2-3 Outline of the Project Area

(1) Socio-Economy

Yogyakarta City is the capital of Yogyakarta Province which is one of 27 provinces in Indonesia.

The city is composed of 14 Kecamatan, and these 14 Kecamatan are further sub-divided into 45 Kelurahan.

Total area of the city is 3,250 hectares, of which urbanized area is 2,753 hectares.

Total population of the city as of 1991 was 413,346, and the population density at urbanized area was 150/hectare on average. The population is estimated to grow to 469,000 by the year 2012 which is the target year of long-term plan.

Yogyakarta City has developed as a representative international tourism city and center of the culture in Indonesia. The tourism industry is ranked at the top of all industries in the city, and 664,416 tourists visited the city in 1989, of which 180,896 were foreigners.

(2) Natural conditions

The climate is tropical throughout the year. The annual rainfall varies in the range of 1,400 mm - 3,100 mm with an average of 2,000 mm.

The season is divided into dry season and rainy season; the dry season is from May to October, and rainy season is from November to April. Temperature varies in the range from 22 °C to 34 °C.

Yogyakarta City is located at the south foot of volcano Merapi, and its altitude is from 80 m to 130 m above sea level.

Four (4) rivers of Winongo River, Code River, Belik River and Gajah Wong River are running through the city from north to south, by which the drainage areas of the city are divided into five (5) areas as shown in Fig. 2-3. The land surface of the city is inclining at the gradient of 0.8 % from north to south, but the surface is almost flat to east-west direction.

According to the geological survey, the sub-soil strata in the construction site of sewage treatment plant are composed of the following soil characteristics.

- Silt of volcanic ash or silty sand in the layer at a depth between ground surface and 5-7 m.
- Hard silty sand or sand of volcanic ash in the layer at a depth between 5-7 m and 11-17 m.

(3) Social Environment

1) Infrastructures

Yogyakarta City is an international tourism city, and there are many hotels and stores in the city. Road and electricity supply are well developed.

The site for treatment plant is located in a rural area more than 10 km away from the city border. Road width is narrow as 4 - 5 m, and there are few telephone facilities.

There is a power transmission line of the National Electricity Corporation (PLN) along the Jalan Bantul about 800 m east from the site.

2) River water pollution

River water in the city is much polluted due to lack of appropriate wastewater disposal system. The river water quality was observed by YUDP in mid of dry season of 1991 at seven (7) sites of the Winongo, Code and Belik rivers.

BOD ranges from 9 mg/l to 75 mg/l with an average of 42 mg/l. CODcr varies between 22 mg/l and 350 mg/l, averaging 92 mg/l. Fecal Coliform is in the order of 10^7 - 10^{12} MPN/100 ml.
Details are shown below.

	BOD (mg/l)		COD (mg/l)		FC (MPN/100 ml)	
	UP	DN	UP	DN	UP	DN
Winongo River						
Taman Sari	36	45	65	86	2.4×10^9	2.4×10^{10}
Serangan	14	32	22	43	2.4×10^9	2.4×10^{10}
Code River						
Gondomanan	31	68	75	111	1.1×10^8	1.7×10^8
Prawirodirjan	69	87	121	350	2.4×10^9	2.7×10^8
Karangkajen	26	50	43	108	4.6×10^9	1.6×10^{12}
Gondolayu	9	16	22	43	2.7×10^7	9.0×10^7
Belik River						
Gayam	32	75	65	139	2.4×10^{11}	1.6×10^9

Note : UP: upstream of sewerage outlet
DN: downstream of sewerage outlet

Observed locations are shown in Fig. 2-3.

3) Groundwater pollution

Shallow groundwater in the city is much polluted. High level of NH_4 and Fecal Coliform are observed in many shallow wells of the city. It is likely due to human waste disposal into underground by on-site sanitation system.

While, the service ratio of piped water supply in the city is still in a low level. Approximately 85 % of the population are using individual shallow wells for drinking water supply without any treatment.

This indicates a high potential of waterborne disease contraction of the people.

(4) Existing Sewerage System

1) Service area and served population

The existing sewerage network was constructed under the colonial rule in 1936-38 and was later expanded, starting in 1955 by the local government. It is separated from the storm water drainage network.

As of 1991, the sewerage system covers 612 ha of the city (19 % of the city area), serving 57,920 people (14 % of the city population).

The sewerage service area, served population and nos. of connection are summarized below.

(1)	Total Area of City (ha)	3,257
(2)	Sewerage Service Area (ha)	612
(3)	Total Population of City	413,346
(4)	Sewerage Served Population	57,920
(5)	Nos. of House Connection	11,320
	Domestic Connection	9,050
	Non-domestic Connection	2,270

Location of the existing sewerage service area is shown in Fig. 2-4.

2) Sewer networks and treatment plant

Total length of the existing sewers is estimated to be 90,948 m with a break-down of;

- Lateral Sewer: 82,103 m
- Main/Trunk Sewer: 8,845 m

Slope of the existing lateral sewers (east-west) and trunk sewers (north-south) is mild. This makes it necessary to flush sewer pipes with river water. Hence, flushing pipes with a total length of 19,443 m are additionally provided.

Most lateral sewers and flushing pipes are egg-shaped with a diameter of 20/30 cm. Most trunk sewers are also egg-shaped with larger diameters of 30/45, 35/52.5 to 40/60 cm. The diameters of the trunk sewers are not sufficient to convey all the flushing water, hence at several locations, excess water overflows into the rivers.

Almost all the collected sewage is not treated. A pilot plant was constructed in 1940 and rehabilitated in 1969. It is of trickling filter type with a design capacity of 10 l/s. It is used for research.

3) Sewerage system outside the city

There is a sewerage system outside Yogyakarta City. It covers the Gajah Mada University and neighboring area located in Kel. Caturtanggal, Kec. Depok and Kel. Sinduadi, Kec. Melati of Kab. Sleman. The area adjoin the northern boundary of the city. The service area, served population and nos. of connection of the sewerage system are as follows.

(1)	Service Area (ha)	110
(2)	Served Population	7,040
(3)	Nos. of House Connection	1,375
	Domestic Connection	1,100
	Non-domestic Connection	275

Location of the existing service area is shown in Fig. 2-4.

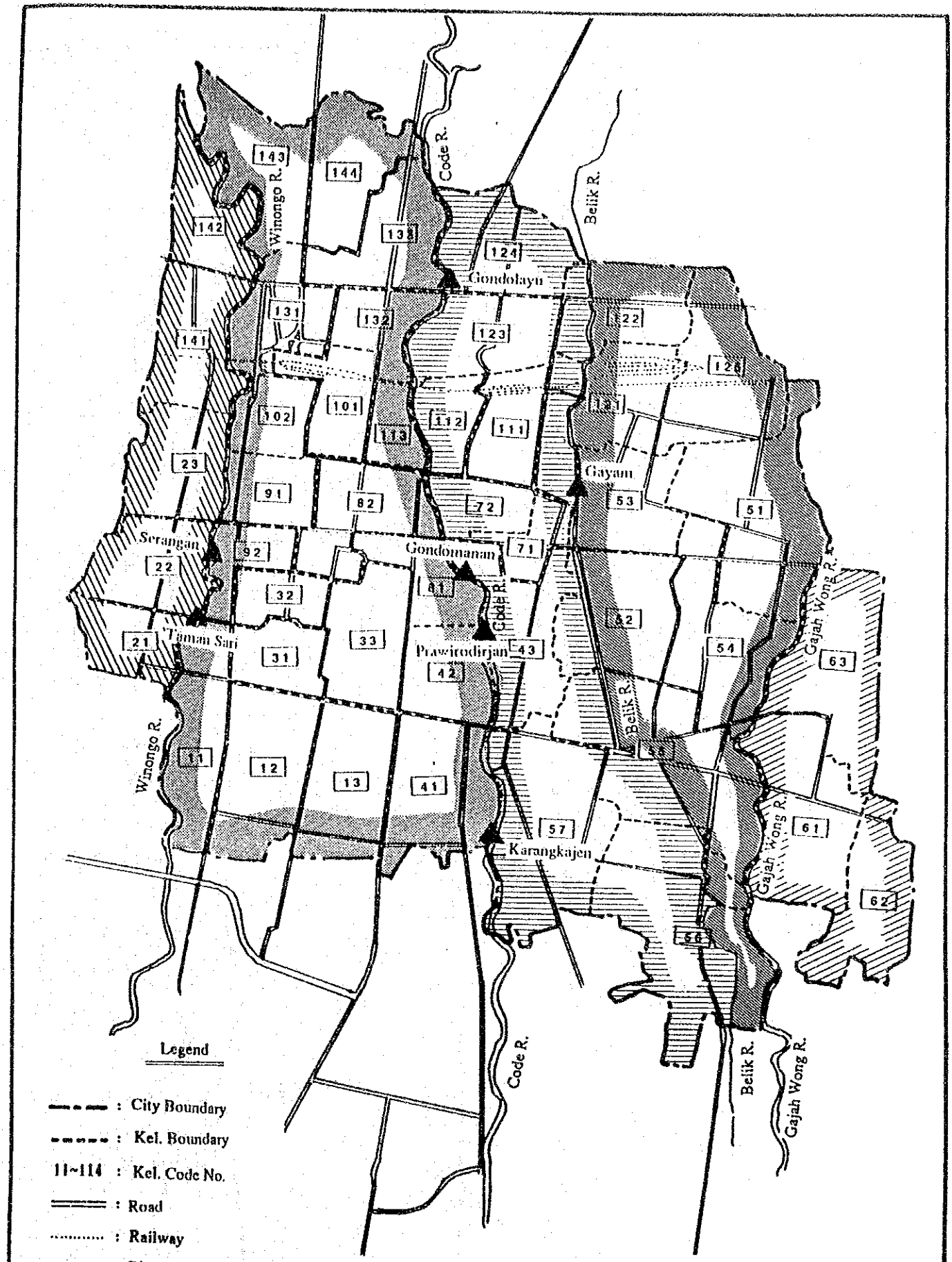


Fig. 2-3 Division of City Area

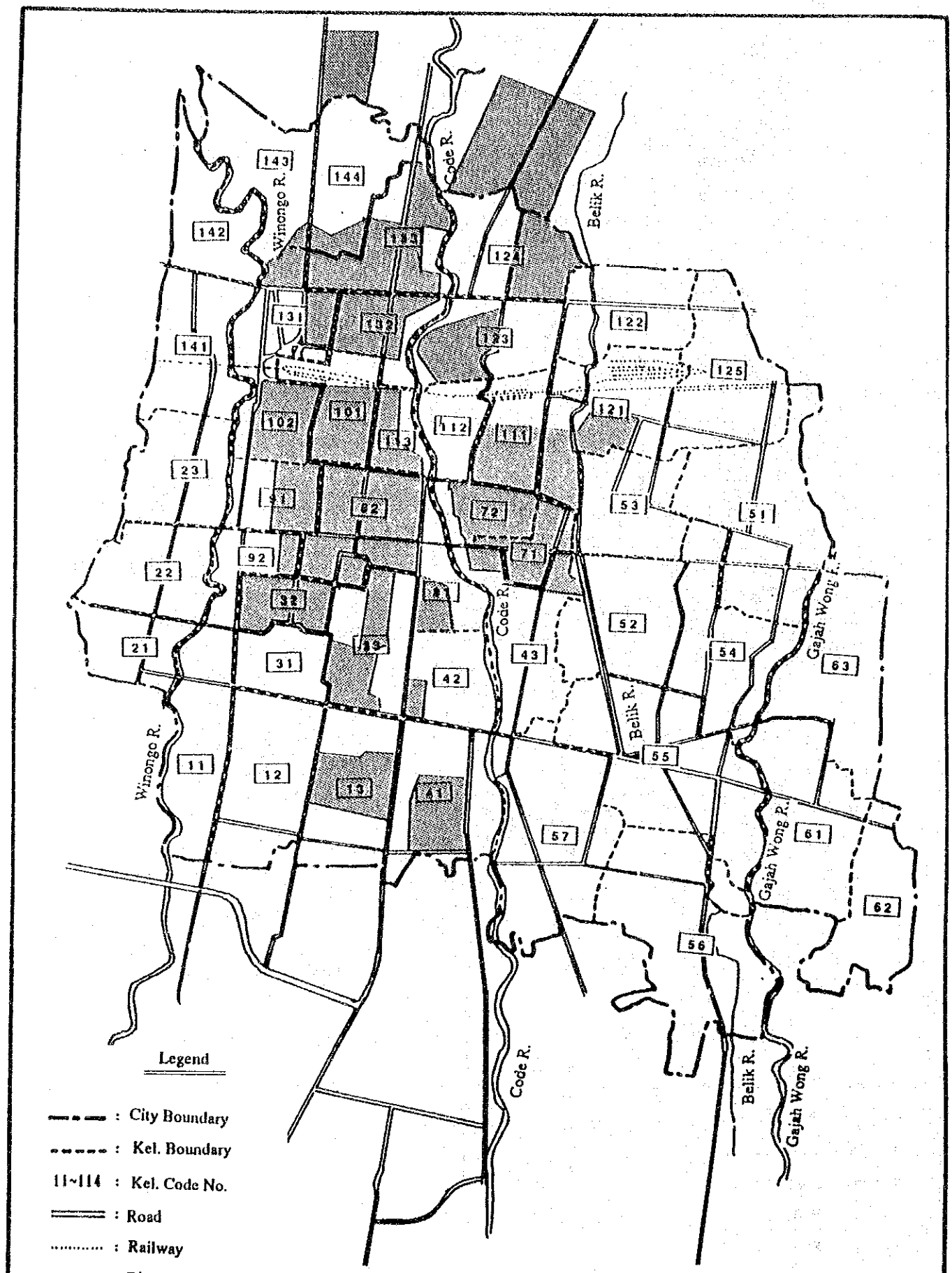


Fig. 2-4 Existing Sewerage Service Area

CHAPTER 3 OUTLINE OF THE PROJECT

Chapter 3 OUTLINE OF THE PROJECT

3-1 Objective

In order to cope with the serious contamination of river water and groundwater in Yogyakarta City, the Governmet of Indonesia has prepared a master plan of sewerage development as a part of YUDP, and established a medium-term plan setting the target at the year 2002 and long-term plan setting the target at the year 2012.

The medium-term plan incudes construction of lateral sewer (7 km), trunk sewer (17 km) and sewage treatment plant (15,500 m^3/day) in addition to increasing the number of house connections in the existing service area and rehabilitation of the existing sewer networks for the target service area of 1,330 ha covering the major part of Yogyakarta City, and a part of Kabupaten Sleman and Kabupaten Bantul.

In order to accomplish this medium-term plan, the Governmet of Indonesia requested ADB loan for the construction of lateral sewer (7 km) and upstream trunk sewer (11 km), and also requested the Governmet of Japan to provide a grant aid for the construction of sewage treatment plant and installation of downstream trunk sewer (6 km) connected to the treatment plant.

The objective of this project is to construct the sewage treatment plant and downstream trunk sewer to attain the target of the medium-term plan along with the upstream trunk sewers and lateral sewers to be constructed with the financial assistance of ADB.

3-2 Study and Examination on the Request

(1) Examination of the Necessity and Appropriateness of the Project

1) This project is considered to be appropriate as the subject for grant aid from the following viewpoints:

(i) Yogyakarta City is developing as an international tourism city and the center of academy and culture in Indonesia. However, the contamination of the river water and groundwater (being used for drinking by 85 % of total population of the city) is serious. It is necessary to develop the sewerage system immediately. According to the investigation by YUDP, the patients diagnosed as diarrhea at 18 health service offices in the city during January - June, 1992 were as many as 145 persons/week on average.

(ii) Average river water quality in the city reaches 42 mg/l in stream BOD according to the observation by YUDP. Self-purification effects of river can not be expected anymore. This river water pollution is very heavy, compared with international river water quality standards (Japanese river water quality standard of the lowest class is less than 10 mg/l in stream BOD).

(iii) A large number of Fecal Coliform are counted in the river water and groundwater. It indicates a high potential of waterborne diseases in the project area.

(iv) The existing sewer network (approx. 90 km including the lateral sewers) is utilized effectively. The construction of sewage treatment plant will maximize the benefits of sewerage system along with the existing sewerage facilities.

(v) The following effects are expected from this project.

i) Contraction of waterborne diseases will be reduced by the purification of river water and groundwater.
Moreover, the landscape of river will be improved, and it will contribute to the tourism development of the city.

ii) There are few full-scaled sewage treatment facilities in Indonesia. Successful operation of the proposed sewage treatment plant will facilitate the development of sewerage in other cities.

iii) Training of operators and technical engineers by this project will contribute to the dissemination of sewerage facilities in other cities.

2) Environmental impact of the construction of sewage treatment plant

It is required to conduct the environmental assessment and obtain an approval of the authorities concerned before the start of construction according to the governmental regulation.

Environmental assessment of this project is now being carried out by YUDP. However according to the preliminary analysis of the JICA study team, adverse environmental impacts of this project are considered small and less important as described below.

(i) Air

No adverse impact is expected to the atmosphere except the emission of odor. However, odor emission of the proposed facultative aerated lagoon treatment system is considered minimal due to the aerobic nature of treatment. Moreover,

(ii) Noise

The main source of expected noise is aerator operation. Noise nuisance is considered also minor because the site is remote from residential areas. Tree planting around the treatment plant will be useful for reduction of the noise.

(iii) Sludge

Sludge generated in the process of wastewater treatment will be accumulated in the bed of lagoon for long time and digested under anaerobic condition. Hence, odor of desludged sludge is minor. The desludged sludge will be dried for final disposal. This dried sludge contains no pathogenic bacteria.

(iv) Effluent

i) Water quality standards in Indonesia

(a) Bedog River is only used for agriculture but not used for domestic and industrial water supply.

(b) National standards for wastewater effluents are established by the order of Minister of Interior (KEPMEN KLH) and those for river water quality are by the government regulation (PP No. 20/1990).

Those are shown below.

(Wastewater Effluent Standards)

	Category of Receiving Water			
	I	II	III	IV
BOD (mg/l)	less than 20	less than 50	less than 150	less than 300

Note: 1. There is no standards for Fecal Coliform

2. Category of receiving water
   I. : drinking water source
   II. : agriculture/fishery water source
   III. : no water usage
   IV. : no water usage

Bedog River is in the category II.

(River Water Quality Standards)

	Category of River Water			
	A	B	C	D
Fecal Coliform MPN/100 ml	0	less than 2,000	–	–
Total Coliform MPN/100 ml	less than 3	less than 3,000	–	–

(Note) 1. There is no standard value for BOD.

2. Category of river water
   A : drinking water source necessary for no treatment
   B : drinking water source necessary for treatment
   C : agriculture/fishery water source
   D : no usage

   Bedog River is in the category C.

(c) Effluent quality of the sewage treatment plant of this project shall be below 50 mg/l in BOD according to the above water quality standards.

ii) Standards for river water quality and wastewater effluents in Japan (for reference)

(a) River water quality standards
Water quality in the river of agricultural water source shall be below 8 mg/l in stream BOD. No standards of Fecal Coliform are provided.

(b) Wastewater effluent standards
BOD shall be below 160 mg/l and further below 120 mg/l on daily average. Fecal Coliform shall be below 3,000 MPN/ml on daily average.

iii) Assessment of wastewater effluent and river water quality

The treated wastewater quality of this project is estimated to be 38 mg/l in BOD and 4 x 10^4/100 ml in Fecal Coliform, and the design wastewater discharge is 0.18 m^3/s (refer to Chapter 4, 4-3 (3)).

The water quality of Bedog River is estimated to be 6.9 mg/l in stream BOD after receiving the wastewater effluents as shown below, assuming that the river flow is 3.0 m^3/s in dry season and original river water quality is 5.0 mg/l in stream BOD.

$(3.0 \times 5 + 0.18 \times 38)/(3.0 + 0.18) = 6.9$ mg/l

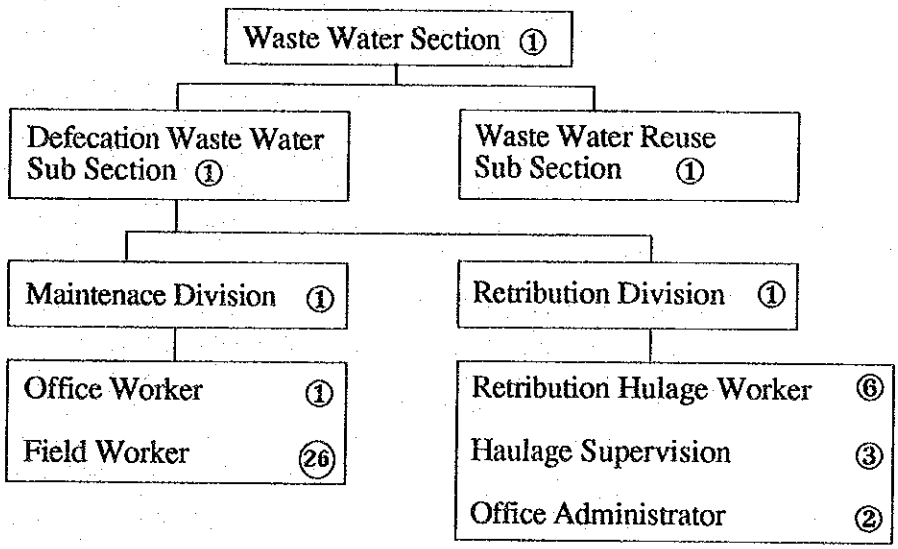
The effluent quality of this project meets both Indonesian and Japanese Standards. Adverse effects of this project on the Bedog River is considered minor.

(Note) The flow rate of Bedog River is presumed from the data obtained from Water Resource Department (Dinas Pengairan) of Yogyakarta Province.

(2) Operation and Management Plan

1) Organization in charge of operation of existing sewerage facilities in Yogyakarta

(i) The existing sewerage facilities in Yogyakarta City are managed and operated by Cleaning and Park Department (Dians Kebersihan Dan Pertamanan - DKP) which is a part of municipality organization.
In the DKP, there is Waste Water Section (Seksi Penanggulangan Air Kotor), in which 43 staff members including the Section Chief are working.



(Note) The figures in (○) show the number of staff members.

The operation and maintenance of facilities are under the responsibility of Maintenance Division, and fee collection is conducted by Retribution Division.

(ii) The organization in charge of pilot plant of trickling filter system has 103 staff members including analysts for other than wastewater. It belongs to the separated organization (Environment Technical Board of Province: Balai Teknik Penyehatan Lingkungan), and is outside the scope of medium-term plan.

2) Operation and management in the medium-term plan of YUDP

(i) Organization

After completion of the medium-term plan, the entire sewerage system including the existing facilities will be managed by a new organization.

The new organization will be established under the administration of the Provincial Government, because the service area of the facilities covers not only Yogyakarta City but also a part of two Kabupatens.

(ii) Number of staff member

In this project, the number of staff members for new organization is proposed.

3) Revenue and expenditure of wastewater section in Yogyakarta City

The revenue and expenditure of DKP for sewerage facilities in 1991 fiscal year are as follows:

(Expenditure)

(1)	Personnel expenses	:	Rp.	39.6×10^6 (for 43 persons)
(2)	Maintenance expenses	:	Rp.	4.15×10^6
	Total		Rp.	43.75×10^6

(Revenue)

(1)	Tariff	:	Rp.	8.25×10^6
(2)	Subsidy from Province	:	Rp.	35.5×10^6
	Total		Rp.	43.75×10^6

(i) The tariff income is only 19 % of the total expenditure. The tariff income is calculated based on the following rates.

Rp. 150/month/domestic connection

Rp. 250/month/non-domestic connection (hotel, factory, stores, etc.)

(ii) The new tariff system as shown in Table 3-1 has been employed since the beginning of 1992 fiscal year.

(iii) For reference, the total expenditures related to infrastructure in Yogyakarta City for 1988 fiscal year was Rp. 2.7 billion.

(iv) According to Real Demand Study by YUDP, the average income per household in Yogyakarta City for 1991 was about Rp.160,000/month. Under the new tariff system, tariff for a household of 5 or less (family members) is Rp.1,000/month, which is 0.6 % of average monthly income.

Table 3-1 New Tarrif List

	Classification	Maintenance Fee (Rp./month)	Management Fee (Rp./month)	License Fee (Rp.) (at registration only)
Domestic	1 ~ 5 persons/house	500	500	2,000
	6 ~ 10 persons/house	1,000	500	2,500
	11 ~ 20 persons/house	2,000	500	3,000
	21 ~ 50 persons/house	4,000	500	3,500
	51 persons or more/house	8,000	500	4,000
Non-domestic	Capital Rp.25 x 10^6 or less	3,000	500	2,500
	Capital less than Rp.50 x 10^6	6,000	500	5,000
	Capital Rp.50 x 10^6 or more	12,000	500	7,500

(3) Relation with Other Aid Organizations

1) The master plan and feasibility study of this project has been conducted with the assistance of Swiss Government as a part of YUDP.

2) The scope of this project is to construct sewage treatment plant, downstream trunk sewer extending to the treatment plant, and discharge line connecting between the treatment plant and Bedog River according to the medium-term plan (see Fig. 3-1).

On the other hand, the Governmet of Indonesia is requesting ADB loan for the upstream trunk sewer and lateral sewers.

Therefore, the prerequisite for this project is the construction of upstream trunk sewer under the ADB loan.

(4) Project Components

The components of this project are as follows. (Refer to Fig. 3-1)

1) Construction of sewage treatment plant

Capacity: 15,500 m^3/day

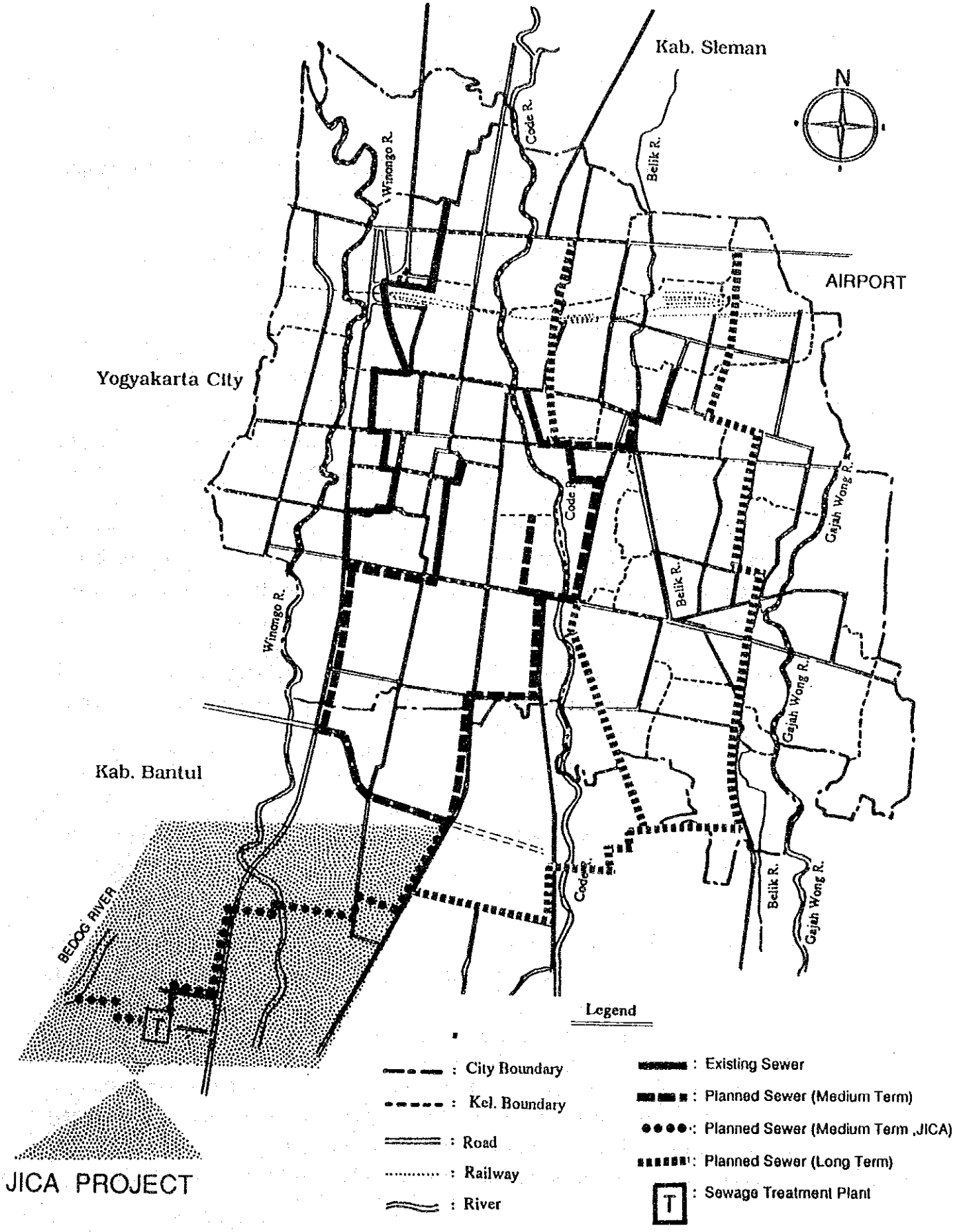
2) Installation of trunk sewer

Downstream side trunk sewer of 6 km (gravity flow) extending to the treatment plant.

3) Installation of discharge line

Discharge line of 2 km from the treatment plant to Bedog River.

Fig. 3-1 Scope of Project



3-3 Project Description

(1) Executing Agency and Managing Organization

This project will be implemented by the Central Government [Directorate of Environmental Sanitation (PLP), Directorate General of Human Settlements (Cipta Karya)].

After completion of this project, a new managing organization under the administration of Yogyakarta Provincial Government will be established.

(2) Sewerage Development Plan

1) National Sewerage Development Plan

(i) The Governmet of Indonesia is envisaging the construction of off-site facilities (sewerage) in the large cities in the 5th 5-year plan started in 1989.

(ii) Policies for the development of urban infrastructures and the improvement of institutional and financial capability of local governments are established in the Integrated Urban Infrastructure Development Program (IUIDP) prepared by the Central Government.

(iii) The study on the Yogyakrta Urban Development Project (YUDP) has been carried out based on the concept of IUIDP by the Provincial Government of Yogyakarta with the technical assistance of Swiss Government.

2) Sewer development plan in YUDP

YUDP prepared the medium and long-term plans of the sewerage development for the Yogyakarta urban area covering the Yogyakarta City, and the adjoining urban areas of Kab. Sleman and Kab. Bantul in 1991.

The medium-term plan intends to mainly increase the number of service connections in the existing sewerage service area, rehabilitate the existing sewerage system and provide a new sewage treatment plant. The plan targets the year 2002. However, the construction is scheduled to be completed by 1996.

The long-term plan will extend the sewerage service area to areas where on-site facilities are not feasible and/or where off-site systems are affordable. It will further include expansion of the treatment system. The plan targets the year 2012. The construction is scheduled to be implemented during 1996 to 2012.

(i) Sewerage development plan of Yogyakarta City

The sewerage service area will be increased to 954 ha (29 % of city area) in 2002 and 1,933 ha (59 %) in 2012, serving 94,080 people (22 % of city population) in 2002 and 246,720 people (53 %) in 2012.

(ii) Sewerage development plan for outside area of Yogyakarta City

The proposed sewerage development plan serves the following four (4) Kelurahans adjacent to the city.

- Kel. Caturtunggal, Kec. Depok, Kab. Sleman
- Kel. Sinduadi, Kec. Melati, Kab. Sleman
- Kel. Tamanan, Kec. Banguntapan, Kab. Bantul
- Kel. Panggungharjo, Kec. Sewon, Kab. Bantul

The sewerage service area, served population and nos. of connections of the medium and long-term plans are summarized below.

Item	Unit	Medium-term	Long-term
		(2002)	(2012)
1. Total Area of City	ha	3,257	3,257
2. Sewerage Service Area	ha	1,330	2,413
1) Domestic Area	ha	1,112	2,133
2) Non-domestic Area	ha	218	300
3. Total Population of the City	person	436,294	468,975
4. Sewerage Served Population	person	110,912	272,960
5. Nos. of House Connection		21,690	53,505
1) Domestic Connection		17,330	42,650
2) Non-domestic Connection		4,360	10,855

The sewerage service areas are shown in Fig. 2-2.

The proposed major sewerage construction works of the medium and long-term plans are summarized below.

(YUDP Plan)

	Medium-term (1992-1996)	Long-term ((1996-2012)
Rehabilitation of Existing Network		
Lateral Sewer (m)	2,500	-
Trunk Sewer (m)	2,500	-
Extension of Network		
Lateral Sewer (m)	7,400	48,100
Trunk Sewer (m)	17,050	18,500
River Crossing (place)	2	2
Flushing Pipe (m)	2,500	23,000
Treatment Plant (m^3/d)	15,500	37,000

Location of the proposed trunk sewer extension by the medium and long-term plans are shown in Fig. 3-1. The proposed treatment site is also shown in this figure.

3) Outline of this project

The outline of this project is as follows.

(i) Project components (refer to Fig. 3-1)

i) Construction of sewage treatment plant
Construction of sewage treatment plant to meet the medium-term plan.
Capacity : 15,500 m^3/day

ii) Installation of trunk sewer
Installation of trunk sewer of 6 km connected to the treatment plant

iii) Installation of discharge line
Installation of treated wastewater discharge line from the treatment plant to Bedog River (approximately 2 km).

(ii) Service area

The service area of this project is 1,330 hectares under medium-term plan and 2,413 hectares under long-term plan of YUDP.

(3) Location and Condition of Project Site

1) The location of project site is shown in Fig. 3-1. The sewage treatment plant is located at Dusun Diro and Dusun Cepit of Desa Pendowoharjo, Kecamatan Sewon, Kabupaten Bantul.
[Dusun: Sub-organization of village (Desa)]

2) The site of sewage treatment plant is located in the vast rice field and far from residential areas. The land is flat.

(4) Outline of Facilities

Fig. 3-2 shows the outline of facilities of this project.

1) Sewage treatment plant

The sewage treatment plant of facultative aerated lagoon will be constructed within the site of 6.7 hectares.

2) Trunk sewer

Concrete pipe (diameter 1,000 mm and 1,300 mm) will be installed from J1. Lingkar Selatan to the treatment plant.

3) Discharge line

Concrete pipe (diameter 800 mm) and open channel will be installed from the treatment plant to Bedog River.

(5) Operation and Maintenance Plan

1) Required activities and staff members

(i) A new organization for sewerage management will be set up after completion of the medium-term plan. The organization will operate and maintain the whole sewerage facilities of the project area including the existing sewer networks.

(ii) The required operation and maintenance works are maintenance of sewer networks, collection of tariff, and operation and maintenance of sewage treatment plant.

(iii) The required number of staff members is shown in Table 3-2.

Table 3-2 Number of Staffs for New Organization

No.	Work Item	Staff	Number of Staffs	Basic, etc.
1.	Maintenance of Sewer Networks			maintenance of sewer networks and discharge line including the operation of flushing gates
		(1) Field Worker	36	26 persons for existing pipeline of 19 km. In the medium-term, 24 km is extended
		(2) Office Worker	6	including Section Chief and Division Chief
		Sub Total	42	
2.	Collection of Tariff	(1) Tariff Collector	12	existing : 6 person for 11,320 connections. medium-term : 21,690 connections
		(2) Supervisor of Tariff Collection	6	
		(3) Office Administrator	6	including Division Chief.
		Sub Total	24	
3.	Operation and Maintenance of Sewage Treatment Plant	(1) Office Worker	3	including a Manager.
		(2) Engineer	2	1 Electrical, 1 Mechanical
		(3) Forman	2	
		(4) Worker	12	6 persons x 2 shifts
		(5) Water Quality Analyst	3	
		Sub Total	22	
		Total	88	

2) Required cost

The expenses necessary for the maintenance and operation of sewerage facilities after the completion of medium-term plan are estimated as follows:

No.	Item of Expenses	Expense (Rp x 10^6/Year)	Basis
1.	Personnel	158.4	88 persons x Rp. 150 x 10^3/month x 12 months
2.	Electricity	141.1	1,086,853 KWH x Rp. 120/KWH + Rp. 10,656 x 10^3
3.	Operation and Maintenance	107.3	① maintenance cost for sewer networks Rp. 4.15 x 10^6 x $\frac{114\ km}{90\ km}$ = Rp 5.3 x 10^6 ② O & M cost for treatment plant Rp. 102 x 10^6
	Total	406.8	excluding escalation, depreciation and loan repayment.

3) Tariff income

The annual tariff income under the new tariff system after completion of the medium-term plan is calculated as follows.

Tariff income from domestic connections

= (number of connections) x (tariff) x (tariff collection rate : N)
= 17,330 x Rp. 1,250/month x 12 months/year x N
= Rp. 260 x N x 10^6/year -------①

Tariff income from non-domestic connections

= 4,360 x Rp. 3,500/month x 12 months/year x N
= Rp. 183 x N x 10^6/year--------②

In the above calculation, the average tariff of domestic connection and non-domestic connection were assumed to be Rp. 1,250/month and Rp. 3,500/month respectively. Moreover, the existing illegal connections (56 % of total connections as of 1992) were assumed to be completely registered.

Therefore, the total tariff income will be ① + ② = Rp. 443•N x 10^6/year

4) Balance of income and expenditure (the year 2000)

In order to cover the expenses necessary for operation and maintenance by the above tariff income,

Rp. 443 x N x 10^6/year = Rp. 406.8 x 106/year

therefore, N = 0.92

it is necessary to maintain the tariff collection rate at 92 % or higher.

The following measures shall be taken to maintain the sound management of the new sewerage organization in financial aspect.

(i) Elimination of illegal connections

(ii) Improvement of tariff collection rate (92 % or higher)

5) Balance of income and expenditure before the year 2002

The above balance of income and expenditure was calculated for the year 2002 when the medium-term plan is to be completed.

The sewerage facilities of the medium-term plan will be completed in 1996, however, the number of connections of the medium-term plan will not attain the target until the year 2002. It will be difficult to maintain the profitability of sewerage organization during the period of 1996 to 2002. Subsidy from the government will be necessary for the time being.

6) Replacement of the equipment

Replacement of the mechanical and electrical equipment in the sewage treatment plant is necessary at an interval of about 10 years. The new sewerage organization shall take the following actions.

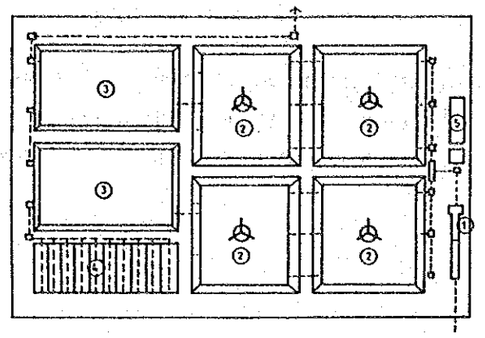
(i) Prepare the replacement plan of equipment

(ii) Secure the budget for replacement

Elimination of the illegal connections and improvement of the tariff collection rate are essentially necessary to secure the budget for the replacement of equipment. The tariff rate shall be raised if necessary.

Fig. 3-2 General Plan of Sewerage Facilities (JICA Scope)

SEWAGE TREATMENT PLANT (STP)



① Coarse Screen/Grit Chamber/Fine Screen/Pump Pit/Pump
② Facultative Aerated Lagoon
③ Maturation Pond
④ Sludge Drying Bed
⑤ Administration Building

3-4 Technical Cooperation

Indonesia has little experience in operation and maintenance of sewage treatment plant. Hence, on-the-job training of engineers and operators is essentially necessary.

During the construction period of this project, the operation and maintenance manual of sewage treatment plant will be prepared and intensive on-the-job training will be conducted based on the manual. These works will be performed as a part of this project.

CHAPTER 4 BASIC DESIGN

Chapter 4 BASIC DESIGN

4-1 Design Policy

The basic design of this project will be conducted based on the following design policies.

1) The sewerage facilities shall be designed in compliance with national policy, regulations and standards concerning sewerage facilities in Indonesia.

2) The sewerage system shall be well coordinated with YUDP plan and smoothly connected with upstream trunk sewer of ADB loan.

3) The sewage treatment plant shall be designed to suit the site conditions with due consideration to the following aspects.

   (i) Natural conditions especially characteristics of tropical climate
   (ii) Required technology level of sewage treatment system
   (iii) Location and required space of treatment plant
   (iv) Economic efficiency
   (v) Easiness of operation and maintenance

4) Sewer pipe materials and structural type of treatment plant shall be selected or determined, considering the local construction conditions. Local materials shall be employed as much as possible.

5) Mechanical and electrical equipment of the treatment plant shall be designed so that a high level technology may not be required for their operation and maintenance.

6) Construction schedule shall be prepared with due consideration to the climatic conditions and work efficiency at the site.

7) Supply of electric power and water to the treatment plant are the works under the responsibility of the Governmet of Indonesia. Intensive discussions shall be made with the related agencies and officials so that these works can be implemented without delay.

4-2 Design Criteria

(1) The design criteria of sewage treatment plant under YUDP are as follows:

(Medium-term plan)

- Served population: 110,000 persons
- Average sewage: 15,500 m^3/day (179 l/s)

- Peak flow of sewage: 1,282 m³/hour (356 l/s)
- BOD load: 5,103 kg/day (46 g/person/day)
- Sewage BOD concentration: 332 mg/l

(Long-term plan)

- Served population: 273,000 persons
- Average sewage: 37,000 m³/day (428 l/s)
- Peak flow of sewage: 3,007 m³/hour (835 l/s)
- BOD load: 12,572 kg/day (46 g/person/day)
- Sewage BOD concentration: 348 mg/l

The peak flow is calculated by the following formula.

[(flushing water volume) + (domestic sewage volume + non-domestic sewage volume) x 2]

(2) The above design criteria are considered to be appropriate, compared to other similar projects. Therefore the sewage treatment plant of this project is designed based on the above design criteria for the medium-term plan.

Ponds and lagoons are designed to meet the average sewage flow rate. Pumps and connection pipes, etc. are designed to meet the peak flow of sewage.

(3) The peak factor for the design of trunk sewer is determined to be three (3), referring to that of other similar projects. This is as same as YUDP plan.

Peak factors for the design of trunk sewer adopted in other similar project are shown below.

Project	Peak Flow Factor	Remarks
1) 1977 Master Plan of Jakarta Sewerage & Sanitation Project	$4.02\ Q^{-0.154}$ Q : daily average discharge in 1,000 m³/d	In case Q = 37,000 m³/day Peak Factor: 2.3
2) Bandung Urban Development Project (BUDP)	1.5 ~ 4 Depending on population density	
3) Medan Urban Development Project (MUDP)	2 ~ 5 Depending on population density	

(4) The standards applied to design the facilities of this project are as follows.

(i) Manning's formula :
It is employed for the design of trunk sewer and discharge line of gravity flow.

(ii) Guideline for sewerage facility design in Japan :
It is used for the design of sewage treatment plant. However, reduction of BOD load by facultative aerated lagoon is calculated by the formulae of Marais and Duncan Mara (see, Section 4-3 (3)).

(iii) The following standards are applied to the design of civil works, and mechanical and electrical equipment.

* Japan Industrial Standard (JIS)
* Standard of Japan Electric Standard Examination Commission (JEC)
* Japan Electric Machine Standard (JEM)
* International Electro-Technical Commission (IEC)
* Steel Structure Design Standard in Japan
* Concrete Structure Calculation Standard in Japan

4-3 Basic Plan

(1) Project Area

As shown in Fig. 3-1, the sewage treatment plant, trunk sewer and discharge line of this project are all located in Kabupaten Bantul.

(2) Design of the Trunk Sewer

The trunk sewer of this project is about 6.0 km long from the southern edge of sewerage service area to the treatment plant, and there is no connection of lateral sewers in this section. Fig. 4-1 shows the service area and trunk sewer route, and Fig. 4-2 the longitudinal profile of overall sewer networks in YUDP plan.

1) Design criteria

(i) Design wastewater discharge
The sewer pipe is designed to meet the peak flow of the wastewater discharge in the year of 2012. The design peak flow is obtained by adding flushing flow to

domestic and non-domestic wastewater with a peak factor of three (3). The design discharge of the sewer pipe of this project is given below.

i) Upstream section : 1.34 km between the uppermost section and the junction with the trunk sewer C. Q = 731 l/s

ii) Downstream section : 4.32 km from the junction with the trunk sewer C and the sewage treatment plant. Q = 1,413 l/s

(ii) Flow velocity

The Manning's formula is applied for calculation of the velocity of gravity flow. The minimum velocity is 0.6 m/s and maximum velocity is 3.0 m/s. The roughness coefficient of the Manning's formula is assumed as n = 0.013 for RC pipe

(iii) Allowance of sewer pipe capacity

Allowance of sewer pipe capacity to design peak discharge is assumed to be 50 % - 100 %.

(iv) Depth of sewer pipe laying

The minimum earth covering depth of sewer pipe is determined as 1.5 m to prevent collapse of pipe due to load on it. While, the maximum depth of pipe invert is determined to be 5.5 m to minimize ground water infiltration.

(v) Location of sewer pipe laying

The sewer pipes will be installed under the road, in principle. The pipes will be installed at the edge side of road in order to avoid the interruption of traffic in the trunk road section (2,704 m) which has a wider width and at the center of road in the village road section (2,915 m) which has narrow width. The standard section of pipe installation is as shown in Fig. 3-2.

(vi) Manhole

Manhole will be placed at the following locations.

i) Starting point of sewer route
ii) Point where the diameter, direction or gradient of pipe is changed
iii) Junction with other sewer line
iv) At every 100 m for the strait section of sewer pipe
v) Point where manhole is necessary for maintenance

2) Longitudinal profile and cross section

The proposed longitudinal profile and diameter of the sewer pipe are summarized below.

(i) Upstream section (between the uppermost section and the junction with the trunk sewer C)

- Distance : L = 1,338 m
- Slope : S = 1:180
- Earth covering depth : D = 1.7 - 3.6m
- Pipe diameter : Ø = 1,000 mm

(ii) Downstream section (between the junction with the trunk sewer C and the sewage treatment plant).

- Distance : L = 4,317
- Slope : S = 1:800
- Earth covering depth : D = 1.6 - 3.9 m
- Pipe diameter : Ø = 1,300 mm

For details of the longitudinal profile, see Fig. 4-3.

3) Structural design of sewer pipes and manhole

(i) Type of sewer pipes

Reinforced concrete pipe of socket type will be used considering easiness and reliability of the connection of pipes.

(ii) Foundation for sewer pipes

The soil at the depth where the pipes are installed is sand or silty sand with N value of 15 - 40. These soils are classified into ordinary soil and hard soil from the viewpoint of soil durability.

Groundwater table is at 0.9 m - 4.0 m depth below the ground surface.

Sewer pipes will be installed by open trench method. Sand mixed with gravel will be laid in the bed of open trench as the foundation of sewer pipe. Cross-tie will also be placed on the bed of open trench to support the sewer pipe.

(iii) Manhole

Manhole is planned to be a reinforced concrete structure molded at the site. Cast iron will be used for the manhole cover.

(iv) River crossing

i) Basic conditions

The proposed sewer pipe crosses the Winongo River by a siphon structure. Any other structures than siphon are not practical. The siphon consists of two (2) sewer pipes of which one is used for emergency. A spillway is provided to discharge wastewater into Winongo River at an emergency time of the sewage treatment plant. The proposed structures are shown in Fig. 4-10.

ii) Hydraulic calculation for siphon

The hydraulic head loss caused by siphon is calculated by the following formula.

$$H = i \times L + 1.5 \times \frac{V^2}{2g} + \alpha$$

where, i ; Hydraulic gradient in the siphon pipe (1 : 350)
L ; Length of siphon pipe (21 m)
V ; Flow velocity in siphon pipe (1.68 m/s)
g ; Acceleration of gravity (9.8 m/s^2)
α ; Allowance (3 cm)

The flow velocity in siphon pipe is designed to be 1.2 - 1.3 times of the flow velocity in upstream sewer pipe to prevent the sedimentation of soil and mud. From the above formula, hydraulic head loss of the siphon at Winongo River is calculated to be 0.3 m.

iii) Siphon Structure

Manholes are installed at inlet and outlet of the siphon pipes.

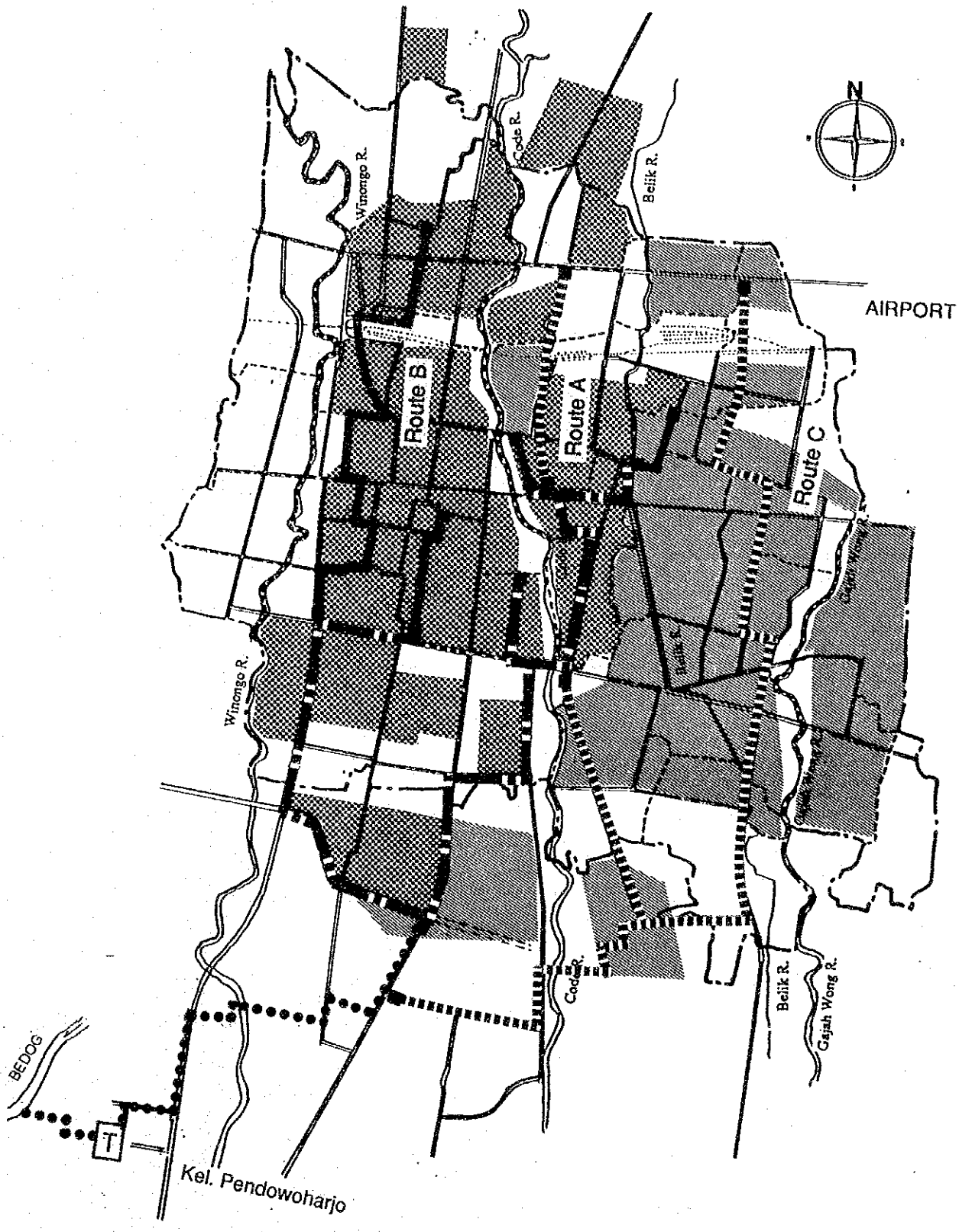
The connection points between these manholes and trunk sewer pipes are designed with bell-mouth shapes to lower the hydraulic head loss of the inlet and outlet of the siphon.

Inside of the manholes, flash-boards for maintenance and a concrete base for submersible pump are provided.

The earth cover over the siphon pipes is more than one meter, which will be sufficient because the river bed consists of rock and hard clay soil.

Siphons at the Winonga River and irrigation channel of discharge line are shown in Fig. 4-10 and Fig. 4-11.

Fig. 4-1 Planned Service Area and Trunk Sewer



: Planned Service Area (Medium Term : 2002)

: Planned Service Area (Long Term 2012)

: Existing Sewer

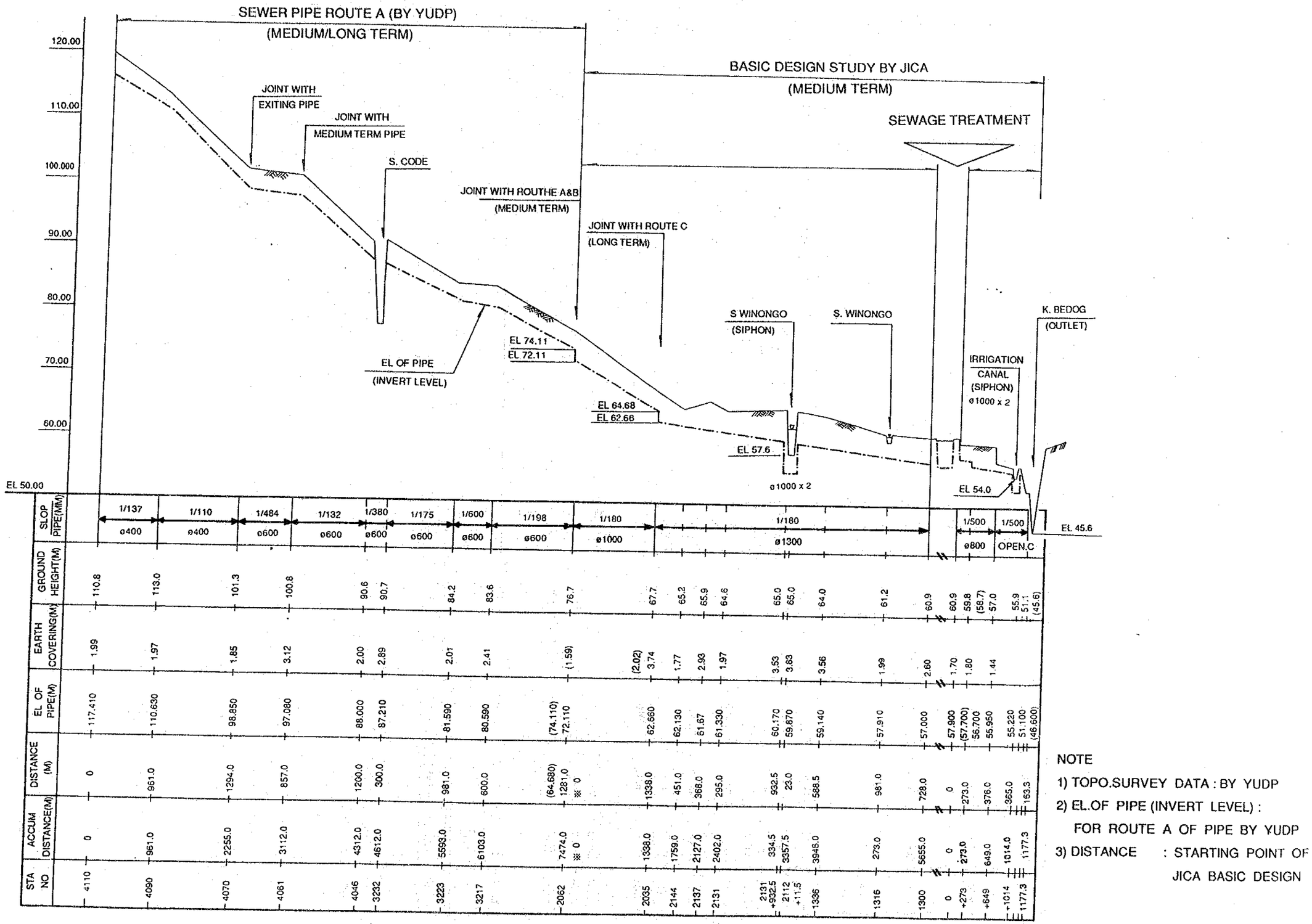
: Planned Sewer (Medium Term)

: Planned Sewer (Medium Term ,JICA)

: Planned Sewer (Long Term)

T : Sewage Treatment Plant

Fig. 4-2 Longitudinal Profile of Overall Sewer Network (1/3)



NOTE

1) TOPO.SURVEY DATA : BY YUDP
2) EL.OF PIPE (INVERT LEVEL) :
   FOR ROUTE A OF PIPE BY YUDP
3) DISTANCE : STARTING POINT OF
   JICA BASIC DESIGN

Fig. 4-2 Longitudinal Profile of Overall Sewer Network (2/3)

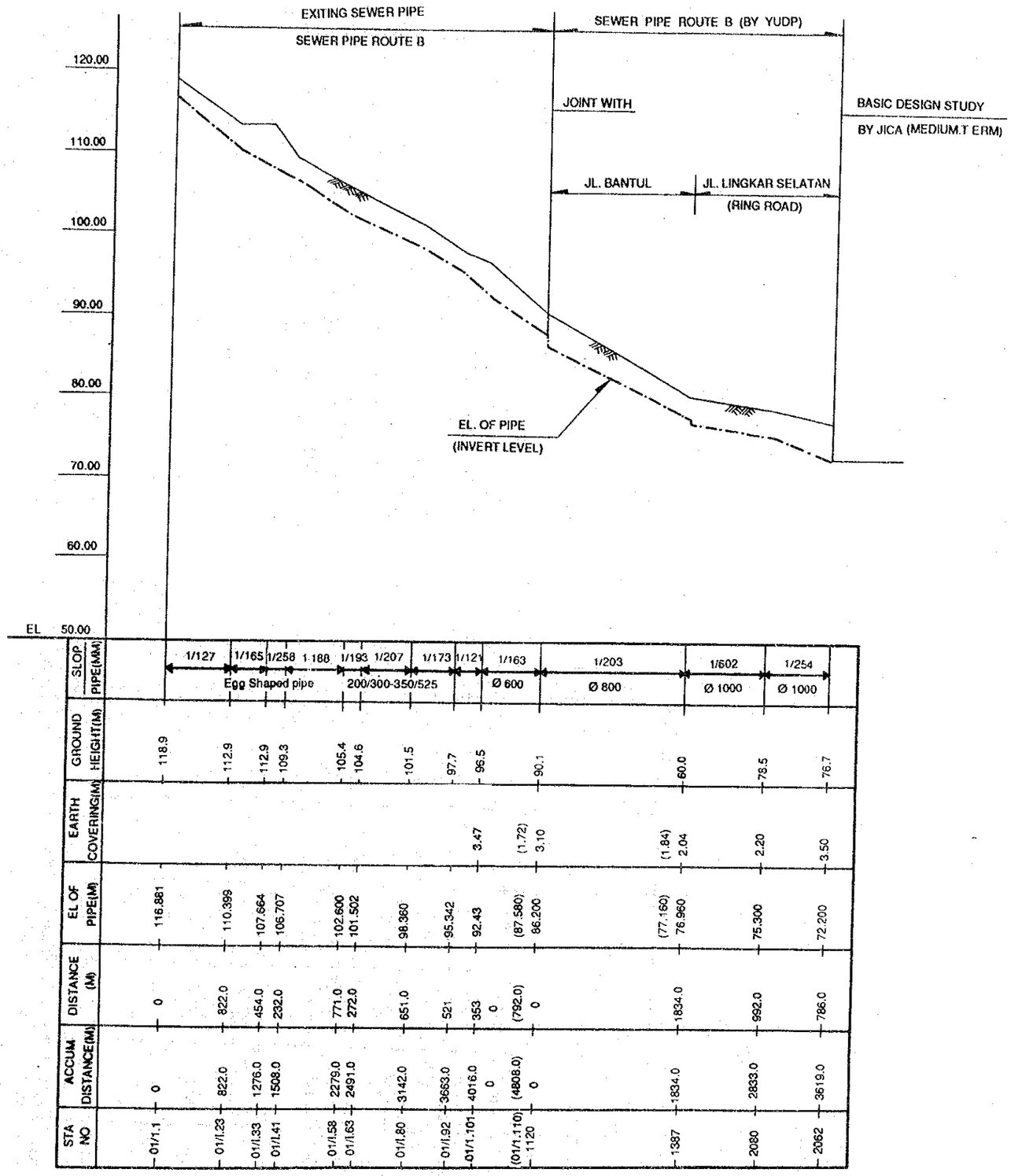


Fig. 4-2 Longitudinal Profile of Overall Sewer Network (3/3)

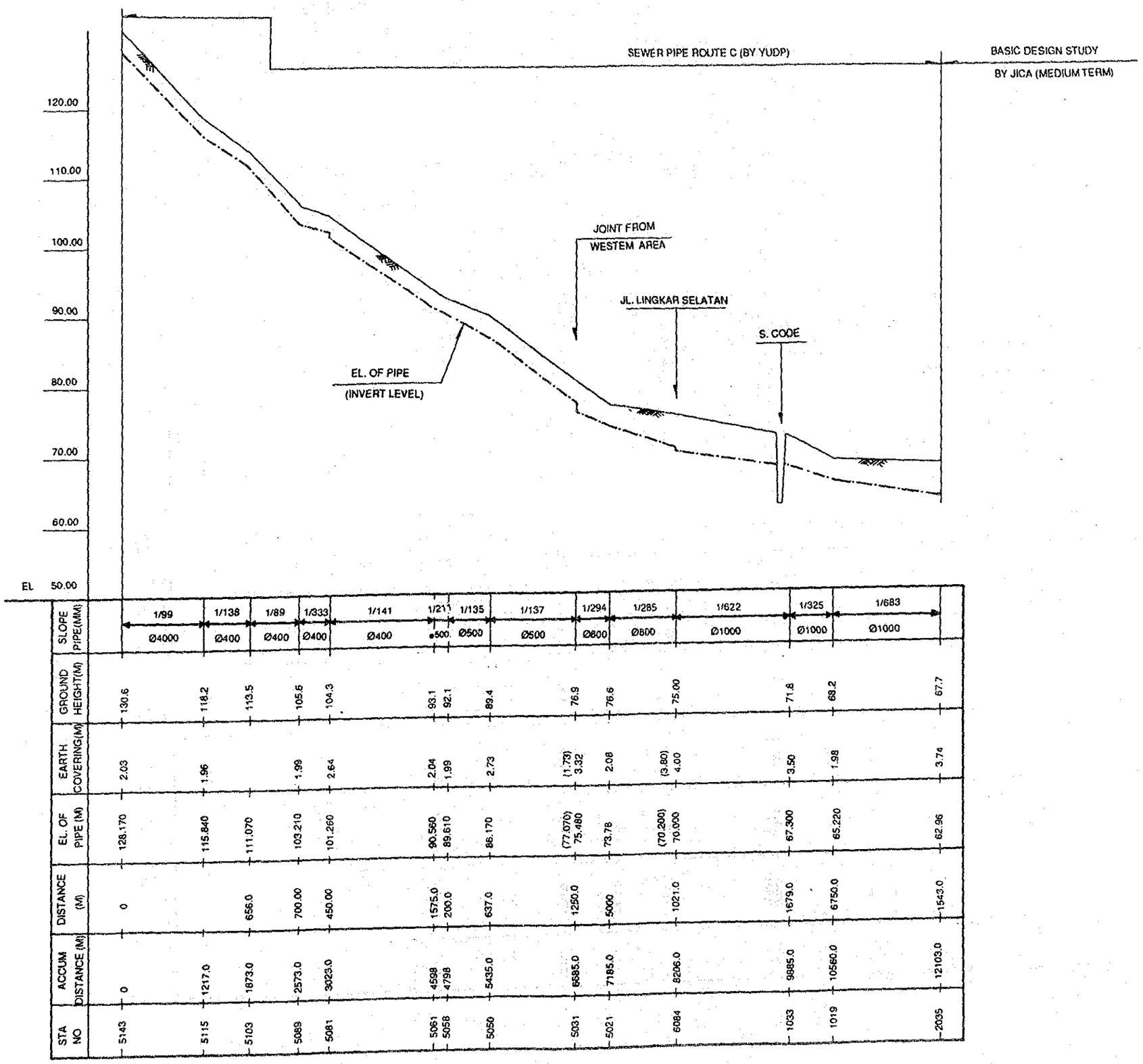
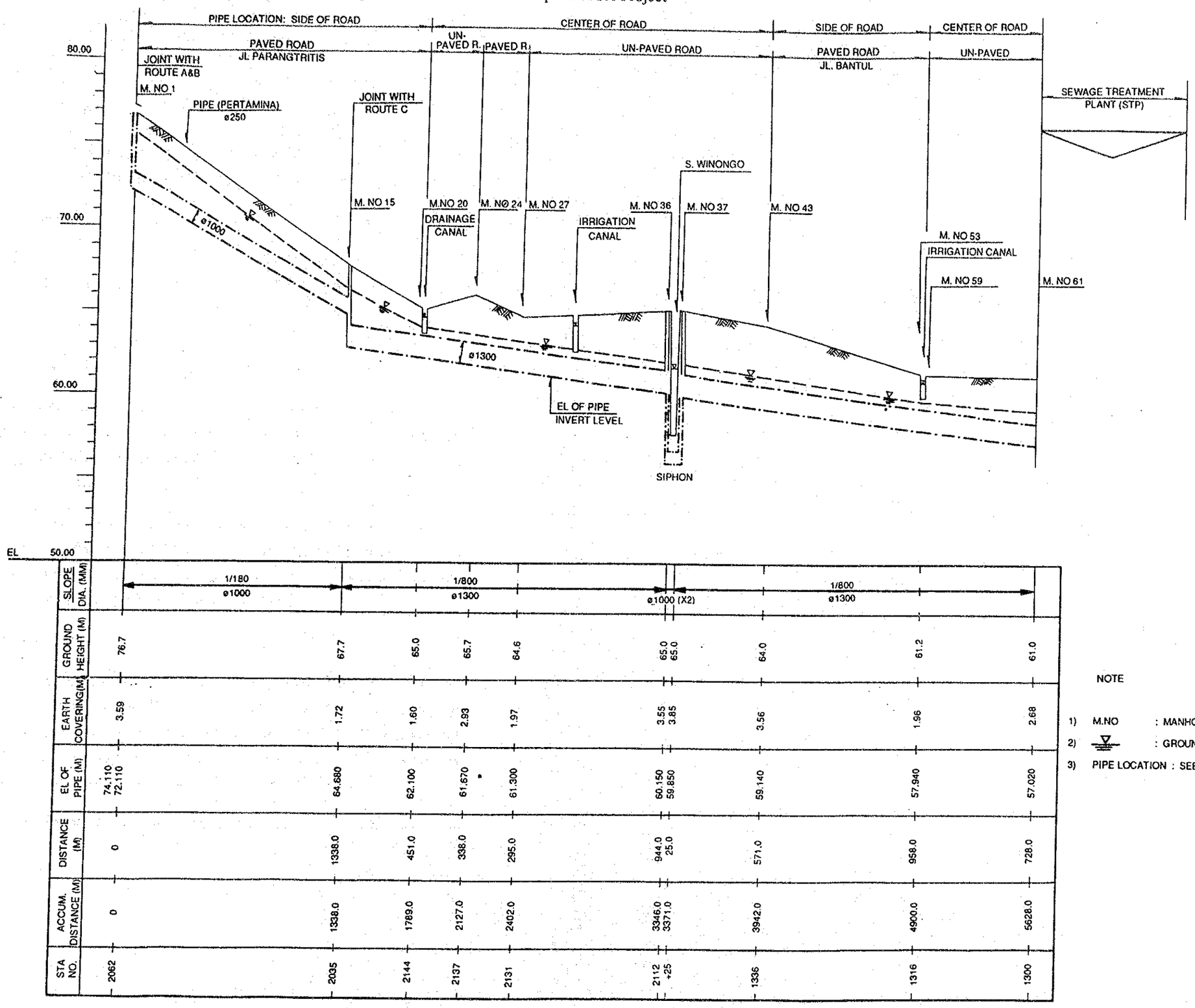


Fig. 4-3 Longitudinal Profile of Sewer Pipe of JICA Project



NOTE

1) M.NO : MANHOLE NO.
2) ▽ : GROUND WATER LEVEL
3) PIPE LOCATION : SEE STANDARD SECTION

(3) Design of Sewage Treatment Plant

1) Design wastewater quantity and quality

The sewage treatment plant is designed to treat the wastewater discharge in the year 2002. The design wastewater quantity and quality are summarized below.

(i) Average sewage flow : 15,500 m^3/day (179 l/s)

(ii) Hourly peak flow : 1,282 m^3/hr (356 l/s)
The hourly peak flow is estimated assuming a peak factor of two (2).

(iii) BOD load : 5,103 kg/day (46 g/person/day)

(iv) Influent BOD concentration : 332 mg/l

(v) Effluent BOD concentration : 30 ~ 40 mg/l
According to the wastewater effluent standard by the order of Minister of Interior, allowable effluent BOD concentration of this project is 50 mg/l (refer to Chapter 3, Section 3-2).

However, the sewage will be treated up to a moderate level of 30 ~ 40 mg/l as BOD, taking into consideration that the treated wastewater may be discharged into the neighbouring irrigation channels for agricultural use in future and adverse environmental effects on Bedog River shall be minimized.

2) Site of sewage treatment plant

The site of the sewage treatment plant is located between the Bedog River and the Winongo River. Its location is about 400 m west of the Jl. Bantul, near the village office of Pendowoharjo (see, Fig. 4-4). Presently, the site is used for sugar cane and rice cultivation. The site is mainly village property. The provincial government has already arranged for the land acquisition of 6.7 ha for the treatment plant.

The site can be reached from Jl. Bantul by two (2) asphalt roads with a width of 3.0 ~ 4.0 m.

3) Sewage treatment system

(i) Selection of treatment system

i) Study result of YUDP

YUDP conducted a comparative study for the following three (3) treatment systems in April 1992 (refer to the "Feasibility Study/EIA Sewage Treatment Plant Yogyakarta").

(i) Facultative aerated lagoon
(ii) Trickling filter with facultative pond
(iii) UASB

They recommended facultative aerated lagoon as the optimum one from integral view points of technology, economy and environments.

The view of the JICA study team on this matter is as follows.

The facultative aerated lagoon and the tickling filter with facultative pond are the most adequate systems to attain a moderate treatment level of BOD 30 - 40 mg/l under the condition that 6.7 ha of land space is available for the treatment plant.

Aerated lagoon system of complete mixing can save the required land space but it requires larger power supply. Trickling filter with secondary settling tank (facultative pond is replaced by secondary settling tank) can also save the land space but can not attain the target effluent quality of BOD 30 - 40 mg/l. These systems are evidently inferior to the above two (2) systems of facultative aerated lagoon and trickling filter with facultative pond.

The UASB (Upflow Anaerobic Sludge Blanket) system is a treatment system based on the anaerobic treatment as the biological process.
The advantages of this treatment are as follows.

(i) The energy requirement of this process is low,
(ii) The production of the sludge is low,
(iii) Generated gas can be utilized for other uses.

In Japan, this process is adopted to treat the waste water from Beer industry, etc. However, BOD removal ratio of the UASB reactor is around 70 % and it is necessary to install an aerobic treatment facilities after this process to achieve BOD 50 mg/l of treated water.

In the F/S of YUDP, the Facultative and Maturation ponds are proposed to be installed after UASB reactors. Therefore, there is not so much difference from other two systems in viewpoints of the space for the facilities and construction cost. The most important disadvantages of this process is the limited experience on a large scale treatment facilities, especially in the sewage treatment. Worldwide around 60 plants of a small scale (up to 100m^3/h) are in operation, but there are few plants of a large scale.
UASB is not recommendable due to lack of experience.

ii) Result of stage II survey

Based on the minutes of discussions at stage I survey, detailed comparisons on "the facultative aerated lagoon" and "trickling filters with facultative pond" systems were conducted in the stage II survey. The result is as follows:

(a) The comparison was conducted for the following items.

a) Effluent BOD
b) Sludge volume
c) Site space
d) Cost for electric power
e) Environmental aspects (generation of smell, mosquito etc.)
f) Operation and maintenance
g) Future extension measures in case no additional land is available

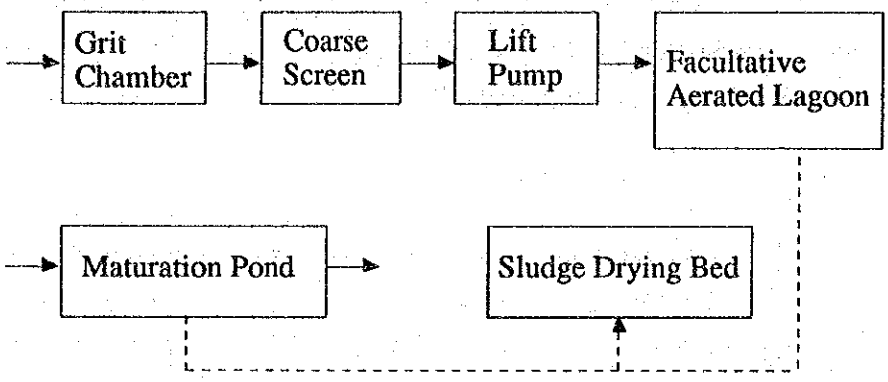
After detailed comparison, it was concluded that the facultative aerated lagoon system is superior in almost all items except site space and electric power cost which are almost same in both systems. (Refer to Appendix 11)

(b) The above conclusion was accepted by the Governmet of Indonesia. And the treatment system was designed by the facultative aerated lagoon system.

(ii) Basic design of sewage treatment plant of facultative aerated lagoon system

i) Treatment system

The flow of treatment is as shown below.



The flow-sheet of sewage treatment plant of this project is shown in Fig. 4-5.

ii) BOD removal

BOD removal rate of the facultative aerated lagoon (partial mix aerated lagoon) constructed in the series can be estimated by using the following formula.

$$\frac{Cn}{Co} = \frac{1}{[1+\frac{Kpt \cdot t}{n}]^n}$$

where,

Cn : effluent BOD concentration in pond (n), mg/l

Co : Inflow BOD concentration, mg/l

Kpt : partial mix first order reaction rate constant at T °C of water temperature, 1/day

t : total retention time of ponds, day

n : number of ponds in series

Kpt is calculated based on the standard reaction rate constant at 35 °C.

$Kpt = K_{35}\ (1.085)^{T-35}$, $K_{35} = 1.2$/day [*]

[*] : Marrais, G.V.R : Dynamic Behavior of Oxidation Ponds, 1970

The partial mix first order reaction rate constant of this project is $K_{25} = 0.531$/day, assuming the water temperature as 25 °C.

Final effluent BOD concentration of the proposed facultative aerated lagoon is calculated as follows.

(a) 30% of the influent BOD concentration is removed by settling and anaerobic digestion at the bottom of lagoon. Hence, the remaining soluble BOD is 332 x 0.7 = 232 mg/l.

(b) The proposed facultative aerated lagoon has an effective depth of 4.0 m and a total effective storage volume of 85,284 m^3. Hence, retention time is 5.50 days. Number of ponds in series : n = 2.

(c) Final effluent BOD concentration of the facultative aerated lagoon : C_2 = 38 mg/l.

iii) Power requirement

Oxygen requirement for oxidation and microbial synthesis is estimated as follows.

$RO_2 = 1.46 (Co - Cn)$

Where;

Q	=	wastewater discharge (15,500 m^3/day)
Co	=	influent BOD concentration (232 mg/l)
Cn	=	effluent BOD concentration (38 mg/l)
RO_2	=	183 kg/hr

Power requirement of aerator is calculated to be 114 kw, assuming the oxygen transfer rate of aerator as 1.6 kg O_2/kwh.

Hence, aerator of 30 kw x 4 units are provided. The power supply per unit effective wastewater storage volume is 1.4 w/m^3.

iv) Fecal Coliform reduction

The reduction of Fecal Coliform in ponds in series is estimated by using the following formula.

$$Ne = \frac{Ni}{(1 + Kbt \cdot t_1) + (1 + Kbt \cdot t_2) \cdots (1 + Kbt \cdot t_n)}$$

Where,

Ne	:	number of FC/100 ml of effluent
Ni	:	number of FC/100 ml of influent
Kbt	:	first order rate constant for FC removal at T°C of water temperature, l/day
t_n	:	retention time in pond (n)

Kbt is calculated based on the standard rate constant at 20 °C as follows:

Kbt	=	$K_{20}\ (1.19)^{T-20}$, $K_{20} = 2.6$/day [*]
(*)	:	Duncan Mara : Sewage Treatment in Hot Climates

The first order rate constant for FC removal of this project is $K_{25} = 6.20$, assuming the water temperature as 25 °C.

The proposed treatment plant consists of two (2) parallel streams of identical treatment units. Each treatment unit includes two (2) facultative aerated lagoon and one (1) maturation pond. Retention time of the respective facultative aerated lagoon is 2.75 days and that of the maturation pond is 1.03 day.

Number of FC/100 ml of the effluent from the maturation pond is $Ne = 4 \times 10^4$/100 ml, assuming the number of FC/100 ml of the influent as $Ni = 10^8$/100 ml. This FC number of effluent is considered to be in a satisfactory level.

v) Sludge treatment

Sludge generated in the process of sewage treatment is accumulated in the bottom of the aerated lagoons. The accumulated sludge is desludged by dredging equipment and transferred to the drying bed by dump trucks. Further, the dried sludge will be dumped on the lands outside the treatment plant for final disposal. It may be used as fertilizer if required.

Annual accumulated sludge in the bottom of the facultative aerated lagoon is estimated to be 3,300 m^3, assuming the served population as 110,000 persons and unit sludge production as 30 l/person/year.

vi) Countermeasures against shallow groundwater table

According to the geological study conducted in the stage II survey, the groundwater table is at a depth of 2.4 m - 2.5 m below the ground surface of

treatment plant (EL + 61.4 m). Therefore, it is necessary to provide the following countermeasures or devices.

(a) Prevention of groundwater pollution

Water level of the facultative aerated lagoon under normal operation is EL + 60.9 m, that is, 1.9 ~ 2.0 m higher than groundwater table. Wastewater might infiltrate into groundwater from the bed of the lagoons. The beds of lagoon are covered by water-proof sheets to prevent the wastewater infiltration.

(b) Desludging of lagoon

The elevation of bottom of facultative aerated lagoon is EL + 56.4 m, 2.5 ~ 2.6 m lower than grounwater table. Desludging of lagoon is usually performed under dry condition. However, complete drying up of this lagoon is considered difficult due to the high groundwater table.

The lagoon shall be desludged under normal condition filled with wastewater. Mud dredging equipment with some mechanical devices shall be provided.

After studying the desludging methods, desludging under the condition filled with water using the sludge disposal facilities (mud dredger) is adopted.

vii) Power supply

The total required electric power capacity for sewage treatment plant is 195.7 kw as shown in Table 4-1. The total annual electric power consumption is estimated to be 1,086,809 KWH per year. As a result of discussion with the officials concerned of the Governmet of Indonesia in stage II survey, it was decided to use the power supplied by Electricity Public Corporation (PLN) for normal operation, and install generators for emergency use.

(4) Specifications of sewage treatment plant

Specifications of sewage treatment plant are shown in the Table 4-2.

Table 4-2 Specifications of Sewage Treatment Plant

No.	Facility	Specification	Remarks
1.	Grit Chamber	2 m x 6 m x 1.2 m x 2 ponds (W) (L) (H)	650 m^3/m^2/day
2.	Coarse Screen	2.0 m x 40 mm x 2 sets	steel, manual type
3.	Lift Pump	10.7 m^3/min x 3.5 mH x 3 sets	15 kw/set, 1 stand-by included.
4.	Facultative Aerated Lagoon	76 m x 80 m x 4 ponds	effective depth 4.0 m, retention time 5.5 days, wet masonry, water-proof sheet lining.
5.	Aerator	30 kw x 4 sets	
6.	Maturation Pond	60 m x 98 m x 2 ponds	effective depth 1.5 m, retention time 1.03 days, wet masonry, water-proof sheet lining.
7.	Sludge Dying Bed	34 m x 98 m x 1.5 m (W) (L) (H)	capacity 4,998 m^3 sludge volume : 3,300 m^3/year
8.	Power Generator	300 KVA x 1 set	for emergency use.
9.	Buildings	342 m^2	generator room, electric room, operation room, laboratory, machine room, storage.

Layout of each facility is shown in Fig. 4-7.

Table 4-1 Electric Power Consumption

EQUIPMENT	CAP. (kw)	RUN HOUR	ACT. INPUT	KWH
LIFT PUMP	15	24	0.8	288
LIFT PUMP	15	24	0.8	288
LIFT PUMP (STANDBY)	(15)			
SAND PUMP	5.5	1	0.8	4.4
SAND PUMP (STANDBY)	(5.5)			
AERATOR	30	24	0.8	576
AERATOR	30	24	0.8	576
AERATOR	30	24	0.8	576
AERATOR	30	24	0.8	576
VENTILATOR	0.4	24	0.8	7.68
TROLLY	0.4	0.5	0.8	0.16
	0.4			
HOIST	0.8	0.5	0.8	0.32
	0.8			
SUBMERSIBLE P.	5.5			nil
	5.5			nil
SUBMERSIBLE P.	5.5			nil
	5.5			nil
LIGHTING	17	10	0.5	85
TOTAL CAPACITY	195.7 kw			
CONT. CAPACITY	240 kva			
TOTAL KWH/DAY				2,978
TOTAL KWH/YEAR				1,086,809

Fig. 4-4 Location of Sewage Treatment Plant

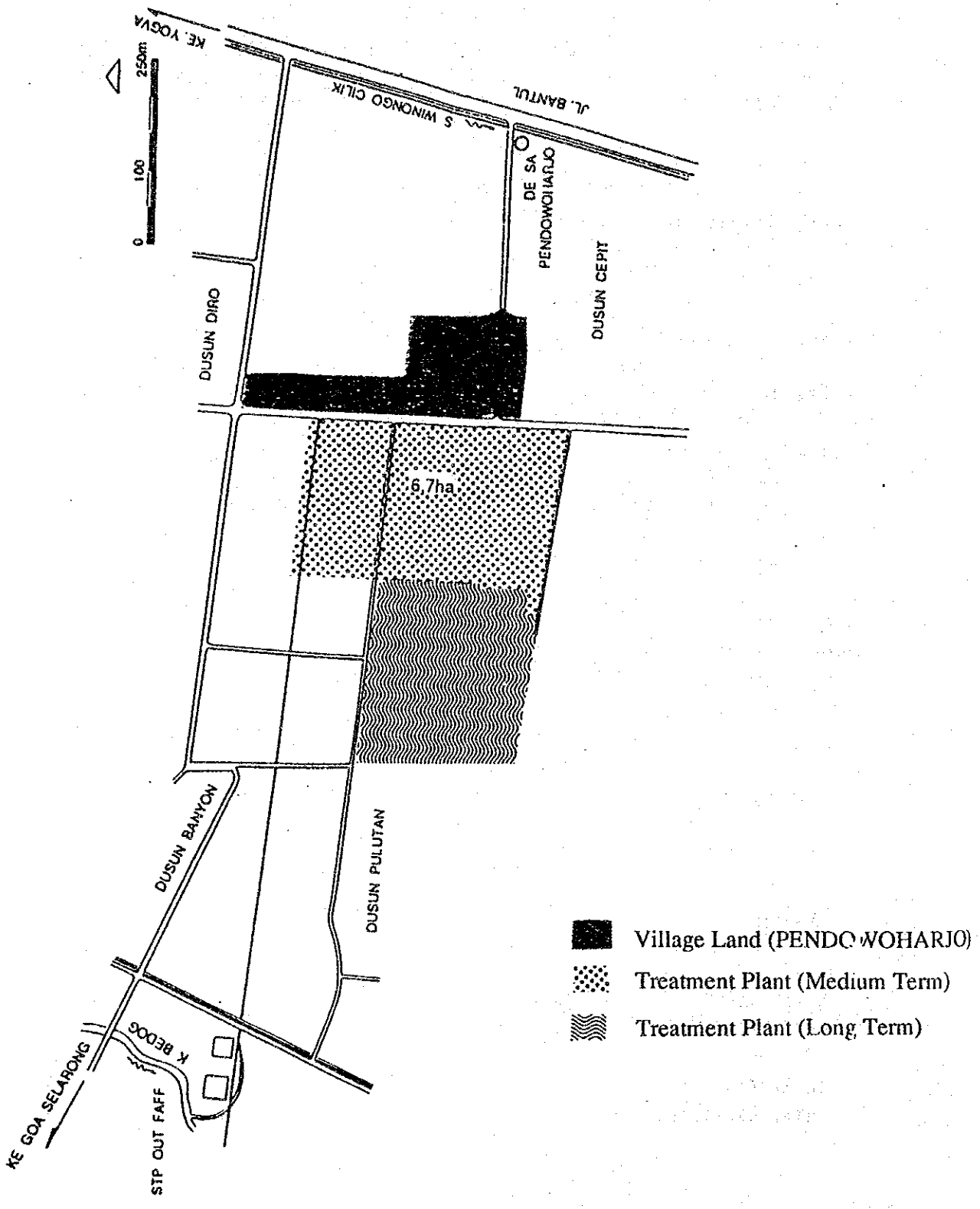
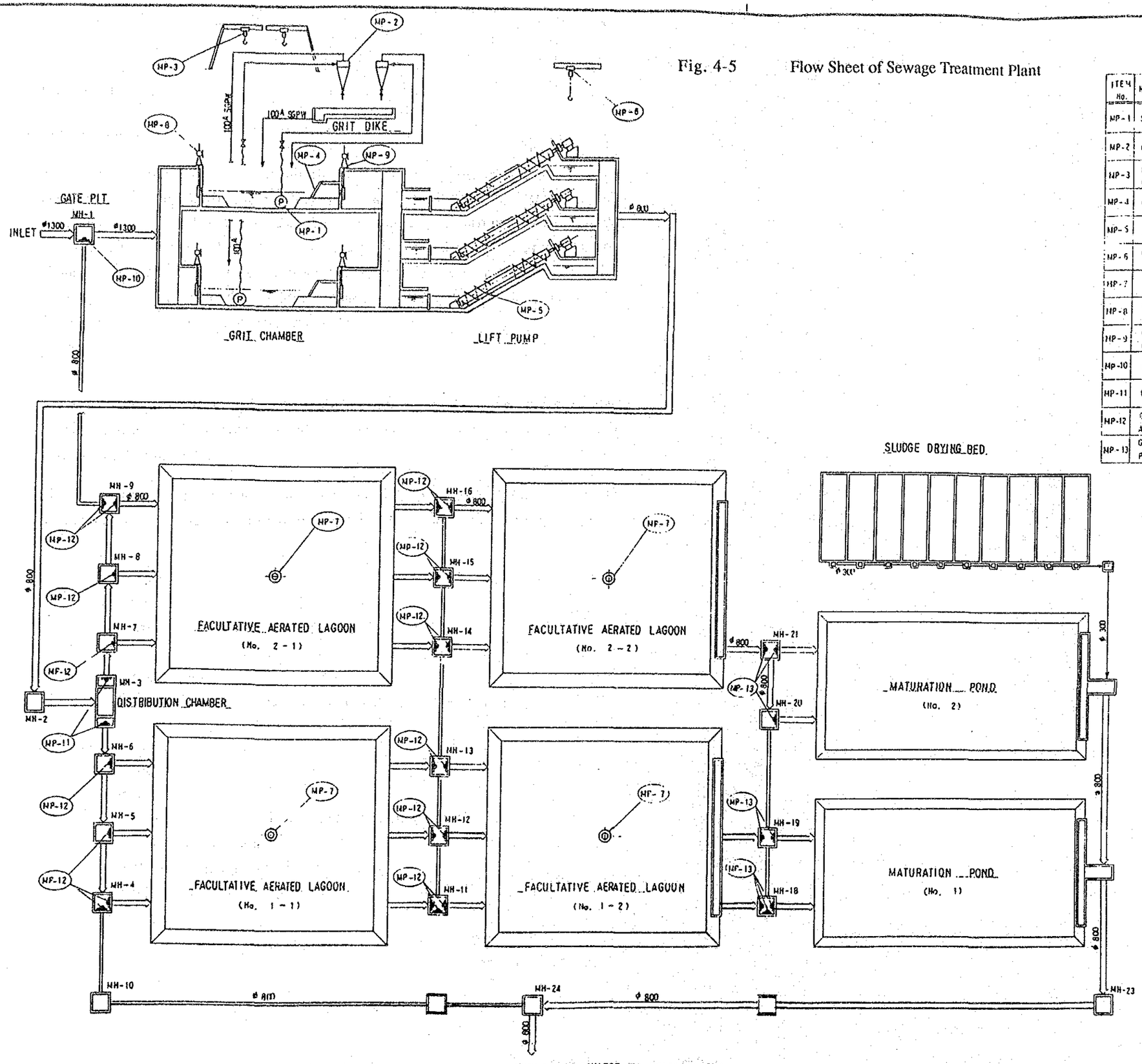


Fig. 4-5 Flow Sheet of Sewage Treatment Plant



EQUIPMENT LIST

ITEM NO.	NAME OF EQUIPMENT	SPECIFICATION	POWER (KW)	QUANTITY	REMARKS
MP-1	SAND PUMP	SUBMARINE PUMP φ100 × 1.0 m³/min × 15mH	5.5	2	
MP-2	CYCLONE SEPARATOR	φ100 × 1.0 m³/min	—	2	
MP-3	ELECTRIC TROLLEY CHAIN HOIST	0.5 ton × 7 mH TRAVELLING 0.4 HOISTING 0.8		2	FOR SAND PUMP
MP-4	COARSE SCREEN	MANUALLY SCRAPED W 2.0 m × 40 mm (OPENING)	—	2	STEEL STRUCTURE
MP-5	LIFT PUMP	SCREW PUMP φ1000 × 10.7 m³/min × 3.5 mH × 35	15	3	
MP-6	GEARED TROLLEY CHAIN HOIST	MANUALLY OPERATED 3.0 ton	—	1	FOR LIFT PUMP
MP-7	AERATOR	TURBINE TYPE SURFACE AERATOR φ 2000	30	4	
MP-8	INLET GATE OF GRIT CHAMBER	MANUALLY OPERATED □800 × 5.0 mH	—	2	
MP-9	OUTLET GATE OF GRIT CHAMBER	MANUALLY OPERATED □800 × 5.0 mH	—	2	
MP-10	BYPASS GATE	MANUALLY OPERATED φ800 × 3.98 mH	—	1	
MP-11	DISTRIBUTION GATE	MANUALLY OPERATED φ800 × 4.1 mH	—	2	
MP-12	GATE FOR FACULTATIVE AERATED LAGOON	MANUALLY OPERATED φ 800 × 4.1 mH	—	21	
MP-13	GATE FOR MATURATION POND	MANUALLY OPERATED φ800 × 2.1 mH	—	8	

LEGEND

MARK	TYPE
or	GATE
	VALVE
Ⓟ	PUMP

(4) Design of Discharge Line

1) Basic conditions

The treated wastewater is discharged to Bedog River through the sewer pipe and open channel. The total length is approximately 1.2 km, of which about 650 m is sewer pipe and about 530 m is open channel. Drainage water from surrounding paddy field will flow into the open channel. The discharge line crosses the existing irrigation channel by siphon and then extends to the Bedog River. The discharge line is provided with a gate before crossing the irrigation channel so that the treated wastewater can be distributed to the irrigation channel if necessary.

2) Design flow

The sewer pipe is designed to meet the wastewater discharge in the long-term plan (2012). The design flow is determined at 0.43 m^3/s of the daily average wastewater volume of the long-term plan.

The design flow of open channel is determined to be 1.5 m^3/s by adding 0.43 m^3/s to the maximum flow volume of 1.08 m^3/s discharged from surrounding paddy fields.

3) Design of discharge line

(i) Sewer pipe

- Distance : L = 649 m
- Slope : S = 1:500
- Earth covering : D = 1.7 - 2.0 m
- Pipe diameter : D = 800 mm (roughness coefficient: n = 0.013)

(ii) Open channel

- Distance : L = 528
- Slope : S = 1:500
- Cross section : Trapezoid (wet masony lining)

  Bottom width of channel : 1.4 m

  Height of channel (minimum) : 1.0 m

  (roughness coefficient: n = 0.02)

(iii) Siphon

i) Hydraulic calculation

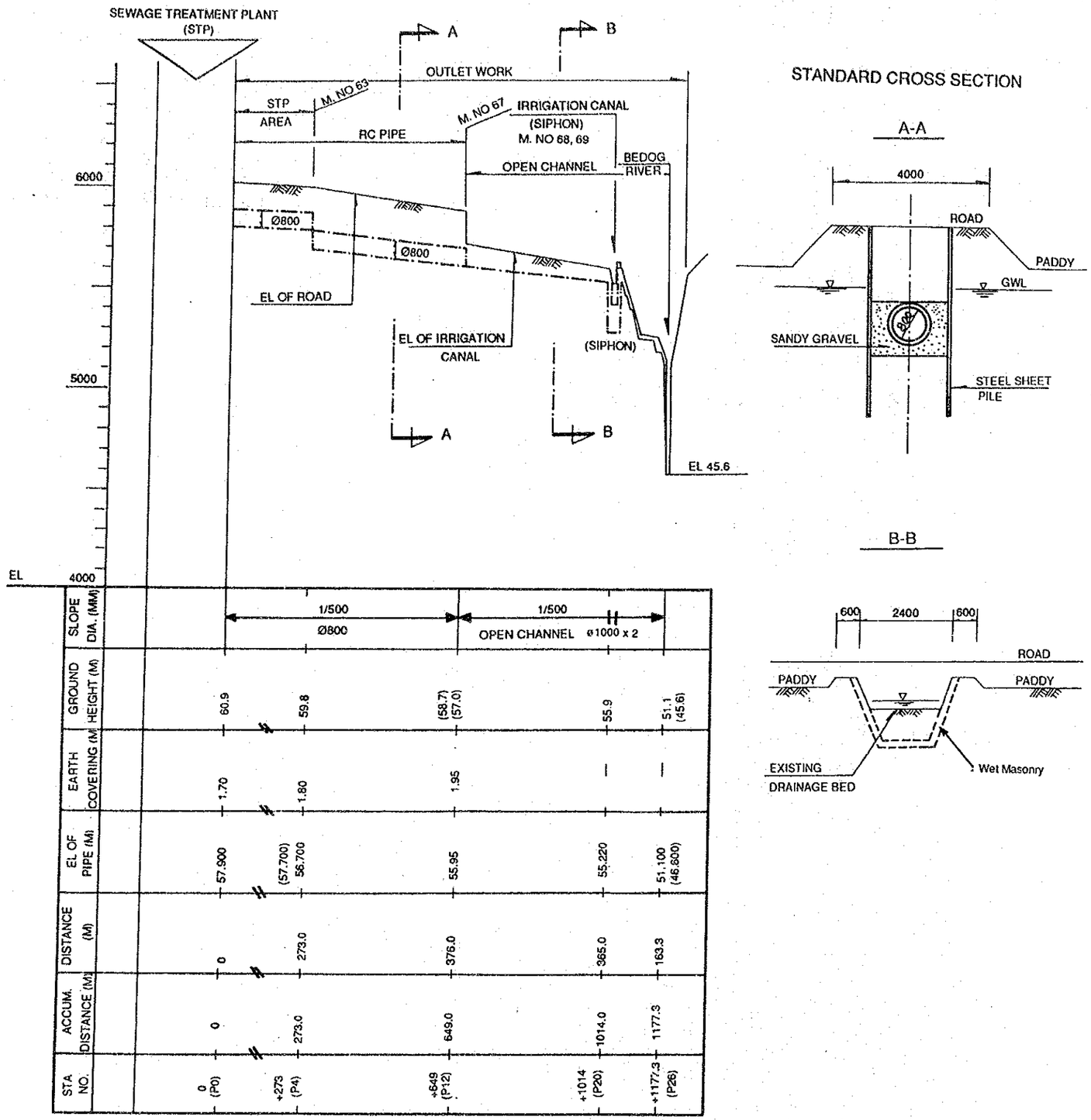
The hydraulic head loss calculated by the same formula as the siphon at Winongo River is 0.35 m. The calculation conditions are as follows:

- i = Hydraulic gradient of siphon (1 : 350)
- L = Length of siphon (12.6 m)
- V = Flow velocity in the siphon (1.9 m/s)
- α = Allowance (3 cm)

ii) Structure

Structure of the siphon is almost the same as that of Winongo River. A gate is provided at the upstream side of siphon. Fig. 4-6 shows the longitudinal profile of discharge line.

Fig. 4-6 Longitudinal Profile of Outlet Work of JICA Project



STANDARD CROSS SECTION

B-B

(5) Basic Design Drawings

Fig. 4-7: Layout of Sewage Treatment Plant
Fig. 4-8: Water level of Sewage Treatment Plant
Fig. 4-9: Single Line Diagram
Fig. 4-10: Siphon at Winongo River
Fig. 4-11: Siphon at Irrigation channel
Fig. 4-12: Details of Manhole

Fig. 4-7 Layout of Sewage Treatment Plant

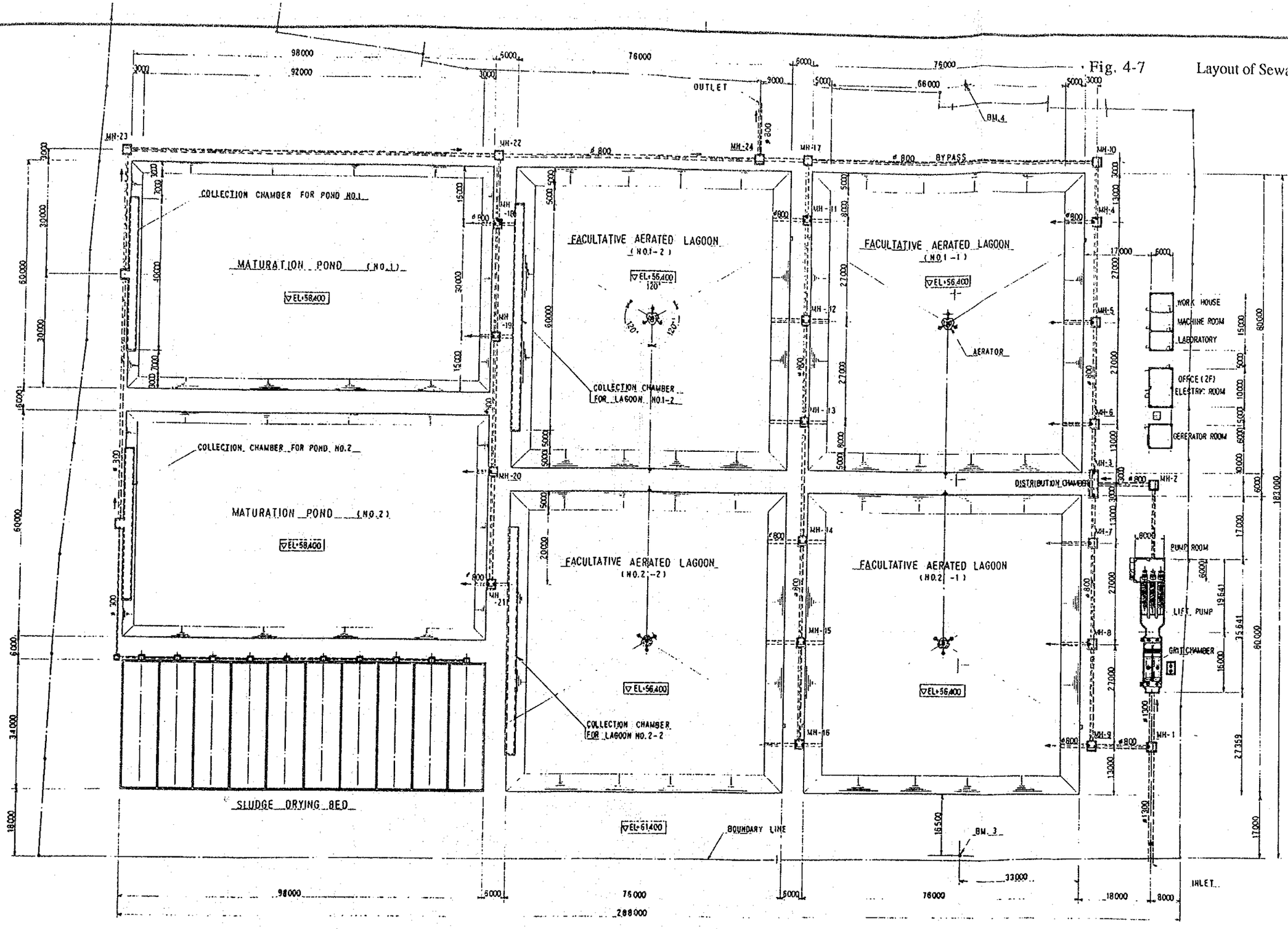


Fig. 4-8 Water level of Sewage Treatment Plant

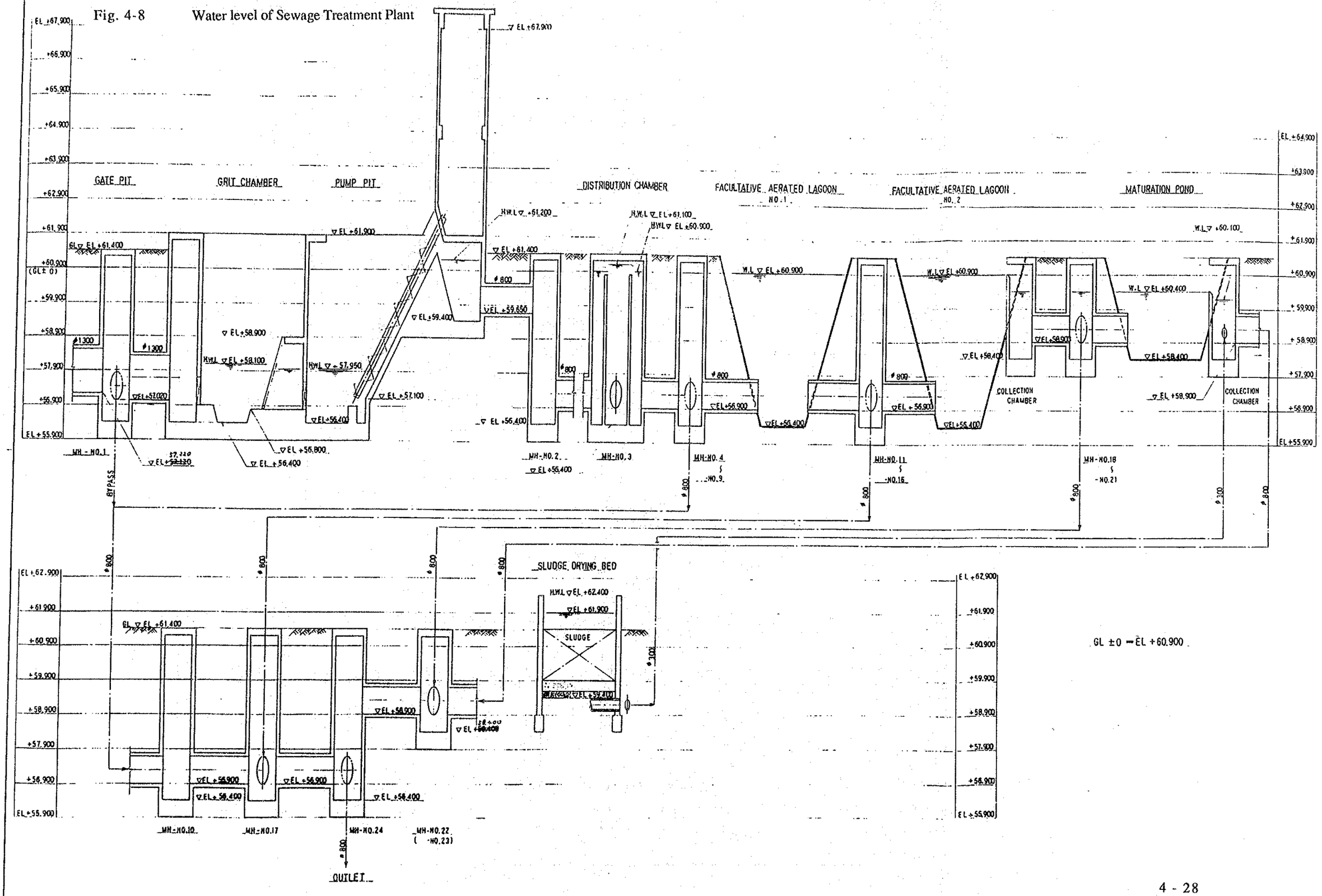
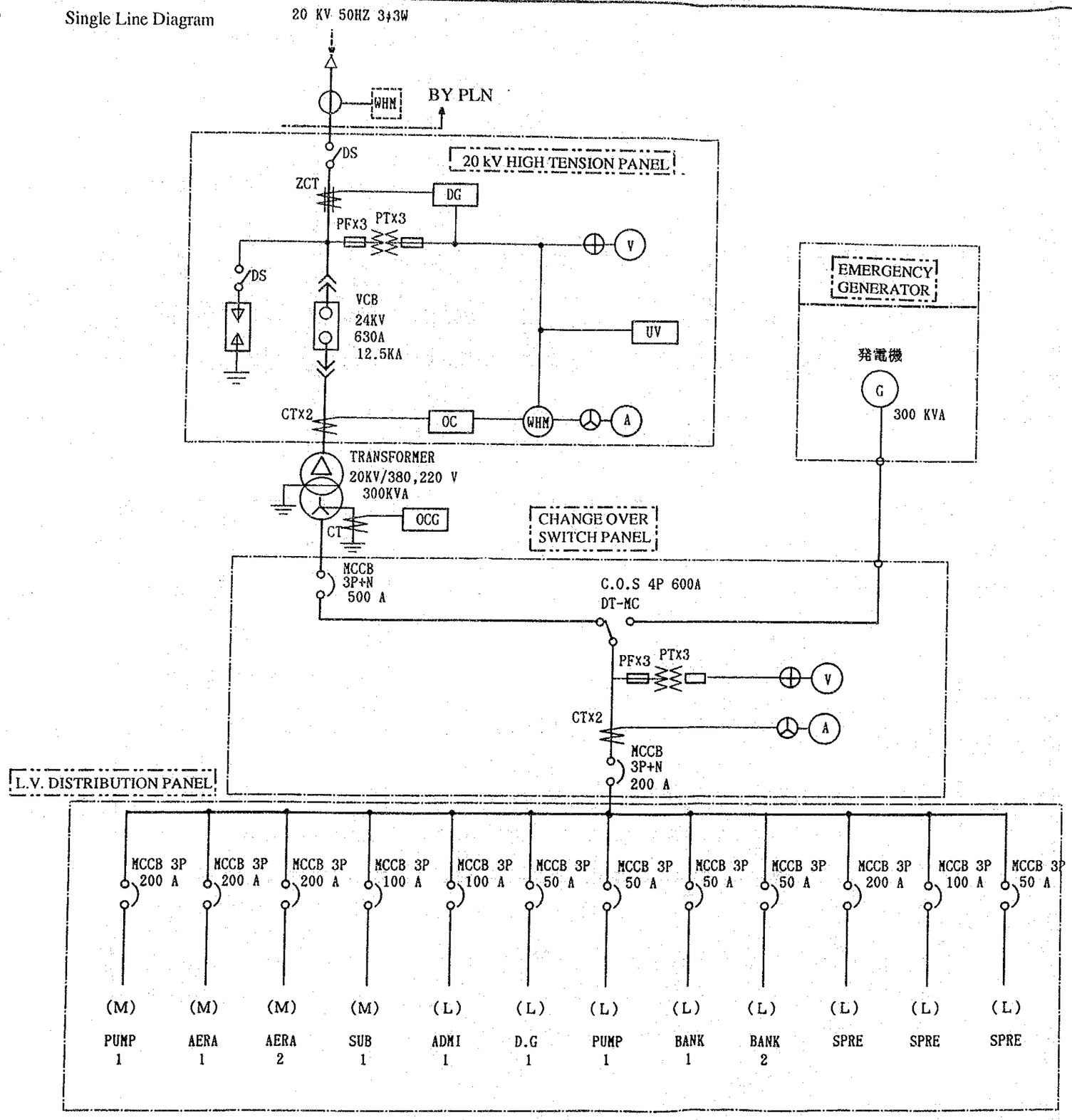


Fig. 4-9 Single Line Diagram



LEGEND

ABB.	NAME
DS	DISCONNECT SWITCH
WHM	WATT HOUR METER
ZCT	ZERO CURRENT TRANSFORMER
DG	GROUND RELAY
PF	POWER FUSE
PT	POTENTIAL TRANSFORMER
VCB	VACUUM SWITCH
V	VOLT METER
A	AMMETER
UV	UNDER VOLTAGE RELAY
CT	CURRENT TRANSFORMER
OC	OVER CURRENT RELAY
MCCB	MOLDED CASE CIRCUIT BREAKER
DT-MC	DOUBLE THROW
OCG	GROUND RELAY

Fig. 4-10 Siphon at Winongo River

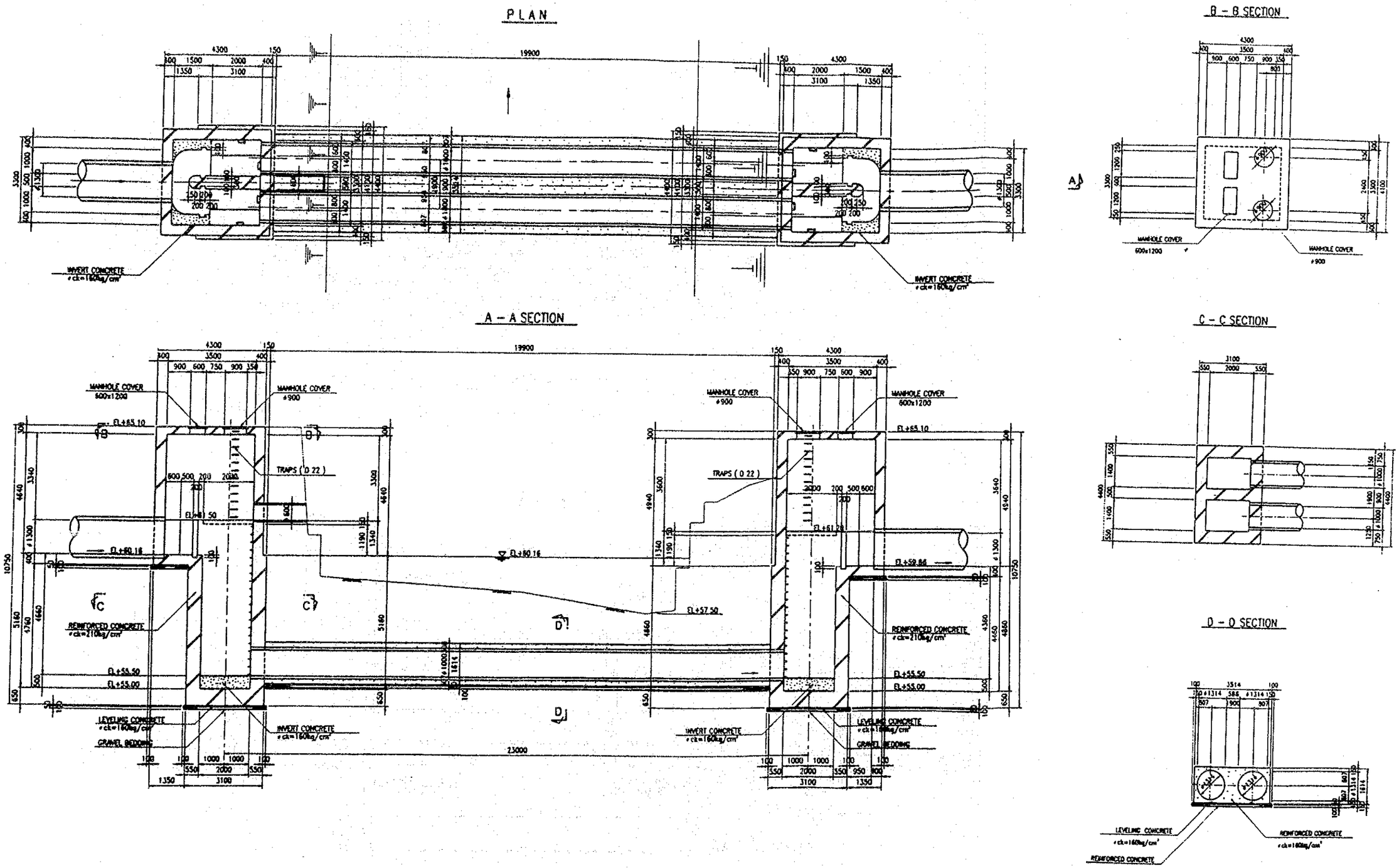


Fig. 4-11 Siphon at Irrigation Channel

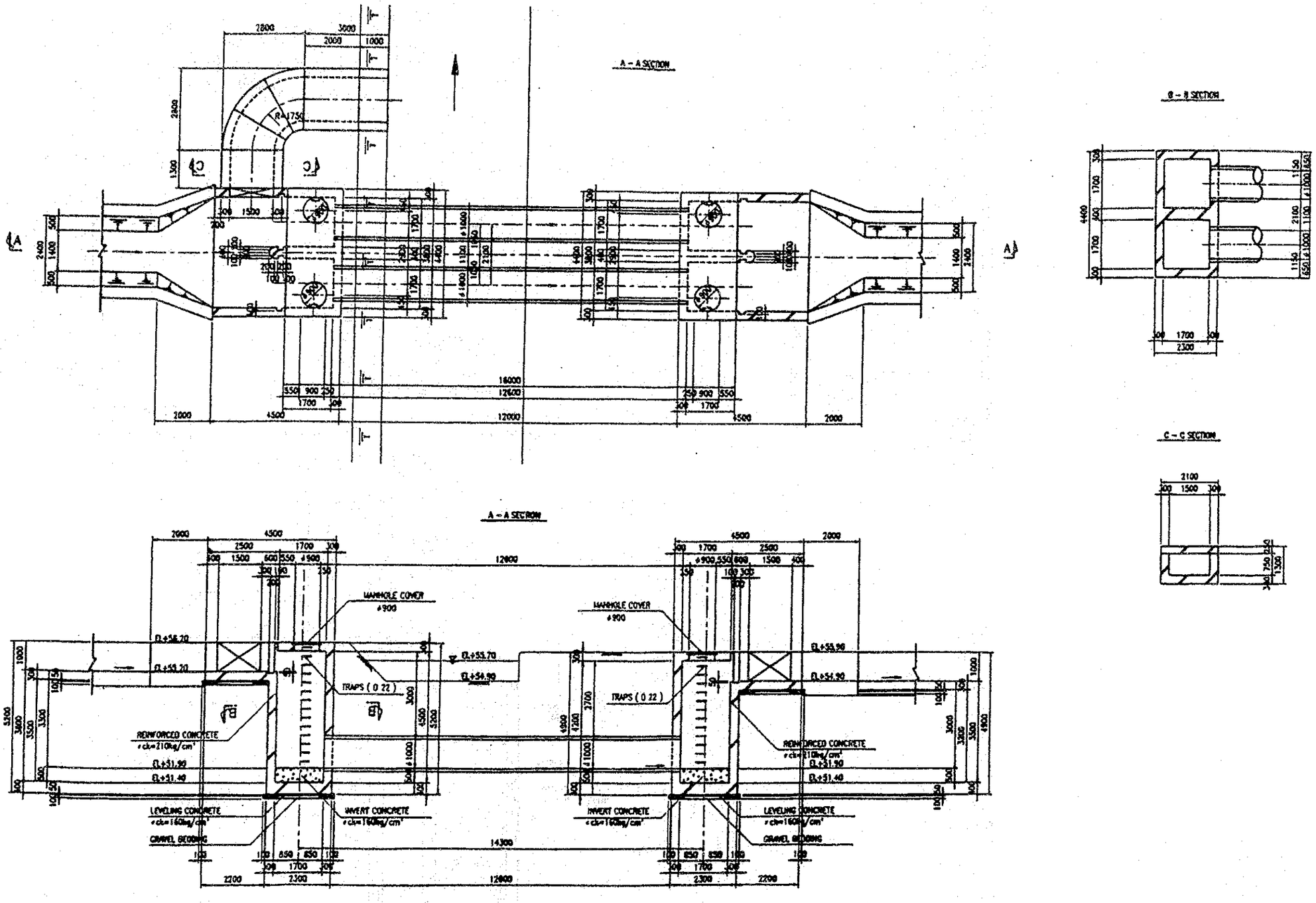
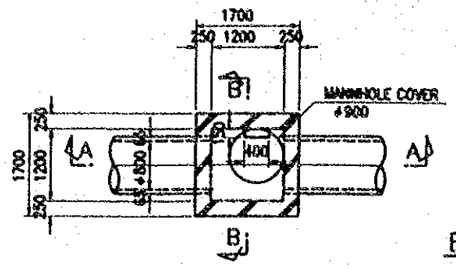
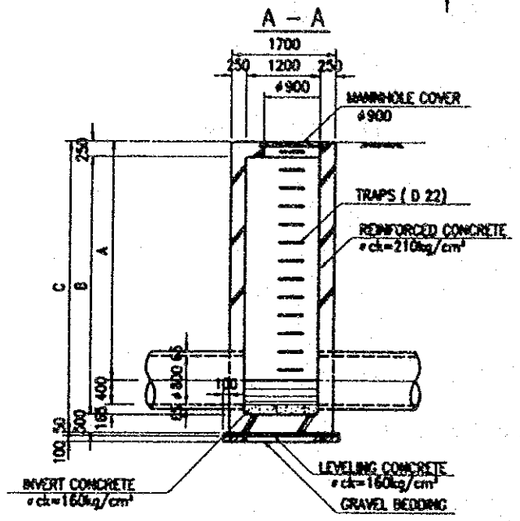


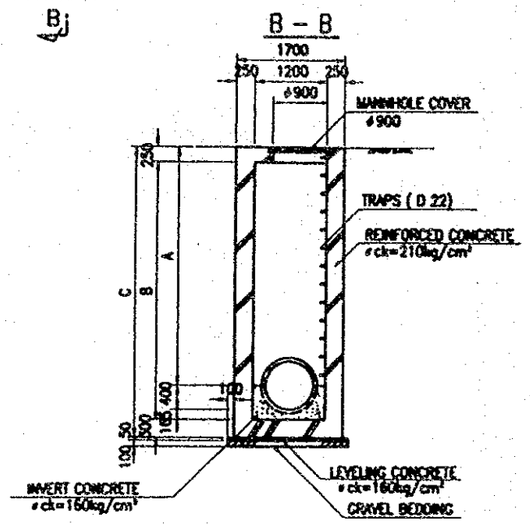
Fig. 4-12 Details of Manhole (1/2)

DETAIL OF MANHOLE FOR SEWER PIPE (1/2)

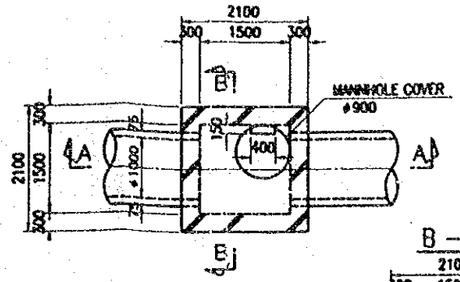
MANHOLE (FOR ϕ800)

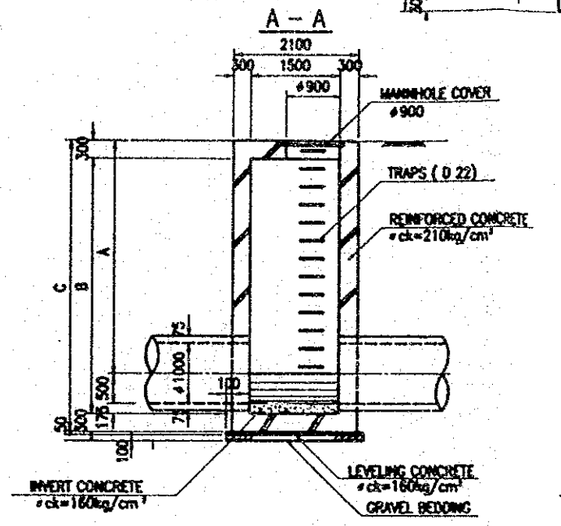


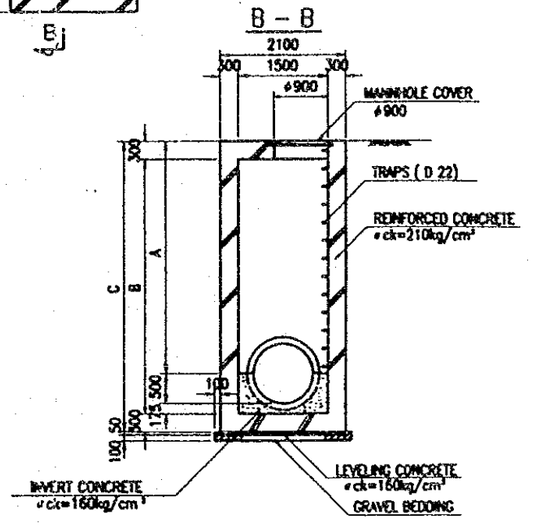




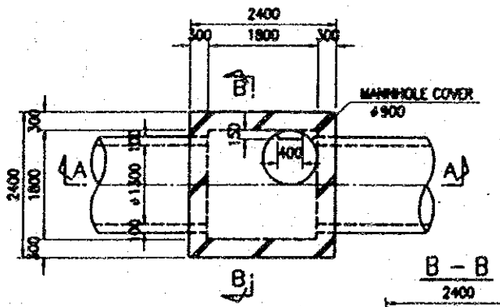
MANHOLE (FOR ϕ1000)

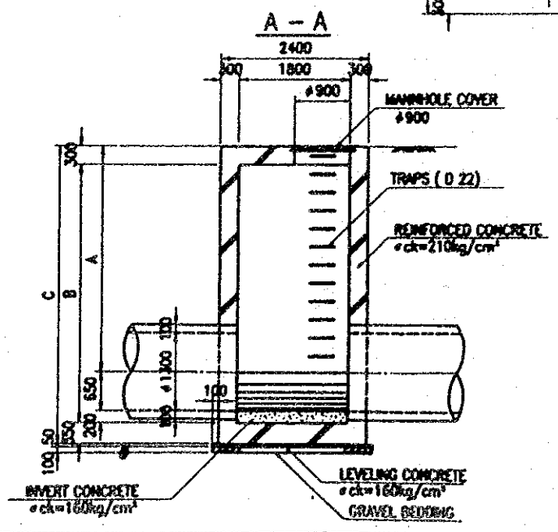


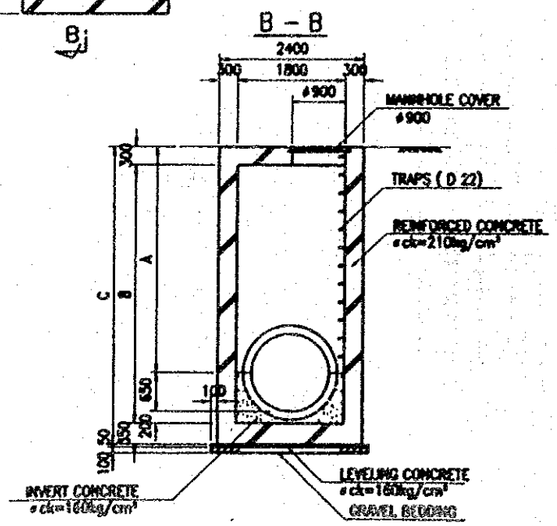




MANHOLE (FOR ϕ1300)





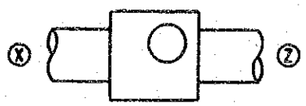


THE REPUBLIC OF INDONESIA MINISTRY OF PUBLIC WORKS CIPTA KARYA				
THE BASIC DESIGN ON THE PROJECT FOR YOGYAKARTA CITY SEWAGE TREATMENT PLANT				
DETAIL OF MANHOLE FOR SEWER PIPE (1/2)				
DATE SEPT.	SCALE V: —— H: 50	DWG.NO.		
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)				

Fig. 4-12 Details of Manhole (2/2)

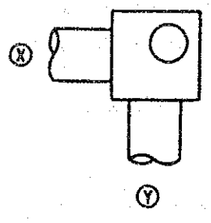
DETAIL OF MANHOLE FOR SEWER PIPE (2/2)

TYPE-A ~ C



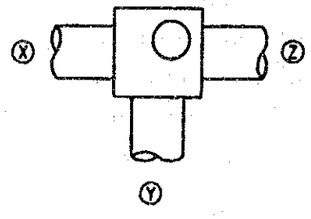
TYPE-A (ϕ800)
TYPE-B (ϕ1000)
TYPE-C (ϕ1300)

TYPE-D ~ E



TYPE-D (ϕ800)
TYPE-E (ϕ1300)

TYPE-F



TYPE-F (ϕ1000)

M.HO.	TYPE OF MH	A			B	C	方 A 向 の 管 径					
		X	Y	Z			X			Y		Z
1	F	ROUTE A	ROUTE B	4090	4465	5085	N	ROUTE A	W	ROUTE B	S	ϕ 1000
2	B	3880	——	3880	4255	4855	N	ϕ 1000	——	——	S	ϕ 1000
3	B	3730	——	3730	4105	4705	N	ϕ 1000	——	——	S	ϕ 1000
4	B	3690	——	3690	4065	4665	N	ϕ 1000	——	——	S	ϕ 1000
5	B	3750	——	3750	4125	4725	N	ϕ 1000	——	——	S	ϕ 1000
6	B	3600	——	3600	3975	4575	N	ϕ 1000	——	——	S	ϕ 1000
7	B	3160	——	3160	3535	4135	N	ϕ 1000	——	——	S	ϕ 1000
8	B	2710	——	2710	3085	3685	N	ϕ 1000	——	——	S	ϕ 1000
9	B	3070	——	3070	3445	4045	N	ϕ 1000	——	——	S	ϕ 1000
10	B	2820	——	2820	3195	3795	N	ϕ 1000	——	——	S	ϕ 1000
11	B	2580	——	2580	2955	3555	N	ϕ 1000	——	——	S	ϕ 1000
12	B	2430	——	2430	2805	3405	N	ϕ 1000	——	——	S	ϕ 1000
13	B	2290	——	2290	2665	3265	N	ϕ 1000	——	——	S	ϕ 1000
14	B	2350	——	2350	2725	3325	N	ϕ 1000	——	——	S	ϕ 1000
15	C	2520	——	4390	4940	5590	N	ϕ 1000	——	——	S	ϕ 1300
16	C	3780	——	3780	4330	4980	N	ϕ 1300	——	——	S	ϕ 1300
17	C	3500	——	3500	4050	4700	N	ϕ 1300	——	——	S	ϕ 1300
18	C	3230	——	3230	3780	4430	N	ϕ 1300	——	——	S	ϕ 1300
19	C	2550	——	2550	3100	3750	N	ϕ 1300	——	——	S	ϕ 1300
20	E	2420	2420	——	2970	3620	N	ϕ 1300	W	ϕ 1300	——	——
21	E	2460	2460	——	3010	3660	S	ϕ 1300	E	ϕ 1300	——	——
22	E	2490	2490	——	3040	3690	N	ϕ 1300	W	ϕ 1300	——	——
23	C	2950	——	2950	3500	4150	E	ϕ 1300	——	——	W	ϕ 1300
24	E	3580	3580	——	4130	4780	S	ϕ 1300	E	ϕ 1300	——	——
25	C	3270	——	3270	3820	4470	N	ϕ 1300	——	——	S	ϕ 1300
26	C	2990	——	2990	3540	4190	N	ϕ 1300	——	——	S	ϕ 1300
27	E	2820	2820	——	3170	3820	N	ϕ 1300	W	ϕ 1300	——	——
28	C	2530	——	2530	3080	3730	E	ϕ 1300	——	——	W	ϕ 1300
29	C	3460	——	3460	4010	4660	E	ϕ 1300	——	——	W	ϕ 1300
30	C	3680	——	3680	4230	4880	E	ϕ 1300	——	——	W	ϕ 1300
31	C	3710	——	3710	4260	4910	E	ϕ 1300	——	——	W	ϕ 1300
32	C	3930	——	3930	4480	5130	E	ϕ 1300	——	——	W	ϕ 1300
33	C	3860	——	3860	4410	5060	E	ϕ 1300	——	——	W	ϕ 1300
34	C	3880	——	3880	4430	5080	E	ϕ 1300	——	——	W	ϕ 1300
35	C	3610	——	3610	4160	4810	E	ϕ 1300	——	——	W	ϕ 1300
36	C	4070	——	4070	4620	5270	E	ϕ 1300	——	——	W	ϕ 1300
37	SIPHON	——	——	——	——	——	——	——	——	——	——	——
38	SIPHON	——	——	——	——	——	——	——	——	——	——	——
39	C	3900	——	3900	4450	5100	E	ϕ 1300	——	——	W	ϕ 1300
40	C	3730	——	3730	4280	4930	E	ϕ 1300	——	——	W	ϕ 1300
41	C	3750	——	3750	4300	4950	E	ϕ 1300	——	——	W	ϕ 1300
42	C	3880	——	3880	4430	5080	E	ϕ 1300	——	——	W	ϕ 1300
43	C	4000	——	4000	4550	5200	E	ϕ 1300	——	——	W	ϕ 1300
44	E	4220	4220	——	4770	5420	E	ϕ 1300	S	ϕ 1300	——	——
45	C	4130	——	4130	4680	5330	N	ϕ 1300	——	——	S	ϕ 1300
46	C	4050	——	4050	4600	5250	N	ϕ 1300	——	——	S	ϕ 1300
47	C	3680	——	3680	4230	4880	N	ϕ 1300	——	——	S	ϕ 1300
48	C	3300	——	3300	3850	4500	N	ϕ 1300	——	——	S	ϕ 1300
49	C	2930	——	2930	3480	4130	N	ϕ 1300	——	——	S	ϕ 1300
50	C	2850	——	2850	3200	3850	N	ϕ 1300	——	——	S	ϕ 1300
51	C	2880	——	2880	3230	3880	N	ϕ 1300	——	——	S	ϕ 1300
52	C	2500	——	2500	3050	3700	N	ϕ 1300	——	——	S	ϕ 1300
53	C	2530	——	2530	3080	3730	N	ϕ 1300	——	——	S	ϕ 1300
54	E	2650	2650	——	3200	3850	N	ϕ 1300	W	ϕ 1300	——	——
55	C	2300	——	2300	2850	3500	E	ϕ 1300	——	——	W	ϕ 1300
56	C	2430	——	2430	2980	3630	E	ϕ 1300	——	——	W	ϕ 1300
57	C	3150	——	3150	3700	4350	E	ϕ 1300	——	——	W	ϕ 1300
58	C	3280	——	3280	3830	4480	E	ϕ 1300	——	——	W	ϕ 1300
59	C	3540	——	3540	4090	4740	E	ϕ 1300	——	——	W	ϕ 1300
60	E	3950	3950	——	4500	5150	S	ϕ 1300	E	ϕ 1300	——	——
61	C	3370	——	3370	3920	4570	N	ϕ 1300	——	——	S	ϕ 1300
62	E	3260	3260	——	3810	4460	N	ϕ 1300	W	ϕ 1300	——	——
63	A	2800	——	2800	3115	3665	W	ϕ 800	——	——	E	ϕ 800
64	A	2300	——	2300	2615	3165	W	ϕ 800	——	——	E	ϕ 800
65	D	2350	2350	——	2665	3215	W	ϕ 800	S	ϕ 800	——	——
66	D	[illegible]	2350	——	2665	3215	E	[illegible]	N	ϕ 800	——	——
67	SIPHON	——	——	——	——	——	——	——	——	——	——	——
68	SIPHON	——	——	——	——	——	——	——	——	——	——	——

THE REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
CIPTA KARYA

THE BASIC DESIGN ON THE PROJECT
FOR
YOGYAKARTA CITY SEWAGE TREATMENT PLANT

DETAIL OF MANHOLE FOR SEWER PIPE (2/2)

DATE	SEPT.	SCALE	V: —— H: 50	DWG.NO.	

4-4 Construction Plan

(1) Construction Policy

Preparation of the detailed design, assisting the Directorate General of Human Settlements with tendering, and project construction supervision will be carried out by a Japanese consultant company.

Prerequisites and important matters to be considered are as follows.

1) The following actions by the Governmet of Indonesia are required to be taken without any delay.

   (i) The land acquisition of the project site and the land clearance for the treatment plant (one month before the start of construction)

   (ii) Acquisition of approvals from the authorities concerned regarding the construction of trunk sewer and discharge line

   (iii) Electric and water supply to the treatment plant

   (iv) Installation and supply of incidental out door works such as gardening, fencing, gate and exterior lighting within and around the site

   (v) Supply of telephone and general furnitures for the control house in the treatment plant

2) The construction of the upstream trunk sewers by ADB loan shall be implemented as scheduled and shall be connected to the trunk sewer of this project at the time of completion of this project.

Contractor will be selected among Japanese companies by an open bid. The criteria for the prequalification of contractor will be decided at the stage of preparation for bidding.

At the construction stage, local contractors will be appointed under a Japanese contractor. However, experts for installation of sheet piles, water-proof sheets in ponds, pumps and aerators, etc. will be dispatched from Japan to secure the construction period and construction quality.

The executing agency of Indonesia for this project is the Directorate General of Human Settlements, Ministry of Public Works, and the project is controlled by a project manager of the central government. Close cooperation will be provided by related agencies of Yogyakarta Province, regarding the approval of detailed design documents and acquisition of approvals from authorities concerned at the construction of trunk sewer and discharge line, etc.

(2) Construction Condition and Remarks for Implementation

1) Construction condition

There is no major construction company in Yogyakarta which can handle large scaled construction works of this kind. Also, there is no manufacturer of concrete pipes nor lease company of major equipment at present. Therefore, the companies which can provide cooperation to Japanese contructor are considered to be those which have head office in Jakarta. Materials for concrete and ready mixed concrete can be procured at Yogyakarta and its surrounding area, but concrete pipe, reinforcing bar, mould panel, etc. must be purchased from Jakarta. Major equipment and steel materials shall be procured in Japan or third countries.

2) Remarks for Implementation

The following remarks shall be paid attention before and during the execution of construction works.

(i) Full discussion shall be made with the related parties and agencies concerning the construction works to be conducted by Indonesian side such as installation of electric line. The consultants shall provide a full support in order to prevent delay in such construction.

(ii) Indonesian side shall obtain approval from related agencies for the construction works such as crossing of river and irrigation channel, etc. The consultants shall provide a full support for the preparation of necessary documents.

(iii) The construction schedule shall be prepared paying due attention to the local climate conditions to avoid the delay of construction.

(iv) Storage of cement and placing of concrete shall carefully be performed since the construction site is prone to heavy rainfall and high humidity.

(v) Sewer pipes are installed under the roads with heavy traffic. The construction plan shall be prepared to minimize the interruption of traffic.

(vi) The earth work of sewage treatment plant shall carefully be performed so that it may not have affects on the shallow wells in the neighbourhood. some countermeasures shall be taken if necessary.

(vii) Operation of the sewage treatment plant shall be started by Indonesian staff soon after completion of the construction works. Hence, training of the local engineers and operators for the operation and maintenance of sewage treatment plant shall be conducted during the construction period.

(3) Detailed Design and Construction Supervision

1) Detailed design

The detailed design will be prepared based on the basic design. Documents necessary for tendering will also be prepared.

The detailed design and tender documents prepared by the consultants shall be approved by Directorate General of Human Settlements (Cipta Karya).

2) Tendering

The consultants will assist Cipta Karya in tender announcement, accepting tender applications from the tender participants, issuing tender documents to the participants, accepting tender documents from the participants, and tender evaluation. Soon after selecting a successful Japanese contractor, Cipta Karya will conclude a contract with the contractor.

3) Construction supervision

The consultants will assist Cipta Karya in evaluation and approval of the construction plan submitted by the contractor, and inspection of the procured materials and equipment by the contractor.

The consultants will hold a series of meetings with Cipta Karya and the contractor prior to commencement of the construction works, witnesses the shipments of the materials and equipment to the project sites, and provide the contractor with necessary instructions related to the civil works, installation of equipment and test operation.

Further, the consultants will control the construction schedule, be responsible for quality control, and will exert an effort to complete the project by the completion date specified in the Exchange of Notes.

(4) Procurement

1) The construction equipment and materials will be procured in Indonesia in principle. However, the following equipment and materials will be procured in Japan to assure the necessary quality.

(i) Aerator
(ii) Lift/submersible pump
(iii) Electric equipment (high/low voltage distribution panel, transformer, etc.)
(iv) Water control gate
(v) Sludge disposal equipment
(vi) Water-proof sheet

Steel sheet pile and H shaped steel used for temporary construction works will be procured from third countries because of difficulty in procurement in Indonesia and economical reason.

2) Submersible sand pump and sludge disposal equipment required for the operation and maintenance of sewage treatment plant are not manufactured in Indonesia. These will be procured in Japan to assure necessary quality.

3) The equipment and materials procured in Japan will be transported from Japan to Jakarta by ship, and transferred from Jakarta to Yogyakarta by land transportation.

Comparison of equipment/material procurement is shown in Table 4-3.

Table 4-3 Comparison of Procurement of Materials and Equipment in Indonesia and Japan

Item	Import from Japan	Procurement in Indonesia
Reinforcing Bars & Cement	Uniform standard and assured quality. Prices relatively stable. However, importing is prohibited.	Standard material is procurable but high price.
Evaluation	X	O
Water-proof Sheet for Treatment plant	Uniform standard and high quality Prices are stable.	Difficult to procure.
Evaluation	O	X
Plywood	Uniform standard and high quality, but high price.	Standard units are easily obtainable.
Evaluation	X	O
Water Control Gate	Uniform standard and high quality, but relatively high price.	Possible to procure local products but low water seal.
Evaluation Result	O	X
Lift Pump & Submer-sible Sand Pump	Uniform standard and high quality, but high price.	Difficult to manufacture in local. Necessary to import with high price.
Evaluation	O	X
Aerator	Since it is special equipment, necessary to order for production. Uniform standard and high quality, but high price.	Difficult to manufacture in local. Necessary to import with high price.
Evaluation	O	X
Sludge Disposal Equipment	Since it is special equipment, necessary to order for production. Uniform standard and high quality, but high price.	Difficult to procure.
Evaluation	O	X
Electrical Equipment (High/Low Voltage Electrical Panel, Transformer)	Since it is special equipment, necessary to order for production. Uniform standard and high quality, but high price.	Difficult to procure.
Evaluation	O	X
Reinforced Concrete Pipe	Uniform standard and high quality, but high price.	Easy to procure standard quality materials.
Evaluation	X	O
Sheet Pile for Temporary Works	Uniform standard and high quality, but high price.	No local product. To be procured from the third country as it is cheaper than imported from Japan.
Evaluation	X	X
Power Generator for emergency use	Uniform standard and high quality, but high price.	Standard units are procurable.
Evaluation	X	O

(5) Construction Schedule

The project will be completed within 33 months. Eight (8) months will be required for detailed design and preparation of tender documents, and 24 months for construction works.

Table 4-4 shows the construction schedule.

(6) Scope of Works

1) Scope of works to be executed by Japan's Grant Aid

Scope of works to be carried out by Japan's grant aid are as follows.

(i) To design the trunk sewer, sewage treatment plant and discharge line.
(ii) To procure the construction materials.
(iii) To contract the contractor to construct the project.
(iv) To supervise the construction works.

2) Undertaking of the Government of Indonesia

(i) To acquire the land.
(ii) To clear the land for sewage treatment plant.
(iii) To acquire approvals from the authorities concerned regarding the construction of the project.
(iv) To supply the electric power to the treatment plant.
(v) To supply the water required for the treatment plant.
(vi) To install and supply incidental outdoor works such as gardening, fencing, gate and exterior lighting within and around the treatment plant site.
(vii) To supply telephone and general furnitures for the control house in the treatment plant.
(viii) To exempt taxes and to take necessary measures for custom clearances of the materials and equipment brought for the Project at the port of disembarkation.
(ix) To exempt Japanese nationals from custom duties, internal taxes and other fiscal levies which may be imposed in Indonesia with respect to the supply of the products and services under the verified contracts.
(x) To accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the verified contracts, such facilities as may be necessary for the performance of their work.

(xi) To use and maintain properly and effectively the facilities constructed and equipment purchased under the Grant Aid.

(xii) To bear all the expenses, other than those to be borne by the Grant, necessary for the execution of the Project.

(7) Cost for undertakings of the Governmet of Indonesia

Cost estimation for the undertakings of the Governmet of Indonesia is as follows. (Excluding the cost for Land Acquisition and Land Preparation.)

Item		Cost		Remarks
		Rp x 10^6	(Yen) ¥ x 10^3	
1.	Access road	10	610	
2.	Power supply for the Treatment Plant	100	6,100	
3.	Water supply for the Treatment Plant	2	122	
4.	Telephone	2	122	
5.	Exterior lighting	24.5	1,495	
6.	Fence	100	6,100	1,200 m
7.	Gardening	17	1,037	240 trees
8.	Furniture	93.5	5,704	
9.	Office for Counter Parts	105	6,405	
Total		454	27,695	

(1 Rp = 0.061 Yen)

Table 4-4 Construction Schedule