Table AII.1.3 Estimated Sewerage Service Population as of 1998

CRT. No	DISTRICT	Area (ha)	Population	Served Area (ha)	Not Served Area (ha)	Served Population	Not-served Population	per capita (lpcd)
1	Radu Negru	22.4	12550	22.4	-	12,550	-	380
2	Viziru I and II	39.29	30193	39.29	-	30,193	-	380
3	Calarasi IV	9.6	4455	9.6	-	4,455	-	380
4	Sos Buzaului	19.61	7113	19.61	-	7,113	-	380
5	Calea Calarasilor	21.03	8197	21.03	-	8,197	-	380
6	Hipodrom	39.04	13848	39.04	-	13,848	-	380
7	Obor	31.02	15580	31.02	-	15,580	-	380
8	Dorobantilor Blvd	34.09	15425	34.09	-	15,425	-	380
9	Scolilor St	6.5	2394	6.5	-	2,394	-	380
10	Independentei Blvd	19.2	4876	19.2	-	4,876	-	380
11	Halelor Square	1.2	548	1.2	-	548	-	380
12	Victoriei St	11.5	4231	11.5	-	4,231	-	380
13	Siretului	6.9	1952	6.9	-	1,952	-	380
14	Apollo	6.1	2581	6.1	-	2,581	-	380
15	Ardealului	1.28	895	-	1.28	-	895	380
16	Galati St	15.79	4502	15.79	-	4,502	-	380
17	Plantelor	2.8	1768	2.8	-	1,768	-	380
18	Progresul	38.96	18805	38.96	-	18,805	-	380
			TOTAL	***325.03***	***1.28***	***149,023***	***895***	
	Subtotal area 1-18 (ha)	***326.31***						
	Subtotal population 1		***149,918***					

CRT. No	DISTRICT	Area (ha)	Population	Served Area (ha)	Not Served Area (ha)	Served Population	Not-served Population	per capita (lpcd)
A	Central zone	98.5	13060	99.5	-	***13,060***	-	295
B	Mediane zone	23.27	2745	23.27	-	2,745	-	170
		209.43	24702	209.43	-	24,702	-	295
	subtotal zone B	232.7	27447	232.7	-	***27,447***		
C	Carantina	40.1	4435	35.09	4.01	***3,992***	***443***	295
D	Radu Negru	18.2	1257	-	18.2	-	***1,257***	110
E	Buzaului	102.87	9746	-	102.87	-	***9,746***	110
F	Lacul Dulce	59.6	1657	-	59.6	-	***1,657***	65
G	N. D. Chercea	208.2	12554	-	208.2	-	***12,554***	110
H	Braila	77.2	5876	-	77.20	-	5,876	65
		57.9	4406	-	57.90	-	4,406	110
		57.9	4407	9.65	48.25	734	3,673	170
	subtotal zone H	193	14689	9.65	183.35	***734***	***13,955***	
			TOTAL	***376.94***	***576.23***	***45,233***	***39,612***	
	Subtotal area A-H (ha)	***953.17***						
	Subtotal population 2		***84,845***					

TOTAL AREA (ha)	1279.48
TOTAL POPULATION (inhab)	234,763

Table AII.1.11 Industrial Wastewater Discharge based on the Questionnaire Surveys

CRT. No	Company Name	Category	Main Products	Water Consumption				Wastewater discharging		
				City Net.	Danube	Underground	Total	Network	Danube	Total
				(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)
0	1		2	3	4	5		6	7	
1	SC AVICOLA SA	1211	Growing - Processing Chicken	10	0	140	150	80		80
2	SINCAR	1211	Slaughter House	181	0	93	274	100		100
3	SC COMSUIM SA	1211	Slaughter House	14	0	4,534	4,548	0	3,057	3,057
4	BRAILACT	1212	Milk Products	196	0	273	469	44		44
10	VERMATA	1221	Fish, Canned Fish	20	30	0	50	17	44	61
9	SC Legume - Fructe	1231	Fruit, Vegetables, Canned F&V	33	0	0	33	47		47
	Food Processing			**454**	30	5,040	**5,524**	**288**	3,101	**3,389**
				14.4%			**37.8%**	**5.6%**		**28.8%**
7	GLUBEDEX	1322	Beer	74	738	0	812	31	842	873
	Beverage			**74**	738	0	**812**	**31**	842	**873**
				2.4%			**5.6%**	**0.6%**		**7.4%**
12	SC PAL SA	1622	Furniture, Matches	224	1,081	0	1,305	42	638	680
	Funiture			**224**	1,081	0	**1,305**	**42**	638	**680**
				7.1%			**8.9%**	**0.8%**		**5.8%**
11	Laminorul	2751	Nail, Steel Wire	0	2,413	96	2,509	300	1,815	2,115
	Metal Products			**0**	2,413	96	**2,509**	**300**	1,815	**2,115**
				0.0%			**17.2%**	**5.8%**		**17.9%**
8	SC PROMEX SA	2931	Construction Machine, Repairing	863	2,052	0	2,915	3,300	0	3,300
5	Santierul Naval	3141	Ship Building	1,384	0	0	1,384	1,200	0	1,200
	Machinery			**2,247**	2,052	0	**4,299**	**4,500**	0	**4,500**
				71.4%			**29.4%**	**87.2%**		**38.2%**
6	SC Hercules		Freight (Motor Transport, service)	149	0	0	149	0	231	231
	Other			**149**	0	0	**149**	0	231	**231**
				4.7%			**1.0%**	**0.0%**		**2.0%**
	Grand Total			**3,148**	**6,314**	**5,136**	**14,598**	**5,161**	**6,627**	**11,788**

Table AII.1.22 Present Industrial Wastewater Pollutant Loads

CRT. No	Company Name	Category	Main Products	Discharge Flow Rate Network (m³/day)	Discharge Flow Rate Danube (m³/day)	Discharge Flow Rate Total (m³/day)	BOD5 Conc. (mg/l)	BOD5 Loads (kg/d)	BOD5 Conc. (mg/l)	SS Conc. (mg/l)	SS Loads (kg/d)	SS Conc. (mg/l)	S	GC	ST	CS	PST	ASU	AL	OD	TF	Remarks
1	SC AVICOLA SA	1211	Growing - Processing Chicken	80		80	431.2	34.5		346	27.7		0	0	0	0	1	0	0	0	0	
2	SINCAR	1211	Slaughter House	100		100	190.9	19.1		276	27.6		0	0	1	0	0	0	0	0	0	
3	SC COMSUIM SA	1211	Slaughter House	0	3,057	3,057	190.9	583.6		276	843.8		0	1	0	1	0	0	0	0	0	
4	BRAILACT	1212	Milk Products	44		44	288.4	12.7		70	3.1		0	0	1	0	1	0	0	0	0	
10	VERMATA	1221	Fish, Canned Fish	17	44	61	30.7	1.9		48	2.9		1	0	1	0	0	0	0	0	0	WWTS-also disinfection;
9	SC Legume - Fructe	1231	Fruit, Vegetables, Canned F&V	47		47	43.1	2.0		97	4.6		1	1	0	0	1	0	0	0	0	WWTS - disinfection with chlorine;
	Food Processing			288 5.6%	3,101	3,389 28.8%		653.8	193		909.7	268										
7	GLUBEDEX	1322	Beer	31	842	873	469.3	409.7		2,278	1,988.7		0	0	0	0	1	0	0	0	0	WWTS-disinfection (chlorine);
	Beverage			31 0.6%	842	873 7.4%		409.7	469		1,988.7	2,278										
12	SC PAL SA	1622	Furniture, Matches	42	638	680	15.2	10.3		158	107.4		0	0	1	0	1	0	0	0	0	
	Funiture			42 0.8%	638	680 5.8%		10.3	15		107.4	158										
11	Laminorul	2751	Nail, Steel Wire	300	1,815	2,115	24.3	51.4		844	1,785.1		0	1	1	1	1	0	0	0	0	WWTS - also neutralization
	Metal Products			300 5.8%	1,815	2,115 17.9%		51.4	24		1,785.1	844										
8	SC PROMEX SA	2931	Construction Machine, Repairing	3,300	0	3,300	27.6	91.1		242	798.6		0	0	1	0	0	0	0	0	0	WWTS - pH adjustment;
5	Santierul Naval	3141	Ship Building	1,200	0	1,200	4.5	5.4		42	50.4		0	0	1	0	1	0	0	0	0	WWTS - also neutralization
	Machinery			4,500 87.2%	0	4,500 38.2%		96.5	21		849	189										
6	SC Hercules		Freight (Motor Transport, service)	0	231	231	4.4	1.0		88	20.3		0	0	1	0	0	0	0	0	0	WWTS - also IMHOFF Tanks
	Other			0 0.0%	231	231 2.0%		1.0	4		20.3	88										
	Grand Total			5,161	6,627	11,788		1,222.7	104		5,660.2	480										

City: Braila
Sampling Point: Outfall No.1

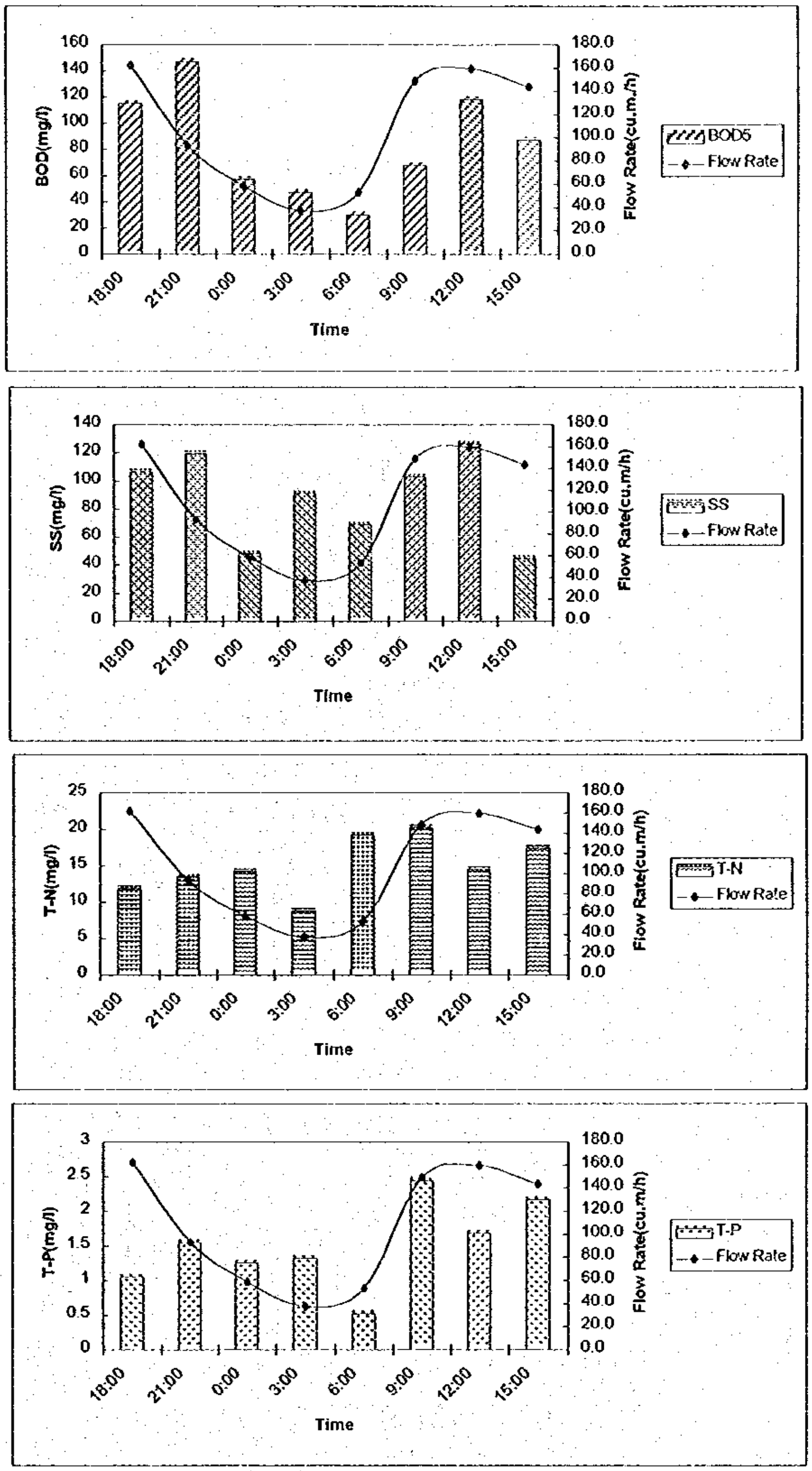


Figure AII.1.2	Result of Wastewater Quality Survey at Manhole at Buzau St. in Braila City

City: Braila
Sampling Point: Outfall No.2

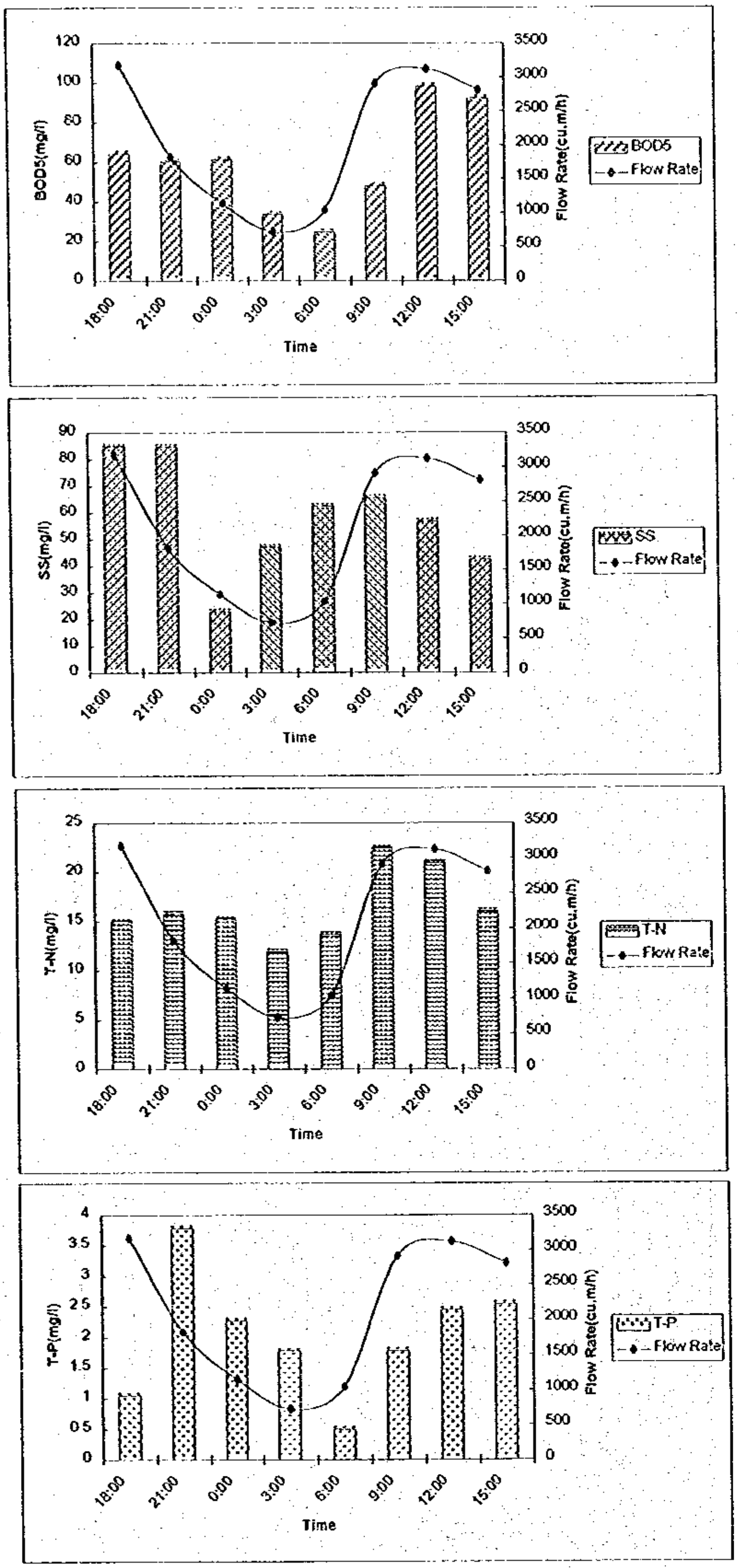


Figure AII.1.3	Result of Wastewater Quality Survey at Collector Germany in Braila City

APPENDIX-2 INTERCEPTOR SYSTEM

1. EXISTING OUTFALLS

Braila City's sewerage system is of a combined system to collect the wastewater and the storm water together into a single sewer line.

There are totally twelve (12) wastewater outfalls in the sewerage system to discharge the wastewater into the Danube River; namely, Braila Sud (BA), Radu Negru (RN), PAL (B1), (B2), Franceza (B3), Danubiu and Imparat Traian (B4), Belvedere (B5), Vadul Schelei (B6), Vadul Rizeriei (B7), Germany (GE), Cezar Petrescu (CP), and Targoviste (TA) as shown in *Figures AII.2.1 and AII.2.2.*

Pumping station SP Braila Sud (BS) starts operation when the water surface elevation of the Danube River becomes higher than +6.3 m M.W.L. Pumping station SP Radu Negru (RN) is usually not operated, but only in case of emergency it is operated.

Flows of each outfall are estimated as shown below:

Flow of Each Outlet

Name (No.) of Outlet Sewer	Existing Out Flow in Dry Weather (*1) (L/sec)	Planned Flow (*2) (L/sec)	Remark
Braila Sud (BS)	300	260	
Radu Negru (RN)		0	
PAL (B1)	20	17	
(B2)	10	9	
Franceza (B3)	15	13	
Danubiu and Imparat Traian (B4)	5	4	
Belvedere (B5)	3	3	Only sanitary wastewater is discharged.
Vadul Schelei (B6)	3.5	3	
Vadul Rizeriei (B7)	12	10	
Germany (GE)	1200	1041	
Cezar Petrescu (CP)	250	217	
Targoviste (TA)	50	43	
Total	1,868.5	1,621	

Name of Pumping Station	Existing Out Flow in Dry Weather (*1) (L/sec)	Planned Flow (*2) (L/sec)	Remark
PS Viziru	55	48	
PS Calarasi 4	28	24	
PS Ship Yard	14	12	

(*1): The present flows are obtained from RA APTERCOL Braila, water company.
(*2): The planned flows are estimated by the JICA study team, based on the total maximum hourly flow of 1621 L/sec

In the existing sewerage system, the Germany (GE) is a main sewer discharging about 60 % of the total wastewater generated in the City. The City has now been constructing a new main sewer named Rosiori running along the Germany to enhance the main sewer capacity and solve the current wastewater disposal problems. The Rosiori-line is connected to the GE near the present outfall.

2. INTERCEPTOR SYSTEM

2.1 COLLECTION SYSTEM PLANS

(1) Planning

In the previous F/S conducted by Braila City, interceptors are planned, to connect the GE line from the terminal of the Rosiori to the planned WWTP. The interceptors are to collect all the dry weather wastewater generated in the City, but during wet weather, twice as much the maximum hourly maximum dry weather wastewater flow (2Q) will be collected. Although the City has the interceptor construction plan, the actual implementation has not been started yet.

Under the present study, the wastewater interceptor sewer system is planned in principle based on the previous F/S study. The planning and design of the interceptor consists of combined sewer mains, combined sewer overflow (CSO) regulator, interceptor sewer and overflow systems.

The planned combined sewer main will runs from the junction of the GE and Rosiori up to the planned CSO regulator. The interceptor sewer is to be laid from the CSO regulator to the planned WWTP. The overflow sewer is from the CSO regulator to the existing outfall. The planned sewer and some accessories are shown in *Figure AII.2.3.* The interceptor sewer is to receive wastewater from the sewers Cezar Petrescu (CP) and Targoviste (TA) on the way to the WWTP.

As the storm water is drained into the combined sewers, storm water management of the GE outfall is studied in the following section. For the interceptor system, combination of the interceptor sewer and pumping station are studied to establish an adequate wastewater collection system in the section "Alternative Study."

There exist other outfalls discharging the wastewater into the Danube River in addition to GE, CP and TA. These are Braila Sud (BS), Radu Negru (RN), PAL (B1), (B2), Franceza (B3), Danubiu and Imparat Traian (B4), Belvedere (B5), Vadul Schelei (B6) and Vadul Rizeriei (B7).

In view of the present conditions of the sewerage system, the installation of a wastewater collection system connecting such outfall sewers to the planned WWTP is mandatory. The basic ideas for such planning may be summarized as follows:

- The wastewater from the existing outfall BS is to be diverted by pumping up to the existing pumping station Radu Negru, from where the wastewater is to be sent further to the existing sewer network, and finally connecting to the Germany and Rosiori. The system may be named as Diversion of Braila Sud;
- The wastewater from the existing outfalls PAL (B1), (B2), and Franceza (B3) are to be collected by a new interceptor sewer and pumped up to the existing sewer network, which is finally connected to the Germany and Rosiori. The system may be named as Braila South Interceptor; and
- The wastewater from the existing outfalls Danubiu and Imparat Traian (B4), Belvedere (B5), Vadul Schelei (B6) and Vadul Rizeriei (B7) are to be collected by a new interceptor sewer and pumped up to the existing sewer network, which is finally connected to the Germany and Rosiori. The system may be named as Braila North Interceptor.

Some detail of these collection systems is shown in *Figure AII.2.2.* The collection system of Diversion of Braila Sud and Braila South Interceptor, and Braila North Interceptor is not designed under this study, since there are many design constraints and uncertainties in the present conditions, such as upstream flows, connecting sewer flows, sewer routes and sewer invert elevations.

(2) Storm Water Management

As the sewerage system is the combined system, main sewers such as the Germany and Rosiori carry both sanitary wastewater and stormwater. Hence, for the planning of the sewer system the quantity of stormwater inflow to the designed combined sewers must first be known.

1) Germany and Rosiori

In the previous F/S, total maximum hourly wastewater and stormwater flows of the Germany and the Rosiori was estimated at 20 m^3/s.

Hourly maximum flow of sanitary wastewater generated in Braila City is estimated to be 1.621 m^3/s under the present study. From this value, the maximum stormwater flow is assumed to be about 18.4 m^3/s. Because many basic data are missing to calculate exact stormwater flow rate, such as drainage tributary area, stormwater runoff coefficient, and concentration time, the flow rate is roughly estimated under the present study as shown in the following table:

Storm Water Flow of Germany-Rosiori

Item	Value	Remarks
Drainage basin of Germany-Rosiori sewer (A)	550 ha	
Run off Coefficient (C)	0.35	
Inlet time (T1)	10 minutes	
Time of flow (T2)	92 minutes	Sewer length is 5,500 km and flow velocity is estimated to be 1 m/s.
Concentration time (T) = T1 + T2	102 minutes	
Rain fall intensity (I)	42 mm/hour	Estimated assuming that Braila is of the area IV in Romania Standards, and 2-year return period of rainfall intensity.
Flow rate (A)	18.0 m^3/s	Q=1/360 x C x I x A x 0.8 0.8 is a storage factor in the sewer under the Romanian Standards.

There exist two outfalls for the GE, comprising two different types of sewers, one is circular sewer of 1,000 mm in diameter and the other 2,200 mm x 1,800 mm hose-shoe section. The each length is 928.7 m at 1.3 ‰ slope, with the total discharge capacity of 7.45 m^3/s. An overflow sewer is to be provided with the capacity of the total hourly maximum wastewater and storm water i.e. 20 m^3/s, because of the possible failures of the WWTP or interceptor sewer operation.

It is verified that the total capacity of the existing two sewers is not sufficient to discharge the required flow; hence, an additional sewer needs to be installed. The additional sewer of 2,800 mm in diameter with a slope of 1.2 ‰ is to have the capacity of 12.55 m^3/s (20 m^3/s – 7.45 m^3/s).

The overflow discharge sewers comprising the two existing and the planned sewers can generally function as gravity sewers. As the invert elevation of outfalls is +4.57 m M.W.L. and the planned high water level (1/100 probability of occurrence) is about+8.0 m M.W.L., a pumping station is required to discharge the overflow when the Danube water level rises too high to discharge by gravity.

The additional overflow sewer and pumping station are not included in this study, because of the uncertainties of storm water flow rate. For this reason, under the current study the overflow sewer is designed to from the planned CSO regulator up to the existing two outfalls as a minimum requirement.

2) Brazdei-Brailita sewer

Braila City has a sewerage planning to cover the western part of the City, in which the planned sewer runs from the western part of the City to the GE outfall through the northwestern part of the City. The sewer is named Brazdei-Brailita. The implementation plan has not been prepared by the City yet.

According to the previous F/S, the total hourly maximum flow of the sanitary wastewater and storm water of Brazdei-Brailita sewer is estimated to be about 15-24 m^3/s, and thence it could be assumed as 18 m^3/s. As the previous F/S study also indicates that the sewer is coming down from high ground districts, the excess wastewater of over 2Q could be discharged by gravity.

The wastewater collection system of Brazdei-Brailita is not designed under this study, since there is not concrete plan and design. The Brazdei-Brailita sewer planning and design is recommended to cover i) wastewater collection system to convey the wastewater twice the maximum hourly wastewater flow to the planned interceptor with CSO regulator, and ii) sewer which will drain the excess wastewater from the CSO by gravity to the Danube River.

(3) Alternative Study

For the interceptor sewer from the end point of the GE to the planned WWTP, two alternative cased are compared to find out the most desirable wastewater collecting system. The difference between the two alternatives is the location of the pumping station to transport the 2Q to the planned WWTP. Alternative 1 is to install a pumping station near the CSO regulator, in this case no influent pumping station is installed in the planned WWTP. In Alternative 2, a pumping station is to be installed in the planned WWTP and the wastewater flows by gravity from the CSO to the planned WWTP.

The advantage accruing to Alternative 1 is that the sewer installation will be easier than Alternative 2 because of the shallower sewer depth. The disadvantage of Alternative 1 is that sewer materials are more costly as the sewer is under pressure, and the pump head may be higher with an increment of friction losses. In addition, the wastewater flow from the two main outfalls, Cezar Petrescu (CP) and Targoviste (TA), is hydraulically complicated to analyze.

General advantages of Alternative 2 are i) the wastewater flow from the two main outfalls, CP and TA is hydraulically rather simple to analyze, and ii) pumping station is concentrated in the WWTP, and as such, operation and maintenance is easier than Alternative 1.

In Alternative 1, studies are made for various sewer sizes to find out the most economical system. There is a close relation between the sewer diameters and friction losses; when the sewer size is smaller, the friction losses will increase. The costs for the pump equipment and operation and maintenance will be higher, but the sewer construction is less costly. In case of large size sewer, the friction losses and pump equipment costs will be lower while the sewer construction costs will be higher.

The result of the comparison between Alternatives 1 and 2, as summarized in *Table AII.2.1*, clearly indicates that Alternative 2 is more economical than Alternative 1. Therefore, Alternative 2 is applied in this study.

2.2 DESIGN OF INTERCEPTOR AND PUMPING STATION

The main sewer is planned to connect the existing manhole at the junction of the Germany and Rosiori to the planned CSO regulator. The interceptor sewer from the CSO regulator to the planned WWTP is planned to send two times of the hourly maximum wastewater flow. The overflow sewer from the CSO regulator to the existing two outfalls is planned, with controlling valves.

The sewer computation sheets and profiles of Alternative 2 are shown in *Table AII.2.2 and Figure AII.2.4*. Layout of the interceptor of Alternative 2 is shown in *Figure AII.2.3*.

2.3 PROPOSED FACILITIES

Planned facilities consist of interceptor sewers, combined sewer overflow (CSO) regulators, connection sewers, manholes and valves. These are described in *Table AII.2.3*. Major features of the facilities are as follows:

(1) Interceptor sewers

The proposed combined sewer main, interceptor sewer and overflow sewer are as follows,

- Combined sewer main of 3,400 mm diameter, 114 m long, and earth covering of 1-3 m, from the existing junction manhole of the Germany and the Rosiori to the planned CSO regulator;
- Interceptor sewer, which is 1,650 mm diameter, 2,740 m long, and earth covering of 1-7 m (but mostly 1-5 m), from the CSO regulator to the planned WWTP and;
- Overflow sewer of 3,400 mm diameter, 83 m long, and earth covering of 1-3 m, from the CSO regulator to the two existing outfalls;

The route of the planned sewer of 3,400 mm diameter will cross the existing railway over 15 m. The sewer will be constructed by open-cut method. The open-cut method will also be applied for sewers crossing the railway, but particular measures will be applied to protect the railway.

Typical sewer construction is shown in *Figure AII.2.5*.

(2) CSO regulators

Combined sewer overflow (CSO) regulators are installed at the main sewer to divert the maximum wastewater of 2Q into the interceptor through the connection sewers. The CSO regulators overflow the excess wastewater from weirs, and discharge it to the existing outfalls.

Two different sizes of CSO regulators, large type and small type, are applied in this study. They are differentiated with overflow rates, size of the combined sewers, and head of weir.

Totally 3 units of the combined sewer overflow (CSO) regulators are installed. Large type CSO regulators are 1 unit for the Germany and 2 units of small type CSO regulators for Cezar Petrescu (CP) and Targoviste (TA).

Typical structures are shown in *Figure AII.2.6*.

(3) Connection sewers

The connection sewer is to carry 2Q of wastewater from the CSO regulator to the interceptor sewer. Length of connection sewers are 20 m and 40 m for Cezar Petrescu (CP) and Targoviste (TA), respectively, both with the earth coverage of 1-3 m. Totally two connection sewers are installed.

(4) Manholes

Manholes are generally installed along the interceptor sewer generally at 200 m interval. These are also installed at the junctions of the sewers and roads. Totally 22 units of manholes are installed along the interceptor sewers.

(5) Valves

Two valves are to be installed along the overflow sewer. One is for the future connection of the overflow pumping station, and the other is for the flow control of the overflow pumping station.

3. WWTP OUTFALL SEWERS

Outfall sewer is to be installed from the planned WWTP up to the Danube River. The sewer, crossing the riverbank and running along the existing channel to the River, will be under pressure all the way from the WWTP chlorine tank through the discharge point. When the Danube River water level becomes higher than the level of annual return period, effluent pumps start the operation to discharge treated wastewater. The pumping station receives the treated wastewater from the chlorination chamber and discharges it to the outfall.

The outfall sewer diameter is 2,000 mm, which is determined based on the calculated head losses and velocity in the sewer. When two times of the maximum hourly flow (280,000 m3/day = 3.241 m3/s) comes into the outfall sewer, the velocity is about 1.0 m/s.

The water level of chlorination chamber is +7.3 m M.W.L., the chlorination tank water depth is 4.0 m, and the ground level of 7.0 m M.W.L. at the chlorination chamber. The sewer elevations at invert and crown are about 4.0 m and 6.0 m respectively, so the earth coverage is about 1.0 m. The earth coverage of 1.5 m is selected for the protection of pipes against the possible physical damage.

As the river bed elevation at the end of the outfall sewer is almost same as the sewer invert elevation of 4.0 m.M.W.L., the sewer length is determined to be 1,100 m.

Table AII.2.1 Comparison of Alternative Study on Pumping Station along Braila Interceptor

Case		Alt. 1-1	Alt. 1-2	Alt. 1-3	Alt. 2
Capital Cost					
Pipe Laying					
Dia	(mm)	1200	1400	1500	1650
Length	(m)	2740	2740	2740	2740
Unit Cost	(US$/m)	230	300	330	300
Cost	(M. US$)	0.630	0.822	0.904	0.822
Pump Equipment for 2Q (3.241 m3/s)					
Head	(m)	29.4	18.9	16.2	13.6
Pump Cost	(M. US$)	1.19	0.96	0.84	0.7
Total Capital Cost of Pipe Laying and Pump Equipment	(M. US$)	1.820	1.782	1.744	1.522
Operation and Maintenance (O/M) Cost					
Electric Power	(M. US$/year)	0.047	0.038	0.036	0.060
Personal fee	(M. US$/year)	0.010	0.010	0.010	0.000
Total of O/M	(M. US$/year)	0.057	0.048	0.046	0.060

Year	Alt. 1-1 Capital		Alt. 1-1 O/M		Alt. 1-2 Capital		Alt. 1-2 O/M		Alt. 1-3 Capital		Alt. 1-3 O/M		Alt. 2 Capital		Alt. 2 O/M	
(j)	(C)	(PV)	(C)	(PV)	(C)	(PV)	(C)	(PV)	(C)	(PV)	(C)	(PV)	(C)	(PV)	(C)	(PV)
1	1.820	1.820	0.057	0.057	1.782	1.782	0.048	0.048	1.744	1.744	0.046	0.046	1.522	1.522	0.060	0.060
2	0.000	0.000	0.057	0.054	0.000	0.000	0.048	0.046	0.000	0.000	0.046	0.044	0.000	0.000	0.060	0.057
3	0.000	0.000	0.057	0.052	0.000	0.000	0.048	0.044	0.000	0.000	0.046	0.042	0.000	0.000	0.060	0.054
4	0.000	0.000	0.057	0.049	0.000	0.000	0.048	0.041	0.000	0.000	0.046	0.040	0.000	0.000	0.060	0.052
5	0.000	0.000	0.057	0.047	0.000	0.000	0.048	0.039	0.000	0.000	0.046	0.038	0.000	0.000	0.060	0.049
6	0.000	0.000	0.057	0.045	0.000	0.000	0.048	0.038	0.000	0.000	0.046	0.036	0.000	0.000	0.060	0.047
7	0.000	0.000	0.057	0.043	0.000	0.000	0.048	0.036	0.000	0.000	0.046	0.034	0.000	0.000	0.060	0.045
8	0.000	0.000	0.057	0.041	0.000	0.000	0.048	0.034	0.000	0.000	0.046	0.033	0.000	0.000	0.060	0.043
9	0.000	0.000	0.057	0.039	0.000	0.000	0.048	0.032	0.000	0.000	0.046	0.031	0.000	0.000	0.060	0.041
10	0.000	0.000	0.057	0.037	0.000	0.000	0.048	0.031	0.000	0.000	0.046	0.030	0.000	0.000	0.060	0.039
11	0.000	0.000	0.057	0.035	0.000	0.000	0.048	0.029	0.000	0.000	0.046	0.028	0.000	0.000	0.060	0.037
12	0.000	0.000	0.057	0.033	0.000	0.000	0.048	0.028	0.000	0.000	0.046	0.027	0.000	0.000	0.060	0.035
13	0.000	0.000	0.057	0.032	0.000	0.000	0.048	0.027	0.000	0.000	0.046	0.026	0.000	0.000	0.060	0.033
14	0.000	0.000	0.057	0.030	0.000	0.000	0.048	0.025	0.000	0.000	0.046	0.024	0.000	0.000	0.060	0.032
15	0.000	0.000	0.057	0.029	0.000	0.000	0.048	0.024	0.000	0.000	0.046	0.023	0.000	0.000	0.060	0.030
16	1.190	0.572	0.057	0.027	0.960	0.462	0.048	0.023	0.840	0.404	0.046	0.022	0.700	0.337	0.060	0.029
17	0.000	0.000	0.057	0.026	0.000	0.000	0.048	0.022	0.000	0.000	0.046	0.021	0.000	0.000	0.060	0.027
18	0.000	0.000	0.057	0.025	0.000	0.000	0.048	0.021	0.000	0.000	0.046	0.020	0.000	0.000	0.060	0.026
19	0.000	0.000	0.057	0.024	0.000	0.000	0.048	0.020	0.000	0.000	0.046	0.019	0.000	0.000	0.060	0.025
20	0.000	0.000	0.057	0.023	0.000	0.000	0.048	0.019	0.000	0.000	0.046	0.018	0.000	0.000	0.060	0.024
21	0.000	0.000	0.057	0.021	0.000	0.000	0.048	0.018	0.000	0.000	0.046	0.017	0.000	0.000	0.060	0.023
22	0.000	0.000	0.057	0.020	0.000	0.000	0.048	0.017	0.000	0.000	0.046	0.017	0.000	0.000	0.060	0.022
23	0.000	0.000	0.057	0.019	0.000	0.000	0.048	0.016	0.000	0.000	0.046	0.016	0.000	0.000	0.060	0.021
24	0.000	0.000	0.057	0.019	0.000	0.000	0.048	0.016	0.000	0.000	0.046	0.015	0.000	0.000	0.060	0.020
25	0.000	0.000	0.057	0.018	0.000	0.000	0.048	0.015	0.000	0.000	0.046	0.014	0.000	0.000	0.060	0.019
26	0.000	0.000	0.057	0.017	0.000	0.000	0.048	0.014	0.000	0.000	0.046	0.014	0.000	0.000	0.060	0.018
27	0.000	0.000	0.057	0.016	0.000	0.000	0.048	0.013	0.000	0.000	0.046	0.013	0.000	0.000	0.060	0.017
28	0.000	0.000	0.057	0.015	0.000	0.000	0.048	0.013	0.000	0.000	0.046	0.012	0.000	0.000	0.060	0.016
29	0.000	0.000	0.057	0.015	0.000	0.000	0.048	0.012	0.000	0.000	0.046	0.012	0.000	0.000	0.060	0.015
30	0.000	0.000	0.057	0.014	0.000	0.000	0.048	0.012	0.000	0.000	0.046	0.011	0.000	0.000	0.060	0.015
31	1.190	0.275	0.057	0.013	0.960	0.222	0.048	0.011	0.840	0.194	0.046	0.011	0.700	0.162	0.060	0.014
32	0.000	0.000	0.057	0.013	0.000	0.000	0.048	0.011	0.000	0.000	0.046	0.010	0.000	0.000	0.060	0.013
33	0.000	0.000	0.057	0.012	0.000	0.000	0.048	0.010	0.000	0.000	0.046	0.010	0.000	0.000	0.060	0.013
34	0.000	0.000	0.057	0.011	0.000	0.000	0.048	0.010	0.000	0.000	0.046	0.009	0.000	0.000	0.060	0.012
35	0.000	0.000	0.057	0.011	0.000	0.000	0.048	0.009	0.000	0.000	0.046	0.009	0.000	0.000	0.060	0.011
36	0.000	0.000	0.057	0.010	0.000	0.000	0.048	0.009	0.000	0.000	0.046	0.008	0.000	0.000	0.060	0.011
37	0.000	0.000	0.057	0.010	0.000	0.000	0.048	0.008	0.000	0.000	0.046	0.008	0.000	0.000	0.060	0.010
38	0.000	0.000	0.057	0.009	0.000	0.000	0.048	0.008	0.000	0.000	0.046	0.008	0.000	0.000	0.060	0.010
39	0.000	0.000	0.057	0.009	0.000	0.000	0.048	0.008	0.000	0.000	0.046	0.007	0.000	0.000	0.060	0.009
40	0.000	0.000	0.057	0.009	0.000	0.000	0.048	0.007	0.000	0.000	0.046	0.007	0.000	0.000	0.060	0.009
41	0.000	0.000	0.057	0.008	0.000	0.000	0.048	0.007	0.000	0.000	0.046	0.007	0.000	0.000	0.060	0.009
42	0.000	0.000	0.057	0.008	0.000	0.000	0.048	0.006	0.000	0.000	0.046	0.006	0.000	0.000	0.060	0.008
43	0.000	0.000	0.057	0.007	0.000	0.000	0.048	0.006	0.000	0.000	0.046	0.006	0.000	0.000	0.060	0.008
44	0.000	0.000	0.057	0.007	0.000	0.000	0.048	0.006	0.000	0.000	0.046	0.006	0.000	0.000	0.060	0.007
45	0.000	0.000	0.057	0.007	0.000	0.000	0.048	0.006	0.000	0.000	0.046	0.005	0.000	0.000	0.060	0.007
46	1.190	0.132	0.057	0.006	0.960	0.107	0.048	0.005	0.840	0.093	0.046	0.005	0.700	0.078	0.060	0.007
47	0.000	0.000	0.057	0.006	0.000	0.000	0.048	0.005	0.000	0.000	0.046	0.005	0.000	0.000	0.060	0.006
48	0.000	0.000	0.057	0.006	0.000	0.000	0.048	0.005	0.000	0.000	0.046	0.005	0.000	0.000	0.060	0.006
49	0.000	0.000	0.057	0.005	0.000	0.000	0.048	0.005	0.000	0.000	0.046	0.004	0.000	0.000	0.060	0.006
50	0.000	0.000	0.057	0.005	0.000	0.000	0.048	0.004	0.000	0.000	0.046	0.004	0.000	0.000	0.060	0.005
total	5.390	2.799	2.850	1.094	4.662	2.573	2.400	0.919	4.264	2.435	2.300	0.883	3.622	2.099	3.000	1.152
Total Present Value	3.893				3.492				3.318				3.251			
Result of Comparison	x				x				x				o			

Present Value(PV) =(C) / (1+R)^(j-1)
Discount Rate (R) = 5 (%)

Table AII.2.2 Computation of Planned Interceptor in Braila

Line No.	Line No. of	Sewer Length(m)		Max. Flow(m3/s)			Sewer Line				Sewer Invert Elevation		Ground Elevation		Earth Covering(m)	
	Lower Sewer	Increment	Total	Sewage	Infilt.	Total	Diameter	Slope	V(m/s)	Cap.(m3/s)	Upper end	Lower end	Upper end	Lower end	Upper end	Lower end
M-CSO	BI1	114	114	20	0	20	3400	1.2	2.391	21.708	6.31	6.173	10.95	11	1.24	1.427
BI1	BI2	263	377	3.241	0	3.241	1650	1.3	1.537	3.286	6.173	5.831	11	10.97	3.177	3.489
BI2	BI3	320	697	0	0	3.241	1650	1.3	1.537	3.286	5.831	5.415	10.97	12.02	3.489	4.955
BI3	BI4	291	988	0	0	3.241	1650	1.3	1.537	3.286	5.415	5.037	12.02	11.11	4.955	4.423
CP	BI4	20	-	-	-	-	600	-	-	-	-	8	-	11.11	-	2.51
BI4	BI5	259	1247	0	0	3.241	1650	1.3	1.537	3.286	5.037	4.7	11.11	12.06	4.423	5.71
BI5	BI6	27	1274	0	0	3.241	1650	1.3	1.537	3.286	4.7	4.665	12.06	11.88	5.71	5.565
BI6	BI7	236	1510	0	0	3.241	1650	1.3	1.537	3.286	4.665	4.358	11.88	9.49	5.565	3.482
TA	BI7	20	-	-	-	-	300	-	-	-	-	8	-	9.49	-	1.19
BI7	BI8	47	1557	0	0	3.241	1650	1.3	1.537	3.286	4.358	4.297	9.49	9	3.482	3.053
BI8	BI9	68	1625	0	0	3.241	1650	1.3	1.537	3.286	4.297	4.209	9	6	3.053	0.141
BI9	BI10	133	1758	0	0	3.241	1650	1.3	1.537	3.286	3.023	2.85	6	5	1.327	0.5
BI10	BI11	203	1961	0	0	3.241	1650	1.3	1.537	3.286	2.85	2.586	5	5.25	0.5	1.014
BI11	BI12	471	2432	0	0	3.241	1650	1.3	1.537	3.286	2.586	1.974	5.25	5.2	1.014	1.576
BI12	WWTP	422	2854	0	0	3.241	1650	1.3	1.537	3.286	1.974	1.425	5.2	5.5	1.576	2.425

Table AII.2.3 Quantity of Planned Interceptor System in Braila

Line No.	Line No. of Lower Sewer	Sewer Line: Sewer Length (m)	Sewer Line: Diameter (mm)	Sewer Line: Earth Covering (m) Upper end	Sewer Line: Earth Covering (m) Lower end	CSO: Small Type	CSO: Large Type	Connection Pipe: Dia(mm)	Connection Pipe: L(m)	Connection Pipe: EC(m)	Interceptor Sewer: Diameter (mm)	Interceptor Sewer: Earth Covering (m) 1-3	3-5	5-7	7-9	Total	Under Railway (length in sewer line)	Inverted Siphon (length in sewer line)	Manhole: Diameter (mm)	Manhole: Earth Covering (m) 1-3	3-5	5-7	7-9	Total	Remark
M-CSO	BI1	114	3,400	1.240	1.427		1				3,400	114				114	10		3,400						
BI1	BI2	263	1,650	3.177	3.489						1,650		263			263			1,650		2		2	4	
BI2	BI3	320	1,650	3.489	4.955						1,650		320			320			1,650		2		2	4	
BI3	BI4	291	1,650	4.955	4.423						1,650		291			291			1,650		1		1	2	
CP	BI4	20	600			1		600	40	1-3															
BI4	BI5	259	1,650	4.423	5.710						1,650		116	143		259			1,650		1	1	2	4	
BI5	BI6	27	1,650	5.710	5.565						1,650			27		27			1,650			1	1	2	
BI6	BI7	236	1,650	5.565	3.482						1,650		172	64		236			1,650		1	1	2	4	
TA	BI7	20	300			1		300	20	1-3															
BI7	BI8	47	1,650	3.482	3.053						1,650		47			47			1,650		1		1	2	
BI8	BI9	68	1,650	3.053	0.141						1,650	67	1			68			1,650	1			1	2	
BI9	BI10	133	1,650	1.327	0.500						1,650	133				133			1,650	1			1	2	
BI10	BI11	203	1,650	0.500	1.014						1,650	203				203			1,650	1			1	2	
BI11	BI12	471	1,650	1.014	1.576						1,650	471				471			1,650	1			1	2	
BI12	WWTP	422	1,650	1.576	2.425						1,650	422				422		40	1,650	3			3	6	
Following sewers are for discharging storm water																									
CSO-2P	2Pipe	83	3400, 2200-1800, 1000	1.427	-1.379						3,400	83				83	5		3,400	2 1 1				2 1 1	2valves
2pipes + add	Danube	773	1000, 2200-1800, 2800	-0.430	-1.032														3,400						

Sammary

CSO

Small Type	Large Type
2	1

Connection Sewer

Dia(mm)	L(m)	EC(m)
300	20	1-3
600	40	1-3

Interceptor Sewer

Dia(mm)	Earth Covering (m) 1-3	3-5	5-7	7-9	Total Length (m)	Remark
1650	1256	1210	234		2700	
1650	40				40	Inverted siphon for storm water
3400	182				182	
3400	15				15	Under railway

Manhole

Dia(mm)	Earth Covering (m) 1-3	3-5	5-7	7-9	Total
1000	1				1
1650	7	8	3		18
2200	1				1
3400	2				2

Valve

Dia(mm)	EC (m) 1-3	3-5	5-7	7-9	Total
3400	2				2

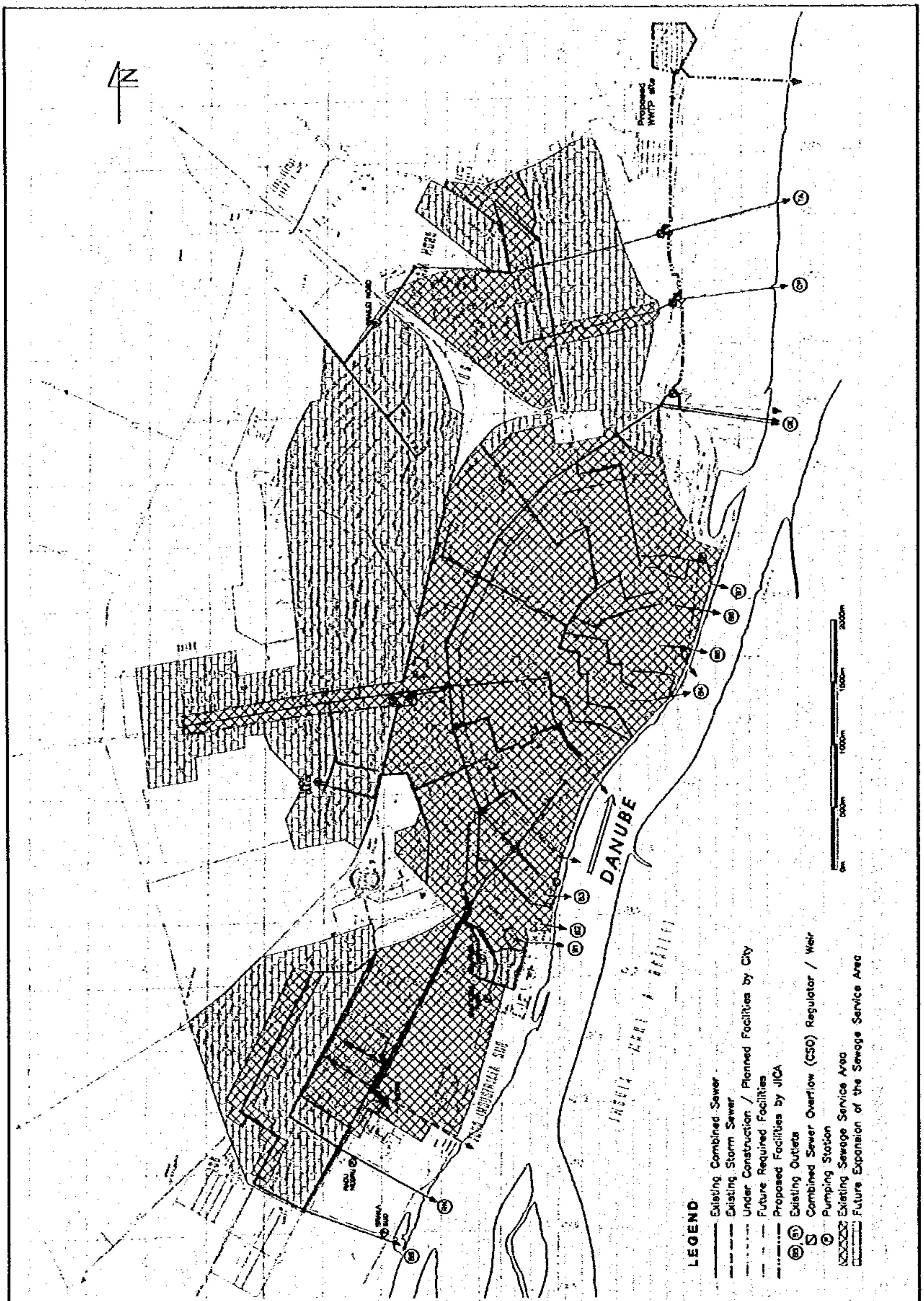


Figure AII.2.1	Braila City Sewerage System (Existing and Planning)

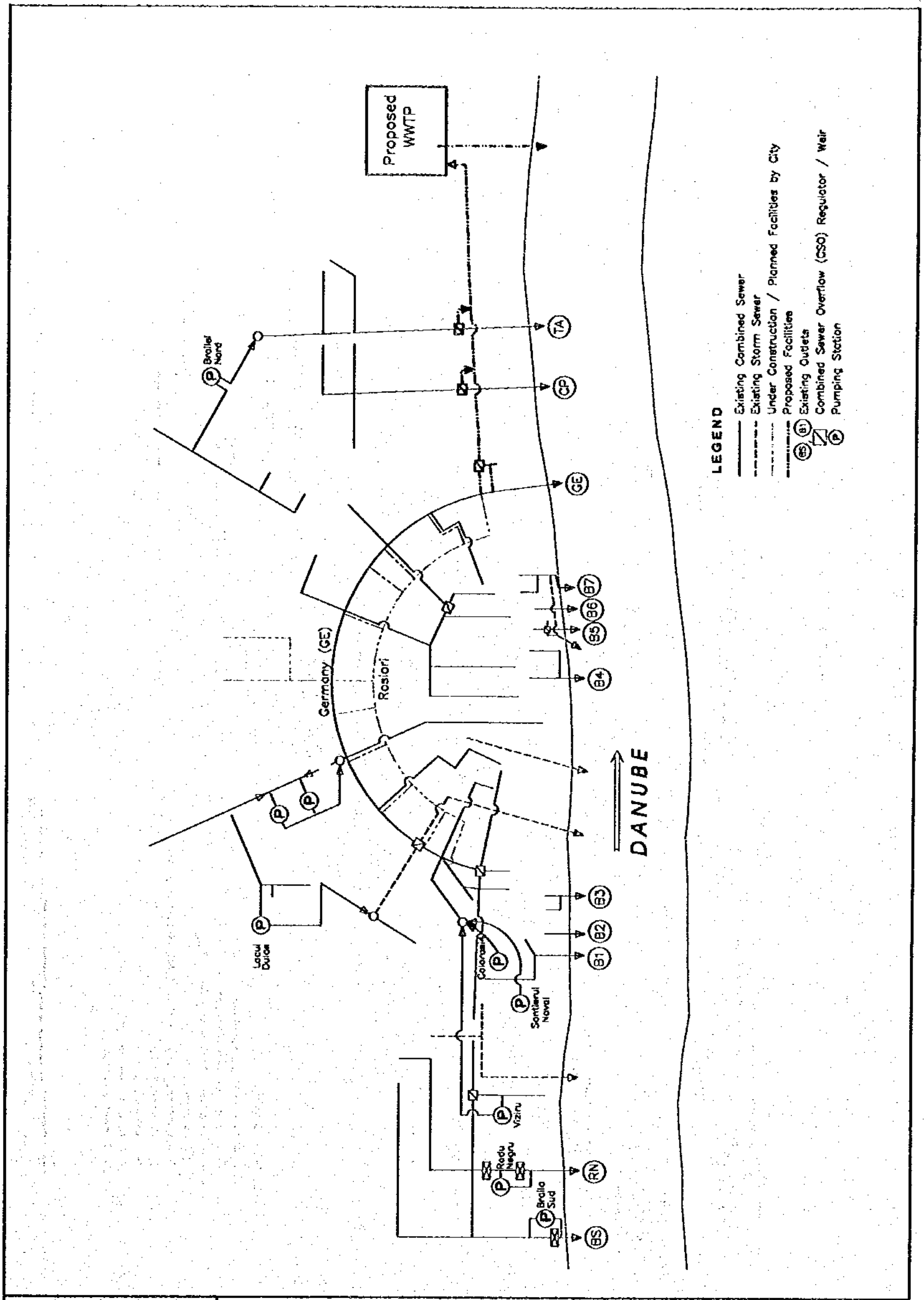


Figure AII.2.2	Schematic Representation of Braila Sewerage System

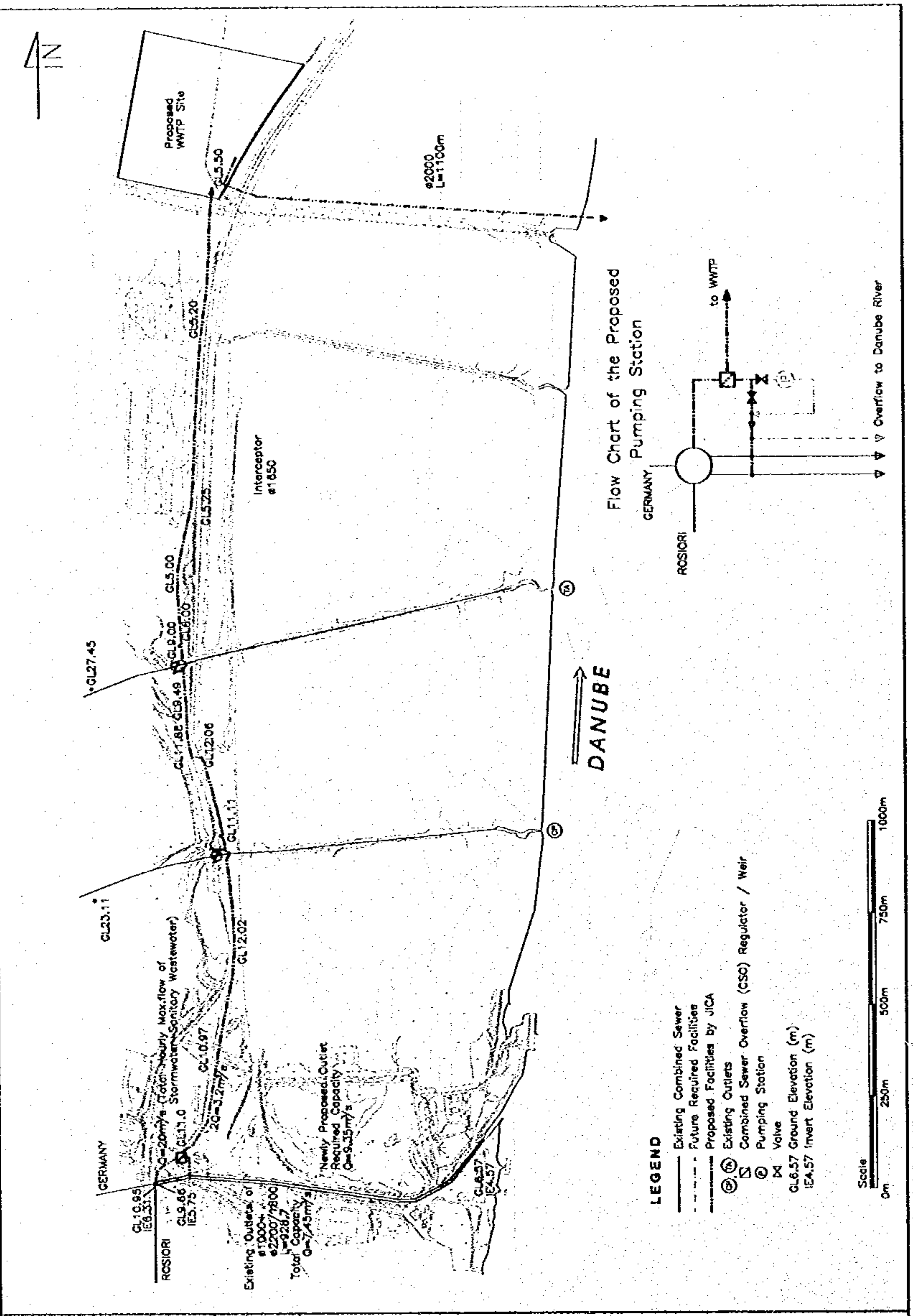


Figure AII.2.3	Proposed Interceptor System of Braila

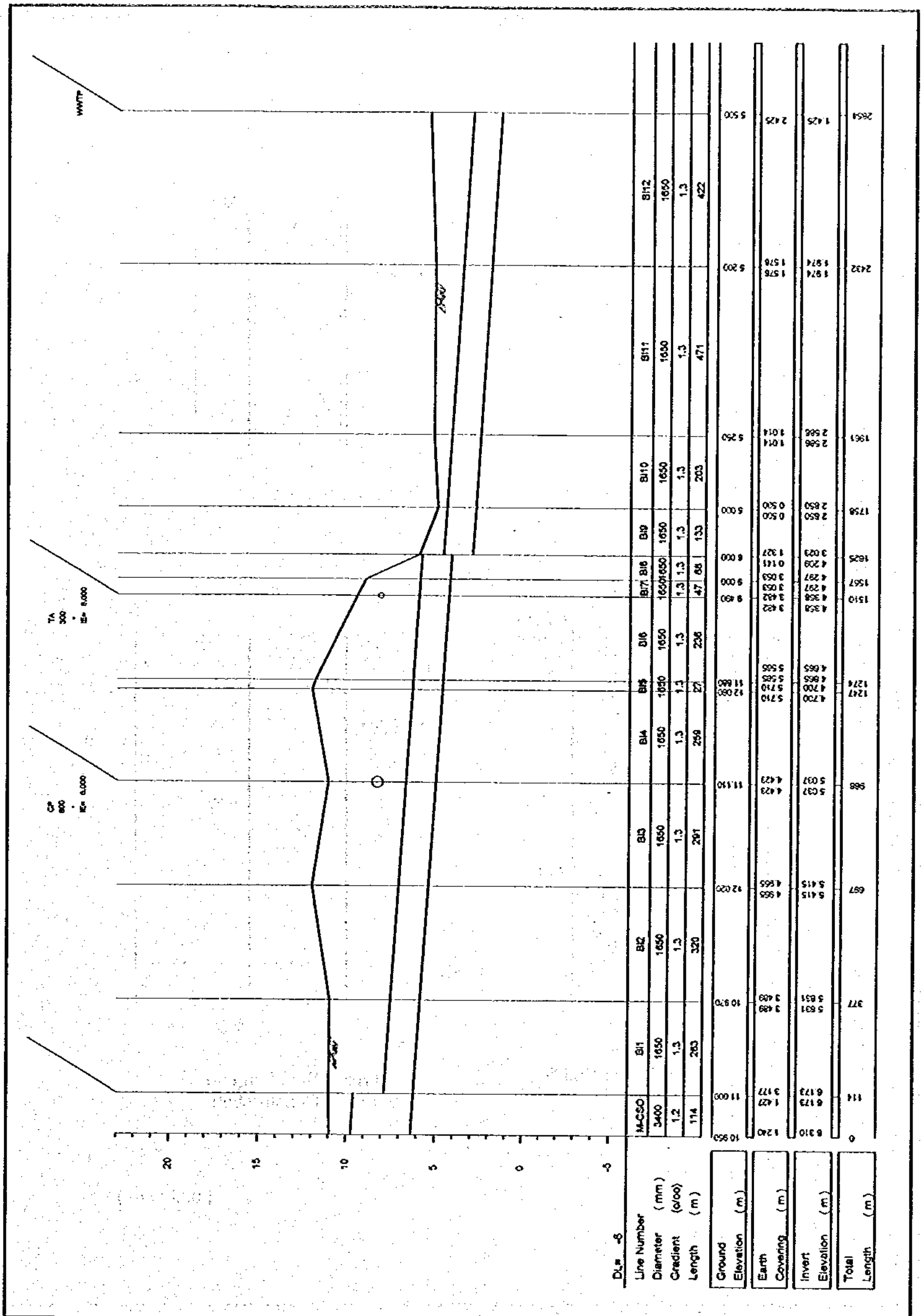
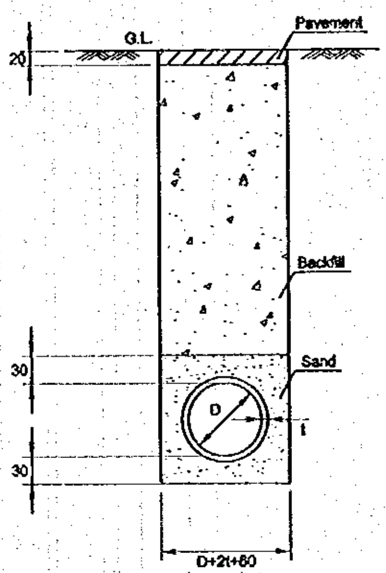
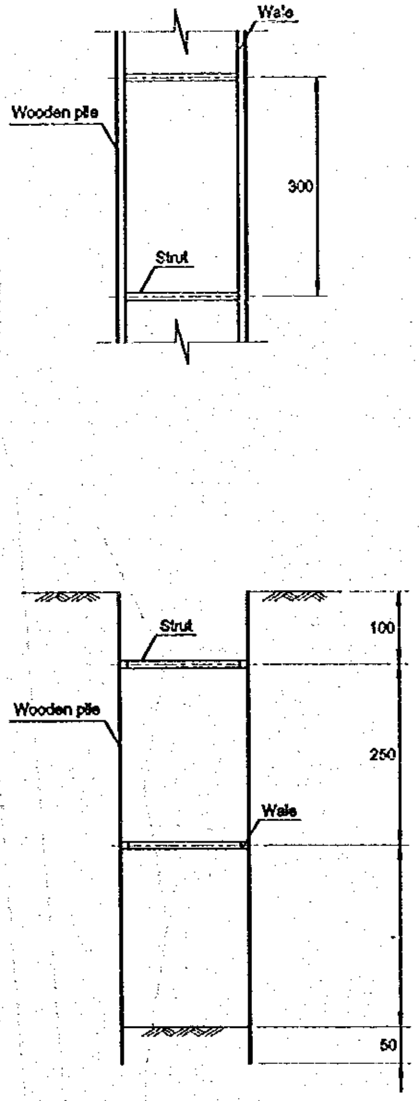


Figure AII.2.4 | **Longitudinal Profile of Planned Interceptor in Braila**



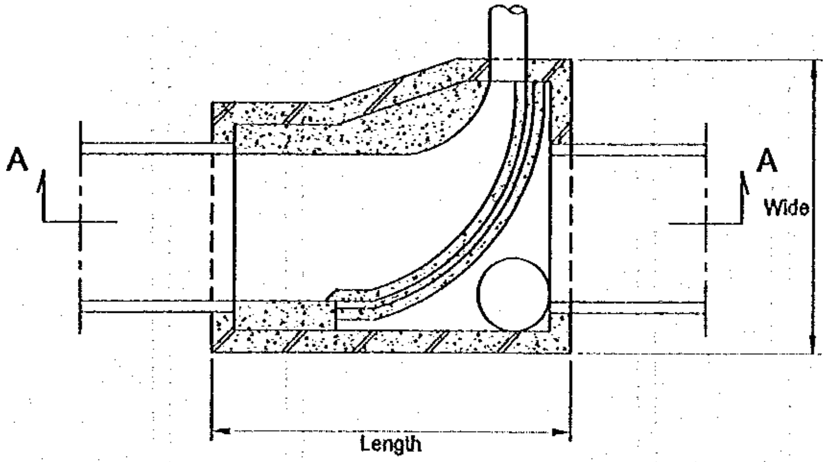
Typical Sewer Bedding



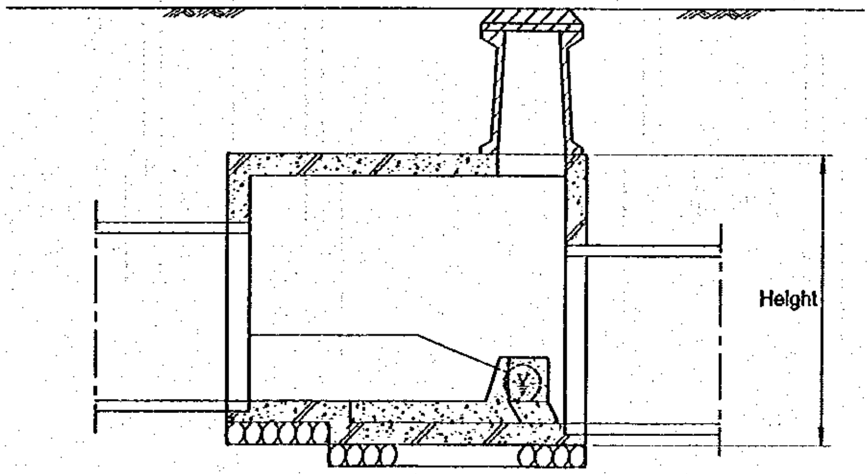
Typical Sheathing on Sewer Construction

(unit : cm)

Figure AII.2.5	Typical Sewer Bedding and Typical Sheathing on Sewer Construction



Plan



Section A-A

(unit : m)

	Wide	Length	Height
Small Type	2	3	2
Large Type	4	5	4

Figure AII.2.6	Typical Combined Sewer Overflow (CSO) Regulator

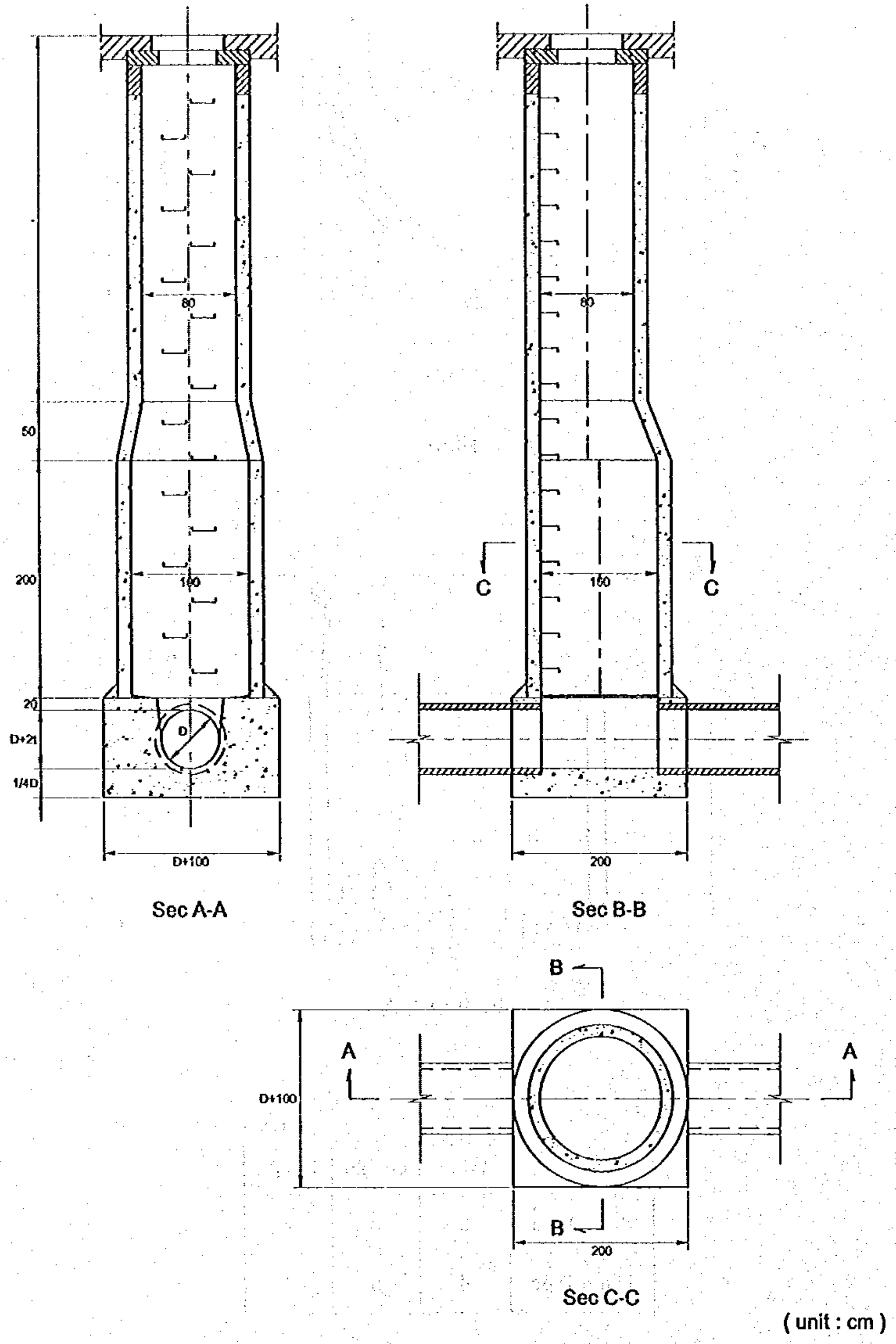


Figure AII.2.7 | Typical Stucture of Manhole

APPENDIX –3 FACILITY PLANNING

1. PLANNING PRINCIPLE

1.1 HYDRAULIC/ORGANIC LOADING OF FACILITIES

For the plant facility design, hydraulic and organic loads to the facilities are determined based on the maximum daily wastewater flow of 115,000 m^3/day or 1.332 m^3/sec. The hydraulic conditions of each secondary component facility are checked for the average and maximum daily, maximum hourly, and peak flow (wet weather) flows. The preliminary and primary treatment facilities are checked for the wet weather flow conditions. No over-topping of any structure under any condition is considered.

All piping and channels are designed to carry the maximum hourly flows, but for the preliminary and primary treatment facilities the wet weather flow is considered. The incoming pressure sewer of 1,200 mm diameter will relieve the wastewater to the influent conduit ahead of the WWTP.

1.2 FLOW DIVISION CONTROL

The plant facility design provides 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. Flow division should be measured using flow measurement devices to assure uniform loading of all unit processes and operations.

1.3 UNIT BYPASSES

A minimum of two units in the liquid treatment process train are to be provided for all unit processes and operations in the plant. The design provides for properly located and arranged bypass structures and piping so that each unit of the plant can be removed from service independently. 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.

1.4 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 which creates a smooth and non-adhering surface, thereby reducing clogging and resistance to flow.

1.5 CONSTRUCTION MATERIALS

The materials of construction and equipment shall be resistant to hydrogen sulfide and other corrosive gases, greases, oils, chemicals, and similar constituents frequently present in sewage. This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided to minimize galvanic action, and consequent corrosion.

1.6 GRADING AND LANDSCAPING

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

1.7 Plant Outfall Lines

The Braila WWTP outfall sewers will be located and designed to discharge the effluent to the Danube River through in a manner not to impair the beneficial uses of the receiving stream, providing for:

- Free fall or submerged discharge at the site; and
- Limited or complete dispersion of discharge across stream to minimize impact on aquatic life movement, and growth in the immediate reaches of the receiving stream.

The outfall structure will be so protected against the effects of floodwater, ice, or other hazards as to reasonably insure its structural stability and freedom from stoppage. The outfall line may have a safe and convenient access, preferably using a manhole, so that a sample of the effluent can be obtained at a point after the final treatment process, and before discharge to or mixing with the receiving waters.

1.8 Site Development

1.8.1 Selected Site

The WWTP site of about 16-hectare area owned by the City is located at the left bank of the Danube River. The land is relatively flat and low-lying with ground surface elevations ranging from 2.5 m to 3.5 m above M.W.L. According to the plant facility layout plan, this land area could accommodate the conventional activated sludge WWTP facilities with the treatment capacity of 115,000 m^3/day.

The surrounding areas of the plant site are agricultural land at present and in foreseeable future, and no residences exist within a distance of 2km from the site. There is a sufficient land space surrounding the site for the possible future expansion of the plant facilities.

1.8.2 Ground Preparation

The selected site is a relatively flat agricultural land with ground elevations ranging between the highest point of 5.6 m and the lowest point of 5.2 m above M.W.L. The elevation of the Danube River protection bank close to the site is at about 10 m above M.W.L. The ground elevations of the surrounding natural grounds are almost same as the site.

Because of these ground conditions, the plant site should be developed on account of the following factors:

- Prepare a flat ground surface for economical and technical reasons;
- Prevent possible mal-function of the plant operation due to the flooding;
- Provide easy access to the plant;
- Reduce the cost for earth works, e.g. excavation and backfilling; and
- Reduce pumping head requirements within the treatment plant system.

The treatment plant structures and all related equipment shall be protected from physical damage preferably by the 100-year flood. According to the record of the Danube River water surface elevations, the 100-year or 1 % probability of occurrence is 7.86 m above M.W.L. whereas that for multi-yearly elevation is 3.91 m above M.W.L.

The plant site surface elevation ranges from 5.2 to 5.6 m above M.W.L., which are lower than the 100-year flood river water surface elevation. The average ground elevation of the site or, at least around the major structures, are to be higher than 7.9 m above M.W.L.

1.8.3 Ground Elevation

The above discussions can be summarized as follows:

- Plant operation and maintenance;	No particular constraint.
- Flood prevention;	Need landfill (higher than the highest river water elevation of 5.5 m above M.W.L.).
- Reduction of earth works;	Present elevation + excess soil = 5.5 + 2.4 = 7.9 m above M.W.L.
- Pumping energy conservation;	Could be saved by providing the effluent pump station after the treatment process.

1.8.4 Site Access

Access to the site can be made through the major road, running from west toward east along the Danube River. From the major road, access road of 6 m wide is to be provided.

1.8.5 Drainage

The planned site elevation is 5.9 m above M.W.L. that is not subject to flooding. The only inundation within the site might be of stagnated stormwater. Hence, an appropriate drainage facility should be provided to handle the stormwater runoffs. Surface drainage may be of open channels or conduits installed along the edge of roads and then discharge the stormwater into the nearby drains.

1.8.6 Water Table/Soil Profiles

The groundwater table in the site is relatively high, and may affect to the deep underground structures.

2. ESSENTIAL FACILITIES

2.1 EMERGENCY POWER FACILITIES

The plant shall have an alternate source of electric or mechanical power to allow continuity of operation during power failures, including provision of at least two independent sources of power, such as feeders, grid, etc., to the plant, or power generators.

Although standby power generating capacity normally is not required for aeration equipment used in the activated sludge type processes, auxiliary power for minimum aeration of the activated sludge is required to protect downstream uses, in addition to such facilities as wastewater pumps, building lighting, chlorine contact tanks, etc.

2.2 PLANT SANITARY SYSTEM

2.2.1 Water Supply System

An adequate supply of potable water under pressure shall be provided for use in the laboratory and for general cleanliness around the plant. No piping or other connections shall exist in any part of the treatment works which, under any conditions, might cause the contamination of the potable water supply.

Potable water from the municipal supply will 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; unless a positive break at the property line is required.

Hot water for any of the above units shall not be taken directly from a boiler or piping used for supplying hot water to a sludge heat exchanger or digester heating unit.

Where a potable water supply is used for any purpose in a plant, a break tank, pressure pump, and pressure tank shall be provided. Water shall be discharged to the break tank through an air gap at least 15 cm above the maximum flood line or the spill line of the tank, whichever is higher.

2.2.2 Other Sanitary Facilities

Toilet, shower, lavatory, and locker facilities shall be provided in convenient locations to serve the expected staffing level at the plant.

2.3 FLOW MEASUREMENT

A Parshall flume should be provided after the preliminary treatment facility to continuously indicate, totalize and record volume of wastewater entering the plant in a unit time. Locations close to turbulent, surging or unbalanced flow, or a poorly distributed velocity pattern shall be avoided. Parshall flumes should be provided only in locations where free discharge conditions exists on the downstream side at the average design flow.

2.4 PLANT BYPASS

The WWTP design calls for accepting the wet weather flow of 3.241 m^3/sec. Flows in excess of this rate may be bypassed to the Danube River at the intermediate pumping station. In the flow bypass structure a broad-crested weir will be set at a calculated hydraulic grade line elevation, which will accomplish this maximum hydraulic plant loading limitation.

The plant bypass should also be constructed at the location ahead of the WWTP. Since the wastewater will be sent to the plant through wastewater lift pumping stations, the frequency of the flow exceeding 3.241 m^3/sec. is expected to be extremely low.

2.5 LABORATORY

The WWTP shall 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;
- The process control necessary for good management of each treatment process included in the design; and
- Industrial waste control or pretreatment programs.

3. PROCESS DESIGN

This section describes the geometry and specification of the process component facilities, which are to be used as a preliminary step to the detailed design.

3.1 HYDRAULIC LOADING OF COMPONENT FACILITIES

The hydraulic loading rates used for the design of the various process components are summarized as follows:

Design Hydraulic Loads of Plant Component Facilities

	Component Facilities	Maximum daily flow	Maximum hourly flow	Wet weather flow
1	Preliminary Treatment	1.332	-	(3.241)
4	Secondary Treatment	1.332	(1.621)	-
5	Chlorine tanks	1.332	-	(3.241)
6	Effluent pumping station	-	-	3.241
7	Sludge management	1.332	(1.621)	-
8	Process pipes and conduits	-	1.621	-
9	Preliminary/primary conduits	-	-	3.241

Note: Wet weather flow rates over two times the dry weather flow will be by-passed.

Figures in the parenthesis are the maximum hydraulic flow rates that the facilities can accommodate.

The secondary treatment process component facilities are checked for the hydraulic conditions of average daily, maximum daily, and maximum hourly flows, whereas hydraulic capacities of the preliminary and primary treatment facilities are designed to be able to accommodate up to twice as much the maximum hourly dry weather flow rate without hydraulic hindrance.

3.2 PRELIMINARY TREATMENT

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

3.2.1 INFLUENT GATE

Gates: At the entrance to the plant, influent gates are provided ahead of the screening facility to control or bypass the influent flows as required. The geometry of the gates is as follows:

- Number of gates: : 2 units
- Type: : Sluice gate (manually operated)
- Gate size: : 1.2 x 1.2 m
- Maximum head losses : about100 mm

Operation: The gates will be operated following the wastewater inflow rates.

3.2.2 SCREENING SYSTEM

In view of the necessity for the efficient operation of the rakes and also for reducing the hydraulic head losses in the screens, the wastewater flow velocity reaching at the channels is planned to be at around 1.0 m/sec.

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

- Number of screens : 2units
- Channel width : 1.6 m
- Clear bar spacing : 100 mm
- Slope from vertical : 60 degrees

- Maximum head losses : 100 mm

Arrangement of Screening Facility: The number of individual screening units should be such that when one unit is taken out of service for maintenance or repair, the remaining units can accommodate the additional screening load with ease. Captured screenings should be kept in closed containers until the screenings are transported to the disposal site for sanitary landfill.

Attention must be paid in the design so that drainage from the screenings is not spilled on the floors. Facilities for down washing the equipment and storage areas must also be provided. This includes appropriate floor drains and piping to return the wastewater back to the head of the plant.

Screenings Disposal: The screenings will contain organic and putrescible materials, and if not disposed of quickly, will represent an attraction and breeding ground for flies and other insects. As a minimum, screenings must be disposed of daily. All collected screenings will be dumped to one common belt conveyor and sent to a hopper for storage, then, dumped into a truck for hauling it to a sanitary landfill.

3.2.3 INFLUENT PUMPING STATION

The pumping station is of dry-well type, being separated completely from wet-wells. A special attention is given in the inflowing channel and wet-well designs to prevent grit settling in the wells.

Provision shall be made to facilitate easy removing of pumps, motors and other auxiliary equipment. Suitable safe means of access should be designed to the dry well of the pumping station, including stairways, handrails and gratings where necessary.

Adequate ventilation should be considered for the wet- and dry wells. For the pump room floor below the ground surface, mechanical ventilation is provided, so arranged as to independently ventilate the dry well. The wet-wells will be open and no mechanical ventilator will be provided.

Pump equipment and operation control: Totally eight units of pump are planned, four pumps each for the wastewater and stormwater, including two-standbys. The pumps are designed to have the same capacity and size where practicable, with the sufficient capacity for handling the flow in excess of the estimated maximum inflow. 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:

No.1 Pump Units
- Type of pumps : Vertical centrifugal mixed flow pump
- Pump diameter : 450 mm
- Pump discharge capacity: 25 m^3/min
- Total dynamic head : 11 m
- Number of pump unit : 4 units
- Motor output : 70 kW

No.2 Pump Units
- Type of pumps : Vertical centrifugal mixed flow pump
- Pump diameter : 600 mm
- Pump discharge capacity: 50 m^3/min
- Total dynamic head : 11 m
- Number of pump units : 2 units(1 standby)
- Motor output : 132 kW

No.3 Pump Units
- Type of pumps : Vertical centrifugal mixed flow pump
- Number of pumps : 2 units (1 standby)
- Pump diameter : 600 mm
- Pump discharge capacity: 50 m^3/min
- Pump total dynamic head: 11 m
- Engine output : 198 ps

Wet-wells (pump wells): The wet-well is divided into two separated compartments for the convenience of cleaning and inspection of the well. Each well is designed to have an individual wastewater inlet.

In order to prevent unnecessary vortices forming in the wells, particular considerations are to be given to the bottom slopes and arrangement of suction pipes, thereby providing optimum hydraulic condition for the pump operation.

The wet-well size is to be determined considering the required space between pumps and proper pump suction conditions. The shape of the well and the detention is determined so as to minimize deposition of solids and prevent the wastewater to become septic.

Dry-well (pump room): In the dry-well, sufficient room is to be maintained between pumps to move the pump off its base with ample clearance left over between suction and discharge piping, and room for on site repairs, inspection, or removal from the room to the surface for repairs.

The size of dry well is to be determined based on the number and type of pumps selected and piping arrangement. A sufficient space between the pumps should be taken each at the both end of the room. The width should provide a sufficient space for the required length for pipes, valves and clearance for maintenance and repairs.

All safety and other requirements are also to be implemented in accordance with local and national safety codes and regulatory agencies. Provisions should also be made for drainage from pump water seal connections.

Piping and valves: Suction, discharge and header piping in the station are sized to be handle the flows adequately. 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 side of each pump to allow proper maintenance of the unit. To the discharge pipeline, electric motor-operated butterfly valves and the check valves shall be installed to ensure the operation of each pump.

Hoisting equipment: An electric overhead bridge traveling crane will be provided in the motor room for handling of equipment and materials which cannot be lifted readily or removed from the station by manual labor.

The crane will be provided in the motor room for handling of equipment and materials, which cannot be lifted readily or removed from the station by manual labor.

3.2.4 Aerated Grit Removal

Type of Grit Chamber: Grit settled by aeration at the bottom of the grit chambers is removed by screw conveyors to the inlet of chambers and then pumped to grit separators by jet pumps. The grit is washed by water to remove organic matters contained in the grit and then discharged to another hopper by a screw discharger. The grit will be finally loaded on a truck for final disposal.

Configuration: The grit removal of the wastewater will be accomplished in 4 trains, one blower each comprising 2 grit chambers, as shown below:

- Number of units	:	4 channels
- Width	:	3 m (including 1.4 m for oil separator)
- Length	:	22 m
- Depth	:	2.35 (side depth) to 3.05 m
- Blowers	:	5 units(one-standby) x 15 m^3/min.
- Influent gates	:	4 units, 800mm x 800 mm
- Effluent gates	:	4 units, 600mm x 600 mm
- Grit hopper	:	1 unit
- Grit removers	:	2 x sand pump, grit lifting device
- Grit screw conveyors	:	2 units

Air Supply: For the total tank length of 88 m, air supply rate is 58 m^3/min. Five units (one-standby) of blowers, each with an air supply rate of 15 m^3/min., will be provided. It is important to have almost equal static head losses for all of the process aeration requirements so that air can be supplied under one common air supply pressure zone.

Grit Removal: A screw conveyor for grit removal from each chamber, together with one grit pump for each chamber, will be operated intermittently on a timer basis. The timers will be set based on operational experience.

The grit water pumps convey the grit mixed with water to the grit separator for grit removal. The removed grit will be conveyed by the grit separator screw into a hopper, which will dump the grit into a truck for hauling it to a sanitary landfill. The water collected at the grit separator will be returned to the head of the plant for further treatment.

Controls : Control of the air supply to the grit chambers will be made through valves on the air down-comer pipes leading into each chamber. The air flow to each down-comer will be set manually by the valve which is followed with a mechanical air flow meter to indicate and control equal air quantity to each chamber.

Degree of Instrumentation: The total air quantity supplied to the chambers will be indicated and transmitted to the main central room.

Data Logging: The data to be logged will be the total air flow supplied to the chambers.

Operational: The only operational control of air quantity supplied to each chamber is by setting the mechanical valves to a flow quantity rate indicated on the downstream mechanical orifice type flow meter. The total air quantity provided by the blowers to the chambers will be indicated and transmitted automatically to the main control room through an electrical signal attached to the orifice flow meter located downstream from the blowers.

3.2.5 Flow Measurement

Because of a simplicity of function and ease of operation, one set of Parshal flume (7 feet) will be installed for measurement of flows after having passed through the grit chambers.

Degree of Instrumentation: The degree of instrumentation for the flow meter is minimal. Conversion of water flow to a flow rate signal is required.

Data Logging: Records of flow rate will be logged.

3.3 PRIMARY TREATMENT

Primary treatment consists of gravity liquid/solid separation in circular clarifiers. Two clusters of the clarifiers, each consisting of clarifier modules of 4 units, thus totally 8 clarifiers will be provided.

3.3.1 Flow Distribution

The wastewater, after passing through the Parshall flume, flows down to the distribution chambers located at the center of each cluster of 4 primary clarifiers, then is distributed to each individual clarifier. The flow split is proportional to the tank surface area.

3.3.2 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 design flow of 1.332 m^3/sec. Thus, the total surface area required is calculated to be 3,384 m^2, with the effective water depth of 2.0 m.

The primary geometry is summarized as follows:

- Surface loading (at maximum daily flow) : 35 m^3/m^2/day
- Design flow rate : 115,000 m^3/day
- Surface area of each clarifier : 484 m^2
- Clarifier diameter : 35 m
- Effective water depth : 2 m
- Number of clarifiers : 4 basins
- Number of clarifier clusters : 1

Primary Sludge Production: The primary and excess sludge production (when excess sludge is returned to the primary tanks) for the daily average flow rate is 1,345 m^3/day or 0.9 m^3/min. at an average solids concentration of 2 %. For the maximum process and operational flexibility, the design will enable biological excess (excess) sludge withdrawal handling be either accomplished directly from the secondary clarifiers or from the primary clarifiers.

Sludge Pumping to Digestion Facilities: The sludge pumping cycle is based on a sludge blanket measurement. The quantity of sludge, primary plus excess sludge from the average flow have been calculated and shown as follows:

- Sludge volume : 1,345 m^3/day
- TSS : 26,890 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 then pumped to a scum drum screen for scum removal. The filtrate is returned to the plant inlet channel for further treatment. All removed scum and oil should be disposed of at the sanitary landfill. A single, common sump serves all the sedimentation tanks. The frequency of scum pumping will be determined on the basis of the scum pit level control.

Controls: The clarifiers operation is manually controlled, but scum and sludge pumps will be operated both automatically or manually. The clarifiers will be provided with a torque limit control and an alarm system.

The scum pumps in the scum pit will be operated both automatically and manually. The automatic operation will be controlled by the water surface elevations in the scum pit.

The sludge pumps will be operated by timer settling. Whether primary sludge only or primary plus excess sludge from the biological stage is pumped to the sludge drum screen and then to the digesters. The removal of sludge from the primary clarifiers will be controlled using timers. The pumping cycles will be established on the basis of operational experience.

The sludge pumping from the primary clarifiers is based on manual operation, by measuring the sludge blanket height (usually twice a day, morning and afternoon). Once the sludge blanket height has been determined, the timing cycle for sludge pumping to the digestion facilities is manually set for each clarifier.

Degree of Instrumentation: Instrumentation will be simple and consist of a report on the running time totalizer for each of the pumps. This information will be transmitted to and recorded at the central control room. Indication of the sludge scraper mechanism operation (torque alarm) will be provided at the central control station.

3.4 BIOLOGICAL TREATMENT

Biological treatment consists of aeration tanks and final clarifers.

3.4.1 Aeration Tanks

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

-	Design inflow rate	:	115,000 m^3/day or 1.332 m^3/sec
-	Average inflow BOD_5 concentration	:	195 mg/l
-	Total BOD_5	:	15,698 kg/day
-	F/M	:	0.3 kg BOD_5/kg MLVSS/d
-	MLSS	:	1,667 mg/l
-	Hydraulic detention time	:	7.3 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)

Reactor Geometry: The biological system layout will be in tank modules. The selection of aeration tank geometry is determined to make the maximum use of the available space. The reactor geometry is summarized as follows:

-	Tank width	:	5.5 m
-	Liquid depth	:	5.5 m
-	Tank length	:	76 m
-	Number of tanks	:	16 units
-	Effective tank volume	:	35,264 m^3

Flow Distribution: The design calls for maximum process flexibility. Hence, in the tank layout, a provision is made to make even flow distribution among all tanks, and ability to isolate individual tanks. The reactors are able to handle the maximum daily flow rate of 1.332 m^3/sec. plus maximum recycle flow of 50 percent based on the maximum daily flow.

Air Supply: The air requirement for the reactor tanks is calculated on the basis of 0.0903 Q(kg O_2/day). Distribution of air to the tanks expected to be even to every ditch: however, these may possibly change. Thus, the air distribution system is designed to have the ability to respond to such changes in air demand. The air delivery system will consist of air diffusers.

Dissolved Oxygen and SS Monitors: A minimum dissolved oxygen concentration of 2.0 mg/l will be maintained in the tanks. Sensors to measure the in-situ dissolved oxygen concentration will be used.

3.4.2 Final Clarifiers

Hydraulic Loading and Surface Area Requirements: The hydraulic loading rate for the clarifiers is 23 m^3/m^2/day at the maximum daily flow rate of 1.332 m^3/sec. Thus, the surface area required of each clarifier is calculated to be 1,424 m^2.

The final clarifier geometry is summarized as follows:

- Surface loading (at Q max.)	:	23 m^3/m^2/day
- Design inflow rate	:	1.332 m^3/sec
- Tank surface area	:	1,424 m^2
- Clarifier diameter	:	45 m
- Sidewater depth	:	3.5m
- Number of clarifiers	:	4 units

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

- Total SS	:	13.76 ton/day
- Sludge concentration	:	0.5 %
- Sludge volume	:	2,752 m^3/day

The excess sludge withdrawal handling will be accomplished either directly from the secondary clarifiers or through the primary clarifiers. In the latter case, the excess sludge is pumped from the clarifiers to the flow distribution chamber of each clarifier. The excess sludge settles with the primary sludge and then pumped to anaerobic sludge digesters through sludge thickeners.

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 non-clog sludge pump
- Pump diameter	:	250 mm
- Capacity	:	6 m^3/min.
- TDH	:	10 m
- Number of pumps	:	4 units
- Motor output	:	22 kW

No.2 Pumps

- Pump type	:	Centrifugal non-clog sludge pump
- Pump diameter	:	250 mm
- Capacity	:	8 m^3/min.
- TDH	:	10 m
- Number of pumps	:	7 units (5 units for additional 50 % return sludge)
- Motor output	:	30 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 non-clog sludge 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: Clarifiers will be operated manually, whereas sludge pumps will be operated both automatically or manually. The clarifiers will be provided with a torque limit control and an alarm system.

The sludge pumping from the secondary clarifiers is based on manually measuring the sludge blanket height. Once the sludge blanket height has been determined, the timing cycle for the sludge pumping to the primary clarifiers or thickener facilities is manually set for each clarifier. The pumps turn on/off sequentially based on the on off time increments for each of the clarifiers. There would be readout showing that pumps are on and the individual pump running times.

Degree of Instrumentation: Instrumentation will be simple and consist of a report on the running time totalizer for each of the pumps. This information will be transmitted to and recorded at the control room. Indication of the sludge scraper mechanism operation (torque alarm) will be provided at the control station.

3.4.3 Chlorine Contact Tanks

Chlorination System: For disinfection of the wastewater before its discharge to watercourses, the disinfection system capacity is 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). This condition must be attainable when maximum flow rates occur and during emergency conditions.

The solution chlorine disinfection system consists of contact tank, chlorination equipment, housing and storage, and ancillary services. Means of removal of solids from the tank bottom are to be provided. Skimming devices will be provided in all contact tanks.

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

- Design flow rate (Max.daily)	:	115,000 m^3/day
- Design chlorine contact time	:	15 minutes
- Hydraulic maximum flow rate	:	280,000 m^3/day (wet weather flow)
- Capacity of chlorine feed system	:	8 mg/l at the weather flow rate
- Hypochlorite feeding rate	:	19 L/min.
- Hypochlorite storage capacity	:	2 x 20 m^3 (8 days)

Duplicate disinfection systems will be provided. Where only two units are installed, each will be capable of feeding the expected maximum dosage rate.

Contact Tanks Geometry: The design aim is to minimize the short-circuiting and dead spaces through basin configuration and flow pattern control. 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 effective depth : 3 m
- Channel length : 100 m
- Tank effective volume : 2,448 m^3
- Effective water depth : 3 m

Equipment: The installed capacity of a chlorine feed system will be sufficient to provide a dosage of 3 mg/l and 8 mg/l at the maximum daily flow and the wet weather flow, respectively. The feed equipment consists 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 : 2 units

No.1 feed pumps

- Type : Diaphragm pump
- Discharge capacity : 3 L/min.
- Number of pumps : 2 units

No.2 feed pumps

- Type : Diaphragm pump
- Discharge capacity : 13 L/min.
- Number of pumps : 2 units (one standby)

Housing and Storage: Local, state and federal safety requirements, including fire code, shall be carefully followed in storing and handling of chlorine.

Ventilation: Forced, mechanical ventilation is to be installed, which will provide one complete air change per minute when the room is occupied. Adequate provisions will be made to insure that one complete air change per minute is provided when the room is occupied.

3.4.4 Effluent Pumping Station

Effluent pumping station structure is in principle the same as the influent pumping station.

Pump equipment and operation control: Totally eight units of pump are planned, four pumps each for the wastewater and stormwater, including two-standby. The pumps are designed to have the same capacity and size where practicable, with the sufficient capacity for handling the flow in excess of the estimated maximum inflow. 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:

No.1 Pump Units

Type of pumps : Vertical centrifugal mixed flow pump
Pump diameter : 450 mm
Pump discharge capacity: 25 m^3/min
Total dynamic head : 5 m

Number of pump unit : 4 units
Motor output : 32 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 : 16 m
Number of pump units : 2 units(1 standby)
Motor output : 60 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: 50 m^3/min
Pump total dynamic head: 5 m
Engine output : 90 ps

Wet-wells (pump wells): The wet-well is divided into two separated compartments for the convenience of cleaning and inspection of the well. Each well is designed to have an individual wastewater inlet.

In order to prevent unnecessary vortices forming in the wells, particular considerations are to be given to the bottom slopes and arrangement of suction pipes, thereby providing optimum hydraulic condition for the pump operation.

The wet-well size is to be determined considering the required space between pumps and proper pump suction conditions. The shape of the well and the detention is determined so as to minimize deposition of solids and prevent the wastewater to become septic.

Dry-well (pump room): In the dry-well, sufficient room is to be maintained between pumps to move the pump off its base with ample clearance left over between suction and discharge piping, and room for on site repairs, inspection, or removal from the room to the surface for repairs.

The size of dry well is to be determined based on the number and type of pumps selected and piping arrangement. A sufficient space between the pumps should be taken each at the both end of the room. The width should provide a sufficient space for the required length for pipes, valves and clearance for maintenance and repairs.

All safety and other requirements are also to be implemented in accordance with local and national safety codes and regulatory agencies. Provisions should also be made for drainage from pump water seal connections.

Piping and valves: Suction, discharge and header piping in the station are sized to be handle the flows adequately. 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 side of each pump to allow proper maintenance of the unit. To the discharge pipeline, electric motor-operated butterfly valves and the check valves shall be installed to ensure the operation of each pump.

Hoisting equipment: An electric overhead bridge traveling crane will be provided in the motor room for handling of equipment and materials which cannot be lifted readily or removed from the station by manual labor.

The crane will be provided in the motor room for handling of equipment and materials, which cannot be lifted readily or removed from the station by manual labor.

3.5 Sludge Management

3.5.1 Gravity Sludge Thickeners

Design Basis: Equipment and piping must be designed to deliver sufficient dilution water to gravity thickeners. 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 for gravity thickening are as follows:

- Average sludge production volume : 3,895 m^3/day
- Sludge withdrawal rate : 615 m^3/day
- Input sludge solids : 26.89 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 : 12 m
- Sidewater depth : 4 m
- Total tank surface area : 452 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. The drive mechanisms will be attached with a skimmer. The collected scum will be discharged into a central scum pit located at the thickeners. Tank covers and odor control systems may be considered depending on adjacent land use.

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:

Sludge pumps

- 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 sludge pumps send the sludge to the drum screen and then screened sludge flows into the sludge thickeners. All removed coarse materials will be dumped from the screen and collected in a bin that will be emptied manually into trucks and hauled to sanitary landfill for final disposal. The specifications of the drum screen are as follows:

- Type : Rotary drum screen
- Number of screen : 1 set
- Screen openings : 4mm

- Screening capacity : 2 m³/min.
- Motor output : 0.4 kW

Controls: The pickets will be provided with a torque limit control and an alarm system. Sludge pumps will be operated using on/off pump controls and timers. The sludge blanket height will be determined manually. Flow rate of dilution water when used will be measured and recorded.

3.5.2 Anaerobic Digestion Tanks

Digestion Process: Active digestion, concentration and storage will undergo in 4 single stage anaerobic digestion tanks. There will be two clusters each consisting of 2 digestion tanks. Mechanical mixing system, heating and gas collection systems will be provided in each of the tanks.

Thickened sludge in the sludge thickeners will be pumped to the digestion tanks. The digested sludge will be drawn by gravity to the storage tanks in the sludge dewatering building. The produced gas will be led to gas holders after passing through gas scrubbers.

Design Basis: The digestion tank capacity is determined based on the following factors:

- Input sludge solids : 21.51 t/day
- Sludge input : 615 m³/day
- Sludge output : 466 m³/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 total tank capacity : 14,013 m³

Tank Geometry: The tank shape will be high vertical cylinder with conical floors. The digester tank capacity is calculated based on the estimated sludge production in 2010. The total number of anaerobic digestion tanks required is 4 tanks in two clusters, with the same capacity and configuration. Tank dimensions are as follows:

- Tank shape : Single stage, high vertical cylinder with conical floor
- Tank capacity : 3,503 m³
- Tank diameter : 15.0 m
- Tank effective water depth : 26.0 m

Sludge Inlets and Outlets: Recirculation, withdrawal and return points, should be provided, to enhance flexible operation and effective mixing. The returns will be discharged above the liquid level and be located near the center of the tank. Raw sludge feed to the digesters will be made either through heat exhangers or directly to the tank.

Sludge withdrawal to dewatering system and disposal will be from the bottom of the tank. This pipe should be interconnected with the recirculation piping, to increase versatility in mixing the tank contents. Additional alternative withdrawal lines will be provided.

Sampling: Sampling hatches should be provided in all tank covers with water seal tubes extending to beneath the liquid surface.

Mixing Systems: Sludge mixing systems should be mechanical recirculation type. The mixing system shall be designed such that routine maintenance can be performed without taking the digester out of service.

3.5.3 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, shall be so designed that under normal operating conditions, including sludge withdrawal, the gas shall be maintained under positive pressure. All enclosed areas where any gas leakage might occur shall be adequately ventilated. Gas meters, with by-pass, should be provided to meter total and waste gas production.

All safety equipment shall be provided where gas is produced. Pressure and vacuum relief valves, flame traps, gas detectors, and automatic safety shut off valves, shall be provided.

Gas Utilization Equipment: Gas-fired boilers for heating digesters will be located in a separate room not directly connected to the digester gallery. Gas lines to these units will be provided with flame traps. 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. Digester galleries will be isolated from normal operating areas to avoid an extension of the hazardous location.

Waste Gas: Waste gas burners should be readily accessible and be located at least 8 meters away from any plant structure if placed at ground level.

All waste gas burners shall be equipped with automatic ignition, such as a pilot light or a device using a photoelectric cell sensor. Necessary approvals from the local authorities concerned are to be obtained for burning any waste gas and any other emissions from the treatment plant.

Any underground enclosures connecting with digesters or containing sludge or gas piping or equipment shall be forced ventilated. The piping gallery for digesters should not be connected to other passages.

Digester Heating: Digesters will be constructed above ground water level and suitably insulated to minimize heat loss.

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 should be made in the layout of the piping and valving to facilitate cleaning of these lines. Heat exchanger sludge piping should be sized for heat transfer requirements.

The boiler 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. Thermometers will be provided to show temperatures of the sludge, hot water feed, hot water return, and boiler water.

Access Manholes: At least two 90-cm diameter access manholes shall be provided in the top of the tank in addition to the gas dome. There should be stairways to reach the access manholes. A separate sidewall manhole will be provided.

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. Nonsparking tools, safety lights, rubber-soled shoes, safety harness, gas detectors for inflammable and toxic gases, and at least two self-contained breathing units should be provided for emergency use.

3.5.4 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. Waste gas burners will be provided to be used in case the gas boilers malfunction. The gas production is estimated assuming that 70 % of the input solid components are biodegradable organic materials, 1 kg of which produces 0.425 m^3 of sludge gas. Thus, the total daily gas production is estimated to be 10,999 m^3. The gas holders will have the minimum gas storage capacity of 8-hour gas production. The geometry of the gas is as follows:

- Type : Dry seal gas holder (membrane seal type)
- Number of units : 2
- Diameter : 12.6 m
- Height : 13.3 m
- Capacity : 1,000 m^3

3.5.5 Belt Filter Press Sludge Dewatering

The daily digested sludge of 801 m^3 is drawn by gravity into the storage tanks located in the dewatering building. The digested sludge production rate and the required dewatering equipment are as summarized in the following:

- Total digested sludge production : 466 m^3/day
- Total sludge solids : 13.98 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 : 3,263 kg/hr.
- Required filter press equipment : 8 units

Compositions and Functions: An air cylinder operated eccentric valve will be installed on the line between the digester and the storage tank. 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, wherein the polymer is mixed with the sludge. For this use, dry polymer is stored in hoppers, and led into dosage tanks by metering feeders and stored in the dosage tanks. The polymer system should have units of motorized hoist for unloading chemicals from trucks.

The dewatered sludge (sludge cake) is conveyed to a cake yard with trough belt-conveyors. The filtrate, together with belt filter cleansing wastewater, is returned to the process wastewater storage tanks by gravity and then pumped to the inlet of the screen chamber by process wastes return pumps. A manually operated overhead crane should be provided in the building for dismantling and repairing the dewatering equipment.

3.5.6 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.

3.6 Layout of Facilities

Lists of equipment are summarized in *Table AII.3.1*. Main structures of the WWTP, such as primary sedimentation tank, aeration tank, final sedimentation tank, sludge thickener, sludge digester, grit chamber and oil separator, chlorination chamber, screening & pumping station, and effluent pumping station are shown in *Figure AII.4.1* to *AII.4.9*. The structures and the layout of facilities are designed based on the design basis described above and the actual site conditions.

4. Electrical, Instrumentation and Control Facilities

This section describes the purpose, functions and outline of the major electrical equipment, instrumentation and control works. The numbers, shapes, sizes, and brief specifications of the equipment described here are for the preliminary engineering purpose, and may be subject to minor changes at the detailed design stage. The numbers, sizes and motor outputs of the equipment are listed in *Table AII.3.1*.

4.1 General

The basic requirements for the electrical, instrumentation and control equipment at the wastewater treatment plant are adequacy, reliability and safety. 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.

Safety involves the protection of plant personnel as well as the safeguarding of equipment under all conditions of operation and maintenance.

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 generation of power from wastewater gas production will be economical if the power is effectively utilized for the plant operation or other purposes.

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

4.2 Electric Power Facility

4.2.1 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.

4.2.2 Power Requirements of the WWTP:

As described in some detail in *Table AII.3.1 "Braila WWTP, List of Mechanical Equipment,* the WWTP mechanical equipment require the maximum electric power supply of 2,050 kW, excluding standby equipment. The electric power requirements by the process are as summarized in the following:

No	Process	Equipment	Motor outputs(kW)	Remarks
1.	Screens	Mechanical screens/auxiliary equipment	0	Standbys excluded
2.	Grit chambers	Blowers	232.0	"
3.	Influent pumps	Pumps, valves	421.1	"
4.	Primary clarifiers	Scrapers, sludge pumps	11.2	"
5.	Aeration tanks	Included in Item 11	0	"
6.	Final clarifiers	Scrapers, sludge pumps,	316.6	"
7.	Chlorine contact tanks	Chemical supply pumps	1.2	"
8.	Sludge thickeners	Scrapers, sludge pumps, valves, screen	32.8	"
9.	Sludge digestion tanks	Mixers, pumps, valves, heaters, fans, blowers	201.2	"
10.	Sludge dewatering	Belt filters, conveyors, pumps, hoists, auxiliaries	193.6	"
11.	Aeration tank blowers	Blower, filters, cranes,	443.2	"
12.	Effluent pumps	Pumps, valves	197.1	"
	Total power requirements		2,050.0	kW

4.2.3 Power Generator

An emergency electric power generator of minimum 500 kW will be provided. 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..

4.2.4 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.

4.2.5 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 throughout the detailed design stage of this project.

4.3 INSTRUMENTATION

4.3.1 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.

4.3.2 Major Monitoring Instrument

Major equipment to be installed are summarized below: Each equipment has an indication meter, an alarm, etc.

- Water level in entrance chamber ; Suspended type level meter
- Gates opening at influent chamber, screen and grit chambers, primary bypass gates, and plant effluent gate ; Potentionmeters
- Primary settling tank, incoming flow ; Ultrasonic flow meters
- Primary sludge flow ; Electro-magnetic flow meters
- Receiving water level at plant effluent gate box ; Suspended type level meter
- Dissolved oxygen at aeration tanks ; DO meters, air flow meters
- Secondary sludge flow ; Electromagnetic flow meter
- Digestion tank temperature ; Thermo-coil
- Digester outlet gas flow ; Orifice flowmeter
- Generator/Heater gas flow ; Orifice flowmeter
- Digested sludge flow ; Electromagnetic flowmeter
- Feed sludge/polymer dosage flow ; Electromagnetic
- Sludge tank/dosage tank level ; Bubble tube level meter
- Thickened sludge flow to digesters ; Electromagnetic flowmeter
- Biogas flow rate to gas heaters ; Orifice flow meter
- Temperature digester return water basin temperature and hot water basin temperature (outlet water from engine generators) ; Thermocoil

4.3.3 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

4.3.4 Local Instrumentation/Control Station

The local instrumentation/control station will provide a monitoring/control point for each process equipment in the event of computer failure, data highway failure, etc. These will be four local instrumentation/control panels, one for each of the following areas:

- Preliminary treatment facility;
- Primary treatment facility;
- Secondary treatment facility;
- Sludge digestion facility;
- Sludge dewatering facility; and
- Power generating facility.

Equipment control, status indication, alarm conditions, indication of measured quantities of process variables, equipment runtime, etc. will be hand wired to the aforementioned local panels as back-up plant operating and monitoring station. Instrumentation/control panels will be located in the electrical room of the respective plant process control building.

The electrical rooms will be environmentally controlled for equipment protection. Local instrumentation/control cabinet will also house the individual instrument loop power supply unit.

4.3.5 Local Process Control Units (Programmable Logic Controllers)

Programmable Logic Controllers, hereinafter named as PLC,will be utilized as the interfacing/control means with field equipment. The PLC technology is adopted for several logical reasons, one of which is the minimum amount of closed loop control required for this plant as well as the rapid development /enhancements made to today's PLC's in comparison to the distributed process controller technology.

Each PLC with its respective I/O's, power supply, etc. will be housed in a separate cabinet independent of any other local control and/or local instrument panel. The design concept derives the installation of one PLC unit or PLC with hot back-up (as applicable) in the following areas:

- Primary treatment facility (single PLC unit);
- Secondary treatment (single PLC unit);
- Sludge digestion facility (single PLC unit);
- Sludge dewatering facility (single PLC unit);
- On-site power generating facility (single PLC unit); and
- Central control room in administration building (PLC unit with hot back-up).

4.3.6 MIMIC Panels (Hard Graphics)

MIMIC panels will be installation (Digital meters) of selected measured process variables (crucial variables) as depicted by the process and/or process design engineers. The foregoing indicating devices/instruments, etc. will be driven by the I/O modules of the PLC installed in the administration building. However, each MIMIC panel will be interfaced with its own utility (one panel).

Adequate speed is necessary to improve and insure proper response time, rapid overall dynamic data update, avoid network crashes, adequate service of host computer to each local processing unit, considerable reduction of CPU halt-time and interrupts of the host computer thereby utilizing execution time of the utility in terms of length of runs (Considerably less restriction associated with length of highway), higher communication speed, lower in cost including cost impact on PLC's and installation cost relative to any other highway.

4.3.7 Historical Data Retrieval

Utilizing historical data retrieval unit will assist plant engineers, laboratory personnel, operating/ maintenance personnel considerably. Row and/or manipulated data will be automatically transferred from the hand disc to the historical data retrieval unit.

Additionally, automatic filing system will be adopted. Actual size of this unit will be determined based on real time capacity required by the system with consideration given to additional space for crunched data, manually entered data, etc.

4.3.8 Work Stations

A single engineering/report generating station will also be installed in the Central Control Room. The operator's workstation will mainly be utilized for plant graphics, equipment control, a point of monitoring live/dynamic/station data, alarms, etc. All events historical data retrieval unit and the hard disc drives.

Equipment will be installed on computer grade furniture. The engineering workstations will mainly be used for reports, trending, manual data entry, engineering computations, etc. The third engineering/report generating workstation will be installed in the plant's superintendent's office.

Emergency lighting will consist of emergency lighting for the required minimum illumination and the guiding lamps. Battery supplied D.C. power is suitable for the power source until the plant gas generator is on.

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 located adjacent to the equipment. The control panel will be equipped with switches for operation.

5. MAJOR PLANT BUILDINGS AND UTILITY SERVICES

5.1 General Layout

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

The garden with vegetation, which along with the shape of the administrative building, contributes to the control of odors coming from the processes buildings.

All the buildings will be of one story type but some of them have double height ceiling as required for the functional and mechanical needs included in that building.

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. Only authorized personnel may visit the plant. For vehicles of inspection or visits to the plant, a parking area with the fiberglass type will be provided.

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.

The workers and administrative buildings are to be separated from other buildings, surrounded by roads and communicated with the outside by an entrance. Shrubs and trees should be planted in front of these buildings to help control odor dispersion.

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, lighting from 300 to 400 lx. with necessary lockers, desks and chairs.

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. Lighting from 400 to 600 Lx, including electric room which is separated by a partition.

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. Lighting is 200 Lx. Rooms separated by partitions for tools storage, welding works, electric works, etc.

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.

5.3 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. A total of four soil test borings, each 30 m deep, were performed within the site in addition to the neighboring area.

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.

Such recommendations refer to excavation systems, control of groundwater, foundation levels, inclination of slope, coefficient of lateral pressure, bearing capacity, expected settlements, and all aspects that should be considered in the design and construction of the treatment plant facilities.

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).

The Field Survey was still on going at the time this Report was prepared and that these are subject to change later on when the results are obtained.

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.

Loads: The following loads shall be considered for the structural design, if applicable:

- Subpressure of groundwater level.
- Lateral earth pressure.
- Hydrostatic lateral pressure.
- Seismic loads - winds.
- Forces due to temperature.
- Forces due to differential in humidity.
- Curing.
- Differential settlements.
- Dead loads.
- Live loads.
- Movable equipment.
- Stationary equipment.

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.

Design: 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.

Materials: 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.

5.4 PRINCIPAL PLANT FACILITIES

5.4.1 Storm Drainage System

The planned site elevation is 9.7 m above M.W.L. and the site is not subject to 100-year flooding. The only inundation within the site might be of stagnated stormwater. Hence, an appropriate drainage facility should be provided to handle the stormwater runoffs. Surface drainage may be of open channels or conduits installed along the edge of roads and then discharge the stormwater into nearby drains.

5.4.2 Water Supply System

The public water supply distribution system is available for the treatment plant water system. However, to secure stable clean water supply to be used for the process a supplemental new well may be dug.

5.4.3 Sanitary System

Wastewater resulting from public health water usage will be drained into the sewer located within the plant site.

5.4.4 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.

5.4.5 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.

Shallow rooted small shrubs should be planted at areas where pipe systems exist, to avoid possible damages. This will eliminate clogging and damaging of the pipes.

The use of small trees around roads and buildings help to give a human scale to the project because structures are usually high.

5.4.6 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.

5.4.7 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 BUILDING UTILITIES

5.5.1 General Requirements

Systems to be considered for the buildings are:

- Ventilation systems to ensure personnel comfort and control of odors;
- Air-conditioning systems to maintain personnel comfort and the best conditions for the electrical and electronic equipment;
- Sanitary and drainage systems;
- Potable water supply system and hot water;
- Storm drainage systems from roof areas;
- Fire protection systems; and
- Ventilation systems to maintain the best conditions of the mechanical rooms.

5.5.2 Design Basis and Criteria

The buildings shall be generally designed based on the following criteria except those that require special considerations:

Indoor Design Parameters

- Offices, Control and Electrical Room		
Temperature	:	20~25 ℃
- Humidity	:	50~55 %
- Machine Rooms		
Maximum temperature	:	35℃
- Ventilation.		

Air Changes

- Machine rooms	:	4 to 6 changes/hour
- Work shops	:	5 to 10 changes/hour
- Store rooms	:	4 to 6 changes/hour
- Rest rooms and blower building	:	3 to 6 changes/hour

Outdoor Design Parameters

- Temperature		
Maximum temperature	:	40.5 ℃
Minimum temperature	:	-26.5 ℃
Average temperature	:	11 ℃
- Precipitation	:	726 mm/year (average)
	:	204 mm/month in October

5.5.3 Specific Building Systems

Office Building: Air conditioning may be provided through a central air handling unit.

Wash room area may have exhaust fans. Plumbing systems shall include domestic water supply and sanitary systems.

Roof drainage should be connected to the surface drainage system which discharges flows into the drainage system in the plant site.

Maintenance and Storage Building: This building will have exhaust fans for ventilation. The maximum allowable indoor temperature may be 35℃.

Generator Building: Roof and sanitary drainage systems should be provided. Forced inlet air and forced air exhaust systems should used for this building.

Pumping Station: Roof and sanitary drainage systems and potable water supply system shall be provided. Portable hand extinguishers for fire protection are to be provided. Forced exhaust air shall be provided at this building.

Aerated Grit Chamber Blower Room: Roof and sanitary drainage and potable water supply systems shall be provided. Portable hand extinguishers for fire protection will be provided. Natural ventilation shall be used.

5.5.4 Natural Conditions

Temperature: Highest, minimum and average temperatures in Braila City area are as follows:

- Highest monthly average temperature (July) : 23.1 ℃
- Lowest monthly average temperature (January) : 2.3 ℃
- Annual average temperature : 11.0 ℃

Humidity: Average humidity in summer is 60 %, at 2.00 p.m. and about 70 % in the littoral zone.

Wind: Predominant local wind direction is northeast to southwest. The average frequencies of such wind are from 25.4 to 28.4 % at an average velocity of 20 m/sec.