration: The grit removal of the wastewater is accomplished in 4 trains. Each train comprises 2 grit chambers, 1 blower and auxiliary equipment, as shown in the following:

- Number of units : 8 chambers (in 4 trains)
- Width : 3 m (including oil separator)
- Length : 22 m
- Depth : 2.35 (side depth) to 3.05 m
- Blowers : 5 units(one-standby) x 30 m3/min.

- Influent gates : 8 units, 800mm x 800 mm
- Effluent gates : 8 units, 600mm x 600 mm
- Grit removers : 4 units with sand pump
- Screw conveyors : 2 units

Air Supply: For the total tank length of 176 m, air supply rate requirement is 119 m^3/min. Five units (one-standby) of turbo blowers, each with an air supply rate of 30 m^3/min., will be provided.

Grit Removal: A trolley with grit lifting device and sand pump removes grit from each chamber. The grit water pumps lift the grit mixed with water to the grit separators for grit separation. The removed grit will be conveyed by the grit screw conveyors into hoppers for storage and hauling it to sanitary landfill.

(5) Flow Measurement

Two units of Parshal flumes (7 feet) will be installed for measurement of flows after having passed through the grit chambers

5.3.2 PRIMARY TREATMENT

Primary treatment consists of gravity liquid/solid separation in circular clarifiers. The clarifier system will consist of two clusters, each having clarifier modules of 4 units.

(1) Flow Distribution

Following the Parshall flumes, the wastewater will flow through two separate conduits to the distribution chamber located at the center of each cluster of 4 primary clarifiers, from where the flow will be distributed to each individual clarifier. The flow split is proportional to the tank surface area.

(2) Primary Clarifiers

Hydraulic Loading and Area Requirements: The hydraulic loading rate for the clarifiers is 35 m^3/m^2/day at the maximum daily average flow of 2.72 m^3/sec. The primary clarifier design criteria are summarized as follows:

- Surface loading (at max. daily flow) : 35 m^3/m^2/day
- Design flow rate : 235,000 m^3/day
- Surface area of each clarifier : 839 m^2
- Clarifier diameter : 35 m
- Effective water depth : 2.0 m
- Number of clarifiers : 8 units
- Number of clarifier clusters : 2

Primary Sludge Production: The primary and excess sludge production for the average daily flow rate is 2,315 m^3/day or 1.6 m^3/min.

Sludge Pumping to Digestion Facilities: The quantities of sludge, primary plus excess sludge from the average flow of 2,311m^3/day have been calculated and shown as follows:

- Sludge volume : 2,311 m^3/day

- TSS : 46,210 kg/day
- Solids concentration : 2.0 %

Scum Management: Scum is removed from the clarifier surface by a rotating scum removal mechanism to a scum pit located near the tanks and is pumped from there to a scum drum screen for scum removal.

Controls: The clarifier operation is manually controlled, but scum and sludge pumps will be operated both automatically or manually. Regardless whether primary sludge only or primary plus excess sludge, sludge is pumped to the sludge drum screen and then to the digesters.

5.3.3 BIOLOGICAL TREATMENT

(1) Aeration Tanks

The design parameters for this process component are established as follows:

- Design inflow rate : 235,000 m^3/day or 2.72 m^3/sec
- Average inflow BOD_5 concentration : 119 mg/l
- Total BOD_5 : 27,965 kg/day
- F/M : 0.3 kg BOD_5/kg MLVSS/d
- MLSS : 1,667 mg/l
- Hydraulic detention time : 6.3 hours at maximum daily flow
- Recycle capability : 50 % of maximum daily flow.
- Liquid depth : 5.5 m
- Aeration system : Bubble diffusers
- BOD removal efficiency : 89.5 % (combined with clarifiers)

The contact reactor geometry is as follows:

- Tank width : 5.5 m
- Liquid depth : 5.5 m
- Tank length : 67 m
- Number of tanks : 32 units
- Effective tank volume : 62,176 m^3

Air supply: The air requirements for the reactor tanks have been calculated on the basis of 0.0772 Q (kg O_2/day). The system will have the capability of maintaining a mixed liquor dissolved oxygen concentration of 1.5 mg/l. Sensors to measure the in-situ dissolved oxygen concentration will be used.

(2) Final Clarifiers

The final clarifier design criteria are summarized as follows:

- Surface loading (at Q max.) : 21 m^3/m^2/day
- Design inflow rate : 2.720 m^3/sec
- Tank surface area : 1,424 m^2
- Clarifier diameter : 45 m
- Sidewater depth : 3.5 m
- Number of clarifiers : 8 units

The secondary sludge production data for the daily average flow rate of are as follows:

- Total SS : 23.13 ton/day
- Sludge concentration : 0.5 %
- Sludge volume : 4,626 m^3/day

The excess sludge withdrawal handling should be either accomplished directly from the clarifiers or through the primary clarifiers.

Return Sludge Pumps: The pump capacity is determined based on the maximum 100 % sludge return ratio of the reactor tank inflows. The pump design parameters are as follows:

No.1 pumps

- Pump type : Centrifugal screw pump
- Pump diameter : 250 mm
- Capacity : 8.2 m^3/min.
- TDH : 10 m
- Number of pumps : 10 sets
- Motor output : 30 kW

No.2 Pumps

- Pump type : Centrifugal screw pump
- Pump diameter : 350 mm
- Capacity : 8.2 m^3/min.
- TDH : 10 m
- Number of pumps : 6 sets (for additional 50% return sludge)
- Motor ouput : 37 kW

Excess Sludge Pumps: The excess sludge of 5,859 m^3/day or 4.1 m^3/min. will be sent either directly or through the primary clarifiers to the sludge thickeners. The criteria for the pump equipment are as follows:

- Pump type : Centrifugal screw pump
- Pump diameter : 100 mm
- Capacity : 1.1 m^3/min.
- TDH : 10 m
- Number of pumps : 6 sets (including 2-standby)
- Motor output : 3.7 kW

Controls: Clarifier operation will be controlled manually, whereas sludge pumps will be operated both automatically or manually. The pumps turn on/off sequentially based on the on off time increments for each of the clarifiers.

(3) Chlorine Contact Tanks

Chlorination System: The chlorinator capacity shall be sufficient to produce an effluent that will meet the coliform bacteria limits specified by the standards for that installation at all time (*e.g.* total coliform bacteria and fecal coliform bacteria numbers are 1 million and 10,000 MPN/100 ml, respectively. The solution chlorine disinfection system consists of contact tank, chlorination equipment, housing and storage, and ancillary services.

Design Parameters: The design parameters for the chlorine contact tank are as follows:

- Hydraulic maximum flow rate : 235,000 m^3/day
- Contact time : 15 minutes at the design rate of flow
- Capacity of chlorine feed system : 3 mg/l at the maximum flow rate
- Hypochlorite storage capacity : 80 m^3 (8 days)

Contact Tank Geometry: The chlorine contact tank will be of reinforced concrete longitudinal baffled basin, which will have a large effective length-to-width ratio. The contact tank geometry is summarized below:

- Number of tank units : 1
- Channel width : 4 m
- Channel depth : 4 m
- Channel length : 204 m
- Tank effective volume : 2,448 m^3
- Effective water depth : 3 m

Equipment: The installed capacity of chlorine feed system will be sufficient to provide a dosage of 3 milligrams per liter at the maximum design rate of flow. The feed equipment will consist of the following:

Solution storage tank

- Type : FRP cylinder type
- Internal diameter : 2,800 mm
- Height : 3,900 mm
- Tank capacity : 20 m^3
- Number of tanks : 4 units

No.1 feed pumps

- Type : Diaphragm pump
- Discharge capacity : 6 L/min.
- Number of pumps : 2 units

No.2 feed pumps

- Type : Diaphragm pump
- Discharge capacity : 13 L/min.
- Number of pumps : 3 units(one standby)

Housing and storage: Local, state and federal safety requirements, including fire code, will be carefully followed in storing and handling of chemicals. Forced, mechanical ventilation is to be installed which will provide one complete air change per minute when the room is occupied.

(4) Effluent Pumping Station

The effluent pumping station structure is in principle the same as the influent pumping station, comprising dry- and wet-wells.

Pump Equipment and Operation Control: Totally eight units of pump are planned, six pumps for the wastewater and two pumps for stormwater, including two-standby. The pumps are designed to have the sufficient capacity for handling the flow in excess of the estimated maximum inflow. In case of emergency, the engine driven pump will be used.

The pump sizes, numbers and capacities of the wastewater pumps are as follows:

Wastewater Pumps

- No.1 Pump Units

Type of pumps	: Vertical centrifugal mixed flow pump
Pump diameter	: 600 mm
Pump discharge capacity	: 50 m^3/min
Total dynamic head	: 5 m
Number of pump unit	: 4 units
Motor output	: 60 kW

- No.2 Pump Units

Type of pumps	: Vertical centrifugal mixed flow pump
Pump diameter	: 900 mm
Pump discharge capacity	: 100 m^3/min
Total dynamic head	: 5 m
Number of pump units	: 2 units (1 standby)
Motor output	: 116 kW

- No.3 Pump Units

Type of pumps	: Vertical centrifugal mixed flow pump
Number of pumps	: 2 units (1 standby)
Pump diameter	: 900 mm
Pump discharge capacity	: 100 m^3/min
Pump total dynamic head	: 5 m
Engine output	: 173 ps

Piping and Valves: Valves are to be provided on the suction and discharge side of each pump to allow proper maintenance of the unit.

Hoisting Equipment: An overhead bridge traveling crane will be provided in the motor room for handling of equipment and materials.

5.3.4 SLUDGE MANAGEMENT

(1) Gravity Sludge Thickeners

The design of gravity sludge thickeners should consider the type and concentration of sludge, the sludge stabilization processes, the method of ultimate sludge disposal, chemical needs, and the cost of operation.

Design Basis: Hydraulic loading to produce overflow rates of 16~33 m^3/m^2/day will be maintained to prevent septicity. The loading rates and resulting solids concentration are as follows:

- Average sludge production volume	: 6,705 m^3/day
- Sludge withdrawal rate	: 1,056 m^3/day
- Input sludge solids	: 46.21 t/day
- SS loads	: 60 kg/m^2/day

Tank geometry: Thickener tanks geometry is summarized as follows:

- Tank shape : Circular
- Number of tanks : 4 units
- Internal diameter : 16 m
- Sidewater depth : 4 m
- Effective tank surface area : 804 m^2
- Thickening mechanism : Rotating type scraper supported by center column with pickets

Equipment Features: Heavy-duty scrapers capable of withstanding extra heavy torque loads should be provided. The thickener mechanism may be provided with pickets to help facilitate the release of water from the sludge and scum skimmers.

Sludge Pumps: The pump capacity is so determined that the pumps can send the thickened sludge within 8 hours. Specifications of the equipment are as follows:

- Type : Sludge pump with suction screw
- Number of pumps : 3 sets (one standby)
- Diameter : 100 mm
- Discharge capacity : 1.2 m^3/min.
- TDH : 20 m
- Motor output : 15 kW

Drum Screen: Prior to pumping the primary or secondary excess sludge to the sludge thickeners, the sludge will be screened by a revolving drum screen for the removal of coarse materials. The specifications of the drum screen are as follows:

- Type : Rotary drum screen
- Number of screen : 1 set
- Screen openings : 4mm
- Screening capacity : 2 m^3/min.
- Motor output : 0.4 kW

Operation and Controls: Tank operation will be manually controlled, but sludge pumps will be operated both automatically or manually. Sludge pumps will be operated using on/off pump controls and timers.

(2) Anaerobic Digestion Tanks

Digestion Process: The anaerobic digestion system will consist of 2 clusters each comprising 2 independent digestion tanks. Mechanical mixing system, heating and gas collection systems will be provided in each of the tanks.

The thickened sludge will be pumped to the digestion tanks after passing through a drum screen. The digested sludge will be drawn by gravity to the storage tanks in the sludge dewatering building.

Design Basis: The total digestion tank capacity are determined by rational calculations based upon the following factors:

- Input sludge solids : 36.97 t/day
- Sludge input : 1,056 m^3/day
- Sludge output : 801 m^3/day
- Temperature to be maintained in the digesters : 35 ℃
- Solid detention time : 20 days
- The degree and extent of mixing in the digesters : Moderately mix
- Required tank capacity : 21,126 m^3

Tank Geometry: The tank shape will be of high vertical cylinder with conical floors, with the same capacity and configuration. Tank dimensions are as follows:

- Tank shape : Single stage, high vertical cylinder with conical floors
- Tank capacity : 5,580 m^3
- Tank diameter : 17.5 m
- Tank effective water depth : 31 m

Mixing systems: The sludge mixing system will be mechanical circulation type. The mixing system will be designed such that routine maintenance can be performed without taking the digester out of service.

(3) Sludge Gas System

Gas Collection, Piping and Appurtenances: All portions of the gas system, including the space above the tank liquor, storage facilities and piping, will be so designed that under normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure. All safety equipment will be provided where gas is produced.

Gas Utilization Equipment: Gas-fired boilers for heating digesters will be located in a separate room not directly connected to the digester gallery. Gas piping will be of adequate diameter for gas flow rate and will slope to condensate traps at low points.

Electrical fixtures: Electrical fixtures and controls in enclosed places where hazardous gases may accumulate will comply with the local or national codes.

Waste Gas: Waste gas burners will be readily accessible and will be located at least 8 meters away from any plant structure if placed at ground level, or they may be located on the roof of the control building at a height of not less than 0.9 m from the top of the roof.

Digester Heating: Sludge will be heated by circulating the sludge through external heaters. Piping may be designed to provide for the preheating of feed sludge before introduction to the digesters. Provisions will be made in the layout of the piping and valving to facilitate cleaning of these lines. The boilers should be provided with suitable automatic controls to maintain the boiler temperature at a fixed rate, to minimize corrosion, and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, or excessive temperatures.

Safety: Local, and national safety requirements must be reviewed and complied with. Those requirements take precedence over the requirements stated herein, if more stringent, and should be incorporated in the design.

(4) Gas Holders

The digestion gas is led to gas holders via gas scrubbers, whereby the gas will be de-sulfarized and used for the boilers. The gas- holders will have the minimum gas storage capacity of 8-hour gas production of the daily gas production of 10,999 m^3. The gasholder geometry is as follows:

- Type : Dry seal gas holder (membrane seal type)
- Number of gasholders : 2 units
- Diameter : 16 m
- Height : 17 m
- Capacity : 2,000 m^3

(5) Belt Filter Press Sludge Dewatering

The digested sludge production rate and the required dewatering equipment are as summarized in the following:

- Total digested sludge production : 801 m^3/day
- Total sludge solids : 24.03 t/day
- Dewatering equipment type : Belt filter press
- Yields per unit length : 130 kg/m/hr.
- Filter width : 3 m
- Daily operation time : 6 hours
- Working days per week : 5 days
- Solids load per hour : 5,607 kg/hr.
- Required filter press equipment : 14 units

The sludge from the storage tank is pumped to the coagulation tank of the dewatering equipment (belt filter press) by sludge feed pumps. Polymer solution is mixed and then pumped into the coagulation tank of the belt filter press. The dewatered sludge (sludge cake) is conveyed to a cake yard by trough belt conveyors. Two units of manually operated overhead crane are provided in the building for dismantling and repairing the dewatering equipment.

(6) Process Wastewater Return Pump Facilities

The process wastewater return pump system is to return the process wastes (i.e. building wastewater, digester supernatant, belt press filtrate and scum filtrate) to the screen inlet chamber for further treatment.

5.4 ELECTRICAL, INSTRUMENTATION AND CONTROL FACILITIES

The number, shapes, sizes, and brief specifications of the equipment are provided for the preliminary engineering design purposes, and are subject to minor changes at the detailed design stage.

5.4.1 General

Adequacy of the major equipment such as circuit breakers, power transformers and the motor control centers are determined largely by the continuous current requirements of the treatment plant loads and the available short-circuit capability of the power supply.

The reliability of the equipment concerns the capacity of the electrical system to deliver power when and where it is required under abnormal, as well as normal, conditions.

The electrical system should be designed with enough flexibility to permit one or more compounds to be taken out of service at any time without interrupting the operation of the plant.

The design of the wastewater treatment plant electrical system must conform with the applicable local codes and regulations.

5.4.2 Electric Power Facility

(1) General

The basic power distribution system can best be described as a secondary single selective system. One electric power line shall be received at the main substation. Another separated line should be planned as a stand-by use in the future.

The received power will be stepped down by the two main transformers and connected to the 380 V bus line. Each transformer shall have a capacity for all loads in the treatment plant by the year 2010.

The 380 V will be stepped down to auxiliary power distribution voltage (lighting and receptacles, etc.) by transformers that are installed at required locations.

The protective relay system shall be considered for proper protection of the electrical equipment in adequate/proper manner. Extensive zone protection will be considered for the parallel operation of the generator with utility power.

Specifications of the electric power facility, current-capacity, short-circuit-capacity, etc., shall be designed taking into consideration any future expansion.

(2) Power Requirements of the WWTP

The WWTP mechanical equipment require the maximum electric power supply of 3,659 kW, excluding standbys.

(3) Power Generator

An emergency electric power generator of minimum 800 kW will be required. The generator is driven by a diesel engine and will be used as the minimum plant electric power source when the power supply is suspended. In order to attain the intent of the above design concept, the generator power line should be connected to the 380 V bus line which is charged by the utility supplied power.

(4) D.C. Power Supply

Uninterruptable D.C. power is supplied to breaker control circuit and an emergency lighting facility. Consequently, uniterruptable A.C. power supply for instrumentation and PC system is converted from D.C. by means of an inverted unit.

A sealed lead-acid stationary battery set shall be selected for this purpose due to its excellent quality features. The capacity of the battery set shall be designed by the required current and 30 minutes discharge time.

Each building within the plant will have its own independent uninterruptable power source unit for better and more effective utilization of the filtered/undistorted power source.

(5) Motor Control Facility

Power feeder to the motors and wiring to the controlling equipment is accomplished through motor control center and relay cubicles. The motor control center and the relay cubicles are divided into individual facility center and relay cubicles such as one set for clarifiers and another for scum screen area.

Each motor must be operated manually from the control station to be located adjacent to the equipment. The control panel will be equipped with switches for operation status indication and meters as required.

Major control sequence is to be accomplished through the relay cubicle as required for each mechanical equipment.

The sub-monitoring panel is to be provided in the room for the purpose of detailed monitoring and back-up operation.

Type of cables/wiring to be utilized, conductor sizes, cable routing/layout and arrangement methods, etc. shall be determined appropriately through the detailed design stage of the project.

5.4.3 INSTRUMENTATION

(1) Design Basis

Instrumentation is an important tool of the wastewater treatment plant because it insures an easy and proper operation and maintenance of such facilities. The equipment should be selected carefully considering its purpose, reliability, locations and costs. They should meet the specific functional needs of the particular equipment with special attention directed toward operation requirements.

(2) Supervisory Control and Data Acquisition System

The system can best be described as a local, independent, process control network with supervisory, central, monitoring station consisting of hard graphic indication (MIMIC) panels and soft monitoring/control station consisting of graphic screens, keyboards, printers, etc. The basic design of the system will be classified as follows:

- Local instrumentation/control station;
- Local process control units (Programmable logic controllers);
- Hard graphic/MIMIC panel;
- Redundant data highway;
- Host computer system and real time data storage;
- Historical data retrieval
- Workstations

5.5 MAJOR PLANT BUILDINGS AND UTILITY SERVICES

5.5.1 GENERAL LAYOUT

Administrative building may consist of several main areas comprising the control room, laboratory, conference room, administrative personnel area, etc.

The workers area should include workshop, storage rooms, restrooms, and a cafeteria for workers. The workshop should be related directly to the service road of the lot to permit easy transport of materials and machinery to be repaired.

The service road will be joined through a gate to the entrance for visitors and parking area that may be open for emergency purposes.

5.5.2 ARCHITECTURAL WORKS

The uncovered preliminary facilities could be a source of odors, and as such, trees should be planted alongside the plant fence to help minimize odors. A landscape design is conceived for the whole lot. There should be trees and grasses wherever they do not disturb wastewater treatment processes.

Administrative Building: The largest areas may be covered with concrete slabs. All the areas may have brick walls, natural light and air conditioning. The floor level of this building is raised more than 30 cm from the ground to protect it from flooding.

Office room may have the capacity of twenty (20) persons with air conditioning system. In addition to the space for laboratory, this area may also include restroom and storage room, with air conditioning, natural and artificial light, and necessary desks and water analysis equipment. Control and electrical equipment room may have air conditioning and ventilation system.

Workers Room: This area consists of restroom for operation and maintenance workers with showers and lockers. This room is also raised 30 cm from the ground level.

Depot/workshop: This room will be for small and big parts of the plant equipment, roof with metallic structure, brick walls, natural light and fans for ventilation.

Generator Room: Main electrical building shall have a floor level raised 30-cm from the planned ground elevation to avoid possible flooding. The building should face a road to permit the flow of machinery. Noise and vibration prevention measures shall be considered. Mechanical ventilation system shall be provided.

5.5.3 GENERAL CRITERIA FOR THE STRUCTURAL DESIGN

Foundations: The soil study performed under the feasibility study includes a sub-surface survey of the plant site and surrounding areas. All the collected soil samples were tested in the field and laboratory to determine the characteristics of the soils, classify them, analyze their behavior during construction or under constant loads.

The floor levels of the various component buildings of the plant will be installed at a minimum level of 30 cm above the site finished mean grade level of 7.9 m above mean Black Sea water level (M.W.L).

Structures: The main structures of the plant are cylindrical and rectangular tanks in shape; pipes with large diameters; pumping facilities, and buildings for the administration, operation and maintenance purposes.

The detail design of all the structures shall be performed in light of obtaining security, cost savings, water tightness, durability, and easy to construct.

Cement, aggregates, reinforcement steel bars, and concrete mix designs shall be in accordance with the requirements of relevant Romanian Standards or equivalent international standards.

The area is located in a zone of seismic risk. According to the Regulation P100/1992, the area is located in a D-degree seismic area. Determination of seismic loads shall be in accordance with the Regulations, local codes or other accepted standards. Each type and size of structures shall be individually designed depending on its own conditions assigning the factors of security established by the standards.

The circumstances shall be evaluated and considered in the plant structural design. Any stationary equipment shall be taken as dead load except for the torque, impact and vibrations that might occur when rotary equipment is involved.

The basic material for the construction of the plant structures will be the conventional reinforced concrete structures. Long span beams may be applied to the structures, which may be of post-tensioned with high resistance-cables.

The structure design shall follow the Romanian National Standards STAS 4273/83 or equivalent international standards and publications.

All materials to be considered for the structural and architectural designs shall be subject to the relevant in the Romanian Standards, or other equivalent international specifications.

5.5.4 Principal Plant Facilities

(1) Site Roads and Parking Areas

Roads and parking areas must be paved with the pavement consisting of granular sub-base and base course materials with an asphalt surface.

(2) Grading and Landscaping

Grading will slope away from structures to the open channels or box culverts. Landscaping includes grass for the area around the roads, structures and buildings. Trees and shrubs will be all along the fence of the site limits.

(3) Site Security

The site must be closed with a chain link fence or other appropriate means. The entrances will have a gate with hardware locks to have them closed when necessary.

(4) Safety

Guardrails: For walkways located in hazardous areas of the structures, guardrails must be used. Guardrails shall be painted with safety colors of yellow and black.

Lighting: There shall be exterior lighting all-over the site, along roads, near the structures and along the edge of the surrounding of fence.

Lifesavers: There shall be one lifesaver at each deep and uncovered structure such as clarifiers and anaerobic ponds.

Site Signs: A sign identifying the project and the owner should be put at the entrances of the site. A sign system for orientation within the plant, as well as a color code for elements of the buildings will be provided.

5.5.5 Layout of Facilities

Figure II.5.1 shows the layout of facilities in the wastewater treatment plant and *Figure II.5.2* shows hydraulic profile of Galati WWTP. List of main facilities are shown in *Table II.5.6*.

Table II.5.6 Main Equipment of Galati WWTP

Item	Specification
Screen and Pump	Influent gate 1.0 m × 1.0 m × 4 units, (including 2 units for rain) Coarse screen B 1.6 m × H 2.0 m × 2 units Fine screen B 1.6 m × H 2.0 m × 2 units Pumps φ600, Q=50 m^3/min, H=16 m, Mp=192 kW, 4 pumps φ900, Q=100 m^3/min, H=16 m, Mp=370 kW, 2 pumps φ900, Q=100 m^3/min, H=16 m, Mp=554 ps, 2 pumps
Grit chamber/ Oil separator	B 3 m × L 22 m × 8 channel
Parshall flume	306 - 12,380 m^3/h × 2 units
Primary Sedimentation Tank	φ35 m effective depth 2.0 m × 8 tanks
Aeration Tank	B 5.5m × H 5.5m × L 67m × 32 tanks (For advanced treatment : B 5.5m × H 5.5m × L 73m × 32 tanks)
Final Sedimentation Tank	φ45 m effective depth 3.5 m × 8 tanks (For advanced treatment : φ40 m effective depth 3.5m × 8 tanks)
Chlorination Chamber	B 4.0m × H 4.0m × L 204m (Chlorination time 15 min)
Sludge Thickener	Inside diameter 16 m × H 4 m × 4 tanks
Sludge Digester	Inside diameter 17.5 m × H 31 m, V = 5,580 m^3 × 4 tanks
Gas Holder	Inside diameter 16 m × H 17 m, V = 2,000 m^3 × 2 tanks
Dewatering Equipment	130kg/m hr, B = 3 m × 14 units (building 56 m × 20 m)
Blower Equipment	Multi stage turbo blower φ350 / φ300, 140 m^3/hr × 4 (building 26 m × 13 m)
Administration Building	30 m × 50 m = 1,500 m^2

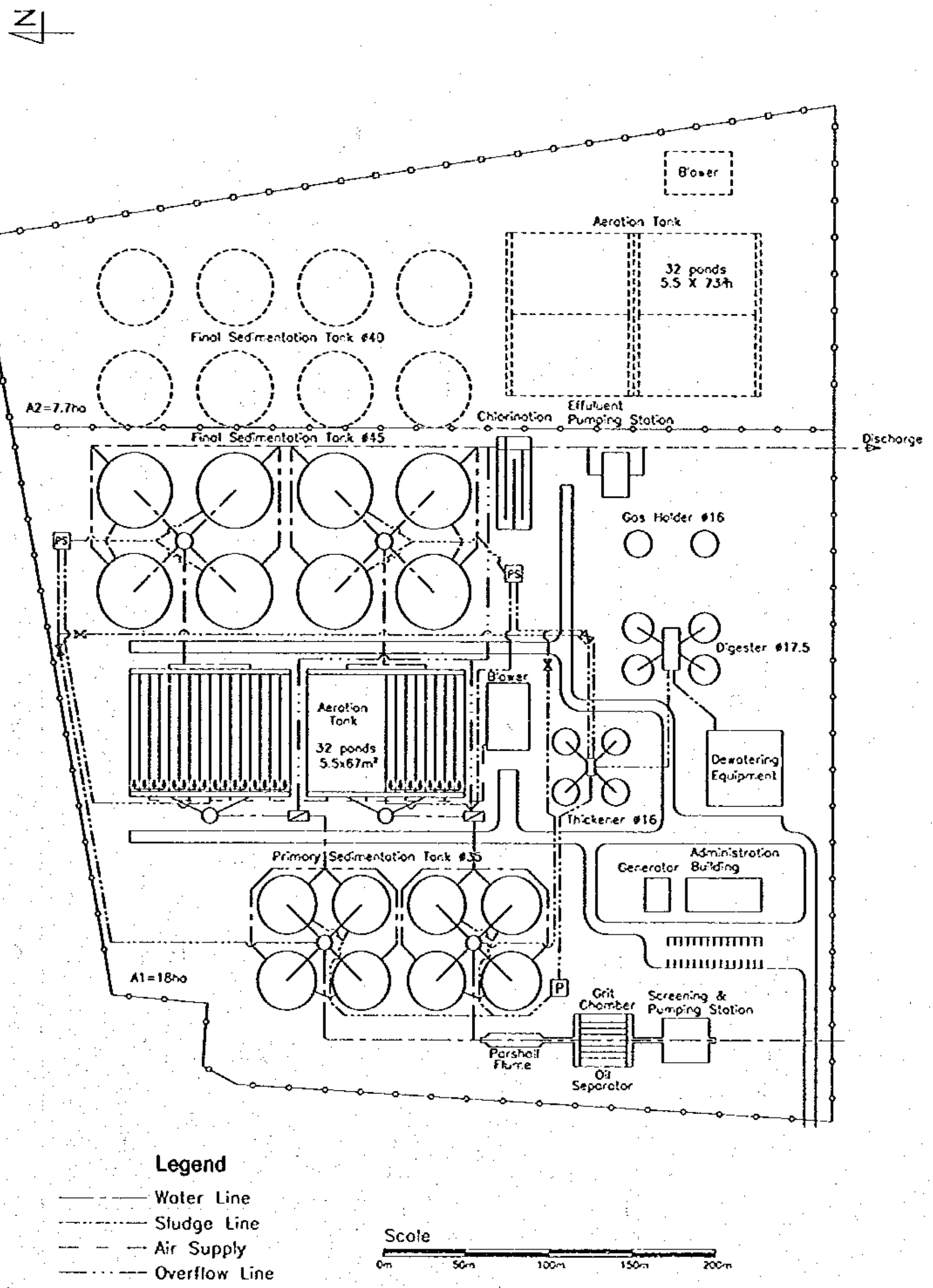

Figure II.5.1	Layout Plan of Galati WWTP

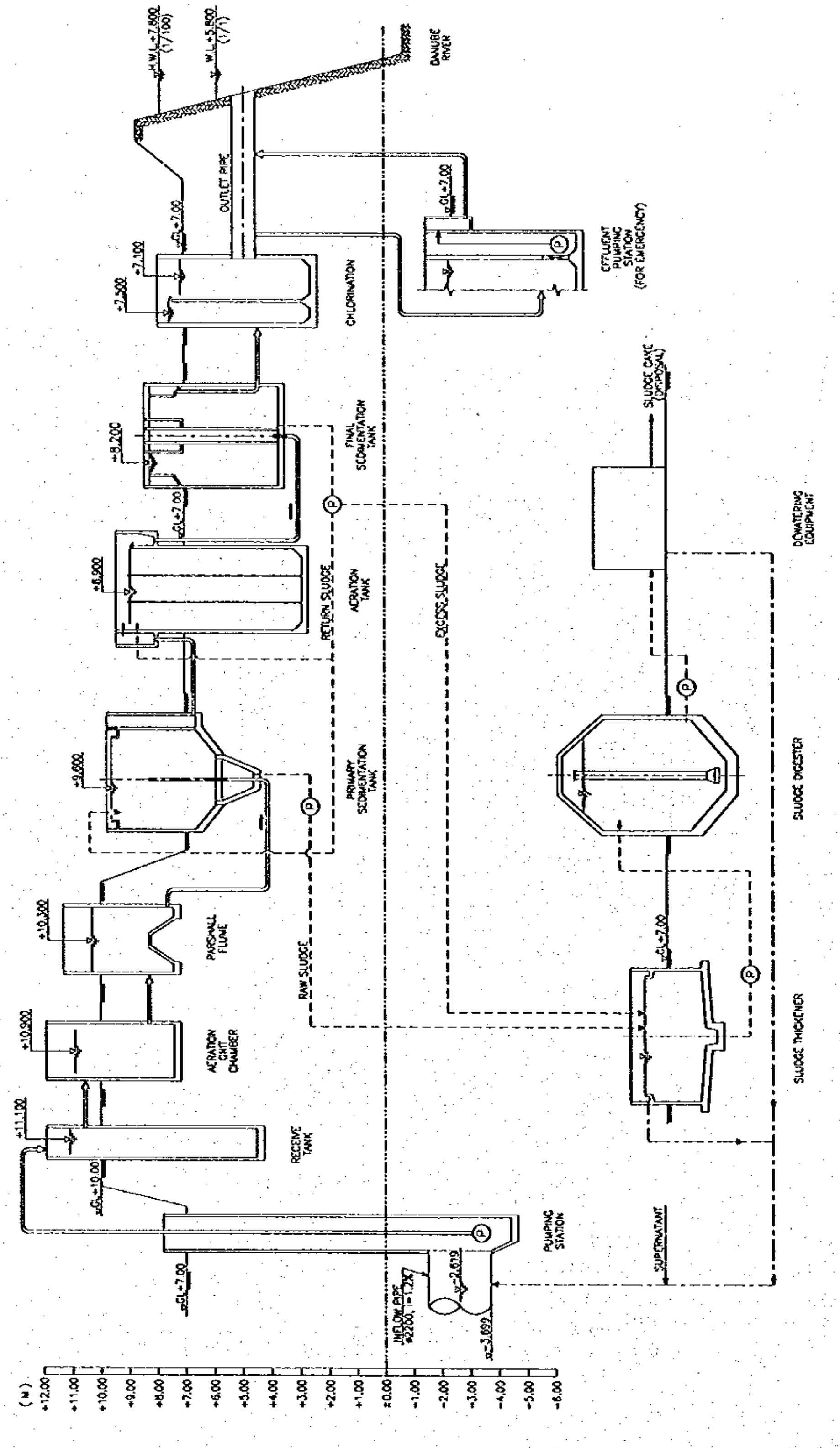

Figure II.5.2	Hydraulic Plofile of Galati WWTP

5.6 CONSTRUCTION PLAN

5.6.1 GENERAL

Major Facilities to be constructed the Project are as follows:

- Interceptor sewer, manhole and CSO
- Wastewater treatment plant

Construction works for above facilities, in general, will be executed by ordinary construction and equipment installation methods using equipment readily available in Galati and/or Romania. In addition, since construction site for the proposed facilities are located within or around Galati City, there would be neither difficulty to transport materials and equipment nor difficulty in obtaining utility services for construction works such as water and electricity.

5.6.2 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 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. Construction plan for the Galati project is presented in *Figure II.5.3*.

	Period (Year)	1st year 2000	2nd year 2001	3rd year 2002	4th year 2003	5th year 2004
Wastewater Treatment Plant						
Influent Pumping Station	1.5					
Wastewater Treatment Process	2.5					
Sludge Treatment Process	2					
Discharge Pumping Station	1.5					
Power Receiving Facility	1					
Administration Building	1					
Interceptor	2					

Figure II.5.3 Construction Plan and Sequence of Works for the Galati Project

CHAPTER 6 OPERATION AND MAINTENANCE PLAN

6.1 DESCRIPTION OF OPERATION AND MAINTENANCE WORKS

Following figure shows necessary operation and maintenance works in WWTP.

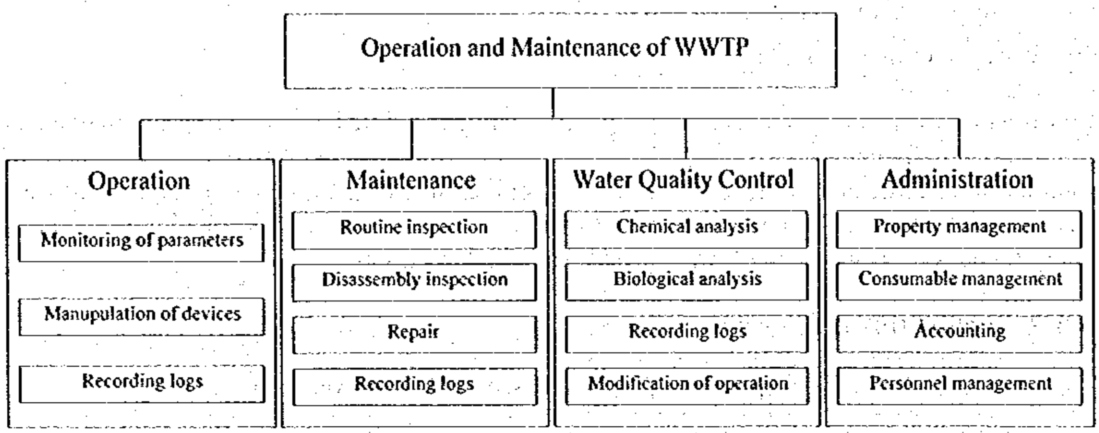

Figure II.6.1 Necessary Operation and Maintenance Work

The works are composed of operation of treatment processes for wastewater and sludge, maintenance work, water quality control, and administrative work.

6.1.1 TREATMENT PROCESS OPERATION

Process operation consists of monitoring of parameters and manipulation of devices such as gates, valves and pumps. The characteristics of these two activities are quite different. Manipulation of devices may be required only several times a day at most, on the contrary, monitoring will be required continuously. Thus, introduction of centralized automatic monitoring system greatly contributes to reduce number of operation staff. Furthermore, automatic monitoring is technically far easier and more reliable than automatic operation. These are the reasons why centralized monitoring system is applied in the proposed WWTP, though the automatic operation system is not introduced.

Tables II.6.1 to *II.6.3* show operation parameters monitored by central control system.

Table II.6.1 General Operation Parameters Monitored by Central Control System

Operation Process	Monitoring parameter
Electrical facilities (including receiving equipment)	Voltage, electric current, electric power, electric power consumption
	Power factor, frequency, temperature of transformer
Others	Atmospheric temperature, humidity, pressure, rainfall
	Direction of the wind, wind velocity, strength of rainfall

Table II.6.2 Wastewater Treatment Operation Parameters Monitored by Central Control System

Operation Process	Monitoring parameter
Grit chamber and oil separator	Inflow gates opening
	Inflow water level and volume (incoming flow), pH
	Water level of pre-screen and post screen
	Intake air flow, supplied air flow and pressure of blower
Pumping station	Water level at wet well
	Supplied water flow
	Effluent water level
	Valve opening
	Bearing temperature of pump and motor
Primary sedimentation tank	Receiving water level
	Underflow sludge volume
Aeration tank	Gate opening
	Receiving water level
	Air volume
Blower equipment	Intake air flow of blower
	Supplied air flow and pressure of blower
	Bearing temperature of blower and motor
Final sedimentation tank	Receiving water level
	Underflow sludge volume
	Excess sludge volume
	Water level of sludge sedimentation pond
Chlorine contact tank	Hypo-chlorite dosage volume
	Receiving water level
Discharge pipe	Discharge water volume
	Water level of river

Table II.6.3 Sludge Treatment Operation Parameters Monitored by Central Control System

Operation Process	Monitoring parameter
Sludge thickener	Inflow sludge volume
	Water level of tank
	Sludge-liquid interface
	Underflow sludge volume
Sludge digester	Inflow sludge volume
	Water level of tank
	Digested sludge transportation volume
	Under flow digested sludge volume
	Supernatant volume
	Outbreak sludge-digestion gas volume
	Digestion tank temperature
	pH
Dewatering equipment	Inflow sludge volume
	Sludge cake volume
Gas holder	Storage volume
	Gas holder level
	Add temperature combustion gas volume
	Excess combustion gas volume

6.1.2 MAINTENANCE WORK

Routine and disassembly inspections are essential to keep proper function of devices. *Table II.6.4* summarizes necessary maintenance work in general.

Table II.6.4 Necessary Maintenance Work

Frequency	Work content
Daily	Check appearance, unusual vibration and sound
	Check condition of lubricants
Monthly	Check gland packing wear and leakage around seals
	Check and, if necessary, replenish lubricants
	Check tension and wear of chains
Yearly	Replace lubricants and gland packing
	Tighten bolts
	Check operation of electric and mechanical devices
	Check operation of protective devices
	Dry up tanks/reservoirs and check submerged devices
Every 1 – 4 years	Overhaul, paint or greasing devices

Results of inspections and any maintenance activities should be recorded in daily or monthly logs. Maintenance staff should request necessary spare parts and consumables so that administrative staff can properly manage them.

6.1.3 WATER QUALITY CONTROL

Water quality control is one of the essential parts of WWTP operation. Operation parameters should be determined by the results of water quality analysis. Analysis items and sampling frequency of each sampling point is summarized below:

Table II.6.5 Analysis Items and Sampling Frequency of Each Sampling Point

Sampling points	Analysis items	Sampling frequency
Inflow channel	Appearance, Odor, Water temperature, Turbidity, pH	Daily or at the time of inspection
	SS, COD	Weekly
	BOD, NH_4-N	Monthly
Aeration tank	Appearance, Odor, Water temperature, Turbidity, pH	Daily or at the time of inspection
	MLSS	Weekly
	Microorganism	Monthly
Outlet of final sedimentation tank	Appearance, Turbidity, pH	Daily or at the time of inspection
	SS, COD, NH_4-N, NO_3-N	Weekly
	BOD	Monthly
Outlet of WWTP	Appearance, Turbidity, pH, Chlorine residual	Daily or at the time of inspection
	SS, COD	Weekly
	BOD, NH_4-N, NO_3-N	Monthly

Source: Japan Sewage Works Association, "Guidelines for Planning, Design and Operation and Maintenance for Small Scale Treatment Works." 1996.

6.1.4 ADMINISTRATIVE WORK

WWTP forms a self-complete organization and needs administrative staff for management of properties and consumable goods, budgeting and accounting, and personnel management. In addition, security guards, building janitors, and cleaning persons are also included in administrative staff.

6.2 EQUIPMENT FOR OPERATION AND MAINTENANCE

In addition to ordinary maintenance equipment such as welding machine or turning machine, at least the following laboratory equipment is necessary for laboratory:

- Temperature/pH/conductivity meters
- DO meters
- COD apparatus
- Turbidity meter
- Low power and high power microscopes
- Digital balances
- Drying ovens
- Incubators
- Laboratory flocculation apparatus
- TOC analyzer
- Hot plate stirrers
- Digestion apparatus
- Laboratory centrifuge
- Vacuum pumps with blower facility
- Evaporation equipment (water bathes, etc.)
- Distillation equipment and rotary film evaporator
- Fume cupboards with ventilation equipment
- Extensive range of laboratory ware
- Continuous still and deionizer units
- Miscellaneous instruments and spares

CHAPTER 7 ORGANIZATION PLAN

7.1 PRINCIPLES OF THE ORGANIZATION PLAN

The organization plan in the Study is made in line with the following principles.

- A current sewerage operating body, S.C. APATERM S.A. will undertake the operation and maintenance of facilities constructed by the proposed project.
- The WWTP section will be established in S.C. APATERM S.A. as a responsible body of WWTP.
- Scope of the organization plan is limited within the personnel related to the operation and maintenance of facilities constructed by the proposed project. The plan does not aim to modify current structure of S.C. APATERM S.A.
- Since the administrative staff of the WWTP section will deal with most part of administrative work related to WWTP, increment of indirect division personnel out of the WWTP section is not envisaged.

7.2 REQUIRED PERSONNEL FOR THE WWTP SECTION

The wastewater treatment process runs for 24 hours continuously. Thus, the operation personnel for the process will work in three shifts. The chief of each shift should be an engineer in order to improve supervision capacity and plant operation control. The personnel for the final sludge disposal site are not included here, because neither construction nor operation and maintenance of the disposal site are within project scope. Following factors are also taken into consideration to estimate the number of required personnel.

- The WWTP should be self-sufficient from the laboratory viewpoint, for the control of treatment processes, research and development processes.
- Though the maintenance personnel will work during daytime in principle, the electric technician should stay for 24 hours continuously taking into account that failures in the electrical area are the most common in general.
- For day/night shift tasks, four persons will share one job. Each of three persons will work for either 8 hours or 12 hours a day, and the additional one will serve as replacement so that the other three may rest one day a week.

Under the section chief who is responsible for all the activities relating to operation and maintenance of WWTP, the following management personnel is deployed:

- Operation supervisor
- Maintenance chief responsible for all maintenance staff
- Laboratory chief responsible for water quality control, especially for sampling and analysis
- Administrative chief responsible

The number of required personnel is shown in *Table II.7.1*.

Table II.7.1 Personnel Requirements for the WWTP Section

Position	Total number	Day shift	Day/night shift
0. Section chief	1	1	-
Subtotal of Item 0	1	1	-
1. Operation			
Chief	1	1	-
Operator (engineer)	1	1	-
Equipment operator	4	-	4
Auxiliary staff	4	-	4
Subtotal of Item 1	10	2	8
2. Maintenance			
Chief	1	1	-
Supervisor	1	1	-
Mechanic I (senior)	2	2	-
Mechanic II (assistant)	1	1	-
Turner	1	1	-
Auxiliary shop staff	1	1	-
Maintenance	1	1	-
Auxiliary staff (mechanical)	4	4	-
Instrumentation chief	1	1	-
Instrumentation technician	1	1	-
Electrician (senior)	5	1	4
Auxiliary staff (electrical)	2	2	-
General concrete works	1	1	-
Stock clerk	1	1	-
Subtotal of Item 2	23	19	4
3. Water Quality Control			
Chief	1	1	-
Chemist	1	1	-
Microbiologist	1	1	-
Sampling auxiliary staff	1	1	-
Subtotal of Item 3	4	4	-
4. Administration			
Chief	1	1	-
Administration assistant	1	1	-
Auxiliary staff	1	1	-
Secretary	1	1	-
Driver	1	1	-
Janitor	1	1	-
Cleaning staff	2	2	-
Gardener	1	1	-
Security guard	4	-	4
Subtotal of Item 4	12	8	4
Total	51	35	16

7.3 OTHER PERSONNEL INCREMENT

The proposed facilities in the Galati feasibility study in addition to the WWTP are as follows:

- 8,202 m of gravitational sewer pipes with 28 manholes
- 5 CSO regulartors

To cope with an increase of work volume du to the above facilities, additional four (4) maintenance persons, or one (1) shift, in the water distribution and sewerage section, is proposed for operation and maintenance of those facilities.

CHAPTER 8 COST ESTIMATE

8.1 BASIS OF COST ESTIMATE

The project cost consists of construction cost, equipment cost, engineering service cost, government administration cost, and physical contingency. The project cost is 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.
- Engineering service cost is including all services for detailed design, tendering assistance and construction supervision. The cost is assumed at 10% of the construction cost.
- Government administration cost is costs that should be prepared by government and/or executing agency (*e.g.* cost for personnel and organization for the project management, cost for commission for external loan, etc.). The cost is assumed at 2 % of the construction cost.
- All percentages mentioned above are assumed from former example of the same kind of projects.
- Physical contingency allowance is assumed to be 10% of the total of construction, equipment, engineering service, and government administration cost.
- Price escalation is not counted.

8.2 CONSTRUCTION COST

The construction cost consists of followings.

- Mobilization and demobilization cost (5% of main works)
- Cost for preparatory works (5% of main works)
- Cost for main works (direct cost and indirect cost)
- Cost for miscellaneous works (10% of main works)

The direct cost for main works (cost for civil work, mechanical/electrical equipment cost, mechanical/electrical equipment installation cost, and construction cost for administration building) are estimated based on the results of preliminary engineering design. Both indirect costs of site expenses and, overhead and profit are estimated at 10% of main works.

The cost for civil and architectural work is estimated by multiplying the quantity of works by unit construction costs. However, since there are no published standard market price list for mechanical/electrical equipment for wastewater treatment, the appropriate price of equipment are determined by obtained quotation from manufacturers that have experience in Romania and/or neighboring countries.

8.3 PROJECT COST

Estimated total project cost is about ROL 1,684,237 million, and its breakdown is shown in *Table II.8.1*. Of the total project cost, ROL 504,061 million or 30% is foreign currency portion, and remaining ROL 1,180,176 million or 70% is local currency portion.

Table II.8.1 Project Cost for Galati Project

	Item	Cost	Foreign currency	Local currency
I	**Construction Cost**	**1,367,075**	**435,707**	**931,368**
	Mobilization and Demobilization	48,824	0	48,824
	Preparatory Works	48,824	0	48,824
	Main Works	976,482	435,707	540,775
	Wastewater Treatment Plant	906,417	435,707	470,710
	Influent Pumping Station	89,076	47,677	41,399
	Wastewater Treatment Process	387,738	193,589	194,149
	Sludge Treatment Process	257,540	146,238	111,302
	Discharge Pumping Station	113,202	47,678	65,524
	Site Finalization	42,789	0	42,789
	Power Receiving Facility	8,592	0	8,592
	Administration Building	7,479	525	6,954
	Interceptor	70,066	0	70,066
	Miscellaneous Works	97,648	0	97,648
	Site Expenses	97,648	0	97,648
	Overhead and Profit	97,648	0	97,648
II	**Engineering Service Cost**	**136,708**	**68,354**	**68,354**
III	**Government Administration Cost**	**27,342**	**0**	**27,342**
IV	**Contingency**	**153,112**	**0**	**153,112**
V	**Project Cost**	**1,684,237**	**504,061**	**1,180,176**

(Unit: million ROL)

8.4 OPERATION AND MAINTENANCE (O/M) COST

Major portions of O/M cost of the WWTP are electric power charge for the equipment and cost for personnel. The O/M cost for the Galati project is estimated at ROL 16,518 million as shown in *Table II.8.2*.

Table II.8.2 Operation and Maintenance Cost for Galati Project

Item	Unit	Unit price	Quantity	Total (million ROL)
Personnel	ROL/month/ person (average)	2,000,000	55	1,320
Electricity	ROL/kwh	500	2,134	9,217
Chemical	ROL/kg	5,000	1,822,000	911
Excess Sludge Disposal	ROL/m^3	20,000	533,578	2,768
Repairing	0.5% of Mechanical cost		40,000	800
Others	10% of above			1,502
Total				16,518

CHAPTER 9 IMPLEMENTATION PROGRAM

9.1 IMPLEMENTATION SCHEDULE

The project will be completed within five (5) years from 2000. Pre-construction stage of one (1) year is assumed for the detailed design period and tender process followed by four (4) years' construction works.

Proposed implementation schedule is presented in *Figure II.9.1*.

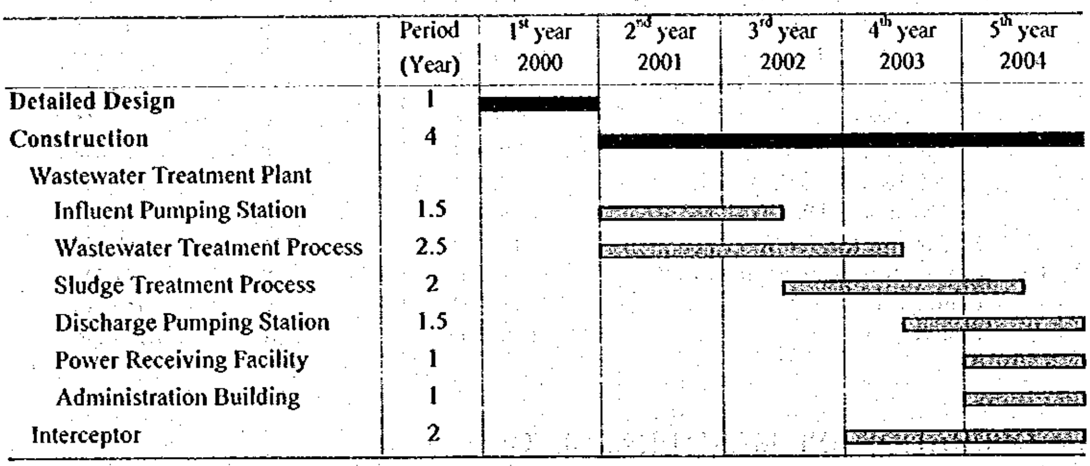

Figure II.9.1 Implementation Schedule of Galati WWTP Project

9.2 DISBURSEMENT SCHEDULE

Proposed annual cost disbursement schedule of the Galati WWTP project during entire project period is shown in *Table II.9.1*.

Table II.9.1 Disbursement Schedule of Galati WWTP Project

		Total	2000	2001	2002	2003	2004
Detailed Design	Total	68,354	68,354				
	FC	34,177	34,177				
	LC	34,177	34,177				
Construction		1,367,075		240,235	340,454	423,751	362,635
Mobilization and Demobilization		48,824		24,412			24,412
WWTP Construction							
Influent Pumping Station	Total	89,076		43,492	45,584	0	0
	FC	47,677		15,892	31,785	0	0
	LC	41,399		27,599	13,800	0	0
Wastewater Treatment Process	Total	387,738		116,378	155,095	116,266	0
	FC	193,589		38,718	77,436	77,436	0
	LC	194,149		77,660	77,660	38,830	0
Sludge Treatment Process	Total	257,540		0	51,508	103,016	103,016
	FC	146,238		0	29,248	58,495	58,495
	LC	111,302		0	22,260	44,521	44,521
Discharge Pumping Station	Total	113,202		0	0	59,575	53,627
	FC	47,678		0	0	15,893	31,785
	LC	65,524		0	0	43,683	21,041
Site Finalization	Total	42,789		0	0	0	42,789
	FC	0		0	0	0	0
	LC	42,789		0	0	0	42,789
Power Receiving Facility	Total	8,592		0	0	0	8,592
	FC	0		0	0	0	0
	LC	8,592		0	0	0	8,592
Administration Building	Total	7,479		0	0	0	7,479
	FC	525		0	0	0	525
	LC	6,954		0	0	0	6,954
Interceptor Construction	Total	70,066		0	0	35,033	35,033
	FC	0		0	0	0	0
	LC	70,066		0	0	35,033	35,033
Other Costs	Total	341,769		55,954	88,266	109,861	87,688
	FC	0		0	0	0	0
	LC	341,769		55,954	88,266	109,861	87,688
Construction Supervision	Total	68,354		17,088	17,088	17,088	17,088
	FC	34,177		8,544	8,544	8,544	8,544
	LC	34,177		8,544	8,544	8,544	8,544
Government Administration		27,342		4,805	6,809	8,475	7,253
Contingency		153,112	6,835	26,213	36,435	44,931	38,698
O/M Cost	Total	1,551,950					
	FC	1,161,000					
	LC	390,950					
Total Disbursement		3,236,187	75,189	288,341	400,786	494,246	425,074
FC		1,665,061	34,177	63,154	147,012	160,368	99,350
LC		1,571,126	41,012	225,187	253,774	333,878	326,325

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
O/M Cost	Total	15,638	15,638	15,638	15,638	15,638	15,638	15,638	402,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	402,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	402,638	15,638
	FC								387,000								387,000								387,000	
	LC	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638
Total Disbursement		15,638	15,638	15,638	15,638	15,638	15,638	15,638	402,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	402,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	402,638	15,638
FC		0	0	0	0	0	0	0	387,000	0	0	0	0	0	0	0	387,000	0	0	0	0	0	0	0	387,000	0
LC		15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638	15,638