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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF DEVELOPMENT,
NEW COMMUNITIES, HOUSING AND PUBLIC UTILITIES
ARAB REPUBLIC OF EGYPT

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3.8 SEWERAGE SYSTEM

3.8.1 Design Concept

(1) Purpose of Sewerage System

The purpose of sewerage system construction in this Project Area are conceived as follows.

a. The water quality preservation of the public water area (Suez Bay).

The wastewater generated in the Project Areas is estimated to be about 51,900 m^3/day (Average Daily). The wastewater, the potential threat to the water environment, have to be properly managed so as not to cause adverse impact on the water quality of the receiving water body (Suez Bay).

The sewerage systems is recommended as the technically sound measure for managing wastewaters thus protecting water environment from pollution.

b. To develop clean and safe sanitary condition of the living and working environment.

As a result public health is secured, basic need for urban community is fulfilled and the amenity of urban life is preserved.

c. To establish effective and economical wastewater management system.

By adopting the sewerage system, where all wastewater are collected and conveyed to the single treatment plant, which is a centralized system, wastewater could be handled more effectively and economically as compared with decentralized system (each factory treats it's own wastewater individually).

The proposed centralized systems with it's systematic collection pipes and concentrated treatment process conserve the possibility of reuse of treated effluents, whenever feasible.

The wastewater from each factory must comply with the standards designated by the Egyptian Law No. 93 for 1962 - 1989, which regulates industrial effluents.

Factories must introduce pre-treatment processes before discharging effluents to public sewer if their water qualities do not meet the standards specified by the above mentioned law. (See Figure 3.8-2-1)

(2) Service Area

The area to be covered by the sewerage system including industrial and residential areas are as follows and as shown in Figure 3.8-1-1.

<u>Project Area</u>			
Ataqa I.E. West and East	:	294	ha
Ataqa I.E. Coastal	:	61	ha
Adabiya I.F.Z.	:	58	ha
Wastewater Treatment Plant	:	4.5	ha
Center A	:	2.1	ha
Center B	:	9.2	ha
Center C	:	8.3	ha
<u>Future Expansion Area</u>			
Residential Area	:	132	ha
Expansion Area of Ataqa I.E.	:	106	ha
Total Service Area		**675.1**	**ha**

(3) Sewerage System

Based on the local practices in sewerage systems, the rainfall-runoff is to be drained into the wastewater pipe. Therefore the sewerage system being employed for this project is a combined system.

The industrial wastewater will be conveyed to the Wastewater Treatment Plant (hereinafter called WWTP) in Adabiya about two (2) kilometers south of the project area. The treated effluent will be transported by gravity to the coast of the Suez Bay and eventually discharged into the Bay. Location of the outfall of treated wastewater from wastewater treatment plant is shown in Figure 3.8-1-2.

The results of the water quality simulation analysis shows that discharge of the treated wastewater at the point mentioned above, is acceptable, from the view-point of water pollution control.

* Refer to the Final Report, Chapter 3.12 "The Environmental Impact Analysis"

The domestic sewage from the residential area will be pumped up to the US-AID wastewater treatment plant located to the north of the project after it collection.

The sewerage system diagram is shown in Figure 3.8-1-3.

(4) Design Capacity of the Sewerage

The design quantity of the wastewater is determined on the basis of the design criteria (NOPWASD) stating that the average wastewater production is usually 80 % of the average water consumption.

Although a combined system is being used, the flow rate of rainfall-runoff is not incorporated into the design capacity. Since it is not necessary based on the local practices, and the capacity of the WWTP need not be increased.

(5) Consideration Reuse of Treated Wastewaters

The feasibility of reuse of treated wastewater effluent could be studied only after the inflow rate of the treatment plant has reached the design level and the treated effluent quality, which is the basic data concerned to reuse, could be analyzed and determined to a reasonable degree.

Therefore, reuse of treated wastewater effluent is left for future consideration. In this Project it is considered as follows:

If the reuse of treated effluents or the improvement of effluents quality becomes necessary, filter equipment can be installed.

An area for the sand filter process has been set aside and the water levels of related processes have been planned taking into consideration possible future connection to the filter.

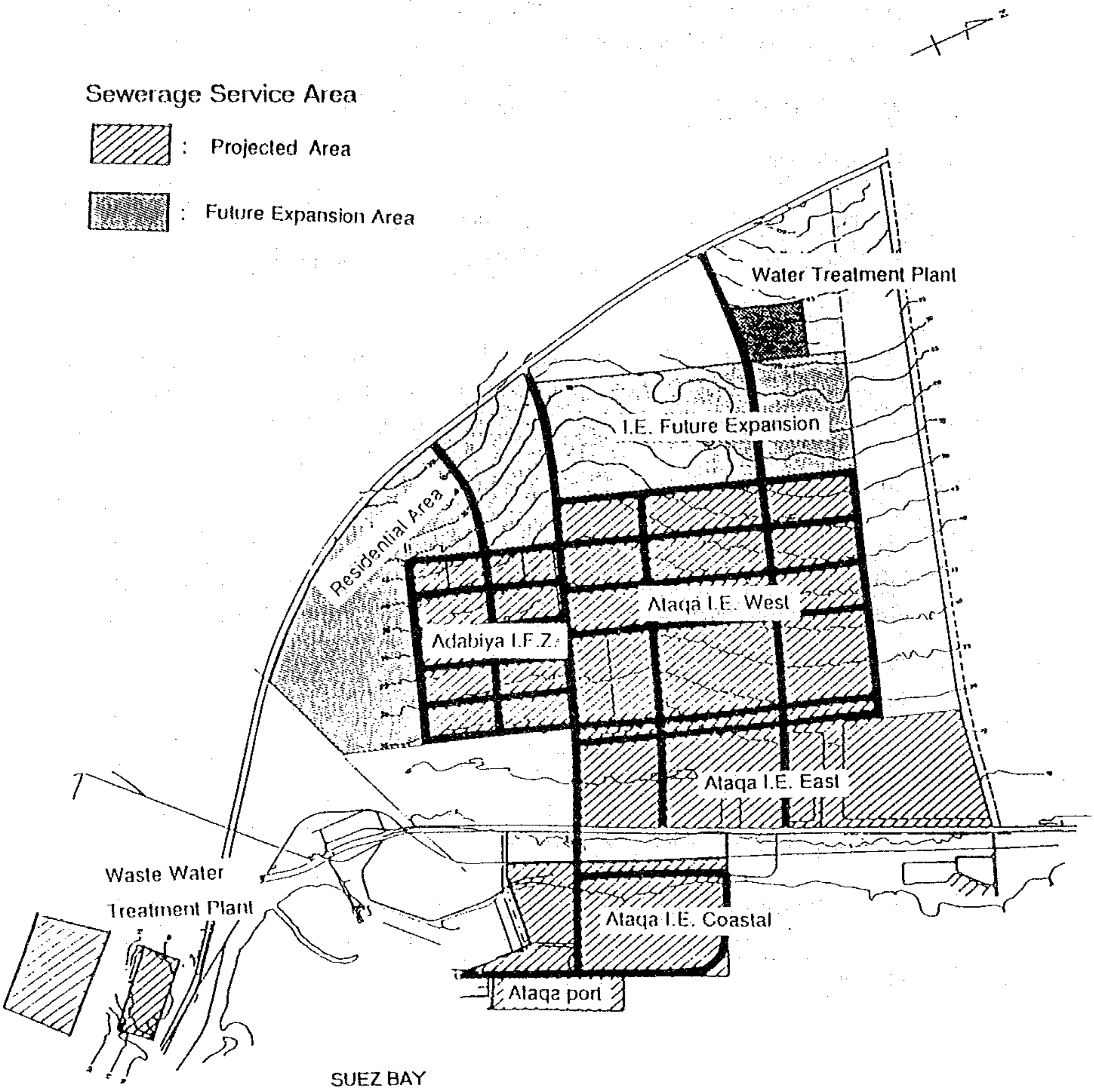


Figure 3.8-1-1 Sewerage Service Area

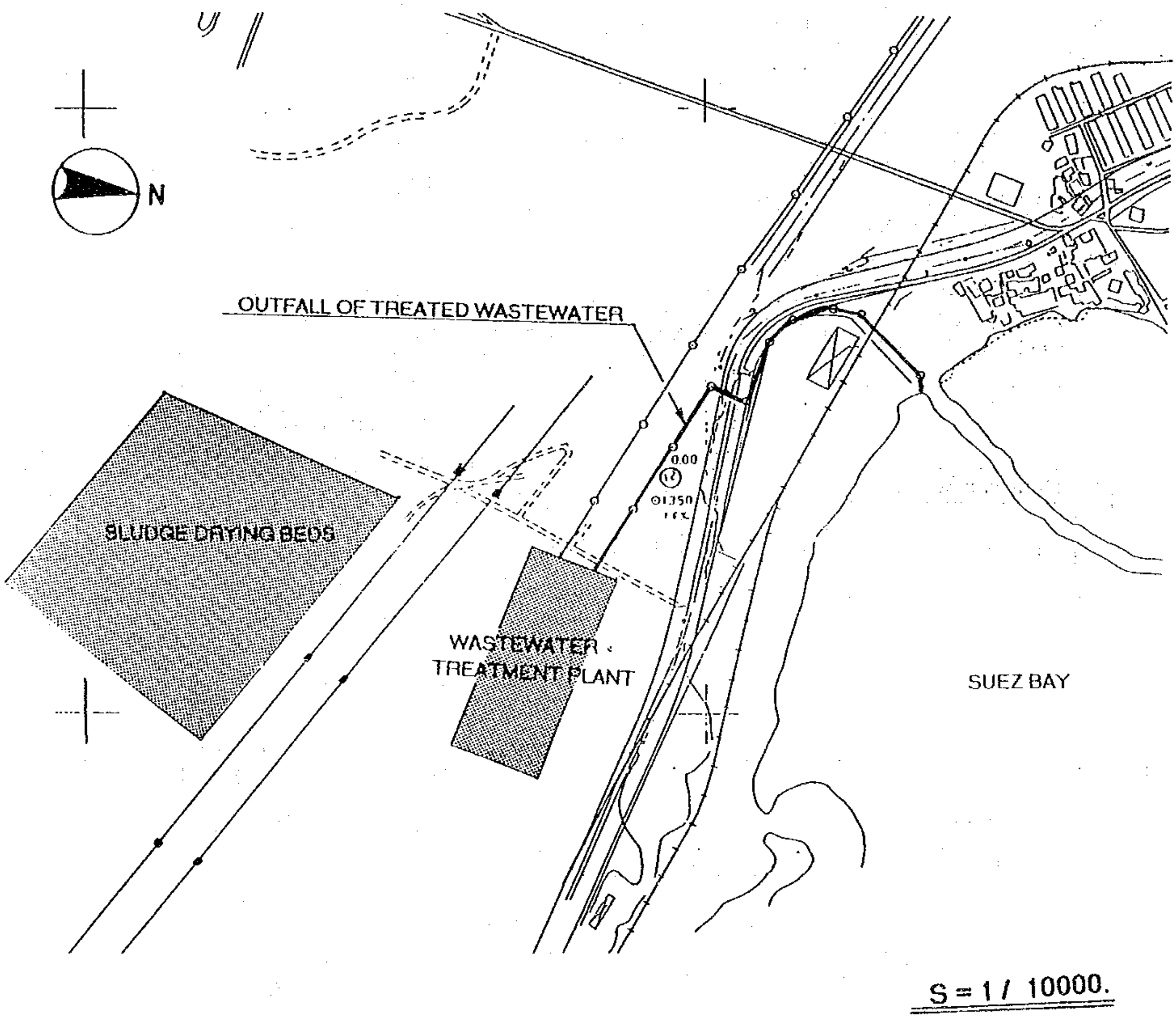


Figure 3.8-1-2 Location of the Outfall of Treated Wastewater from Wastewater Treatment Plant

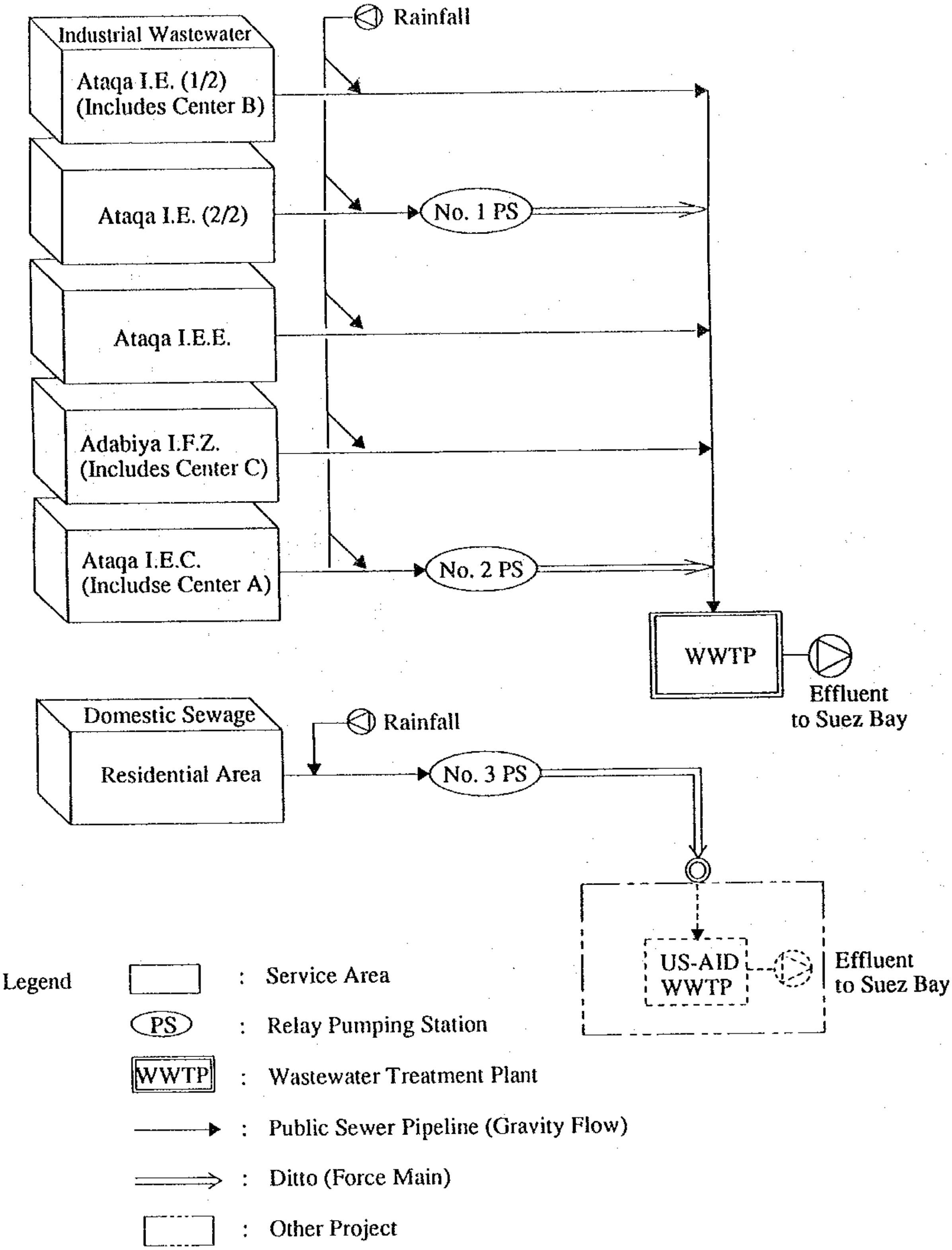


Figure 3.8-1-3 Sewerage System Diagram

3.8.2 Design Conditions and Criteria

(1) Legislation Codes and Criteria

In Egypt, legislation pertinent to wastewater are mainly relevant to the disposal of wastewater from various establishments to public sewers , watercourses, and/or to cultivable lands.

(a) The law No. 93 for 1962 - 1989

Standards and specifications which should be fulfilled by wastewater, which are licensed to be drained into public sewers from public, commercial, or industrial places, are given by this law and its executive regulations. Also, standards and specifications that should be fulfilled by wastewater to be drained by surface irrigation, or by irrigating cultivable lands are prescribed in the executive regulations of this law. The article which were defining watercourses and regulating the dispose of wastewater into them have been deleted from this law by the declaration of the law No. 48 for 1982.

(b) The law No. 48 for 1982

The declaration of this law is intended to protect of the river Nile and waterways from pollution. It regulates and specifies the standards that should be met by wastewater licensed to be drained into watercourses defined by this law. Consequently, NOPWASD wastewater system design criteria. (Annex (1) to Report CG-12 Wastewater System Design Criteria-Final Report" NOPWASD, November 1990) specifies that wastewater treatment plants disposing of their effluents to water courses shall be designed to meet the requirements of the law No. 48 for 1982, on effluent limitations.

In both Laws, the Ministry of Health (MOH) and its organizations have been designated as the official authorities to carry out in their laboratories; analysis of samples taken from either wastewater licensed to be drained into public sewers, (according to law 93/1962), or from wastewater licensed to be drained into public sewers, (according to the law 48/1962).

A schematic diagram showing the checking points of wastewater qualities through a sewerage system, according to the laws mentioned above, is given in Figure 3.8-1-2-1.

(c) The Egyptian Code of Practice for the design and construction of pipelines for water supply and sanitary drainage nets.

This Code was issued by the ministerial decree No. 286 for 1990 by the Minister of Development, New Communities and Housing and Public Utilities. As it is clear from its title, the code is mainly concerned with the design and construction of pipelines an their accessories.

(d) The National Organization for Potable Water and Sanitary Drainage (NOPWASD) Design Criteria.

This criteria was an outcome of the project titled "Water and Wastewater Institutional Support Project" (WWISP), which was performed under the USAID Project. The final report of the project (The Criteria); written in English will be available for distribution or sale to design consultants in Egypt. NOPWASD has already used it, and it is known as NOPWASD's criteria. However, the criteria should be considered as a starting point.

Regarding locations of wastewater treatment plants, no guidelines have been mentioned in the above materials. However through discussions with MODANC Technical Committee, it was understood that: in Egypt it is a common practice to locate wastewater treatment plants apart from any urban community with a distance ranges from 500 m to 2.5 km depending on the types of treatment of treatment processes used in the plant.

MOH: Ministry of Health

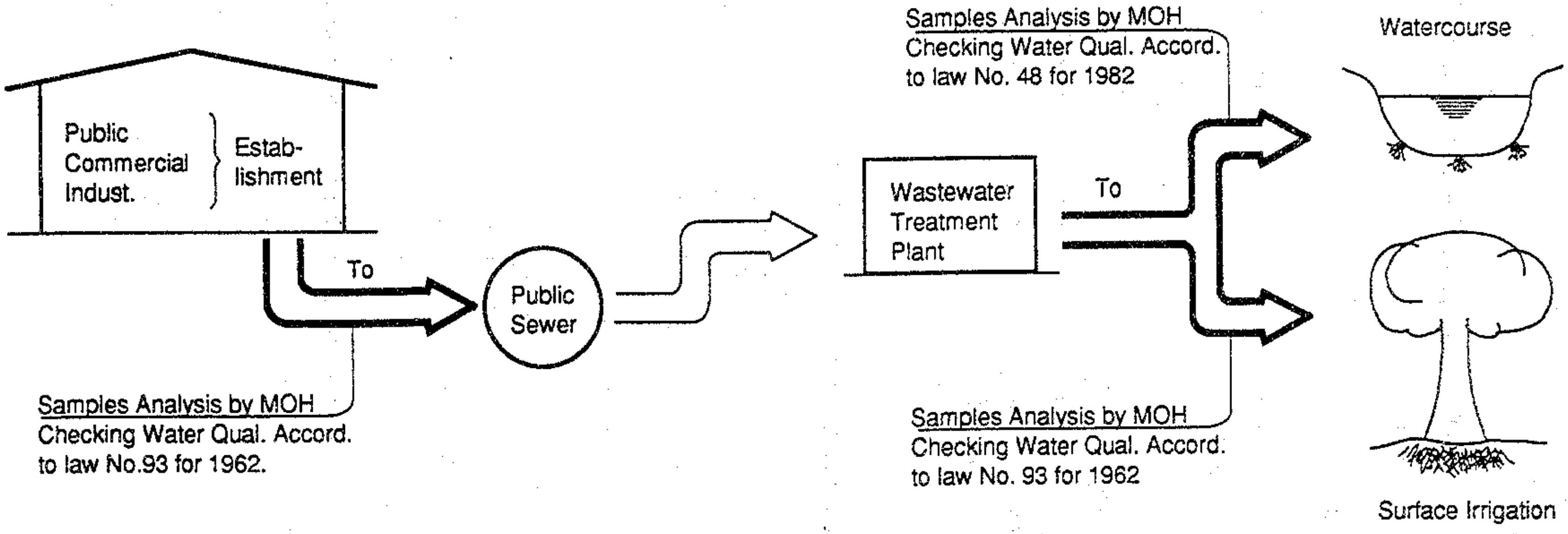


Figure 3.8-2-1 A schematic Diagram showing Checking Locations of Wastewater Quality in a Sewerage System

(2) Wastewater Characteristics

(a) Kind of Wastewater

The kind of wastewater to be treated and the drainage pattern into the sewer in this project are described below:

1) Industrial wastewater

Industrial wastewater means wastewater from industrial complexes, such as Ataqa I.E., Ataqa I.E.C, Ataqa I.E.E, Adabiya I.F.Z, Ataqa Port, and center areas A, B and C.

Industrial wastewater must be treated in each plant (wastewater source) to reach the water quality stipulated by Egyptian Law 93 before being drained into the sewer (i.e., the wastewater source must treat it to reach the water quality stipulated by Law 93).

2) Domestic sewage

Domestic sewage is that from the residential area with a population of 35,000.

After collection in the sewer, domestic sewage is pumped by the relay pumping station to the US-AID sewage treatment plant (a different project) which is located to the north of this project area.

(b) Quantity and Quality of Wastewater

Tables 3.8-2-1 and 3.8-2-2 show the quantity and quality of industrial wastewater and domestic sewage. Tables 3.8-2-5 and 3.8-2-6 show more detailed values for the quantity and quality of industrial wastewater and domestic sewage.

Detailed estimation of wastewater quantities and qualities are given in Appendix 3.8-1.

Table 3.8-2-1 Wastewater Quantities

Item \ Kind of Wastewater	Industrial Wastewater	Domestic Sewage
1. Average Daily	46,500 (m^3/d)	5,400 (m^3/d)
2. Maximum Daily	55,800 (m^3/d)	7,020 (m^3/d)
3. Peak Hourly	3,875 (m^3/hr)	450 (m^3/hr)

Table 3.8-2-2 Wastewater Qualities

Item \ Kind of Wastewater	Industrial Wastewater	Domestic Sewage
1. PH	6 to 10	6 to 9
2. BOD	330 mg/l	280 mg/l
3. COD	280 mg/l*-1	580 mg/l*-2
4. SS	380 mg/l	400 mg/l

*-1 COD measured using potassium permanganate method.

*-2 COD measured using dichromate method.

Table 3.8-2-3 shows the actual survey data of industrial wastewater qualities in Cairo.

Table 3.8-2-3 Actual Survey Data of Industrial Wastewater

Item	Wastewater Qualities		
	Average	Minimum	Maximum
1. BOD	396 mg/l	200 mg/l	660 mg/l
2. SS	509 mg/l	256 mg/l	1,068 mg/l

The above data was obtained from MODANC, in August, 1992

(c) Quality of Treated Industrial Wastewater

Table 3.8-2-4 shows the quality of treated industrial wastewater from the wastewater treatment plant.

In Egypt, industrial effluent to public sewer is not allowed unless it does meet the regulations specified by the Egyptian law No. 93 for 1962.

The qualities of treated industrial wastewater can be obtained when the raw wastewater qualities conform the values shown in Table 3.8-2-2.

Table 3.8-2-4 Treated Industrial Wastewater Qualities

Item		Qualities
PH	(-)	6 to 9
BOD	(mg/l)	less than 20
COD *-1	(mg/l)	less than 50
SS	(mg/l)	less than 50
OIL [mineral]	(mg/l)	less than 5
OIL [Animal & Vegetable]	(mg/l)	less than 30
Coliforms	(MPN/100 ml)	less than 3,000

*-1 COD measured using potassium permanganate method.

Table 3.8-2-5 Quantity and Quality of Industrial Wastewater

Industry	Quantity (Avg. Daily)	Quality						
		PH	BOD		COD*		SS	
	m³/day	-	mg/l	kg/day	mg/l	kg/day	mg/l	kg/day
1. Ataqa I.E. and Adabiya I.F.Z								
1) Food	2,400	6 to 10	400	960	310	744	340	816
2) Wood Products	2,400	6 to 10	100	240	280	672	120	288
3) Plastic	1,890	6 to 10	390	738	340	643	90	171
4) Paper Products	2,140	6 to 10	400	856	200	428	390	835
5) Spinning & Waving	5,310	6 to 10	400	2,124	260	1,381	230	1,222
6) Electrical	4,370	6 to 10	240	1,049	170	743	500	2,185
7) Mechanical & Metal ind.	1,630	6 to 10	280	457	280	457	300	489
8) Building Materials	5,060	6 to 10	270	1,367	50	253	500	2,530
9) Chemicals & Pharmaceutic	3,000	6 to 10	400	1,200	400	1,200	500	1,500
10) Others	6,420	6 to 10	400	2,568	480	3,082	500	3,210
Sub-Total	34,620	6 to 10	334	11,559	278	9,603	383	13,246
2. Ataqa I.E. Expansion Area	10,280	6 to 10	334	3,434	278	2,858	383	3,938
3. Ataqa Port	1,400	6 to 10	200	280	180	252	250	350
4. Commercial & Public Use	200	6 to 10	200	40	180	36	250	50
Total	46,500	6 to 10	330	15,313	280	12,749	380	17,584

*: COD measured using potassium permanganete method.

Table 3.8-2-6 Quantity and Quality of Domestic Sewage

Quantity (Avg. Daily)	Quality						
	PH	BOD		SS		COD*	
m³/day	-	mg/l	kg/day	mg/l	kg/day	mg/l	kg/day
5,400	6 to 9	280	1,490	400	2,128	580	3,086

* COD measured using dichromate method.

(3) Common Conditions :

(a) Mechanical works

For the criteria concerning the wastewater treatment plant and relay pumping station, the "Wastewater System Design Criteria (Nov., 1990)" of NOPWASD was used. For any matters not specified in this Criteria, the "Design Manual for Sewage Works" (1984) of Japan was applied. The summary is described in Section 3.8.2.(4).

(b) Electrical and Instrumentation Works

1) Applicable Standard

All electrical and instrumentation works covered by these specifications shall be designed, manufactured and tested in conformation with the latest revision of the following relevant Japanese standard or equivalent. List of applicable standards is shown in Table 3.8-2-7.

The dimensions of all parts and the characteristics of all materials shall conform to the relevant Japanese standards too.

2) Unit

The metric system shall be used as the unit system for dimensions and weights for instruments and all other apparatus for the equipment.

3) Service Conditions

Maximum ambient air temperature	40 °C
Minimum ambient air temperature	-5 °C
Maximum relative humidity	90 %
Maximum altitude above sea level	1,000 m

Note : Adequate countermeasures for the following conditions shall be considered for electrical equipment when they are to be used under such conditions:

- Harmful gas such as hydrogen sulfide
- Dust such as sand dust
- Salt air

Table 3.8-2-7 List of applicable standards

Abbreviation	Name of the Standards
JIS	Japan Industrial Standard
JEC	Standard of the Japanese Electro-technical Committee
JEM	The Standard of the Electrical Manufacturer's Association

(c) Civil Works

As to the design criteria, Egyptian Code (1989) for reinforced concrete structures should be referred to.

As other design criteria and conditions for civil works in connection with the sewerage the specifications of the Japan Society of Civil Engineering are applied. Summary of design criteria and conditions of civil work are shown in Table 3.8-2-8.

Table 3.8-2-8 Summary of Design Criteria and Conditions for Civil Work

	Item	Criteria and Conditions	Remarks
1.	Unit Weight of Principal Materials		
	Reinforced Concrete	gc = 2.50 t/m³	
	Plain Concrete	gc = 2.20 t/m³	
	Backfilling Soil	gc = 1.80 t/m³	
2.	Design and Coefficient of Load		
	Group Load (Pond Floor Slab, Corridor, etc.)	W1 = 0.3 t/m²	
	Imposed Load		
	(Surcharge at the time of earth pressure calculation -------------------------------- Normal)	qo = 1.0 t/m³	
	(Surcharge at the time of earth pressure calculation -------------------------------- At time of earthquake)	qe = 0.0 t/m³	
		W2 = ACTUAL Weight	
	Seismic Coefficient		
	Vertical Seismic Coefficient	KV = 0	
	Horizontal Coefficient	KH = 0.05	
	Coefficient of Earth Pressure		
	(Normal)	Ko = 0.5	
	(At Time of Earthquake)	KH =Ko (1+KH) = 0.5 (1+0.1) = 0.55	
	Dynamic Water Pressure at Time of Earthquake		
	According to of Wester Guard Equation		
3.	Principal Stress Intensity on Principal Materials		
(1)	Concrete (Design Strength)	s ck = 210 kgf/cm²	
	Allowable Bending Compressive Stress Intensity	s ca = 80 kgf/cm²	
	Allowable Shearing Stress Intensity	In case of Calculating Diagonal Tension Bar	
	(Beam)	ta = 3.0 kgf/cm²	
	(Slab)	ta = 3.0 kgf/cm²	
		In case of Calculating Diagonal Tension Bar	
	(SD 30)	ta = 19 kgf/cm²	
	Allowable Bond Stress Intensity	ta = 6.7 kgf/cm²	
(2)	Reinforcement (SD 390)		
	Allowable Tension Stress Intensity	s sa = 2,000 kgf/cm²	

	Item	Criteria and Conditions	Remarks
(3)	Extra Coefficient of Allowable Stress Intensity At Time of Earthquake	1.33	
4.	Conditions of Reinforcement Arrangement		
(1)	Covering of Reinforcement		
	Floor Slab	d = not less than 5.0 cm	
	Side Wall, Surface of Floor Slab	d = not less than 7.0 cm	
	Underside of Floor Slab (Spread Foundation)	d = not less than 10.0 cm	
(2)	Extended Length of Reinforcement	35 D	
5.	Physical Constant to be Used in Design Calculation		
(1)	Young's Modules		
1)	Steel Material	Es = 2.0×10^6 kg/cm²	
2)	Concrete		
	Calculation of Statistically Indeterminate Force and Elasticity and Deformation	Ec = 2.0×10^5 kg/cm²	
	Calculation of Stress Intensity of Member	Ec2 = 1.3×10^5 kg/cm²	
(2)	Coefficient of Linear Expansion		
	(Not Considered)		
(3)	Pressure of Landslide Waters		
1)	Ordinary Water Pressure (Hydrostatic Pressure)		
	Design Reference Water Level in the Pond		
2)	Water Pressure at Time of Earthquake		
	Calculation from Approximate of Westergard's Formula	$Pd = 7/12\ b\ KWH^2$ $Hd = 0.4\ H$	
	Pd Dynamic Water Pressure Acting (t/m) K Horizontal Seismic Coefficient W Unit Weight of Water (t/m³) H Water Depth (m), B : Pond Width (m) b Correction Coefficient Depending on Pond Width (Table 1-3) Hd Working Position of Pd from Pond Bottom (m) = 0.4 H		
	(Table 1-3)		
3)	Buoyancy		
	Underground Water Head is Considered as being an Upward Action on Base Plate.	U = W x H	

(Table 1-3)

B/H	1	1.5	2	3	4
b	0.67	0.835	0.921	0.983	0.996

	Item	Criteria and Conditions	Remarks
	where U Buoyancy (t/m^2) W Unit Weight of Water (t/m^3) H Distance from Underground Water Level to Base Plate		
6.	Others The standards of various kinds necessary in the other calculations shall be in principle in accordance with the standards of the Japan Society of Civil Engineering (1986 Edition) and design part of concrete standard specifications enacted in 1986.		

(4) Wastewater Treatment Plant

(a) Design Criteria

A summary of the relevant criteria is shown in Table 3.8-2-9.

Table 3.8-2-9 Design Criteria of Wastewater Treatment Processes

Item			Criteria	Remarks
1.	Design Flow			
	Raw Wastewater Pumping Station	m^3/hr	3,875	Peak Hourly
	Other Equipment	m^3/day	55,800	Maximum Daily
2.	Kind of Wastewater	-	Industrial Wastewater	Include Wastewater from Center A, B, C
3.	Primary Sedimentation Tank			
-1.	Overflow Rate	$m^3/m^2 \cdot day$	less than 35	at max. daily flow
			less than 52	at peak hourly flow
-2.	Retention Time	hour	2.0 ~ 4.0	
4.	Aeration Tank			
-1.	BOD-SS Load	kg/kg•ss•day	0.2 ~ 0.5	
-2.	MLSS	mg/l	1,000 ~ 3,000	
-3.	Aeration Time	hour	more than 6	based on design flow
5.	Final Sedimentation Tank			
-1.	Overflow Rate	$m^3/m^2 \cdot day$	less than 52	at peak hourly flow
-2.	Retention Time	hour	1.8 ~ 3.0	
6.	Filter			[Future Equipment]
-1.	Line Velocity	m/day	less than 200 ~ 230	
-2.	Bed Depth	m	0.6 ~ 1.0	
-3.	Kind of Media	-	Anthracite and Sand	
7.	Chlorination Equipment			
-1.	Chlorine Contract Time	minute	15	at peak hourly flow
		minute	30	at avg. daily flow
-2.	Dosage	mg/l	6.0	at tertiary filtration effluent

	Item		Criteria	Remarks
8.	Sludge Thickener			
-1.	Solid Loading	$kg/m^2 \cdot day$	25 ~ 59	
-2.	Hydraulic Loading	$m^3/m^2 \cdot day$	16 ~ 32	
9.	Dewatering Equipment			
-1.	Type		Drying Beds	
-2.	Retention Time	day	5 ~ 7	
-3.	Dimensions	m	Width 6 ~ 8	
		m	Length 30 ~ 45	
10.	Others			
-1.	Number of Stand-By			
	Main Pumps		at least 40 %	as actual load
	Main Blowers		at least 40 %	as actual load
-2.	Capacity of Generator for Emergency		100 %	as actual load

(b) Comparative Study and Conclusions

1) Selection of Biological Process

As the result of a comparative study of the several wastewater treatment processes (i.e., stabilization Pond, Aerated Lagoon, Oxidation Ditch, Conventional Activated Sludge and so on.), conventional activated sludge process was selected from view points, of economy, required land area, and as well experienced with similar capacities wastewater treatment Plants.

For the results of this comparative study, refer to Appendix 3.8-2-1.

2) Selection of Aeration System

After a comparative study of the three aeration systems (i.e., a circulation aeration by blower system, a total aeration by blower system and a mechanical surface aeration system) circulation aeration using a blower system was selected from view points of economy, energy, and maintainability.

For the results of the comparative study, refer to Appendix 3.8-2-2.

3) Selection of Sludge Collector

The comparative study on type of sludge collector for primary and final sedimentation tanks is described in Appendix 3.8-2-3. As the results of this study, link belt type was selected from view points of economy, energy saving and maintainability.

4) Selection of Sludge Treatment Facility

Based on the result of a comparative study of the two treatment facilities (Mechanical type and Drying Bed), the drying bed method was selected from view points of economy, energy saving and maintainability.

The volume of sludge from both primary and final sedimentation tanks is reduced in the sludge thickener. The thickened sludges are dewatered at the drying beds and produced sludge cakes are transported and dumpted to a designated site.

5) Reuse of Treated Industrial Wastewater

Because the Project Area is a new industrial estate, the type of industry can only be estimated with a "likely or maybe" version, as well as the quality of the industrial wastewaters. Under such situation, it is rather impossible to judge the feasibility of reusing treated effluents. Consequently, in this section a cost comparison study is presented for the following three cases.

Case - 1. The treated effluents require filtration process only to be reusable.

Case - 2. The treated effluents require a process train of filtration and activated carbon adsorption.

Case - 3. The treated effluents require a process train of filtration and reverse osmosis process.

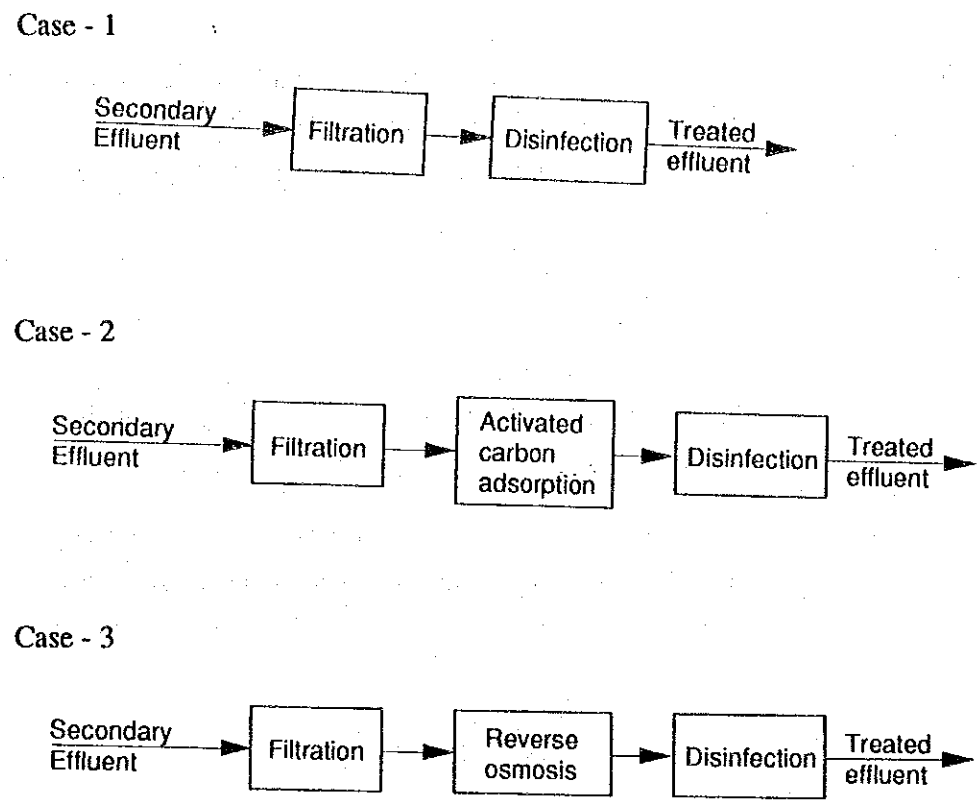


Figure 3.8-2-2 Comparative Flow Diagram of Reuse

Table 3.8-2-10 Cost Comparison of the Reuse of Treated Industrial Wastewater

(Unit Million LE)

Item	Case - 1	Case - 2	Case - 3
Capital	15.353	53.227	132.803
O & M Cost (30 years)	24.360	295.860	582.960
Total	39.713	349.87	715.763
Unit Cost	0.53 LE/m^3	1.14 LE/m^3	1.86 LE/m^3

Based on the results of a comparative study of the above three cases, reuse of treated industrial wastewater still not feasible from view points of qualities and economy, at present.

Still this reuse option of treated industrial wastewater based on its quality shall be considered in future.

(5) Sewer Pipeline

(a) Design Criteria

A summary of the relevant criteria is shown in Table 3.8-2-11.

Table 3.8-2-11 Design Criteria for Sewer System

Item		Criteria
1.	Design Flow	Peak Hourly Flow (Q max.)
2.	Q max./Q ave.	2
3.	Coefficient of Roughness (n)	"VC": 0.012 (Vitrified clay pipe) "RC": 0.013 (Reinforced concrete pipe)
4.	Minimum Diameter	Ø175 mm
5.	Minimum Cover	1.0 m
6.	Velocity	Min : 0.6 m/s, Max : 3.0 m/s
7.	Distance between Manhole : L	175 mm ≦ Ø < 200 mm L = 30 m 200 mm ≦ Ø < 300 mm L = 50 m 300 mm ≦ Ø < 400 mm L = 60 m 400 mm ≦ Ø < 900 mm L = 100 m 900 mm ≦ Ø < 1,200 mm L = 150 m 1,200 mm ≦ L = 300 m
8.	Drop Manhole	When an incoming sewer is more than 60 cm higher than a manhole invert elevation a drop manhole shall be adopted.

Table 3.8-2-12 shows the peak hourly flow from services area.

Table 3.8-2-12 Peak Hourly Flow (Q max.)

	Service Area		(ha)	Wastewater Quantities		
				Average Daily m^3/day	Peak Hour m^3/hr	Wastewater Quantity per Unit Area m^3/s. hr
	Ataqa I.E. and Adabiya I.F.Z.	Ataqa I.E.	294	34,620	2,885	0.001940
		Ataqa I.E.C.	61			
		Adabiya I.F.Z.	58			
	Ataqa I.E. Expansion Area		106	10,280	857	0.002246
	Ataqa Port		-	1,400	117	0.0325
	Commercial and Public Use	Center A	2.1	150	13	0.000190
		Center B	9.2			
		Center C	8.3			
		Grain Terminal	-	40	3	0.0008
		Water T.P.	4.5	10	0.8	0.0002
	Total		453.1	46,500	-	-
	Residential Area		132	5,400	450	0.000940
	Total		132	5,400	450	0.000940

(b) Comparative Study and Conclusions

1) Main Sewer Routes

Routes for main sewers have to be planned with the objective function to minimize the initial cost under the following constrains: minimum cover, shortest path, and least number of crossing with other utilities or structures. Main sewer routes selected taking into consideration of the above mentioned requirement are shown in Figure 3.8-2-3.

2) Selection of Gravity Sewer Pipe Material

Four (4) sewer pipe materials namely, vitrified clay, glass reinforced pipe, PVC and reinforced concrete are compared in Table 3.8-2-13.

Table 3.8-2-13 Comparison of Sewer Pipe Materials

	Locally Produced						Imported	
	Vicrified clay		Glass reinforced plastics		Polyvinyl chloride		Reinforced concrete	
	"VC"		"GRP"		"PVC"		"RC"	
Available size	100 mm~1,250 m		200 mm~1,800 m		110 mm~400 m		200 mm~2,000 m	
Anti acid measure	Unnecessary		Unnecessary		Unnecessary		Necessary	
Heat resistance	○		△		△		lining Surface △	
Weight	12.0kg/m~1,100.0kg/m		5.1kg/m~211.7kg/m		1.63kg/m~17.8kg/m			
Values of "n"	0.012		0.011		0.011		0.013	
	"VC"		"GRP"		"PVC"		"RC"	
Cost (LE/m)	200mm	27	200mm	140	200mm	40	200mm	10
	250mm	40	300mm	225	250mm	60		
	300mm	45	400mm	340	315mm	100	600mm	48
	375mm	54	500mm	400	400mm	160	1,000mm	104
Joint	Socket and spigot with fill-up by jute and cement		Rubber ring socket		Rubber ring socket		Ditto	
Oil resistance	○		Rubber ring △		Rubber ring △			
Effective Working Life	◎		△		△		△	
Overall Appraisal	○		△		△		△	

- Legend -

◎ : Excellent

○ : Good

△ : Fair

X : Not-Good

Based on this comparative study of the above four sewer pipe materials, Vitrified Clay and Reinforced Concrete pipe were selected from view points of economy and acid resistance. The available pipe diameter of each materials are as follows.

Materials	Available Diameter
Vitrified Clay "VC"	100 to 900 mm
Reinforced Concrete "RC"	more than 1,000 mm
Polyvinyl Chloride "PVC"	110 to 400 mm

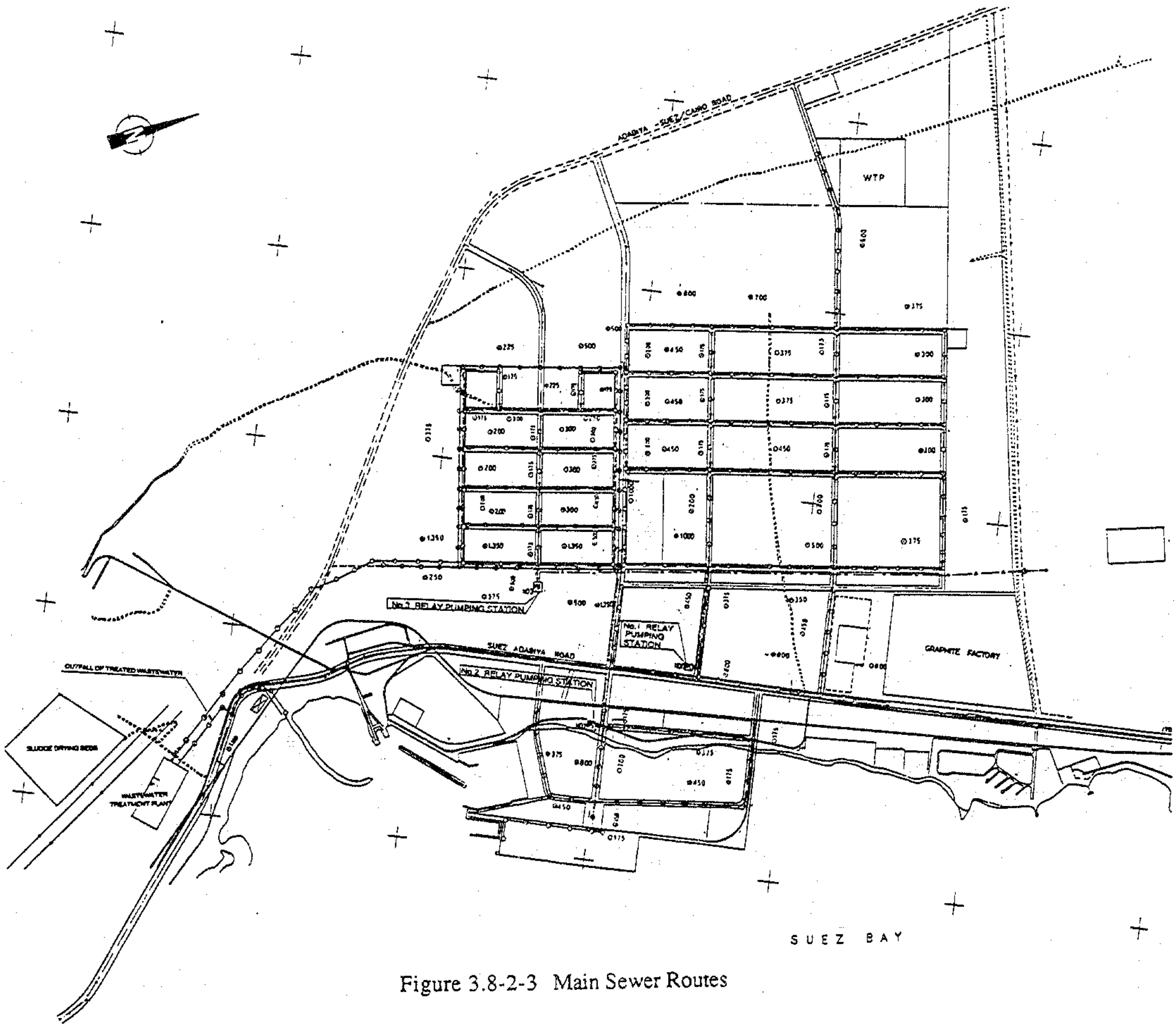


Figure 3.8-2-3 Main Sewer Routes

(6) Relay Pumping Stations

(a) Design Criteria

A summary of the relevant criteria is shown in Table 3.8-2-14.

Table 3.8-2-14 Design Criteria for Relay Pumping Station

Item		Criteria
1.	Wet Well Capacity	$V = \frac{T \times Q}{4}$ V = minimum wet well volume between the levels of lead pump "on" and "off", (m^3) T = pumping cycle, (min.) Q = pumping rate of the lead pump, (m^3/min.)
2.	Force Main Design Friction Losses	$h_t = \frac{10.7\ Q^{1.85}\ L}{C^{1.85}\ D^{4.87}}$ h_t = friction loss in force main, (m) L = length of force main, (m) D = pipe diameter, (m) Q = Flow rate (m^3/sec.)
3.	Values of "C" for Hazen-Williams Formula Cast Iron New, Unlined	C : 130 (Case of Old Pipe C : 100)
4.	Number of Stand-by	main pumps : 40 % of Actual Load
5.	Capacity of Generator for Emergency	100 % of Actual Load only for Main Pumps
6.	Pump Protection	Grit chamber Coarse screen : Clear opening 60 mm
7.	Force Main	Minimum Diameter : 80 mm Minimum Velocity : 0.6 m/s Pipe Materials : Ductile Cost Iron Pipe

(b) Comparative Study and Conclusions

1) Relay Pumping System for Industrial Wastewater

Result a comparative study of the three relay pumping system, along with a summary of their design conditions are shown in Table 3.8-2-15.

Table 3.8-2-15 Design Conditions for Relay Pumping Station

Items \ Pumping Station		No. 1 P.S.	No. 2 P.S.	No. 3 P.S.
1.	Kind of Wastewater	Industrial Wastewater	⟶	Domestic
2.	Collected Area	Ataqa East (119 ha)	Ataqa Coastal (61 ha)	Residential (132 ha)
3.	Destination	Sewer Pipe of Ataqa I.E.	Sewer Pipe of Ataqa I.E.	US-AID WWTP
4.	Wastewater Quantities (Peak Hourly)	830 m^3/hr	550 m^3/hr	450 m^3/hr

The comparative study of industrial relay pumping systems are given in Appendix 3.8-24.

2) Selection of Main Pumps

The type of main pumps is studied in Appendix 3.8-2-5.

As the result of this comparative study, submersible type pump was recommended from view points of economy and required area.

However, the vertical shaft type pumps were selected by requirement of MONDANC/NOPWASD from the view point of easy maintenance.

3.8.3 Design and Specifications

(1) Wastewater Treatment Plant

(a) Outline

1) Treatment Facility Unit

The capacity of the treatment plant is 55,800 m^3/day. The plant is divided into four parallel trains. Each train has a capacity of 55,800/4 = 13,950 m^3/d and can be operated independent of each other. Due to this separation, train by train construction is also possible if necessary.

2) Future Installation Facilities

A land space for a sand filter installation has been set aside. In the future, if reuse of the treated wastewater is required and the reuse itself is considered to be feasible, a water reclamation process including a sand filter can be constructed in the reserved area.

3) Capacity Calculations

Calculations to determine the necessary volume in accordance with the required capacity are attached to Appendix 3.8-3-1, 3.8-3-2.

4) Hydraulic Profile

Hydraulic calculations to determine the water level for each facilitiy are attached to Appendix 3.8-3-3.

5) Layout Plant of Wastewater Treatment Plant and Drying Beds

See Figure 3.8-3-1.

6) Detailed Layout Plan of Wastewater Treatment Plant

See Figure 3.8-3-2.

7) Process Diagram of Wastewater Treatment Plant

See Figure 3.8-3-3.

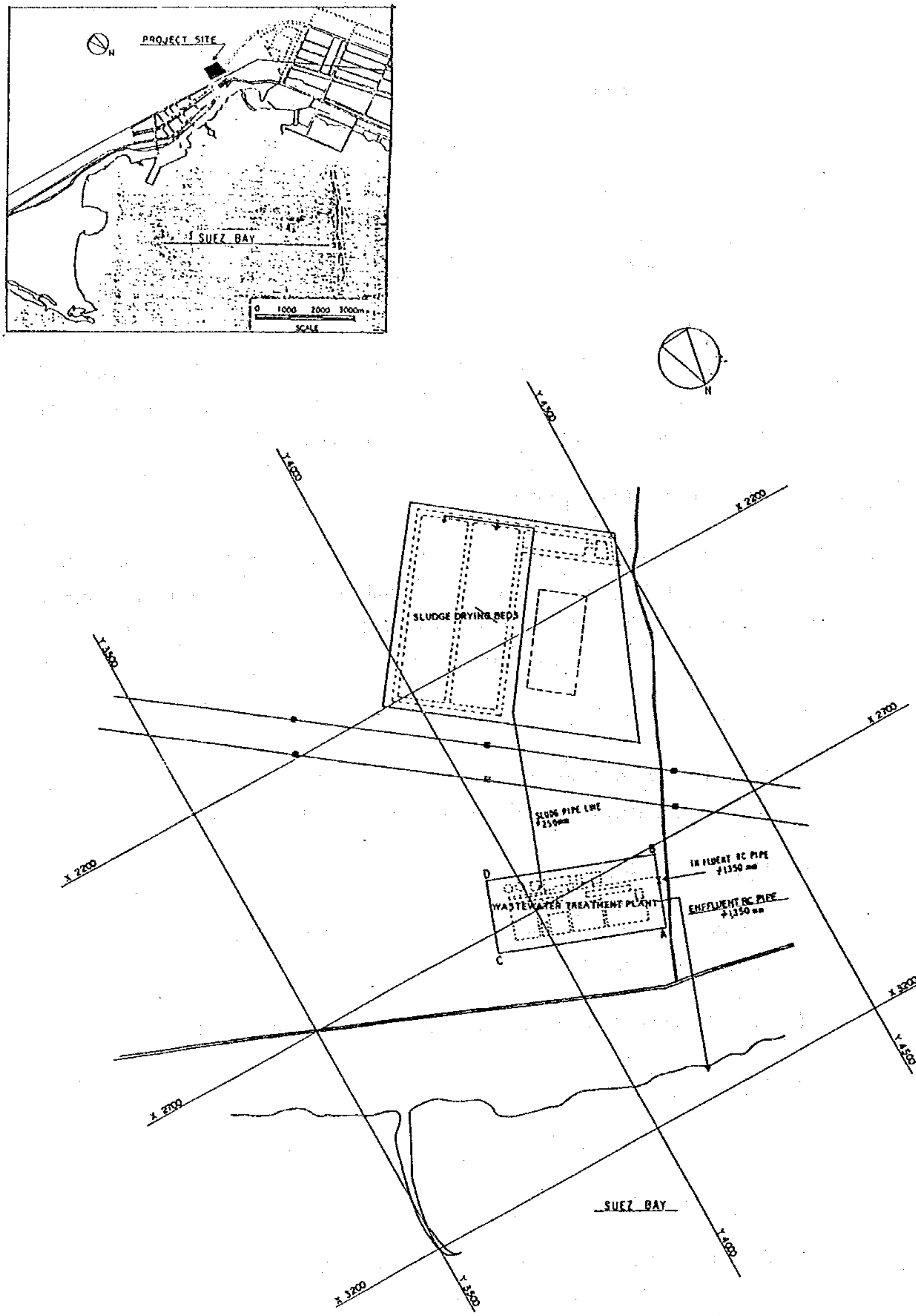
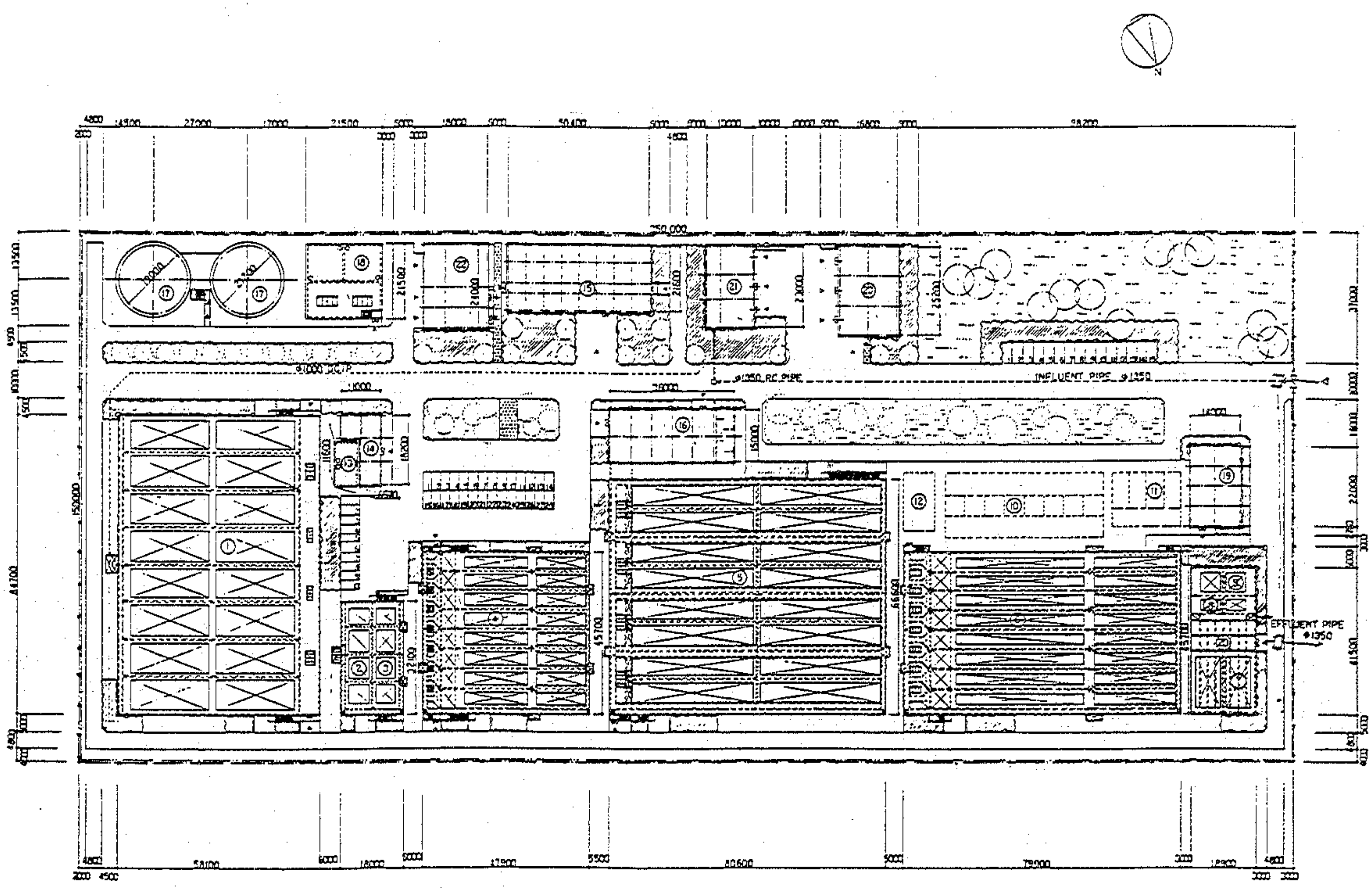


Figure 3.8-3-1 Layout Plan of Wastewater Treatment Plant and Drying Beds



NOTE

(1) Storage Tank
(2) Neutralization Tank
(3) Coagulation Tank
(4) Primary Sedimentation Tank
(5) Aeration Tank
(6) Final Sedimentation Tank
(7) Chlorine Contact Tank
(8) Treated Water Tank
(9) Filtered Tank
(10) Filter
(11) Filter Tank
(12) Backwashed Tank
(13) Neutralization Dosing House
(14) Coagulant Feeding House
(15) Operation Center
(16) Blower House
(17) Sludge Thickener
(18) Sludge Basin and Sludge Feeding Pump House
(19) Filter Pump and Backwash Pump House
(20) Chlorination House
(21) Raw Waste Water Pumping Station
(22) Power Sub-Station
(23) Work Shop
(dashed box) Future Facuties

Figure 3.8-3-2 Detailed Layout Plan of Wastewater Treatment Plant

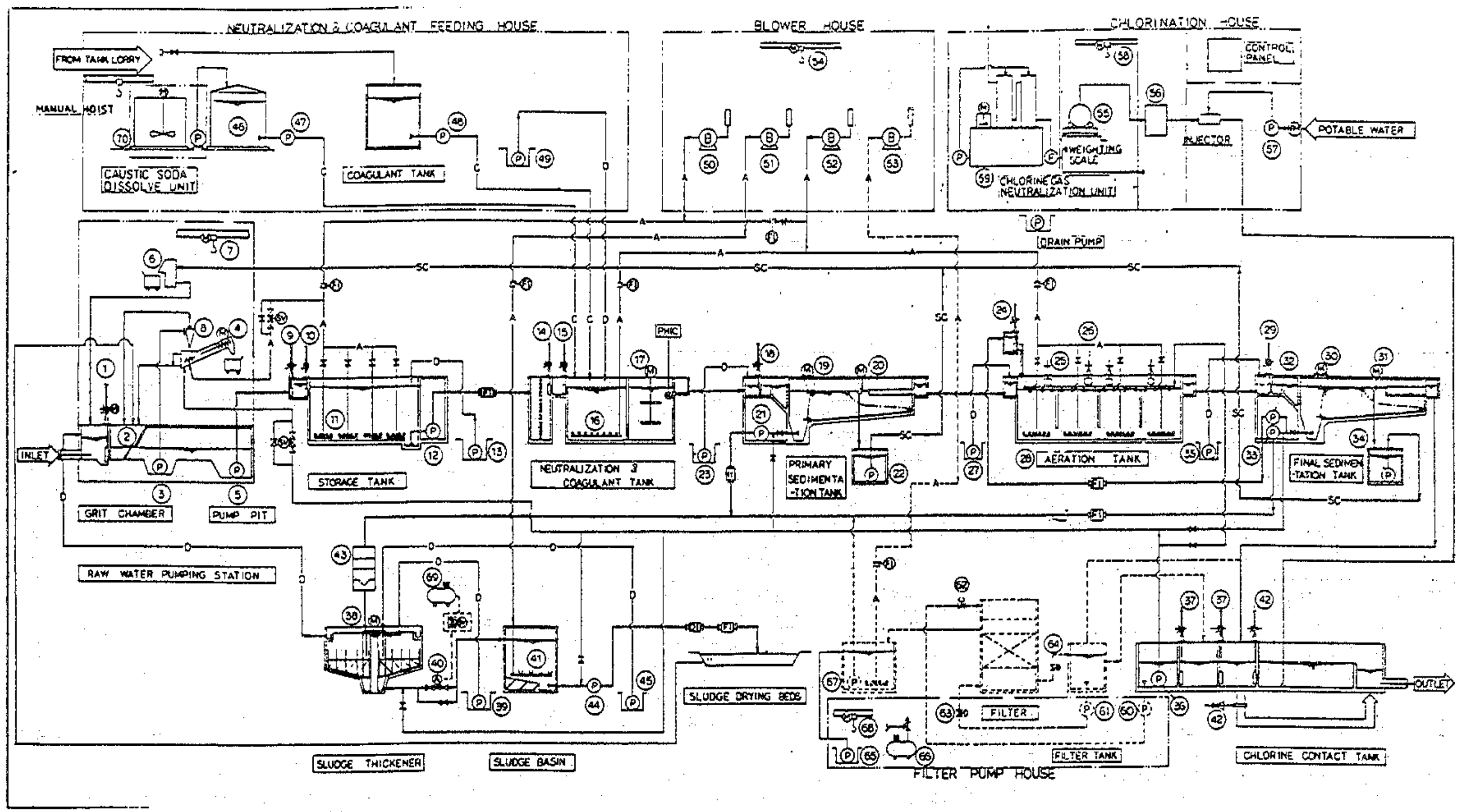


Figure 3.8-3-3 Process Diagram of Wastewater Treatment Plant

(b) Specifications

1) Raw Wastewater Pumping Station

This facility is to accept incoming wastewater, which flows from the Ataqa industrial area and passes through relay pump stations or sewer pipe lines by gravity flow. The wastewater which reaches to the raw wastewater pumping station is pumped up to the next storage tank.

This facility is to remove screenings and sand contained in the incoming wastewater using a fine screen and grit chamber to protect the pumps, and to convey wastewater to the next process by pump.

The specifications for this equipment are shown in Table 3.8-3-1.

Table 3.8-3-1 Specifications for Raw Wastewater Pumping Station Equipment

No.	Name	Number	Type	Capacity	Motor KW
	Grit Chamber	1	Rectangle (Concrete)	3.6 m W x 15.0 m L	-
M-1	Influent Gate	1	Power Operated Sluice Gate	$1,400^W$ x $1,400^H$	1.5
M-2	Bar Screen	1	Manual Operation Type	3,875 m^3/H Pitch 30 mm $2,000^W$ x $4,200^H$	-
M-3	Sand Pump	2 (1)	Submersible Pump	80∅ x 0.5 m^3/min x 18 m	5.5
M-4	Grit Washer	1	Air Bubbling Screw Conveyor (with 0.2 m^3 container)	200∅ x 5 mL	1.5
M-5	Sewerage Pump	6 (2)	Submersible Pump	400∅ x 16.15 m^3/min x 13 m	55.0
M-6	Scum Screen	1	Wedge Wire Screen (with 0.3 m^3 container)	60 m^3/H	-
M-7	Chain Hoist	1	Power Operated Type	2.8 ton x 6 m	2.4+0.2
M-8	Cyclone	1	Vertical Cyclone	40 m^3/H	-

NOTE : ( ) STAND-BY

2) Storage Tank

This tank's function is to store for a considerable time the wastewater pumped up from the raw wastewater pumping station.

This is to make a uniform the quantity and quality of the wastewater to be sent to the next process.

Air bubbling is applied in the storage tank so as to prevent decomposition and suspended solid sedimentation.

The wastewater is pumped up to the next processes, the neutralization and coagulation tanks.

The wastewater is detained in the storage tank for 6 hours.

Although the aeration is applied to prevent sedimentation, it is necessary to clean up the tank periodically. (Example: approximately one time/year)

The specifications for this equipment are shown in Table 3.8-3-2.

Table 3.8-3-2 Specifications for Storage Tank Equipment

No.	Name	Number	Type	Capacity	Motor KW
	Storage Tank	8	Rectangle (Concrete)	10.0 m W x 50.0 m L x 3.5m H	-
M - 9	Storage Tank Inlet Gate	2	Movable Weir Type	$1{,}000^{W}$ x 300^{stroke}	-
M-10	Storage Tank Separated Gate	4	Manually Operated Sluice Gate	500^{W} x 500^{H}	-
M-11	Diffuser	160	Perforated Pipe Type	600 ~ 1,200 l/min	-
M-12	Raw Water Pump	6 (2)	Horizontal Sewerage Pump	Ø300 x 10.0m^3/min x 9.0 m	30.0
M-13	Floor Drain Pump	2 (1)	Submersible Pump	Ø50 x 0.1 m^3/min x 10 m	0.75
FI-1	Air Flow Meter	8	Orifice Type	Ø200 600 ~ 2,800 Nm^3/H	-
M-50	Mixing Blower	3 (1)	Roots Type	250Ø x 59 m^3/min x 0.4 kg/m^2	55.0

NOTE : ( ) STAND-BY

3) Neutralization and Coagulation

The purpose of this process is to neutralize the PH of wastewater and to let it coagulate by adding coagulants and finally to form flocs. The flocs are to be separated from liquids by gravitational sedimentation in the sedimentation tank as part of the next process.

The kind of this wastewater is almost industrial wastewater ninety nine (99) percent or more from the project area. It has contained many waste materials such as metals (except the heavy metals), oil, COD, chlorine ion, several chloride, other in-organic compounds and so on which can't be decompose biologically. Therefore this process should be applied for remove them.

Sodium hydroxide (solid of 45 % Na OH) and aluminum salfaite (liquid of 8% solution as Al_2O_3) are used as a neutralizing agent and coagulant respectively.

The specifications for this equipment are shown in Table 3.8-3-3.

Table 3.8-3-3 Specifications for Neutralization and Coagulation Equipment

No.	Name	Number	Type	Capacity	Motor KW
	Neutralization Tank	4	Rectangle (Concrete)	7.0 m W x 7.0 m L x 4.0 m H	-
	Coagulation Tank	4	Rectangle (Concrete)	7.0 m W x 7.0 m L x 4.0 m H	-
M-14	Distributor Gate	2	Movable Weir Type	$1,000^{W}$ x 300^{ST}	-
M-15	Inlet Gate	4	Manual Operated Sluice Gate	500^{W} x 500^{H}	-
M-16	Diffuser	32	Disc Type	150 l/min, PC	-
M-17	Coagulation Tank Mixer	4	Double Paddle Type	194 m^3 x 12 RPM	11.0
M-70 (a)	Caustic Soda Solution Tank	1	Mild Steel (Rebber lined)	4.2 m^3	-
M-70 (b)	Caustic Soda Solution Tank Mixer	1	Propeller Type	4.2 m^3 x 295 rpm	2.2
M-70 (c)	Caustic Soda Transfer Pump	2 (1)	Centrifugal Pump	50Ø x 0.2 m^3/min x 10 m	1.5
M-46	Caustic Soda Tank	1	Mild Steel	30 m^3	-

No.	Name	Number	Type	Capacity	Motor KW
M-47	Caustic Soda FeedingPump	6 (2)	Screw Pump Type	20Ø x 0.1 l/min x 5 kg/cm^2	0.2
M-48	Aluminum Sulfate Feeding Pump	6 (2)	Diaphragm Pump Type	40Ø x 20 l/min x 5 kg/cm^2	0.75
M-49	Floor Drain Pump	2 (1)	Submersible Pump	50Ø x 0.1 m^3/min x 10 m	0.75
M-71	Buffer Plate	4	Plate Type	$1,000^W$ x 600^D x $3,000^H$	-
M-72	Buffer Plate	4	Plate Type	$1,000^W$ x 600^D x $3,000^H$	-
FI-2	Air Flow Meter	4	Orifice Type	50Ø x 35 ~ 175 Nm^3/H	-
PH-IC	PH Meter	4	Soaking Type	Indicator & Control	-

NOTE : ( ) STAND-BY

4) Primary Sedimentation Tank Equipment

The function of the primary sedimentation tank is to remove suspended and settlable solids of organic and/or inorganic, by gravitational sedimentation, which decreases BOD and SS substances to be loaded into the biological treatment process. Originating from it's role, the primary sedimentation process is the preliminary treatment process in the biological treatment process. For quick removal of settled sludge a sludge rake and sludge pump are provided in the tank.

The specifications for this equipment are shown in Table 3.8-3-4.

Table 3.8-3-4 Specifications for Primary Sedimentation Tank Equipment

No.	Name	Number	Type	Capacity	Motor KW
	Primary Sedimentation Tank	4	Rectangle (Concrete)	10.0 m W x 40.0 m L x 3.0 m H	
M-18	Inlet Gate	8	Manual Operated Sluice Gate	400^W x 400^H	-
M-19	Rake	4	Chain Flight Double Link Type	(5.0^W x 40.0^L x 3.0^H) x 2	1.5
M-20	Scum Skimmer	8	Power Operated Scum Skimmer	Pipe Skimmer Ø300 x 5.0 m L	0.4
M-21	Sludge Pump	6 (2)	Horizontal Sludge Pump	80Ø x 0.2 m^3/min 15 m	3.7
M-22	Scum Transfer Pump	4 (2)	Submersible Pump	100Ø x 0.9 m^3/min x 16 m	5.5
M-23	Floor Drain Pump	2 (1)	Submersible Pump	50Ø x 0.1 m^3/min 10 m	0.75

NOTE : ( ) STAND-BY

5) Aeration Tank

This equipment is highly important in the biological treatment process. Aeration is the method of propagating various kinds of aerobic bacterias with organic matter in the sewage being the source of nutrition.
This activated sludge process is the method to remove organic matter by coagulating suspended solids and colloidal matter through bacterial metabolism.

The clarifying functions of the activated sludge process are summarized below.

(1) Absorption of organic matter
(2) Oxidation and Assimilation of absorbed organic matter
(3) Formation of a floc with quick sedimentation

Aerated effluent separates solids from liquids in the final sedimentation tank in the next process, and the supernatant water flows out, while the settled activated sludge is returned to the aeration tank as return sludge, and again employed in the sewage treatment process and surplus sludge is treated in the sludge treatment tank.

The specifications for this equipment are shown in Table 3.8-3-5.

Table 3.8-3-5 Specifications for Aeration Tank Equipment

No.	Name	Number	Type	Capacity	Motor KW
	Aeration Tank	4	Rectangle (Concrete)	15.0 m W x 72.0 m L x 5.0 m H	-
M-24	Return Sludge Inlet Gate	8	Movable Weir Type	500^{W} x 300^{ST}	-
M-25	Inlet Gate	8	Movable Weir Type	$1,000^{W}$ x 300^{ST}	-
M-26	Step Gate	24	Movable Weir Type	400^{W} x 300^{ST}	-
M-27	Floor Drain Pump	2 (1)	Submersible Pump	50Ø x 0.1 m^3/min 10 m	0.75
M-28	Diffuser	720	Fine Bubble Type	(200 l/min, PC x 2/set)	-
FI-3	Air Flow Meter	8	Orifice Type	300Ø (1,600~7,800 Nm^3/min)	-
M-52	Aeration Blower	12 (4)	Roots Type	200Ø x 37.0 m^3/min 0.55 kg/m^2	55.0
M-54	Chain Hoist	2	Power Operated Type	2.0 ton x 4.0 m	1.5+0.4
M-73	Spray Nozzle	384	Cock Type	10 l/min, PC	-
M-36	Spray Pump	6 (2)	Submersible Pump	100 x 1.0 m^3/min x 20 m	7.5

NOTE : ( ) STAND-BY

6) Final Sedimentation Tank

As described in the former section, aerated effluent separates solids from liquids in the final sedimentation tank and the liquid flows out to next process.

In the tank, a sludge rake, sludge pump and a scum collector are provided as in the primary sedimentation tank.

Return sludge to the aeration tank and surplus sludge to the sludge treatment process are transported from the final sedimentation tank.

The specifications for this equipment are shown in Table 3.8-3-6.

Table 3.8-3-6 Specifications for Final Sedimentation Tank Equipment

No.	Name	Number	Type	Capacity	Motor KW
	Final Sedimentation Tank	4	Rectangle (Concrete)	5.0 m W x 70.0 m L x 2.5 m H	-
M-29	Inlet Gate	8	Manual Operated Sluice Gate	500^W x 500^H	-
M-30	Rake	4	Chain Flight Double Link Type	(5.0^W x 70.0^L x 2.5^H) x 2	2.2
M-31	Scum Skimmer	8	Power Operated Scum Skimmer Type	Pipe Skimmer 300∅ x 5.0^L	0.4
M-32	Sludge Return Pump	6 (2)	Horizontal Sludge Pump	250∅ x 4.9 m^3/min x 8.0 m	18.5
M-33	Sludge Pump	6 (2)	Horizontal Sludge Pump	80∅ x 0.6 m^3/min x 17 m	5.5
M-34	Scum Transfer Pump	4 (2)	Submersible Pump	100∅ x 0.9 m^3/min x 16 m	5.5
M-35	Floor Drain Pump	2 (1)	Submersible Pump	50∅ x 0.1 m^3/min x 10 m	0.75

NOTE : ( ) STAND-BY

7) Sand Filter (Future Equipment)

This sand filter is for a future plan and a detailed design is not been made at this stage.

If the reuse of treated effluents or the improvement of effluents quality becomes necessary, filter equipment can be installed to further treat the clarified effluent from the final sedimentation tank.

An area for the sand filter process has been set aside and the water levels of related processes have been planned taking into consideration possible future connection to the filter.

The specifications for this equipment are shown in Table 3.8-3-7.

Table 3.8-3-7 Specifications for Filter Equipment (Future Equipment)

No.	Name	Number	Type	Capacity	Motor KW
	Filter Tank	4	Rectangle (Concrete)	4.0 m W x 10.0 m L x 2.5 m H	
M-60	Filter Pump	6 (2)	Horizontal Centrifugal Pump	250∅ x 10m³/min x 10 m	30.0
M-61	Back Wash Pump	2 (1)	Horizontal Centrifugal Pump	500∅ x 450∅ 25.2 m³/min x 15m	90.0
M-62	Filter Inlet Valve	8	Actuator Butterfly Valve	300∅	-
M-63	Back Washed Water Value	16	Actuator Butterfly Valve	600∅	-
M-64	Treated Water Value	8	Actuator Butterfly Valve	500∅	-
M-65	Floor Drain Pump	2 (1)	Submersible Pump	50∅ x 0.1 m³/min x 10 m	0.75
M-66	Compressor	2 (1)	Pressure ON-OFF Type	600 l/min x 9.5 kg/cm²	5.5
M-67	Transfer Pump	2 (1)	Submersible Pump	150∅ x 0.3 m³/min x 8 m	7.5
M-68	Chain Hoist	1	Power Operated Type	2.0 ton x 6 m	1.5+0.2
M-76	Filter Media	8	Gravel Sand Anthracite	10.8 m³/lpc 7.2 m³/lpc 14.4 m³/lpc	-
M-53	Back-washed Tank Mixing Blower	2 (1)	Roots Type	65∅ x 2.2 m³/min x 0.4 m	3.7

NOTE : ( ) STAND-BY

8) Chlorination Equipment

This equipment is designed to eliminate almost all the colon bacilli in the effluent, and to keep the number of colon bacilli within the values shown in the effluent criteria. Chlorine gas dissolved in the water is used as the disinfecting agent.

Disinfection is carried out through dissolving chlorine gas in the sewage.

The specifications for this equipment are shown in Table 3.8-3-8.

Table 3.8-3-8 Specifications for Chlorination Equipment

No.	Name	Number	Type	Capacity	Motor KW
	Chlorine Contact Tank	8	Rectangle (Concrete)	2.0 m W x 25.0 m L x 2.5 m H	-
M-55	Chlorine Container	12	Cylinder Type	1.0 ton	-
M-56	Chlorinator	3 (1)	Injector Vacuum Type	10 kg/H	-
M-57	Booster Pump	3 (1)	Horizontal Centrifugal Pump	65Ø x 0.3 m^3/min x 40 m	5.5
M-58	Chain Hoist	1	Power Operated Type	2.0 ton x 4 m	1.5+0.4
M-59	Chlorination Control Panel	1	Stand Type	-	-
M-75	Injector	3 (1)	Injector Type	40Ø	-
M-74	Chlorine Gas Detector	1	Diffusion Type	Range : 0 ~ 3 ppm (with 3 sensors)	-
M-55 (b)	Container Weighting Scale	2	Load Cell Type (with	Indicate;: 0 ~ 3 ton Weight Indicator)	-
M-59 (a)	Caustic Sods Solution Tank	1	Square Type	1.0 m^3 Mild Steel Tank Mixer (0.75kw x 1pc)	0.75
M-59 (b)	Coastic Soda Solution Storage	tank	Squre Type (Inside-Rubber lined)	16.0 m^3 Mild Steel	-

No.	Name	Number	Type	Capacity	Motor KW
M-59 (c)	Caustic Soda Circulation Pump	2 (1)	Horizontal centrifugal pump x 15 m	80 mm Ø x 0.9 m^3/min x 15 m	5.5
M-59 (d)	Neutralization Tower	2	Cylinder Type	Approx. 930 mmØ	-
M-59 (e)	Chlorine Exhaust Fan	2	Chemical Turbo Fan	45 m^3/min x 250 mm Aq	3.7
M-37	Chlorine Contact Tank Gate	3	Manually Operated Type	$1,000^W$ x $1,000^H$	-
M-42	Filter Tank & Treated Tank Gate	3	Manually Operated Type	$1,000^W$ x $1,000^H$	-

NOTE : ( ) STAND-BY

9) Sludge Treatment Equipment

Sludge generated in the primary and final sedimentation tanks is naturally concentrated by gravity and it's volume decrease.

Then the concentrated sludge is pumped up to drying beds to dry.

Dried sludge is transported out of plant and disposed of at an appropriate site.

The quantity to be treated is approximately 22.1 ton/day with a load of 100 % and dry solids of 2 %.

The specifications for this equipment are shown in Table 3.8-3-9.

Table 3.8-3-9 Specifications for Sludge Treatment Equipment

No.	Name	Number	Type	Capacity	Motor KW
M-38	Sludge Thickener	2	Center Post Type	19Ø x 3.0 mH	1.5
M-39	Floor Drain Pump	2 (1)	Submersible Pump	50Ø x 0.1 m^3/min x 10 m	0.75
M-40	Thickened Sludge Drain Valve	2	Reverse Action Diaphragm Valve	250Ø x (with 3-way Solenoid value)	-
M-69	Compressor	2 (1)	Pressure ON-OFF Type	250 l/min x 9.5 kg/cm^2	2.2
M-43	Sludge Flow Scale Distribution Tank	1	Weir Type	Approx. $1,600^W$ x $3,000^L$ x $1,000^H$	-
M-41	Diffuser	30	Disc Type	250 l/min, pc	-
M-44	Sludge Feed Pump	6 (2)	Horizontal Sludge Pump	80Ø x 0.6 m^3/min x 53 m	18.5
M-45	Floor Drain Pump	2 (1)	Submersible Pump	50Ø x 0.1 m^3/min x 10 m	0.75
M-51	Sludge Basin MixingBlower	2 (1)	Roots Type	125Ø x 10 m^3/min x 0.35 kg/cm^2	11
	Sludge Drying Beds	160	Drying Bed	8 m x 45 m Retention Time 5.2 Days	-

NOTE : ( ) STAND-BY

10) Electrical Works

(i) Electrical Equipment

Electrical works shall cover the design, manufacturing and shop testing of the following electrical equipment including the auxiliary equipment and spare parts for the wastewater treatment plant (herein after called W.W.T.P.) as well as erection work including their materials, field testing and commissioning.

The specifications for this equipment is shown in Table 3.8-3-10.

Table 3.8-3-10 Specifications for Electrical Equipment

Description		Number	Remark
1.	Low voltage switchgears	1 lot	
-1	380 V incoming panel	(6 sets)	
-2	Feeder panel	(8 sets)	
-3	Condenser panel	(3 sets)	
2.	Motor Control Center (C/C), Auxiliary relay panel and local control & interface panel	1 lot	
-1	C/C-1 Group	(9 sets)	
-2	C/C-2 Group	(8 sets)	
-3	C/C-3 Group	(8 sets)	Refer to drawings and appendix as follows:
-4	C/C-4 Group	(8 sets)	
-5	C/C-5 Group	(15 sets)	- Single line diagram
-6	C/C-6 Group	(10 sets)	- Instrumentation flow diagram
-7	C/C-7 Group	(8 sets)	- Electric panels
-8	C/C-8 Group	(5 sets)	- Appendix 3.8-4-1
3.	Local control panels	1 lot	
-1	Indoor stand type	(17 sets)	
-2	Outdoor stand type	(26 sets)	
4.	Centralized supervisory equipment	1 lot	
-1	Centralized supervisory panel with mosaic graphic panel	(1 set)	
-2	Uninterruptable power supply	(1 set)	
5.	Instrumentation	1 lot	

(ii) Erection Materials

Table 3.8-3-11 shows erection materials.

Table 3.8-3-11 Erection Materials

Description		Number	Remark
1.	Cables and Accessories	1 lot	
2.	Cabling Route Materials	1 lot	Refer to drawings as follows:
3.	Grounding Materials	1 lot	
4.	Supporting Materials for Panels	1 lot	- Wiring plan
5.	Street Lighting Fixtures	1 lot	
6.	Sealing Materials	1 lot	
7.	Distribution Boards for Lighting	1 lot	
8.	Lighting Fixtures	1 lot	
9.	Socket Outlets	1 lot	
10.	Ventilation Equipment	1 lot	
11.	Miscellaneous Materials	1 lot	

(iii) Erection Work

Table 3.8-3-12 shows erection work.

Table 3.8-3-12 Erection Works

Description		Number	Remark
-1	Installation of Panels	1 lot	
-2	Cabling and Terminating	1 lot	Refer to drawings as follows:
-3	Cabling Route Work	1 lot	
-4	Grounding Work	1 lot	- Wiring plan
-5	Installation of Supporting Materials for Panels	1 lot	
-6	Street Lighting Work	1 lot	
-7	Lighting	1 lot	
-8	Ventilation	1 lot	
-9	Others	1 lot	

11) Laboratory

It is therefore necessary for the treatment plant to have test equipment for items necessary for the maintenance of the plant as well as water quality and sludge testing equipment for regulatory items required by law.

The purposes of the water quality and sludge tests in the laboratory are listed below:

(i) Examination of water quality as stipulated by law

(ii) Periodic examination of the water quality in each facility of the treatment plant to ascertain the operation a state of the plant

(iii) Use of test results as data to calculate plant maintenance cost

(iv) Use of test results as data to improve the plant operation methods or functions

(v) Examination of the water quality of the sea water to ascertain the effect of the discharged outfall.

The treatment plant of this project will have the equipment for the minimum analysis required for normal water quality control. The analytical items and equipment are shown for each facility in Tables 3.8-3-13 and 3.8-3-14 respectively.

Table 3.8-3-13 Items for Water Quality Analysis with Respective Sampling Points

Sampling Points / Items of Analysis	Raw Pumping Station	Primary Sedimentation. T		Aeration. T	Final Sedimentation. T	[Filter]	Chlorine Contact. T
	Inflow	Inflow	Outflow	Mixed Liquid	Outflow	Outflow	Outflow
Temperature							○
Water Temperature	○		○	○	○		○
Transparency by Cylinder Test			○		○	○	○
PH.	○	○			○		○
Total Solids	○	○	○				○
Suspended Solid	○	○	○		○		○
Dissolved Solids	○						○
Dissolved Oxygen				○	○		○
Biochemical Oxygen Demand	○	○	○		○		○
Chemical Oxygen Demand	○	○	○		○		○
Total-Nitrogen	○						○
NO2-N	○						○
NO3-N	○						○
Total-Phosphorous	○						○
Chloride ion	○						○
Fluorine ion	○						○
Cyanide	○						○
n-Hexane Extract	○						○
Phenol	○						○
Total Coliform	○				○		○
MLSS				○			
Water Content			sludge		sludge		
Cadmium	○						○
Zinc	○						○
Hexavalent Chromium	○						○
Iron	○						○
Arsenic	○						○
Manganese	○						○
Copper	○						○

[ ] is a future equipment.

Table 3.8-3-14 Equipment for Water Analysis

Equipment		Q'ty	Type
1.	Turbidity/Color Meter	1	Sphere Method Type
2.	PH/ORP/Temp. Meter	1	Potable Type
3.	DO/O_2/Temp. Meter	1	Polarograph Type
4.	DO Meter	1	Potable Type
5.	BOD Analyzer Unit	1	Manometric Method Type
6.	COD Analyzer Unit	1	Dichromate Method Type
7.	Total Coliforms	1	Agar Cultivation Method
8.	SS	1	Gravimetric Analysis Method
9.	TDS	1	Potable Type
10.	n-Hexane Extract Analyzer Unit	1	Gravimetric Analysis Method
11.	Phosphorous/Nitrogen Meter	1	Desk-top Autoclave Type
12.	Chloride Meter	1	Composite Cl-ion Electrode Type
13.	Mercury Meter	1	Reduction-Evaporation Method Type
14.	Spectrophoto Meter	1	Single-beam Optics
15.	Experiment Table	6	Center Table and Side Table
16.	Drying Oven	1	Auto Control Type
17.	Pure Water Producer	1	Ion Exchange and Filtration Method Type
18.	Water Content Meter	1	Heat and Drying Method Type
19.	Refrigerator	2	120 *l*
20.	Balance	1	Digital type
21.	Microscope	1	With Table

(2) Sewer Pipeline

(a) Hydraulic Calculations for Sewer

The Manning formula is most commonly used in hydraulic calculations for sewers.

Manning formula:

$$v = \frac{1}{n} \cdot R^{\frac{2}{3}} \cdot I^{\frac{1}{2}}$$

in which v : Flow velocity (m^3/sec.)

R : hydraulic radius (m)

I : hydraulic gradient

n : roughness coefficient of the channel

By using the Manning formula the required size and gradient of sewers can be calculated and the results are shown in Appendix 3.8-3-5.

(b) Materials

1) Vitrified Clay (VC) Pipes

In the "Wastewater System Design Criteria" of NOPWASD, the "VC" pipe is regarded as an acceptable material for sewerlines. Through discussions with MODANC and NOPWASD it has been concluded that "VC" pipes are suitable for sewers. In this project up until a diameter of 900 mm, the "VC" pipe is used.

2) Reinforced Concrete (RC) Pipes

For pipes over 1,000 mm, reinforced concrete pipes treated with acid resistance measure is used in this project. Because the wastewater generated in the project area is from an industrial area, it is recommended that the reinforced pipes should receive a PVC, or an epoxy lining as an extra protection.

3) Polyvinyl Chloride (PVC) Pipes

For the connection of factory inlets and rainfall inlets to manholes, "PVC" pipes are used.

(c) Instllation Works

1) Excavation and Timbering

Utilizing the detailed design, the sewers' longitudinal profiles has been determined. From the planned sewer longitudinal profile, it is clear that the excavation depth required for sewer pipe installation is less than 3.0 m over about 80 percent of the total sewer length in the Project Area.

Excavation without timbering can be used in areas with sufficient space where the side wall of the trench is graded in such away to protect the trench from soil collapse. In order to minimize the space to be excavated, trenches in and along planned roads of the project area should be rectangle cross section with the non slope side wall.

Timbering should be applied to the excavation with the depth more than 2.5 m (for clay) and 1.5 m (for sand). The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe.

Before pipe laying, the ground shall be prepared true to line and grade with a sufficient width to permit satisfactory construction of the bedding. Special care shall be taken to remove any hard or destructive material from the foundation area.

When soft, spongy or unstable soil is encountered, such soil shall be removed under the pipe for a width and to a depth as necessary and replaced with sand or other suitable selected material and properly compacted, to provide adequate support for the pipe.

The prepared surface shall provide a firm foundation of uniform density throughout the course of the pipe. The Contractor's attention is drawn to the fact that excavations may have to be carried out in gravel and sand layers which chould easily collapse. Adequate countermeasures to ensure the safety shall be adopted.

2) Bedding

Bedding shall be constructed by bedding the sewer pipe in a trench cut through an embankment and into the natural ground to a depth indicated in the longitudinal cross-section plan. A foundation of sand or concrete shall be properly applied as in the drawing.

3) Backfilling

Backfilling shall be carried out with the material indicated in the drawings. It shall be placed in uniform layers not exceeding 0.15 m in uncompacted depth and compacted as embankment fill for layers at depths below subgrade. Special care shall be taken to compact the material under the haunches of the pipe and to ensure that backfill shall be brought up evenly on both sides of the pipe.

4) Leakage Test

After the installation is completed, the sewer lines shall be tested with water for leakage inspection.

5) Cleaning

As the work progresses, the interior of the pipe shall be kept clean of all dirt and superfluous materials. Where pipe sizes are small, a suitable swab or tag shall be kept in the pipe and pulled forward past each joint immediately after the jointing has been completed.

6) Manholes

Manholes shall be constructed as shown in the drawings and at every change of direction or change of gradient. The invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as long a radius as the size of the manhole will permit. The invert channels shall be formed directly in the concrete base, or shall be constructed by laying full-section sewer pipe through the manhole and breaking out of the top half after the surrounding concrete has hardened. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels with a gradient not less than 10 cm per 30 cm. When the depth of the manhole from the top of cover to the invert of the sewer exceeds 1.0 m, the manhole shall have 20 mm diameter steel rungs of approved design accurately anchored in the walls. Rungs shall be not less than 30 cm in width, spaced at least approximately 35 cm apart and installed with at least 15 cm of toe space from the inside face of the rung to the manhole wall.

(3) Relay Pumping Stations

Wastewater in Ataqa East, Ataqa Coastal, and the Residential area, which cannot be drained to the treatment plant by gravity flow, is collected in the relay pumping station in each area and pumped to the specified location by a sewage pump. The station is equipped with a coarse screen and grit chamber to protect the pump by removing screenings and sand contained in raw wastewater.

The specifications for this equipment are shown in Table 3.8-3-15.

Table 3.8-3-15 Specifications for Pumping Stations

	Description	Q'ty	Type	Capacity		
				No. 1. PS	No. 2. PS	No. 3 PS
1	Main Pump	3 (1) [1]	Vertical Shaft	250 Ø	200 Ø	200 Ø
2	Check Valve	3 (1)	Swing	250 Ø	200 Ø	200 Ø
3	Gate Valve	3 (1)	Manual Operation	250 Ø	200 Ø	200 Ø
4	Discharge Pipe	1 lot	Ductile Iron Pipe	250 ~ 450 Ø	200 ~ 350 Ø	200 ~ 350 Ø
5	Intake Gate	1	Manual Operation	800 x 800 mm	800 x 800 mm	800 x 800 mm
6	Coarse Screen	2	Bar Screen	60 mm Bar Pitch	60 mm Bar Pitch	60 mm Bar Pitch
7	Generator	1	Diesel Engine	150 KVA	125 KVA	150 KVA
8	Incoming Panel	1	Self-Standing	380 v, 50 Hz	380 V, 50 Hz	380 V, 50 Hz
9	Motor Panel	3	Self-Standing	for 45 KW Moror	for 37 KW Motor	for 45 KW Motor

Note : ( ) STAND-BY at PUMPING STATION
[ ] STAND-BY at WARE HOUSE

(4) Building Works

(a) Outline

Drawing package and calculation package. Introductory description regarding the following items for the buildings of sewerage system are referred to the Chapter 3.6.1. Introduction based on similar contents in response to this section.

However it should be noted that the scope of works for buildings includes only the normal architectural, structural, mechanical and electrical works assigned for building design and excludes civil works, equipments and utility works related to the system.

(b) Summary of Floor Area of the Buildings

The Summary of the buildings for wastewater treatment plant are shown in Table 3.8-3-16.

Table 3.8-3-16 Buildings for Wastewater Treatment Plant

1. Buildings	No. of Stories	Type of Struct.	Floor Area (sq.m)	Bldg. No.
1) Power substation	1	RC"	432	1
2) Workshop and warehouse	2	RC"	423	2
3) Operation center	2	RC"	2,177	3
4) Chlorination house	1	RC"	92	4
5) Blower house	1	RC"	521	5
6) Neutralization dosing house	1	RC"	126	6
7) Relay pumping station (3 locations)	1	RC"	87	7, 8, 9
8) Guard house	1	WD		10

(c) Description of Building Design

Description of building design cover the following items of architectural, structural, mechanical and electrical works.

- Design condition and criteria
- Building and system design concept and solution
- Material used

Undertaking the design, similar approach and solution have been adopted as described in the Chapter 3.6. For detail information and description, Chapter 3.6 will be referred.

However, functional aspects have been taken into consideration as a primary objective to achieve in designing of buildings due to functional nature of the buildings.

3.8.4 Operation and Maintenance

(1) System Outline

(a) Organization

An organization related to the operation and maintenance of the sewerage system is shown in Figure 3.8-4-1.

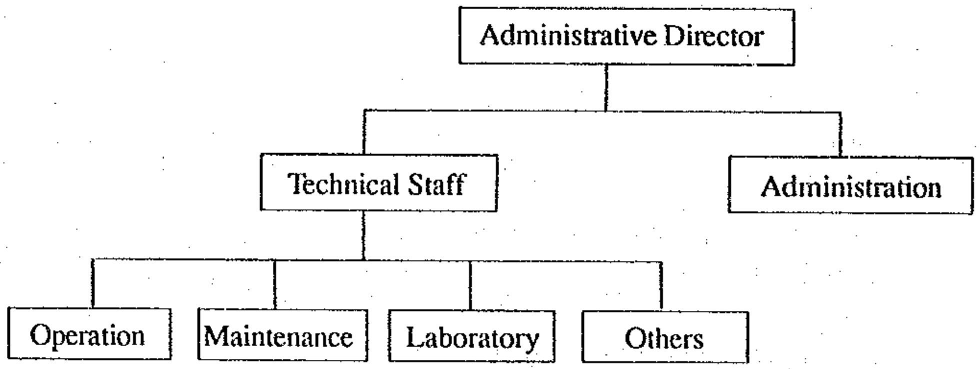


Figure 3.8-4-1 Organization of Sewerage System

(b) Number of Staff

The required staff related to the operation and maintenance of the sewerage system is shown in Table 3.8-4-1.

Table 3.8-4-1 Number of Staff

	Kind of Work	Speciality							Total
		Mechanical	Electrical	Instrumental	Chemical	Civil	Architecture	Others	
1.	Directors office								
	-1. Engineer					1			1
	-2. Worker							1	1
	-3. Secretary							1	1
	Sub-Total	0	0	0	0	1	0	2	3
2.	Wastewater Treatment Plant								
	-1. Engineer	2	2	1	1	1	1		8
	-2. Operation Worker	9	9	2	3	3	2		28
	-3. Maintenance Worker	6	4	2	2	4	2		20
	-4. Laboratory Worker	1			5				6
	-5. Other	2						5	7
	Sub-Total	20	15	5	11	8	5	5	69
3.	Pipelines								
	-1. Engineer	1				2			3
	-2. Operation Worker					10		5	15
	-3. Maintenance Worker					10			10
	Sub-Total	1	0	0	0	22	0	5	28
4.	Relay Pumping Station								
	-1. Engineer	1	1			1			3
	-2. Operation Worker	6	6			6		2	20
	-3. Maintenance Worker	including to WWTP							-
	Sub-Total	7	7	0	0	7	0	2	23
5.	Administration								
	-1. Office Worker							9	9
	-2. Secretary							9	9
	Sub-Total	0	0	0	0	0	0	18	18
	Total	28	22	5	11	38	5	32	141

(2) Wastewater Treatment Plant

(a) Outline

Operators can supervise the process operating conditions of the W.W.T.P. through a centralized supervisory panel in the operation center. However, the operation of equipment shall be basically carried out by the local control panel(s) and control device(s).

(b) Normal Operations

* Manually operated equipment or machine(s) -- Manual operation by operator.

* Motor/air/actuator-operated equipment or ----- Manual operation by operator machine(s) using the local control panel(s) and control device(s).

However, the following equipment shall be operated both in the manual and automatic modes:

* Sewerage Pump Operation------
  * Automatic mode
    The pumps shall be automatically operated according to the water level of the pump well at the raw wastewater pumping station.
  * Manual mode
    Manual operation according to the level meter as observed by the operator.

* pH control of Neutralization --- Tank
  * Automatic mode
    Caustic soda or aluminum sulfate shall be injected by feeding pump(s) based on pH information supplied by the pH meter and the quantity controlled by the pH controller. The object is to maintain neutral pH (pH = approximately 7).
    However, the control range of pH values for the controller shall be set manually.
  * Manual mode
    Manual operation according to pH meter as observed by operator.

* Chlorination Control ------------ * Automatic mode
  Chlorinated water shall be automatically injected by the feeder according to proper ratio of effluent flow.
  In this case, the ratio of effluent flow shall be set by manual operation.

  * Manual mode
    Manual operation according to the instructions given by operator.

* Floor Drain Pump --------------- * Automatic mode
  The pumps shall be automatically operated according to the water level of the pump well.

  * Manual mode
    Manual operation according to the water level as observed by the operator.

(c) Operation under Abnormal Conditions

When abnormal equipment conditions occur and are confirmed on the centralized supervisory panel in the operation center, an operator shall be dispatched immediately to the site and the details of the abnormal equipment conditions shall be checked.

The stand-by shall be used and the faulty equipment shall be dealt with in accordance with the trouble shooting and instruction manuals.

(d) Operation under Power Failure Conditions

1) When a power failure occurs on the 22 KV loop transmission line, the emergency generator sets will be started up automatically at the substation.

However, the centralized supervisory panel in the center will continue to indicate the actual status of the W.W.T.P. using an uninterruptable power supply even if power failure has occurred.

The operator will confirm the start-up of the emergency generator sets which will be monitored on a supervisory panel, another operator will be dispatched immediately to the substation and the air circuit breaker for the emergency generator sets shall be connected to the 380 V bus line manually after checking that the air circuit breakers for commercial power are opened.

2) Power from the emergency generator sets will be supplied to the electric room of the W.W.T.P. and then air circuit breakers which were opened promptly by the under voltage relay (27) in the electric room of the W.W.T.P. shall be closed again manually in a prescribed sequence.

Power will be changed over to the emergency generator sets successfully from commercial power by the above procedure.

3) Then, operators shall be dispatched to each local control panel and equipment shall be brought on-line again in a gradual sequence.

The functions of W.W.T.P. will be restored by power from the emergency generator sets.

(e) Operation under Power Recovery Conditions

1) After power recovery conditions are registered on the supervisory panel, an operator will be dispatched to the substation, air circuit breakers for the transformer shall be closed after air circuit breakers for the emergency generator sets are opened.

In this situation, power failure could occur again at any time.

2) Power from commercial sources will be supplied to the electric room of the W.W.T.P. and then air circuit breakers which were opened promptly by the under voltage relay (27) in the electric room of the W.W.T.P. shall be closed again manually in a prescribed sequence.

Power will be changed over to commercial power from the emergency generator sets successfully by the above procedure.

3) Then, operators shall be dispatched to each local control panel, and equipment shall be brought on-line again in a gradual sequence.

The function of the W.W.T.P. will be restored to operation by commercial power.

(3) Sewer Pipeline

(a) Outline

In order to keep the wastewater conveyance system in good condition to maintain a smooth flow and utilize its capacity fully, the following maintenance work is required:

a. Inspection and cleaning or dredging
b. Repair of sewer pipe breakages
c. Countermeasures for calamities and accidents
d. Instructions for house connections

(b) Maintenance of each facility

1) Sewer

a. Inspection of flow conditions and situations where debris has accumulate
b. Checking of depressions in the ground surface along sewer lines
c. Inspection of sewer pipe breakages
d. Monitoring and prevention of poisonous gas generation

2) Manholes

a. Inspection of cover breakages
b. Inspection of interior structural conditions

3) House inlet and connection pipes

a. Checking of structural conditions and silting of house inlets
b. Checking clogging and breakages in house connection pipes

(4) Relay Pumping Stations

(a) Operation Methods

1) Normal Conditions

Pumps shall be operated by induction motor with 380 V, 50 Hz, 3 phase, 4 wire normal power supply.

Pumps are started manually and controlled by water level.

2) Operation under Abnormal Conditions

Among three pumps installed, two (2) pumps operate in parallel and one (1) pump is a stand-by in case of accidents. Also, another one (1) pump (pump and motor) should be provided at ware house.

All pumps are designed for quick installation and easy repair.

3) Operation under Power Failure Conditions

The diesel generator shall be set up to operate two (2) pumps under emergency conditions. The diesel generator shall be designed to operate for six (6) hours continuously.

The generator shall start automatically when it receives the voltage drop signal and be stopped manually.

(b) Maintenance

1) Smooth Running

It is important to clearly understand the system, construction and performance of equipment for daily maintenance. To maintain the high performance of equipment, it is necessary to record details of inspection and repair.

2) Maintenance of Equipment

In the pumping station, the grit chamber is arranged to remove screenings and grit at the inlet channel. It is important to remove screenings and grit frequently to maintain enough volume for the pumps.

3) Spare Parts

Spare parts are important for the continuous operation of the pumping stations. It is desirable to keep two (2) sets for parts that wear out. One (1) set for other parts is sufficient in case of accidents or other problems.

3.8.5 Economic Analyses

(1) An Estimation of Capital and O & M Costs

Capital cost and O & M cost are shown in Table 3.8-4-2 below.

Table 3.8-4-2 Cost Estimation

(Million LE)

Item	Capital	O & M (Million/Year)
Sewer Pipe	41.25	-
Pumping Station	29.61	0.40
WWTP	176.52	7.44
Total	247.38	7.84

(2) Economic Analyses

Economic analyses were carried out for three cases on the basis of the construction staging scheme. The construction staging is programmed in accordance with the final implementation schedule and an assumption. Results of these analyses are given in Tables 3.8-4-4 to 3.8-4-6. A brief explanation about each case is given below.

Case - 1: The whole construction work will be implemented within 3 years in accordance with the final implementation schedule. Revenue will be expected in full-scale from the next year after construction is completed.

Case - 2: The construction schedule is same as Case - 1. Revenue is distributed in the same way as Case - 3.

Case - 3: The construction work is staged to 3 phases. Revenue is expected from the next year after the completion of every phase of construction, in proportion to the available capacity of the wastewater treatment plant.

Similar analyses were carried out for the evaluation of the reuse of treated domestic sewage. Results of these analyses are given in Table 3.8-4-7.

(3) The results

The results of the analyses are shown in Tables 3.8-4-4 to 3.8-4-6. The user charge is estimated together with alternative resources of revenue and outcomes are shown in Table 3.8-4-3:

Table 3.8-4-3. Comparative Study of the User Charge

	Item		User Charge (LE/m³)	Land Price Increase Rate (LE/m²)	Government Aid from (LE/m³)
Case -1	All Costs by user charge	Table-8.12	1.8	-	-
		Table-8.13	1.8	-	-
		Table-8.14	1.6	-	-
Case -2	O & M payment by charge	Table-8.12	1.1	52.0	-
		Table-8.13	1.1	52.0	-
	capital cost interest by land price	Table-8.14	1.0	53.8	-
Case -3	O & M by user charge	Table-8.12	0.4	31.5	1.0
	Interest repayment by Government Aid	Table-8.13	0.4	31.5	1.0
	Capital cost by land price	Table-8.14	0.4	31.5	0.8
Case -4	O & M by user charge	Table-8.12	0.4	83.5	0.3
	Interest by Government Aid	Table-8.13	0.4	83.5	0.3
	Capital cost repayment by land price	Table-8.14	0.4	89.2	0.2

*Area of I.E. = 768 ha (Roads, Green Area exclude)

Case - 1: unrealistic

Case - 2: user charge is still high when compared with portable water tariff 0.5 LE/M³

Case - 3: user charge is reasonable and so is land price

Case - 4: recommendable

Exchange rate are as follows.

1 US$ = 3.58 LE

[Appendix 3.8-1] Wastewater Characteristics

1 Introduction

This section of the report is concerned with the characteristics of domestic sewage and industrial wastewater of the project service area.

Determination of the type and size of required treatment facilities are direct functions of the design flow quantity, design pollutant loads and the treated water quality, which are in turn functions of the expected domestic and type of industries in the service area.

The quantity and quality design criteria are described below.

2 Wastewater Quantity and Quality

2.1 Wastewater Quantity

The wastewater flow (Average Daily) has been taken to be about 80 percent of the water supply, which is in accordance with the criteria given by the Egyptian Code.

Maximum Daily and Peak Hourly wastewater quantities are estimated as follows:

a. Industrial wastewater
- Maximum daily = average daily x 1.2
- Peak hourly = average daily x 2.0 x 1/24

b. Domestic sewage
- Maximum daily = average daily x 1.3
- Peak hourly = average daily x 2.0 x 1/24

2.2 Infiltration

The rate and quantity of groundwater infiltration depends on length of sewers, ground water table, sewers material, sewers joints conditions, sewers diameter soil conditions, topography and so on.

Infiltration of underground water to the sewerage system was taken to be equal to zero, since the results of the site survey showed no trace of groundwater throughout the whole site.

2.3 Wastewater Quality

The domestic sewage and industrial wastewater quality or composition refers to the actual amounts of physical, chemical, and biological components. The important contaminants in wastewater treatment design are PH, BOD, COD, and SS.

BOD	:	Biochemical Oxygen Demand
COD	:	Chemical Oxygen Demand
SS	:	Suspended Solids

Composition of domestic sewage has been established in MODANC. Also composition of industrial wastewater are determined in accordance with the planning of the industrial estate activities and wastewater quality of each industry. Quality of treated wastewaters has to comply with the Egyptian Law No. 48. In case that the Egyptian Law has no criteria, regulations of discharge in Japan are applicable.

In Egypt, industrial effluent to public sewer is not allowed unless it does meet the regulations specified by the Egyptian law No. 93 for 1962.

3 Characteristics of Industrial Wastewater

3.1 Quantity: Q_2 (Avg. Daily)

The quantity is calculated as follows.

$$Q_2 = \text{Q'ty of Water supply} \times 80\,\% + \text{Infiltration}$$
$$= 57{,}817\ m^3/day \times 80\,\% + 0$$
$$= 46{,}254\ m^3/day \Rightarrow 46{,}500\ m^3/day$$

Therefore, the quantity of Avg. Daily, Max. Daily, and Peak Hourly are as follows.

Avg. Daily	46,500 m^3/day
Max. Daily	$46{,}500 \times 1.2 \fallingdotseq 55{,}800\ m^3/day$
Peak Hourly	$\frac{46500 \times 2}{24} \fallingdotseq 3{,}875\ m^3/hour$

Note: The quantities of water supply are shown in Chapter 3.7.

3.2 Quality of Industrial Wastewater (treated wastewater by pre-treatment plants)

Wastewater qualities are estimated by taking the average wastewater quality of each industry as given by the Design Criteria of Sewerage, Sewerage Association of Japan, 1984. Wastewater qualities are as follows.

- PH : 6 ~ 10
- BOD : 330 mg/l
- COD : 280 mg/l ------------ (as potassium permanganete method.)
- SS : 380 mg/l

Note: (1) Wastewater qualities are shown in Table A3.8-1-1.
(2) Wastewaters have to be pre-treated if necessary.

3.3 Quality of Treated Wastewater

The qualities are according to Law No. 48 in Egypt and regulation of discharge in Japan. They are as follows.

- PH : *6 ~ 9
- BOD : less than 20 mg/l
- COD : less than 50 mg/l--------- (as potassium permanganete method.)
- SS : *less than 50 mg/l
- OIL : less than 5 mg/l (Mineral oil)
  less than 30 mg/l (Animal & Vegetable oil)
- Coliforms : less than 3,000 MPN/100 ml

Note: * are according to Law No. 48 in Egypt. Other items are according to Japanese regulations.

Table A3.8-1-1 Quantity and Quality of Industrial Wastewater

Industry	Quantity (Avg. Daily)	Quality						
		PH	BOD		COD*		SS	
	m³/day	-	mg/l	kg/day	mg/l	kg/day	mg/l	kg/day
1. Ataqa I.E. and Adabiya I.F.Z								
1) Food	2,400	6 to 10	400	960	310	744	340	816
2) Wood Products	2,400	6 to 10	100	240	280	672	120	288
3) Plastic	1,890	6 to 10	390	738	340	643	90	171
4) Paper Products	2,140	6 to 10	400	856	200	428	390	835
5) Spinning & Waving	5,310	6 to 10	400	2,124	260	1,381	230	1,222
6) Electrical	4,370	6 to 10	240	1,049	170	743	500	2,185
7) Mechanical & Metal ind.	1,630	6 to 10	280	457	280	457	300	489
8) Building Materials	5,060	6 to 10	270	1,367	50	253	500	2,530
9) Chemicals & Pharmaceutic	3,000	6 to 10	400	1,200	400	1,200	500	1,500
10) Others	6,420	6 to 10	400	2,568	480	3,082	500	3,210
Sub-Total	34,620	6 to 10	334	11,559	278	9,603	383	13,246
2. Ataqa I.E. Expansion Area	10,280	6 to 10	334	3,434	278	2,858	383	3,938
3. Ataqa Port	1,400	6 to 10	200	280	180	252	250	350
4. Commercial & Public Use	200	6 to 10	200	40	180	36	250	50
Total	46,500	6 to 10	330	15,313	280	12,749	380	17,584

*: COD measured using potassium permangancte method.

4. Characteristics of Domestic Wastewater

4.1 Quantity: Q_1 (Avg. Daily)

The quantity is calculated as follows:

$$Q_1 = \text{Q'ty of Water supply} \times 80\,\% + \text{Infiltration}$$
$$= 6{,}650\ m^3/day \times 0.8 + 0$$
$$= 5{,}320\ m^3/day \Rightarrow 5{,}400\ m^3/day$$

Therefore, the quantities of Avg. Daily, Max. Daily, and Peak Hourly are as follows.

Avg. Daily	5,400 m^3/day
Max. Daily	5,400 x 1.3 ≑ 7,020 m^3/day
Peak Hourly	$\frac{5400 \times 2}{24}$ ≑ 450 $m^3/hour$

4.2 Quality of Domestic Sewage

The qualities are obtained from MODANC on July 1992. They are as follows.

- PH : 6 to 9
- BOD : 280 mg/l
- SS : 400 mg/l
- COD : 580 mg/l --------------(as dichromate method.)

4.3 Quality of Treated Sewage

The qualities are according to Law No. 48 in Egypt. However, sewage is treated at wastewater treatment plant of US-AID Project.