(1) Estimated Population

1) Current and Future Population of Khartoum and Sewerage Service Area.

The fluctuation of population of National Capital Khartoum and Khartoum based on the statistics issued by the Department of Statistics is shown in Table 5-1 and Table 5-2.

And population of every sewerage service area for 1983 given by the statistics is shown in Table 5-3.

Table 5-1 Total Population *

Area	1955/56	1964/65	1973	1983
National Capital Khartoum	260,599	438,890	784,294	1,343,791
Khartoum	97,516	173,500	333,906	476,267
Omdurman	116,231	185,380	299,399	526,337
Khartoum North	46,852	80,010	150,989	341,187

Table 5-2 Average Annual Increasing Rate of Population *

Area	1955/65	1965/73	1973/83	1955/83
National Capital Khartoum	5.3%	7.5%	5.5%	6.0%
Khartoum	5.9%	8.5%	3.6%	5.8%
Omdurman	4.8%	6.2%	5.8%	5.5%
Khartoum North	5.5%	8.2%	8.5%	7.3%

Table 5-3 Population of Sewerage Service Areas *(1983)

Zone	Population
A	2,325
B	2,800
C	1,802
D	1,127
E	3,212
F	2,324
G	1,100
H	2,843
J	16,154
K	3,065
M	4,477
P	506
Q	1,100
S	4,182
T	3,972
Total	50,989

Note : * Data from Department of Statistics

2) Estimated Population Calculated in the Sewerage Master Plan

Using the population statistics, water supply master plan and three towns' master plan issued in 1973, the future population was estimated in the Sewerage Master Plan, by a British Consultant in 1981, is shown in Table 5-4.

3) Current (1988) and Estimated (1996) Population

Projected population of Master Plan is greater than the actual figure in 1983.

So current and estimated population in 1996 will be calculated using the increasing rates of '80/85 and '85/90 which are projected in the Master Plan, on the basis of the actual population in 1983. (See Table 5-5).

However, if the estimated population calculated by the increasing rate is greater than the projected population in 2,000 (maximum), maximum should be adopted.

Table 5-4 Estimated Population by Sewerage Master Plan

Zone	1980	1985	1990	2000
A	-----	------	------	------
B	5,990	6,750 (1.13)	7,900 (1.17)	8,400 (1.06)
C	5,450	6,130 (1.12)	7,200 (1.17)	7,640 (1.06)
D	5,640	6,340 (1.12)	7,400 (1.17)	7,900 (1.07)
E	3,030	3,580 (1.18)	4,200 (1.17)	4,450 (1.06)
F	3,800	4,730 (1.25)	5,500 (1.16)	5,890 (1.07)
G	1,100	1,270 (1.15)	1,480 (1.16)	2,270 (1.53)
H	1,700	2,240 (1.32)	2,610 (1.16)	2,780 (1.06)
J	25,970	26,430 (1.02)	26,750 (1.01)	26,900 (1.01)
K	2,790	3,480 (1.25)	4,050 (1.16)	4,310 (1.06)
M	2,350	2,930 (1.25)	3,430 (1.17)	3,640 (1.06)
P	320	420 (1.31)	490 (1.17)	520 (1.06)
Q	-----	------	------	------
S	4,390	6,030 (1.37)	7,050 (1.17)	7,500 (1.06)
T	6,290	8,670 (1.30)	10,100 (1.16)	10,800 (1.07)
TOTAL	68,820	79,000 (1.15)	88,160 (1.12)	93,000 (1.05)

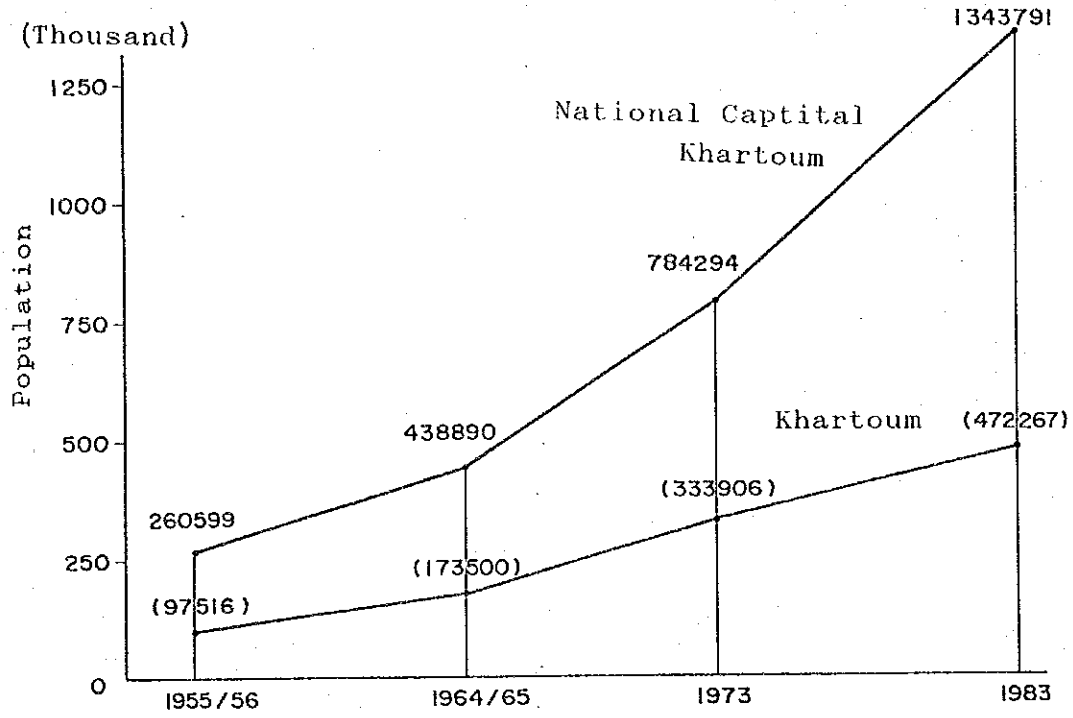
* '80/85 Average annual increasing rate = 2.8%
'85/90 Average annual increasing rate = 2.3%

Table 5-5 Current (1988) and Estimated (1996) Population

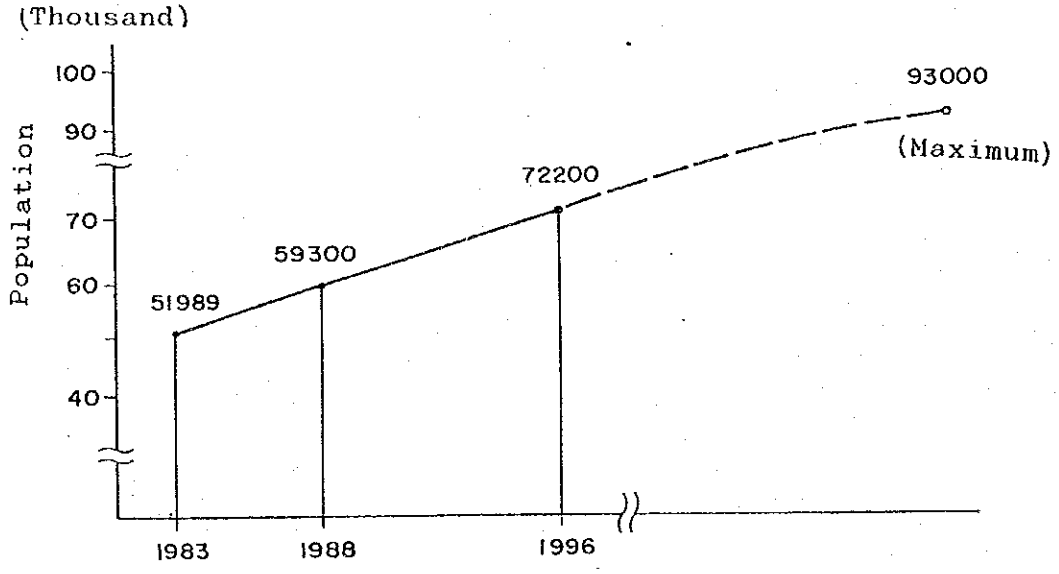
Zone	1983(actual)	1 9 8 8	1 9 9 6	Final Figure
A	2,325	2,673	3,389	-----
B	2,800	3,164	4,012	8,400
C	1,802	2,018	2,559	7,640
D	1,127	1,262	1,600	7,900
E	3,212	3,790	4,450	4,450
F	2,324	2,905	3,684	5,890
G	1,100	1,265	1,604	2,270
H	2,843	2,843	2,843	2,780
J	16,154	18,092	22,941	26,900
K	3,065	3,831	4,310	4,310
M	4,477	4,477	4,477	3,640
P	506	520	520	520
Q	1,100	1,265	1,604	-----
S	4,182	5,729	7,264	7,500
T	3,972	5,481	6,950	10,800
TOTAL	50,989 = 51,000	59,315 = 59,300	72,207 = 72,000	93,000

* '83/88 Average annual increasing rate = 3.1%
'88/96 Average annual increasing rate = 3.0%

Fig. 5-2 Estimated Population



Flactuation of Population in NCK



Estimated Sewerage Service Population

(2) Water Consumption

1) Current and Estimated Water Consumption

Water in Khartoum is supplied by Burri and Mogren water purification plants and pumping wells. The actual water consumption was 112,800 cu.m/day (1985/86), 96,400 cu.m/day (1987/88). Also, the actual water consumption in 1977/78 was 63,760 cu.m/day and the annual average increasing ratio was 4.8 % (1978/88).

According to the Water Supply Master Plan, the planned water consumption for Khartoum was projected at 113,800 cu.m/day (in 1983, served population of 528,000), 147,900 cu.m/day (in 1988, served population of 605,000) and 190,800 cu.m/day (in 1993, served population of 734,000), respectively.

There is a large difference between the actual and projected figures, supposedly due to the delay of the expansion works of the water supply facilities.

Expansion plans of the water supply facilities in Khartoum are only for Mogren (10,000 cu.m/day) and Khartoum North (15,000 cu.m/day) WPP.

Considering these matters, total consumption projected for the target year (1996) was forecasted to be 152,200 cu.m/day, based on the average water consumption (104,600 cu.m/day) from 1986 to 1988, using 4.8 % for the average annual increasing ratio.

However, it is above the capacity of the water supply facility of 137,200 cu.m/day, projected water consumption was supposed to be equal to the capacity 137,000 cu.m/day.

Table 5-6 Actual Water Consumption and Supply Capacity

(Unit: cu.m/day)

Facilities	Actual Water Consumption (Daily Average) 1977/78	1979	1986/87	1987/88	Capacity
Mogren W.P.P	44,725	45,577	-----	53,462	current: 56,000 expansion: 18,000 (1990)
Burri W.P.P.	13,525	15,889	-----	15,731	current: 18,200
Pumping Wells	5,510	5,870	-----	27,200	current: 30,000
Total	63,760	67,386	112,810	96,394	others: 15,000 total: 137,200
Average	65,573		104,602		
Increasing ratio	Average Annual Increasing Ratio: 4.8%				

* Though the capacity of Mogren WPP is 73,000 cu.m/day. It's sending water to Owdurman 17,000 cu.m/day, so the capacity for Khartoum should be 56,000 cu.m/day.

Table 5-7 Actual Water Consumption (1986-1988)

(Unit: cu.m)

	1986/87	1987/88			
		Mogren W.P.P.	Burri W.P.P.	Pumping Wells	Total
Jul'86	3,692,800	1,696,700	475,360	888,000	3,060,060
Aug	2,999,760	1,679,300	453,320	856,000	2,988,620
Sep	3,546,770	1,729,050	452,200	720,000	2,901,250
Oct	3,714,100	1,692,200	496,840	682,000	2,871,040
Nov	3,548,760	1,532,000	479,000	967,000	2,978,000
Dec	2,997,793	1,409,700	428,360	827,000	2,665,060
Jan'87	3,014,440	1,485,800	362,040	730,000	2,577,840
Feb	3,004,060	1,537,600	446,600	825,000	2,809,200
Mar	3,472,870	1,393,900	525,100	750,000	2,669,000
Apr	3,561,741	1,723,200	572,980	825,000	3,121,180
May	3,915,780	1,789,200	515,870	939,000	3,244,070
Jun	3,706,880	1,845,200	534,320	919,000	3,298,520
Total	41,175,754	19,513,850	5,741,990	9,928,000	35,183,840
Daily Average Water Consumption (cu.m/day)					
	112,810	53,462	15,731	27,200	96,394

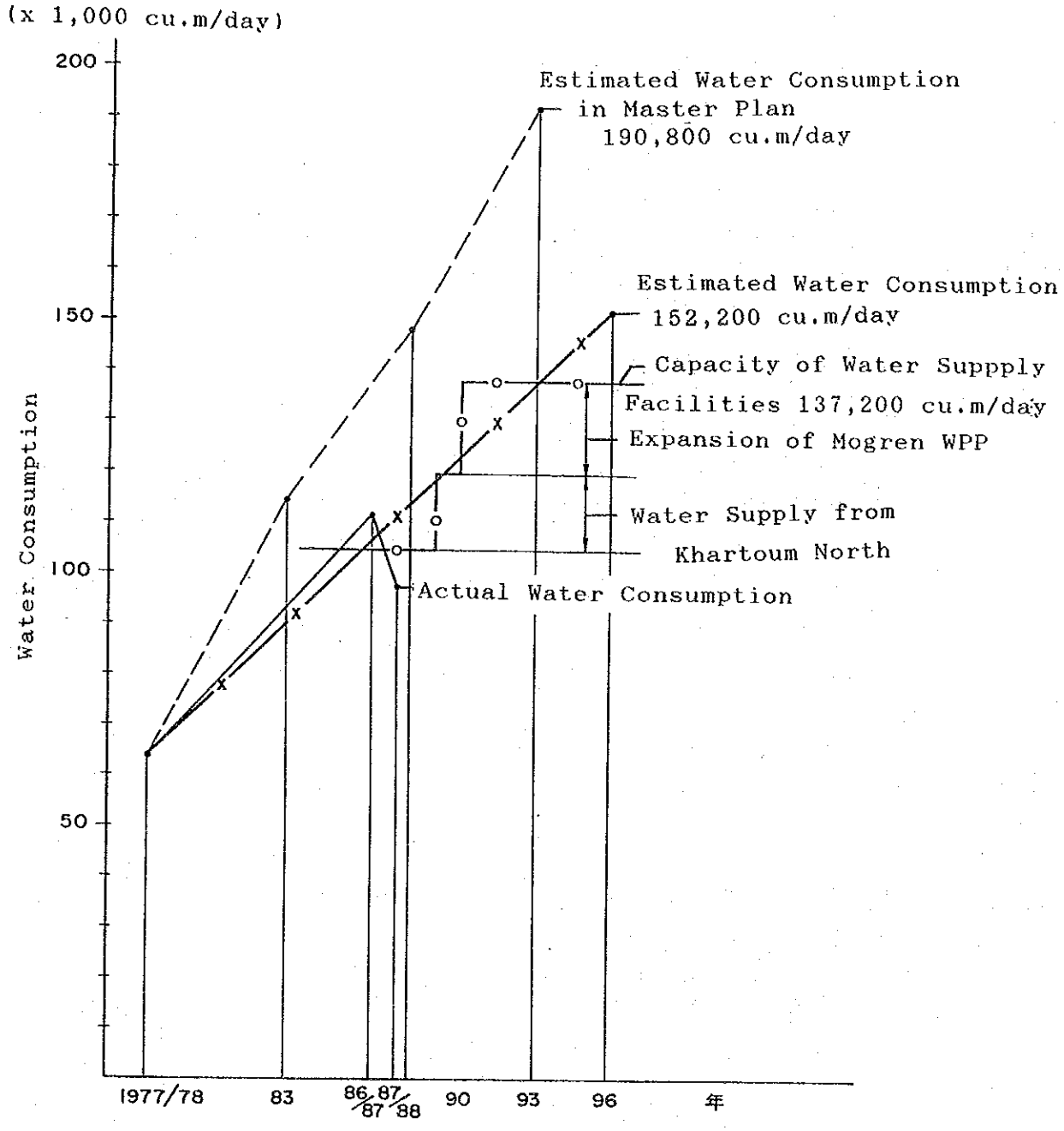


Fig. 5-3 Actual and Estimated Water Consumption and Capacity of Supply Facility

2) Water Consumption within Sewerage Service Area

Although there is no record for the water consumption within the sewerage service area, the water consumption for every zone in the Water Supply Master Plan was figured out.

According to this water consumption, the ratio of the supplied water within sewerage service area was 46 % (1983), 44 % (1988) and 43 % (1993) respectively.

These ratios were calculated by projecting water supply population, commercial consumption and industrial consumption. The calculations seem reliable, such that estimates of the water consumption within the sewerage service area will be carried out using these ratios.

Furthermore, water consumption at current (1988) and 1996 are similar to those in Master Plan at 1983 and 1988; these water supply ratios will also be used.

Consequently, water consumption within sewerage service area was estimated as follows:

Water Consumption	1988	1996
Khartoum	104,600 cu.m/day	137,200 cu.m/day
Sewerage Service Area	48,120 cu.m/day (46 %)	60,370 cu.m/day (44 %)

Table 5-8 Estimated Water Consumption for every Zone

(Unit: 1,000 cu.m/day)

Area No.	1983			1988			1993		
	Low User	Large User	Total	Low User	Large User	Total	Low User	Large User	Total
K1	4.2	6.5	10.7	4.9	9.5	14.4	5.4	14.0	19.4
K2	1.3	6.0	7.3	1.5	9.3	10.8	1.7	15.0	16.7
K3	1.6	17.3	18.9	1.6	19.2	20.8	1.6	21.9	23.5
K4	0.3	5.7	6.0	0.3	7.0	7.3	0.3	8.8	9.1
K5	5.9	3.7	9.6	6.6	5.1	11.7	6.8	7.0	13.8
	13.3	39.2	52.5	14.9	50.1	65.0	15.8	66.7	82.5
	[0.25]	[0.75]	(0.46)	[0.23]	[0.77]	(0.44)	[0.19]	[0.81]	(0.43)
K6	0.0	2.1	2.1		3.7	3.7		6.5	6.5
K7	8.2	0.5	8.7	13.0	1.1	14.1	17.6	2.0	19.6
K8	2.8	2.5	5.3	2.8	3.3	6.1	2.8	4.0	6.8
K9	7.5	0.9	8.4	8.4	1.2	9.6	9.4	1.5	10.9
K10	0.2	1.0	1.2	0.3	2.7	3.0	0.5	5.0	5.5
K11	9.0	1.7	10.7	10.2	2.4	12.6	11.1	3.5	14.6
K12	14.6	0.9	15.5	16.6	1.5	18.1	18.0	2.3	20.3
K13	8.3	0.4	8.7	13.0	1.0	14.0	18.3	2.4	20.7
K14	0.1	0.6	0.7	0.3	1.4	1.7	0.4	3.0	3.4
	50.7	10.6	61.3	64.6	18.3	82.9	78.1	30.2	108.3
Total	64.0	49.8	113.8	79.5	68.4	147.9	93.9	96.9	190.8
	[0.56]	[0.44]	[(1.00)]	[0.54]	[0.46]	[(1.00)]	[0.49]	[0.51]	[(1.00)]

(3) Sewage Flow

1) Current Sewage Flow Rate

Since the sewage flow is not measured and data is not readily available, it is difficult to project the flow. Here are measuring records carried out recently.

- Measurement at Inlet Measure Device (Parshall Frume) at Goaze STP , Jun. 6 - Jul. 12, 1987.
  Average daily flow calculated by the level measurement every hour: 43,300 cu.m/day.

- Estimate during the operation time of the pump station Nos. 6, 9, 15 which send sewage to Goaze STP.
  24-hour measurement Jan. 24, 1987:
  23,100 cu.m/day.
  There is a large difference between the above mentioned data due to:

(i) Measured flow at the inlet of STP is not accumulative and vary if the pumping stations are in operation or not.

(ii) Measuring device is small and when the PS Nos. 6 and 9 are operating, the total flow rate will be above the measuring capacity and the measured figure will be extraordinarily large due to the high water level.

The former (43,300 cu.m/day) seems to be less reliable. On the other hand, the latter (23,100 cu.m/day) was calculated by the capacity of the existing pump and the operation time is supposed to be highly reliable.

While water consumption within the sewerage service area is assumed to be 48,120 cu.m/day, it contains the water consumption of Burri power station (8,000 cu.m/day) which is used only inside of the facility such that the net consumption should be 40,100 cu.m/day.

When the sewage flow rate is to be estimated based on the water consumption, the effective rate concerning the leakage from the supply pipe must be considered. But there is no data available regarding this rate, so it is decided to estimate the sewage flow rate by the actual water consumption when the sewage flow rate was measured.

(a) Estimate of the effective rate using the pump operation time. Measurement of sewage flow rate was carried out Jan. 1987.

- Total Water Consumption in Khartoum, Jan. 1987:
  3,014,440 cu.m/day = 97,240 cu.m/day

- Estimate of water consumption within sewerage service area:

  97,240 x 0.46 = 44,730 cu.m/day

- Water consumption to be discharged into the sewerage system:
  44,730 - 8000 = 36,730 cu.m/day

- Estimated sewage flow rate, Jan. 1987:
  23,100 cu.m/day

- Effective rate: 23,100/36,730 = 0.63 = 63 %

(b) Estimate of effective rate by the measuring device at Goaze STP .
Measurement of sewage flow rate was performed Jun. - July 1987.

- Total water consumption in Khartoum Jun. - Jul. 1987
  Jun: 3,706,880 cu.m/month = 123,562 cu.m/day
  Jul: 3,060,060 cu.m/month = 98,712 cu.m/day
  Average = 111,137 cu.m/day

- Estimate of water consumption within sewerage service area:
  111,137 cu.m/day X 0.46 = 51,120 cu.m/day

- Water consumption to be discharged into sewerage system:
  51,120 - 8,000 = 43,120 cu.m/day

- Estimated sewage flow rate Jun. - Jul. 1987:
  43,123 cu.m/day

- Effective rate: 43,123/43,120 = 1.00 = 100%
  Comparing these two results, the following conclusion is obtained:

- According to the measurement at Goaze STP, the effective rate was about 100 % which seemed extraordinarily high compared with 50- 60 %, a figure deemed reasonable for the developing countries, and less reliable.

- Effective rate, computed by the flow rate which was calculated with the pump operation time, was 63 % and seems to be reasonable.

2) Estimate of Sewage Flow in 1996

Effective rate of 1987 was estimated at 63 %, but for the future (1996), 60 % was adopted as the average rate.

- Estimated water consumption within sewerage service area in 1996: 60,370 cu.m/day

- Water consumption at Burri Power Station:
  8,000 cu.m/day
- Water consumption to be discharged into sewerage system:
  52,370 cu.m/day
- Effective rate: 60 %

- Design sewerage flow: 31,420 cu.m/day
  The flow was divided, with reference to the water supply and sewerage master plan, into domestic, buildings, commercial and public facility and industrial effluent, as follows:

Domestic:	12,620 cu.m/day
	(175 lpcd)
Large effluent from buildings	: 5,900 cu.m/day
Commercial and public facilities:	8,400 cu.m/day
Industrial establishments	: 4,500 cu.m/day
Total	:31,420 cu.m/day

* referred to Master plan (see Table 5-9)

3) Sewage flow in drainage zone

According to the assorted flow rate, we calculated the rate in every drainage zones as shown in Table 5-10.

Table 5-9 Water Consumption per Capita

The existing domestic consumption figures and the projected per capita water demands recommended in the Water Supply Master Plan are shown in Table.

EXISTING PER CAPITA CONSUMPTION AND PROJECTED DEMANDS FOR DOMESTIC WATER WATER SUPPLY MASTER PLAN

Type of Supply	Consumption Level lpcd
Existing (1978)	
Metered Connection	66 to 144 with average of 90
Kiosk Supply	44
Average Domestic	63
Class I and II Housing with good level of service, with or without sewerage	140
Class III Housing with good level of service	85
Projected (1993)	
Class I and II Housing with good level of service with sewerage	175
Class III Housing with sewerage	150
Class III Housing without sewerage	105

Table 5-10 Estimated Sewage Flow In Every Drainage Zone (1996)

Zone	Population (Persons)	Flow Rate (cu.m/day)	P/S (No.)	Zone	Flow Rate (cu.m/day)	Remarks
A	3,389	2,224	1	A, G	3,877	
B	4,012	2,039	2	B	2,039	
C	2,559	1,641	3	C	1,641	
D	1,600	1,121	4	D	1,121	
E	4,450	3,058	5	E	3,058	
F	3,684	3,177	6	1.2.3.4.5 10.F.M.P	18,434	
G	1,604	1,653	7	G	1,653	
H	2,843	497	8	H	497	
J	22,936	6,690	9	H, J	7,187	
K	4,310	1,449	10	K, Q	1,915	
M	4,477	1,515	12	Q	466	
P	520	91	14	S	1,269	
Q	1,604	466	15	S, T	2,799	
S	7,263	1,269	20	6, 15	21,233	No.6-Soba Goaze STP
T	6,949	1,530	21	9,others	10,187	
Other	-----	3,000				
Total	72,200	31,420	Total		31,420	

5.2.3 Design Criteria to Determine Required Function and Scale of Each Facility

(1) Pumping Station

1) Capacity of Pump

Sewage within the existing sewerage service area is carried through pumping stations Nos. 20, 21 and Soba, Goaze trunk sewer to the pump pit of soba STP. Sewage will be pumped up by lift pump to the required level. Through the influent chamber, measuring tank and distribution basin, sewage flows into each lagoon. Pump capacity is fixed by an hourly maximum flow so a spare machine must be installed. Hourly maximum flow is supposed to be 2.0 - 3.0 times of the daily average flow at urban drainage. However for this project, almost every service zone has a pumping station, hourly maximum flow thus seems to be larger as compared to the ordinary. It adopted 2.5 QDA (Daily average flow) for design flow of pumping stations. But for PS Nos. 6, 20, 21 and Soba PS which receive sewage from a number of PS, considering there will be a time lag between the peak flow of the PS, it adopted 2.2 QDA.

2) Head and Output of Pump

Design total head of a pump is calculated from the actual head and head losses. The actual head is a difference between the design water level in the pump pit and level of the weir in the manhole where lifted sewage is discharged. The head losses are friction loss in the pipelines, the loss caused around pumps and discharge loss.

The output of the pump is calculated from the design capacity and total head of the pump according to the following formula:

$$P = Ps\ (1 + \alpha)$$

Where, P : Output of motor (kw)

Ps : Shaft horsepower of pump (kw)

α : Spare (0.15)

$$Ps = \frac{0.163 \times \delta \times Q \times H}{\eta}$$

Where, δ : Specific gravity of water (1.0)

Q : Design capacity of pump (cu.m/min)

H : Total head of pump (m)

η : Efficiency of pump

Design capacity (per pump), actual head, head loses, total head and motor output of the pumps in pumping stations are shown in Table 5-11.

3) Pumping Stations to be Improved by Other Projects

Pumping Stations Nos. 2, 3, 4, 5, 9, 10 and 15 of the Khartoum Sewerage System will be improved under the Arab Development Found, etc. (refer to Appendix - 4)

Scopes and Specifications of their improvement works were evaluated and consistency of them with this Project was confirmed as shown in Table 5-12.

The target year of these improvement works was also verified and confirmed as stated in the Minutes of Discussion. (refer to Appendix - 1)

4) Dimensions of Pump Rooms and Pump Pits in New Pumping Stations

Dimensions of pump rooms were decided considering spaces for equipment such as pumps, pipes, panels, etc. and space for maintenance in accordance with "Standard Drawing for Mechanical Equipment" published by Japan Sewage Works Agency.

Table 5－11　Design Conditions and Specifications of Pumps

Pumping Station	Capacity (cu.m/min)	Level of Pump Pit (m)	Level of Weir in Manhole (m)	Actual Head (m)	Friction Loss of Pipe (m)	Head Loss Around Pump (m)	Discharge Loss (m)	Total Head (m)	Efficiency of Pumps	Shaft Horsepower (kw)	Motor-Output (kw)
No. 1	3.4	374.0	381.723	7.723	14.9	1.5	0.07	24.2 = 25	0.6	26.6	30
No. 6	14.1	375.44	380.20	4.76	25.02	1.5	0.14	31.4 = 32	0.75	113	145
No. 7	1.5	373.245	378.88	5.653	10.7	1.5	0.13	= 18	0.5	10.1	11
No. 8	0.5	375.85	379.975	4.125	7.5	1.5	0.05	13.2 = 14	0.45	2.9	5.5
No. 12	0.4	374.01	377.685	3.675	0.08	1.5	0.03	5.3 = 6	0.45	1.0	3.7
No. 14	1.1	375.01	379.93	4.12	9.25	1.5	0.07	15.7 = 16	0.45	6.6	7.5
No. 20	16.3	376.5	380.296	3.796	22.7	1.5	0.19	28.2 = 29	0.74	120	132
No. 21	7.8	371.6	377.27	5.67	3.42	1.5	0.01	10.6 = 11	0.7	23	30
Soba	16.0	375.4	387.5	12.1	0.03	1.5	0.05	13.7 = 14	0.74	57	75

Notes: The plan of pumping station facilities is given in Table 5－12 while the systematic diagram of pumping stations and the drainage zones they serve are shown in Figure 5－4. Existing pumps in Soba STP have large capacities and are difficult to maintain because they are frequently submerged, hence these will be utilized as spare equipment.

Table 5-12 Plan for the Pump Station (1/2)

Item Pump Station	Capacity of Incoming Sewer (cu.m/min)	Capacity of Receiving Sewer (cu.m/min)	Average Daily Flow (cu.m/min)	Peak Daily Flow (cu.m/min)	Pump Specification	
					This Project	Master Plan
◎ 1	7.2	6.3	2.69	6.73	3.4 cu.m/min x 3 (1)	3.1 x 1 (E) 5.1 x 1 (N) 5.1 x 1 (S)
2	2.9	3.1	1.42	3.55	2.1 x 2	0.9 x 1 (E) 2.1 x 1 (N) 2.7 x 1 (S)
3	2.5	3.1	1.14	2.85	4.8 x 2 2.4 x 1	3.6 x 1 (E) 4.2 x 1 (N) 4.2 x 1 (S)
4	8.6	9.9	0.78	1.95	6.6 x 2	5.4 x 1 (E) 5.7 x 1 (N) 5.7 x 1 (S)
5	5.5	9.9	2.12	5.30	4.5 x 2	4.2 x 2 (N)
6	28.3	--	12.80	28.16	25.5 x 3	27.2 x 2 (N)
◎ 7	4.2	9.8	1.15	2.87	1.5 x 3(1)	0.6 x 1 (E) 1.5 x 1 (N) 1.5 x 1 (S)
◎ 8	3.2	2.7	0.35	0.86	0.5 x 3(1)	2.2 x 1 (E) 2.9 x 1 (N) 2.9 x 1 (S)

◎ : Scope of works of this project

Legend : Existing (E)
New (N)
Spare (S)

Table 5-12 Plan for the Pump Station (2/2)

Item Pump Station	Capacity of Incoming Sewer (cu.m/min)	Capacity of Receiving Sewer (cu.m/min)	Average Daily Flow (cu.m/min)	Peak Daily Flow (cu.m/day)	Pump Specification	
					This Project	Master Plan
9	19.8	---	4.99	12.48	9.1 cu.m/min x 3	9.0 x 2 (N)
10	3.5	4.8	1.33	3.33	2.7 x 2	2.1 x 2 (N)
◎ 12	2.3	1.0	0.32	0.81	0.4 x 3(1)	1.1 x 1 (E) 0.9 x 1 (N) 0.9 x 1 (S)
◎ 14	5.5	2.4	0.88	2.20	1.1 x 3(1)	1.1 x 1 (E) 2.6 x 1 (N) 2.6 x 1 (S)
15	6.6	---	1.94	4.85	2.4 x 1 6.0 x 1	6.0 x 2 (N)
◎ 20 (NO. 6 PS-Soba)			14.75	32.44	16.3 x 3(1)	
◎ 21 (Goaze STP)			7.07	15.56	7.8 x 3	
◎ Soba			21.82	48.00	16.0 x 3	

◎: Scope of works of this project

Legend : Existing (E)
New (N)
Spare (S)

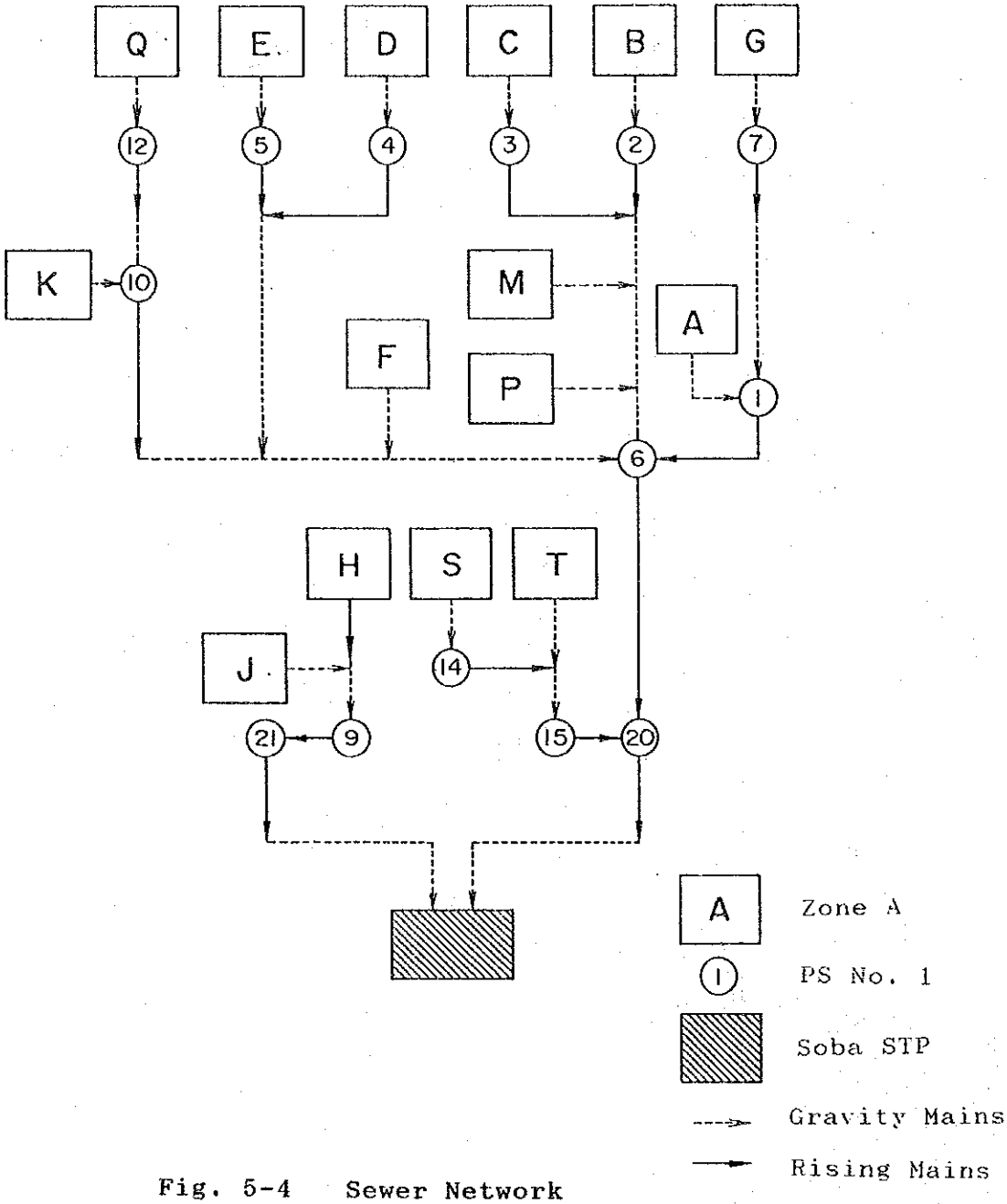


Fig. 5-4 Sewer Network

In order to decide the volume of pump pit, the consideration is that first, the pump pit must have a minimum volume such that the frequency of pump ON-OFF operation is less than 3 times in an hour, to maintain good performance. Considering period for communicating with other pumping stations and for starting the diesel engine generator and restarting pumps, the pump pit should have a volume equivalent to sewage retained in a period of 10 minutes.

Dimensions and effective volumes of three new pumping stations are as follows:

Pumping Station	Dimensions of Pump Room (m) W x L	Dimension & Effective Volume of Pump Pit (m) W x L x H (cu.m)
No. 20	8 x 12	6 x 12 x 9.5 V = 684
No. 21	7.5 x 11	6 x 11 x 9.6 V = 634
Soba	8 x 13	8 x 13 x 10.8 V = 1123

5) Quantities of Spare Parts

Certain quantities of spare parts and consumable goods are necessary to maintain pumping equipment in good condition. However, the Sudanese Government faces difficulties in the procurement of spare parts and consumable goods because of financial constraints.

Therefore, the following spare parts and consumable goods for five years operation are planned to be supplied under the project.

a) Vertical Shaft Screw Type Centrifugal Pump

Spare Parts	Useful Period (months)	Quantity (pcs)
Main Pump		
Shaft Sleeve	10	6
Impeller	20	3
Bearing	6	9
Gland Packing	4	15
O-Ring & Gasket	4	15
Main Motor		
Shaft Sleeve	20	3
Bearing	30	2
Seal Water Pump		
Gland Packing	6	10

b) Vertical Shaft Mixed Flow Pump

Spare Parts	Useful Period (months)	Quantity (pcs)
Main Pump		
Casing Ring	10	6
Impeller Ring	10	6
Shaft Sleeve	10	6
Impeller	20	3
Bearing	6	9
Gland Packing	4	15
O-Ring & Gasket	4	15
Main Motor		
Shaft Sleeve	20	3
Seal Water Pump		
Bearing	30	2
Gland Packing	6	10

(2) Sewage Treatment Plant

Existing facilities at the Soba STP is constructed for stabilization lagoon method with the combination of anaerobic pond + facultive lagoon + maturation pond, and will be utilized with existing treatment method due to the following reasons:

i) Maintenance work of this method is easy, and construction and maintenance cost are also the most economical.

ii) Treated water of this plant will be used for the irrigation purpose in Green Belt Area where afforestation is performed mainly with eucalyptus. Effluent quality can be achieved the design criterias which WHO, World Bank and other countries adopted. (These standards are shown in Appendix - 6)

iii) Although the algae, breeded in ponds, has probability of being discharged with treated water, it flows into the ditch type irrigation canal which will not connect to the public water area. So the effect of the algae to the forest and public water seems to be small.

1) Design Criteria of Soba STP

Based on expected population and flow in 1996, design criteria for this STP are established as follows:

Design Service Population: 72,000

Design Flow : 31,420 cu.m/day (Daily average sewage flow)

Influent quality : Data from Goaze STP and the results of the analysis carried out through this study are as follows:

Data on influent quality at Goaze STP (1978)

	BOD (mg/l)	SS (mg/l)
annual maximum	620	830
annual minimum	60	70
annual average	203	320
monthly maximum	460	540
monthly minimum	120	116

Results of water quality

		BOD (mg/l)	SS (mg/l)
5 Dec. '88	PS	400	--
5 Dec. '88	STP	288	366
5 Dec. '88	STP	280	438
11 Dec. '88	PS	663	74
11 Dec. '88	STP	400	66

Although the annual average are BOD 200 mg/l, SS 300 mg/l, considering changed in seasons and the result of the analysis, BOD 300 mg/l, SS 350 mg/l are adopted as the design criteria.

Effluent quality :

According to the report of EPA USA and World Bank, 80 to 95% is adopted for the removal rate of BOD.

In this project, 85% for the removal rate of BOD, and 80% for SS are adopted. Effluent quality of BOD and SS are 45 mg/l and 75 mg/l, respectively.

2) Design Criteria of Capacity Calculation of Treatment Facilities

Capacity of each treatment facility is designed on the basis of the provisions of World Bank Technical Paper Number 7 "Notes on the Design and Operation of Waste Stabilization Ponds in Warm Climates of Developing Countries."

a) Anaerobic Pond

Sewage, divided by distribution basins, flows into the anaerobic pond by gravity, and sedimentation treatment is carried out separating it into superratant and sludge. Sedimented sludge is digested in its anaerobic condition and its volume is reduced then stored at the bottom of the pond.

Sedimented sludge is dried under the sun and discharged, after the sewage in the pond is draining. This must be done regularly (once in 1-3 years) due to the accumulated sludge sedimentation.

Therefore, two ponds are constructed in one series and used alternatively. According to the World Bank Technical Paper, BOD load is supposed to be 0.1 - 0.4 kg-BOD/cu.m/day and retention time should be approximately 2.0 hours. And, it also suggested that 0.1 kg/BOD/cu.m/day should be utilized in areas which have definite cold seasons (average atmos pheric temperature is 12 degrees C) and 0.4 kg-BOD/cu.m/day should be used for tropic zone (7-30 degrees C). The average atmospheric temperature in winter season at Khartoum is 22 degrees C, so in this project, design criteria is fixed as follows:

BOD load : 0.25 kg-BOD/cu.m/day

Retention time : 2.0 hours

b) Facultative Lagoon

Sewage, treated in the anaerobic pond, flows into facultative lagoon by gravity. Sewage will be treated with oxygen by circulating aeration and photosynthesis by algae, and purified by oxidation of organisms that are present in aerobic and anaerobic bacteria.

Settled sludge at the bottom of the pond will be oxidated and decomposed by anaerobic bacteria.

Though the scale of facultive lagoon is effected by atmospheric temperature and sunshine in the designed area, the World Bank Technical Paper recommend that in tropical and subtropical zone, the capacity should be determined by atmospheric temperature and BOD load, as follows:

BOD surface load: $Sl = 20T - 60$ (kg-BOD/ha/day)

Required hydraulic urface area:

$$A = \frac{10 \times Li \times Q}{\lambda}$$

Note: Li : Influent BOD concentration (mg/l)
Q : Influent flow (cu.m/day)
T : Monthly average lowest atmospheric temperature

Retention time: 7 - 15 days

By the combination of the anaerobic pond and facultative lagoon which is designed with this formula, removal rates of 88 percent for BOD (at 20 degrees C atmospheric temperature) and 99.5 percent for coliform can be expected. This area is applied to subtropical zone since atmospheric temperature is 22 - 23 degrees C. In the winter season, calculation will be carried out using 20 degrees C for design temperature to include a margin of safety.

c) Maturation Pond

Effluent from the facultive lagoon flows into a maturation pond by gravity and the purification of sewage and removal of coliform are performed here.

The number of coliform is determined by the formula shown below:

$$Be = \frac{Bi}{1 + Kb(T)t}, \quad Kb(T) = 2.6(1.19)^{(T-20)}$$

Based on the World Bank Technical Paper, with the combination of anaerobic pond, facultive lagoon and maturation pond which has a retention time of 5 days, removal rates of 92 percent for BOD, 99.975 percent for coliform can be expected.

In this project, the number of coliform in treated water is estimated to be 4,400/100 ml with the assumption that atmospheric temperature in winter time is 22 degrees C and retention time in this pond is 3 days.

Total removal rate of this plant is estimated to be:

BOD ; 80 percent SS ; 80 percent

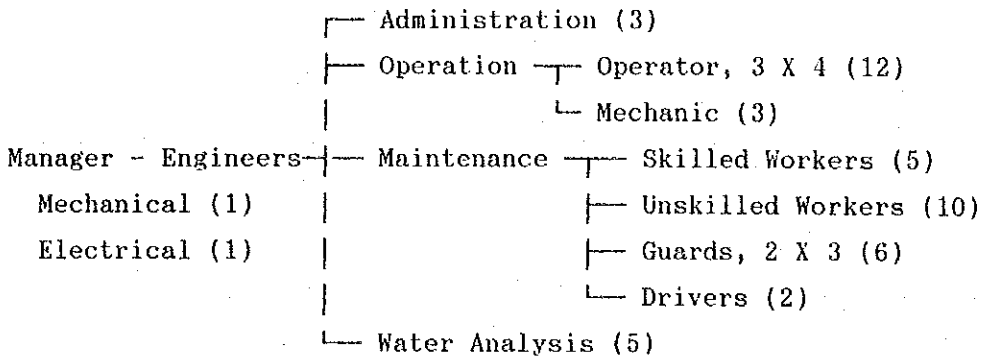
The influence of discharged algae was taken into consideration.

Capacity calculation of Soba STP is shown in Appendix-5.

3) Design Calculation of Administration Building

The space required for the Administration Building is dependent upon the organization of operation and maintenance. With the given needed number and position of staff and personnel under the organization the space requirement is determined on the basis of design standard for sewage treatment plants in Japan. Organization for operation and maintenance, design standard and design calculation are shown hereunder:

Organization of Operation and Maintenance



Design Standard

Office: (3.3 sq.m per capita) X (no. of officer) + 20 sq.m

Multiplying factor :	Manager	: 6.0
	Engineer	: 1.8
	Others	: 1.0

Meeting Room	:	0.5 sq.m x R + 50 sq.m
(R means capacity of the plant in thousand cu.m/day)		
Library	:	13 percent of office area
Store room	:	from necessity
Locker room	:	(1.0 sq.m per capita) x (no. of workers)
Worker's room	:	(1.5 sq.m per capita) x (No. of person in day time) + 5.0 sq.m
Electrical room	:	from necessity
Laboratory	:	from necessity
Workshop	:	from necessity
Dining room	:	from necessity
Lavatory	:	(1.0 sq.m per capita) x (no. of person in day time)
Shower room	:	(1.0 sq.m per capita) x (no. of workers)

Design Calculation

Office	:	Officers consist of a manager, engineers, clerks and water analysts and total of 11 persons 3.3 x (1 x 6.0 + 2 x 1.8 + 8 x 1.0) + 20 = 78 sq.m Adopted; 72 sq.m (6.0 m X 12.0 m)
Meeting room	:	none
Library	:	78 sq.m x 0.13 = 10 sq.m Adopted; 10 sq.m (3.5 m x 3.0 m)
Store room	:	Adopted; 36 sq.m (6.0 m x 6.0 m)
Locker room	:	Operation (6), maintenance (5) total 11 persons 1.0 sq.m x 11 = 11 sq.m Adopted; 10 sq.m (3.5 m x 3.0 m)
Dining room	:	Adopted; 10 sq.m (3.5 m x 3.0 m)
Workers room	:	Operation (6), maintenance (17) total 23 persons 1.5 x 2.3 + 5.0 = 39.5 sq.m Adopted; 36 sq.m (6.0 m x 6.0 m)
Electrical room	:	none
Laboratory	:	Adopted; 72 sq.m (6.0 m x 12.0 m)
Workshop	:	Adopted; 72 sq.m (6.0 m x 12.0 m)
Lavatory and Shower room	:	35 x 1.0 + 23 x 1.0 = 58 sq.m Adopted; 10 sq.m (3.5 m x 3.0 m)

4) Selection of Water Analysis Equipment

Considering items of water analysis in Soba STP, water analysis equipment are selected on the basis of "Architectural Design Standard" of Japan Sewage Works Agency and are listed in Table 5-13.

Items of water analysis and necessary equipment are as follows:

Items of Water Analysis

Ambient Temperature, Water Temperature, Appearance (Color), Odor, Transparency, DO, pH, SS, COD, BOD, Microscope Examination, Total solid, Ignition Residue, Coliform Group Bacteria, NH4-N, Chloride Ion.

(3) Sewer Facilities

1) Diameter of Gravity Mains

According to "Guidelines for Designing of Sewerage Facilities" (Japan Sewage Works Association), Manning's Formula is applied to calculate diameter of gravity mains.

Manning's Formula:

$$Q = A\,V$$
$$V = I/n.R^{2/3} \cdot I^{1/2}$$
$$R = A/P$$

Where, Q : Flow (cu.m/sec)
V : Mean velocity of flow (m/sec)
n : Coefficient of roughness (0.013)
I : Incline (decimal)
R : Hydraulic radius
P : Wetted perimeter

Capacity of existing gravity mains is also examined by Maning's Formula.

Existing gravity mains in NCK is shown in Figure 5-5.

2) Diameter of Rising Mains

Diameter of rising mains is decided principally by the velocity of flow. Standard ranges of velocity in pipes is given below:

Table 5 - 1 3 Water Analysis Euipment

Equipment	Purpose	Quantity	Dimension (cm)			Power Source Capacity	Diameter of Water Supply	Drain	Gas	Ventilation
			Width	Length	Height					
(Devices)										
Balance	Common	1	40	55	50	100V 100W	—	—	—	—
pH Meter	pH	1	40	20	10	100V 100W (A)	—	—	—	—
DO Meter	DO/BOD	1	30	15	25	100V 100W (A)	—	—	—	—
Microscope	Organism	1	40	40	50	100V 0.5Kw	—	—	—	—
Electric Dryer	Common	1	75	70	85	100V 1.8 - 3Kw	—	—	—	—
Hot Bath	SS/DS	1	100	45	25	100V 3Kw	20	X	—	X
Hot Bath	COD	1	100	45	25	100V 3Kw	20	X	—	—
Electric Furnace	VSS	1	50	65	50	200V 4 - 9Kw	—	—	—	X
Incubator	BOD/20°C	1	80	70	120	100V	—	—	—	—
Pure Water Device	Common	1	80	60	160	1.2 - 2Kw	20	X	—	—
Centrifugal Separator	Alkalinity	1	45	60	80	100V 0.2 - 1Kw	—	—	—	—
Vacuum Pump		1	60	30	40	100V 0.3Kw	—	—	—	—
Refrigerator	Samples	1	80	75	230	100V 0.6Kw	—	—	—	—
Refrigerator	Chemicals	1	45	50	125	100V 0.2Kw	—	—	—	—
(Equipment)										
Draft chamber	Common	1	120 150	75	235	100V	20	X	X	X
Main Table			240 300	150	80	100V 1.5 2.0 3.0Kw	20	X	X	—
Table for balance	Balance	1	120	75	75	100V 100W	—	—	—	—
Side Table	Common	1	180 240	75	80	100V 1.5 20 3.0Kw	20 —	X —	X —	— —
Sideboard for Chemicals	Common	1	180	40	180	——	—	—	—	—
Siderboard for Divices	Common	1	180	40	180	——	—	—	—	—

Remarks : X : Required
(A) : Required earthing

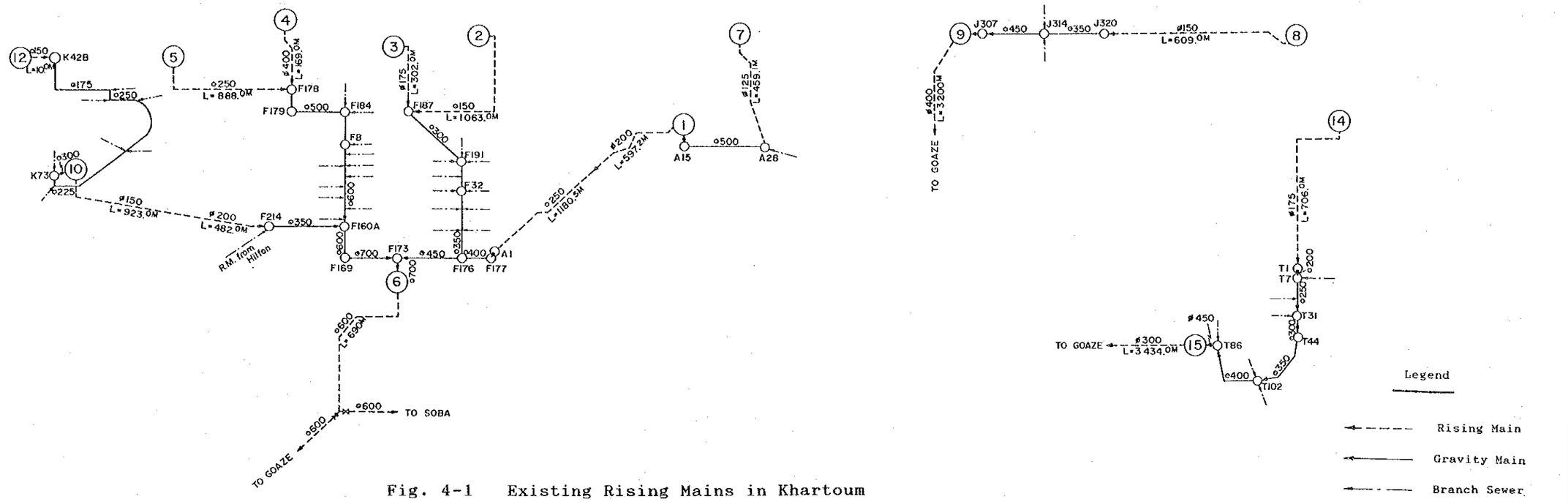


Fig. 4-1 Existing Rising Mains in Khartoum

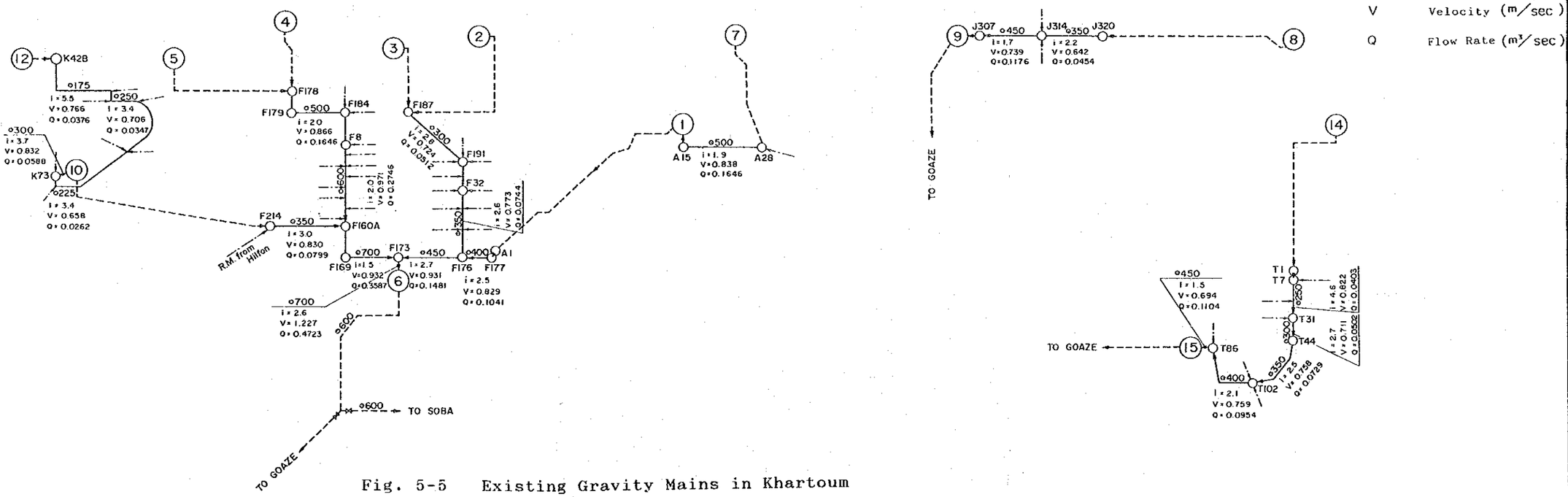


Fig. 5-5 Existing Gravity Mains in Khartoum

Diameter (mm)	Standard Velocity (m/s)
75 - 150	0.7 - 1.0
200 - 400	0.9 - 1.6
450 - 800	1.2 - 1.8
900 - 1,500	1.3 - 2.0
1,600 - 3,000	1.4 - 2.5

Diameter of rising mains with the corresponding velocities from each pumping stations are as follows:

Pumping Station	Design Flow (cu.m/min)	Diameter (mm)	Velocity (m/s)	Remarks
No. 1	6.73	300	1.59	
No. 7	2.87	200	1.52	
No. 8	0.86	150	0.81	
No. 9	12.48	500	1.06	A
No. 10	3.33	200	1.77	A
No. 12	0.81	150	0.76	
No. 14	2.20	200	1.17	
No. 15	4.85	300	1.14	
Soba	48.0	1000	1.0	B

Remarks: A : Existing pump are adopted
B : Existing pipes are used

The velocity in the rising mains of Pumping Stations No. 9, No. 10 and Soba STP are marginally out of standard ranges of velocity since existing pumps and rising mains are used. The slight deviations are not expected to present any major problem.

5.3 Items for Rehabilitation and Basic Engineering Drawings

5.3.1 Items for Rehabilitation

Out line of the sewerage facilities to be rehabilitated, which was fixed in the previous clause is shown in Table 5-14.

5.3.2 Basic Engineering Drawings

We attached the basic engineering drawings for the facilities shown in Table 5-14.

Contents are as follows:

(1) SEWERAGE NETWORK GENERAL PLAN.

(2) RISING MAINS (1/5) (PS No. 7 - 1 - 6)

(3) RISING MAINS (2/5) (PS No. 8 - 9 21)

(4) RISING MAINS (3/5) (PS No. 9 - 21, 10, 12)

(5) RISING MAINS (4/5) (PS No. 6 - AFRICAN ROAD)

(6) RISING MAINS (5/5) (PS No. 14, 15 - 20)

(7) PRESSURE MANHOLE

(8) GRAVITY MAIN (GREEN BELT - Soba STP)

(9) Soba STP GENERAL PLAN

(10) LAYOUT PLAN

(11) OVERALL HYDRAULIC FLOW THROUGH DIAGRAM

(12) SCREEN GRIT AND PARSHALL FLUME

(13) VALUE BOX (1)

(14) VALUE BOX (2)

(15) DISTRIBUTION CHAMBER

(16) OUT LET

(17) INTERPOND CONNECTION

(18) ADMINISTRATION OFFICE (1)

(19) ADMINISTRATION OFFICE (2)

(20) ADMINISTRATION OFFICE (3)

(21) SEWER FLOW DIAGRAM

(22) KEY PLAN OF EACH PUMPING STATION

(23) PUMPING STATION No. 1

(24) PUMPING STATION No. 6

(25) PUMPING STATION No. 7

(26) PUMPING STATION No. 8

(27) PUMPING STATION No. 12

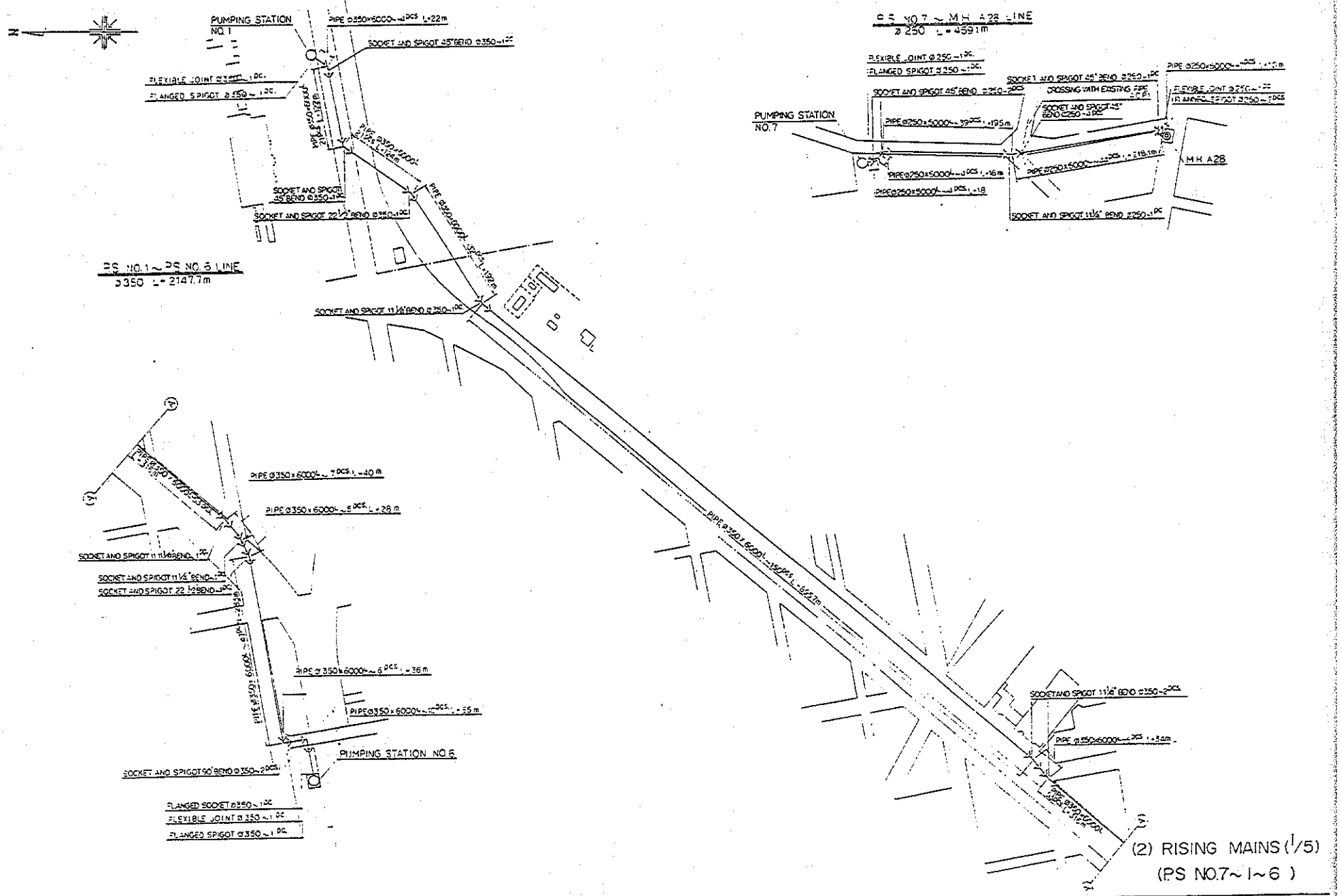
(28) PUMPING STATION No. 14

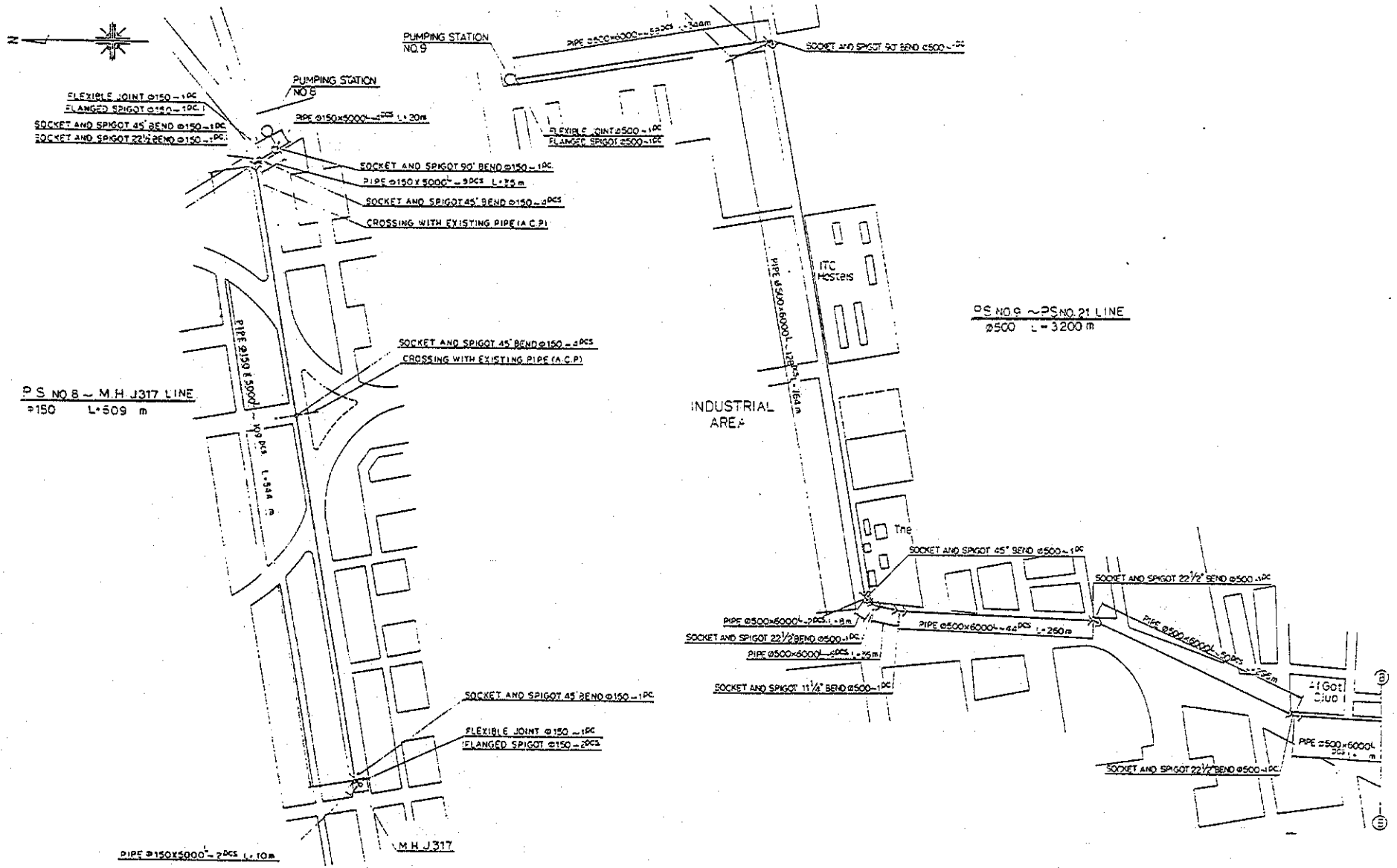
(29) PUMPING STATION No. 20

(30) PUMPING STATION No. 21

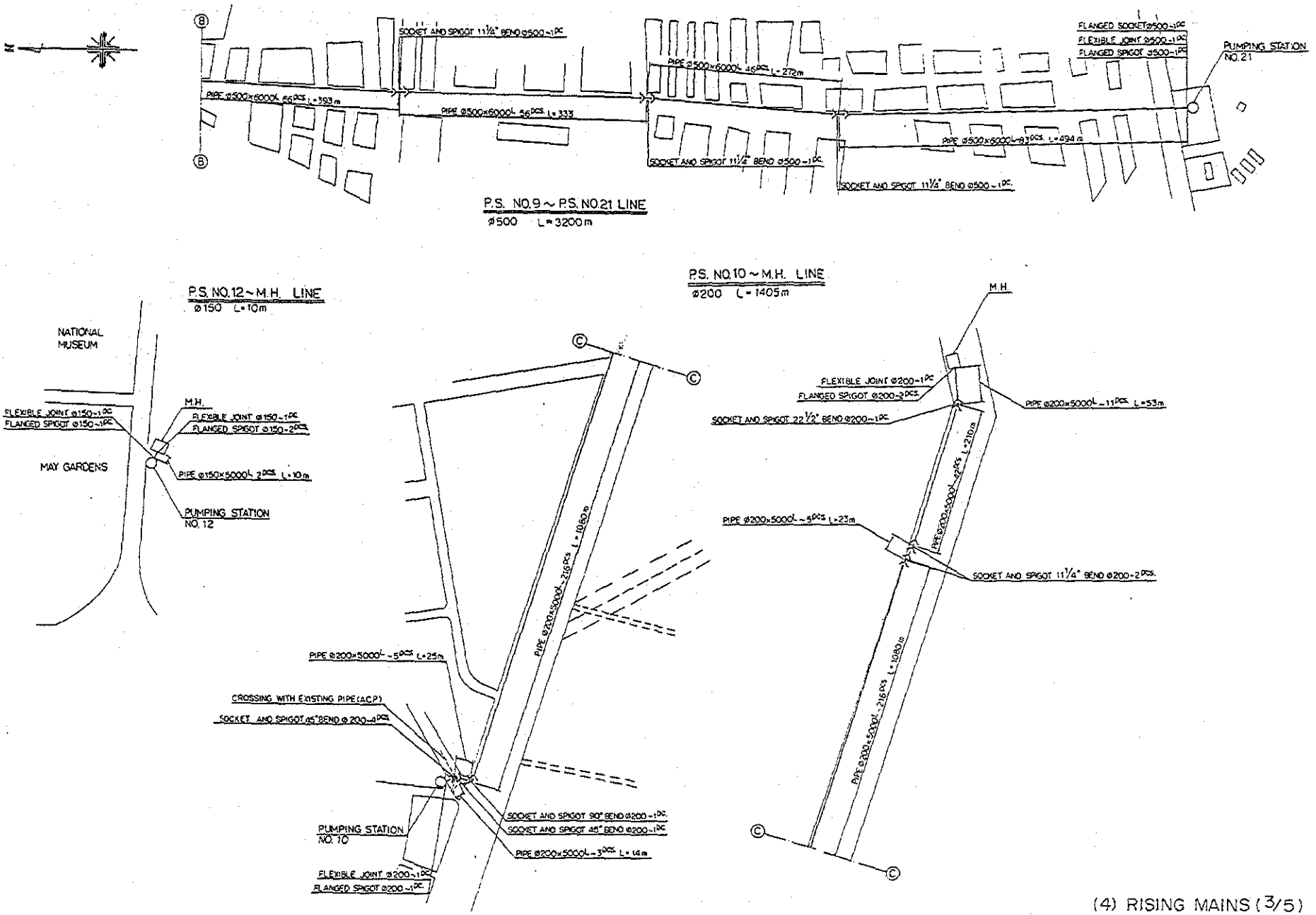
(31) Soba PUMPING STATION

(1) SEWERAGE NETWORK
GENERAL PLAN

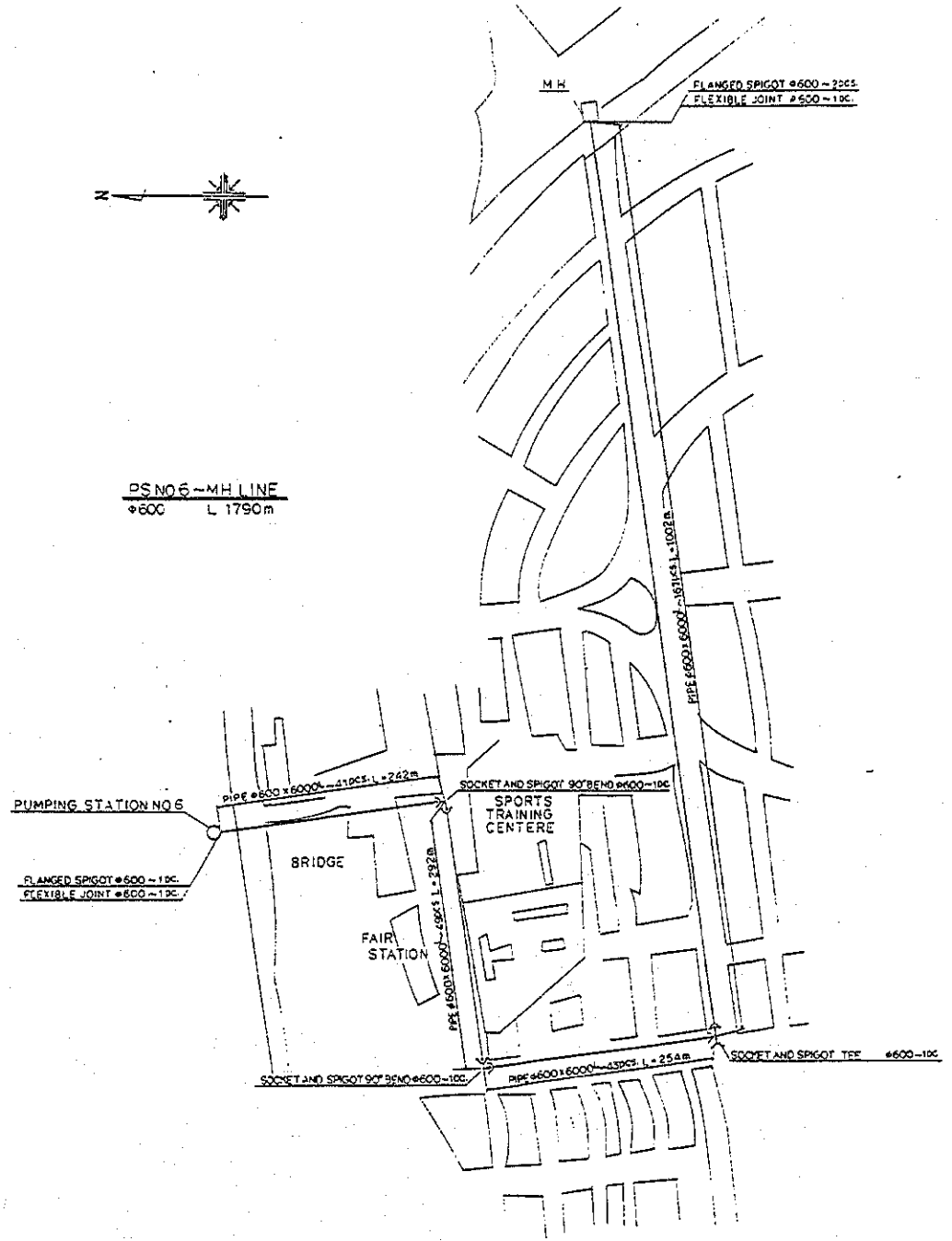

PUMPING STATION NO.1
PS NO.1 ~ PS NO.6 LINE
Ø350 L = 2147.7m
PS NO.7 ~ MH A28 LINE
Ø250 L = 4591m
PUMPING STATION NO.7
MH A28
PUMPING STATION NO.6
(2) RISING MAINS (1/5)
(PS NO.7~1~6)



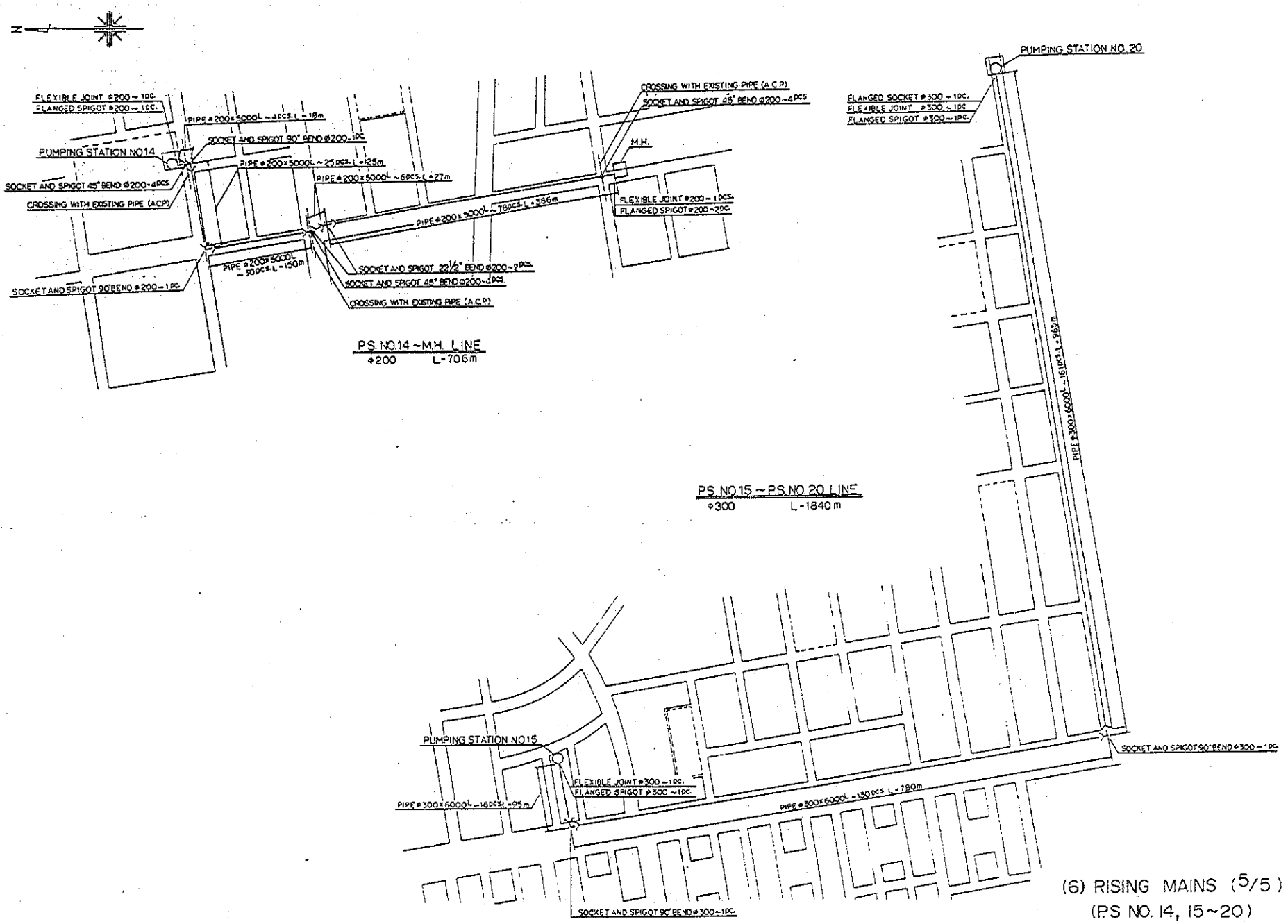
(3) RISING MAINS (2/5)
(P.S NO.8~9~21)



(4) RISING MAINS (3/5)
(PS NO.9~21, 10, 12)



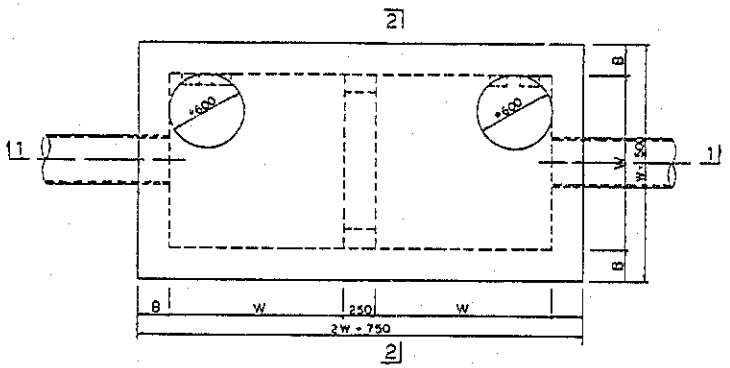
(5) RISING MAINS (4/5)
(PS NO.6 ~ AFRICAN ROAD)



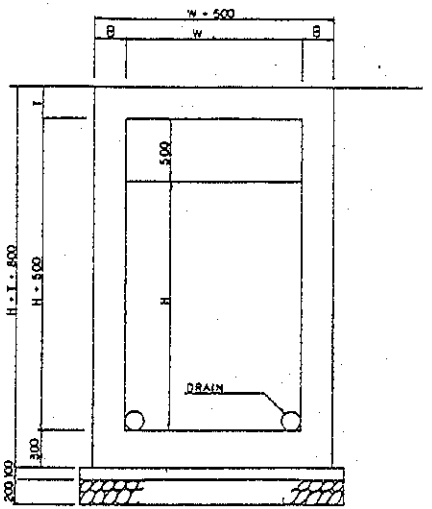
(6) RISING MAINS (5/5)
(P.S NO. 14, 15~20)

MAN HOLE

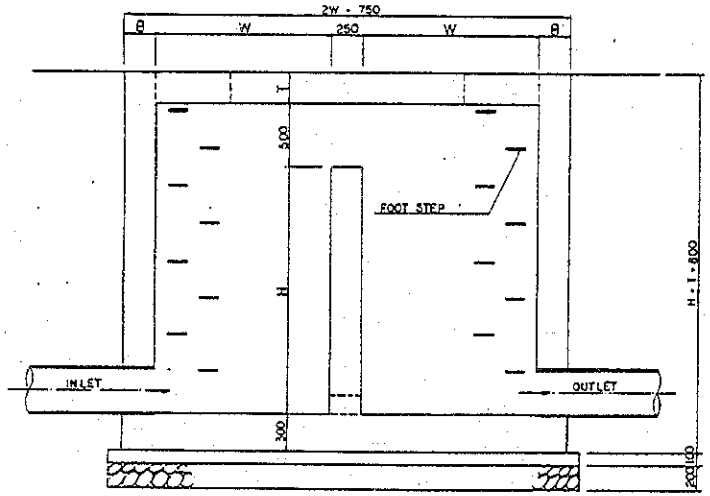
PLAN



2—2



1—1



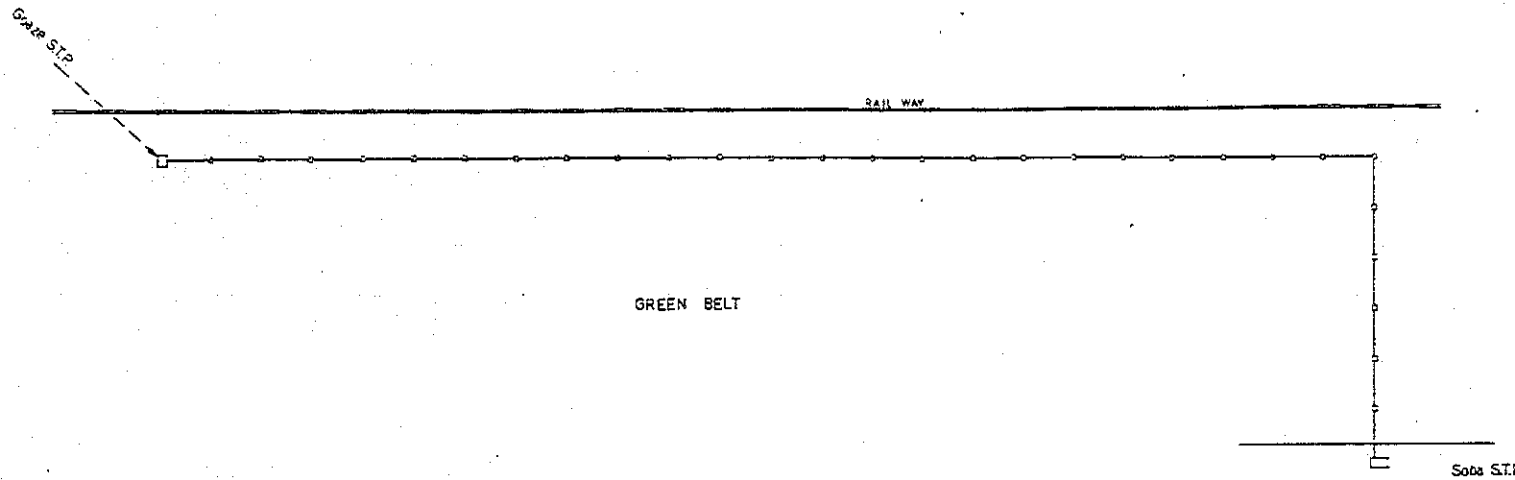
(UNIT : M)

MANHOLE NO.	W	H	T	B
7	1.3	2.0	0.2	0.15
8	1.0	1.5	0.2	0.15
10	1.4	2.0	0.2	0.15
12	0.9	1.0	0.2	0.15
14	1.1	2.0	0.2	0.15
21	2.7	2.0	0.3	0.25

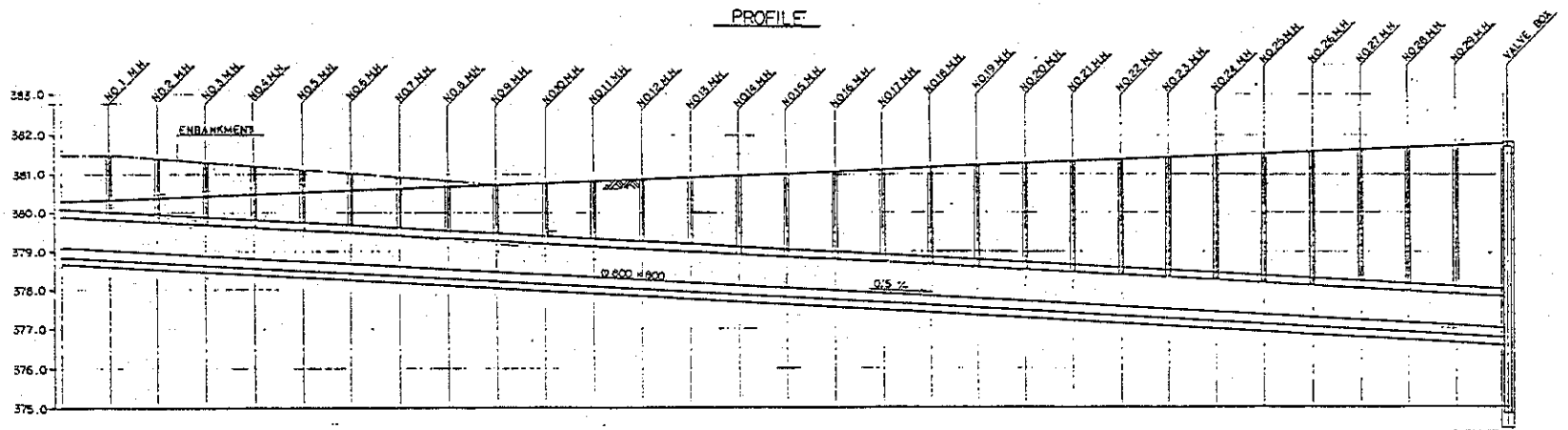
(7) PRESSURE MAN HOLE

GRAVITY MAIN Scale V = 1:60 H = 1:5000

PLAN

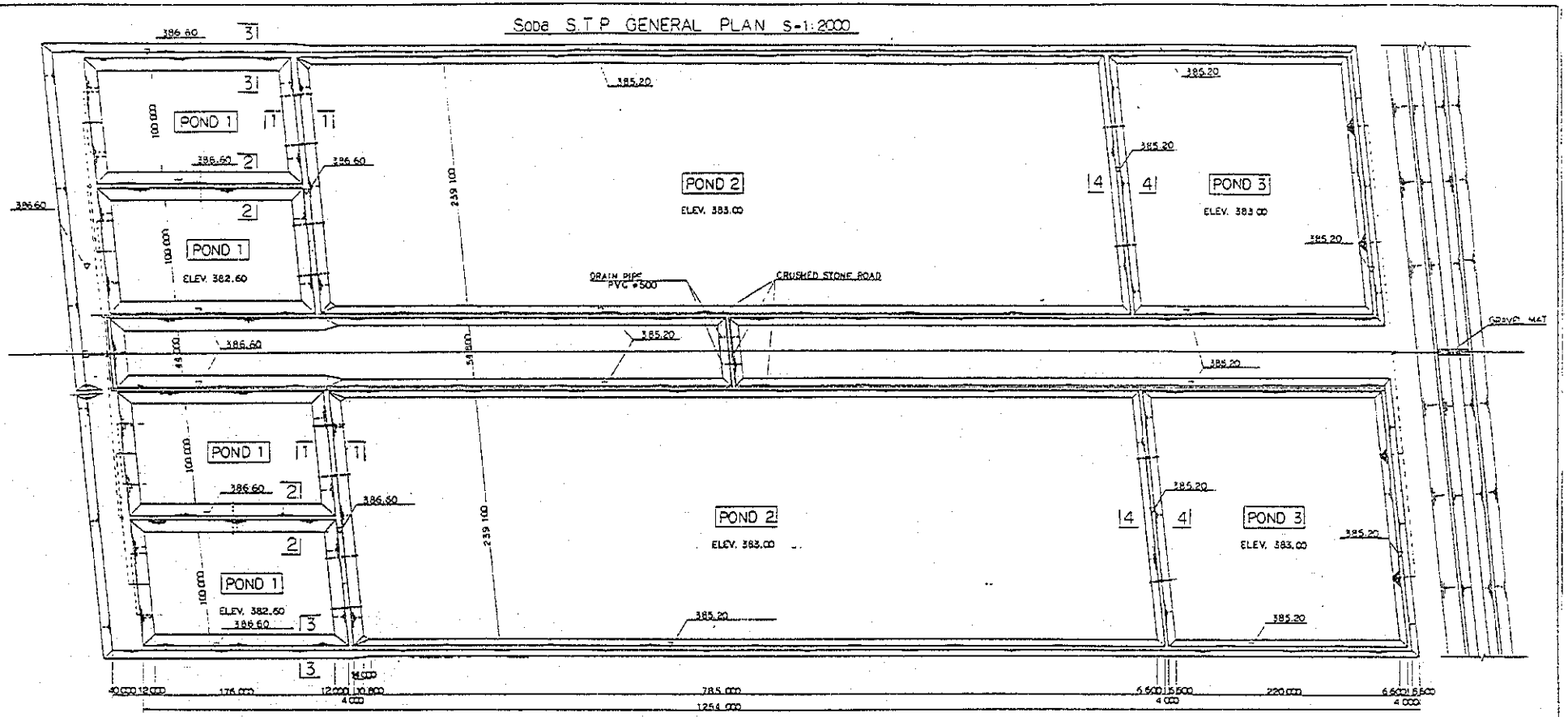


PROFILE



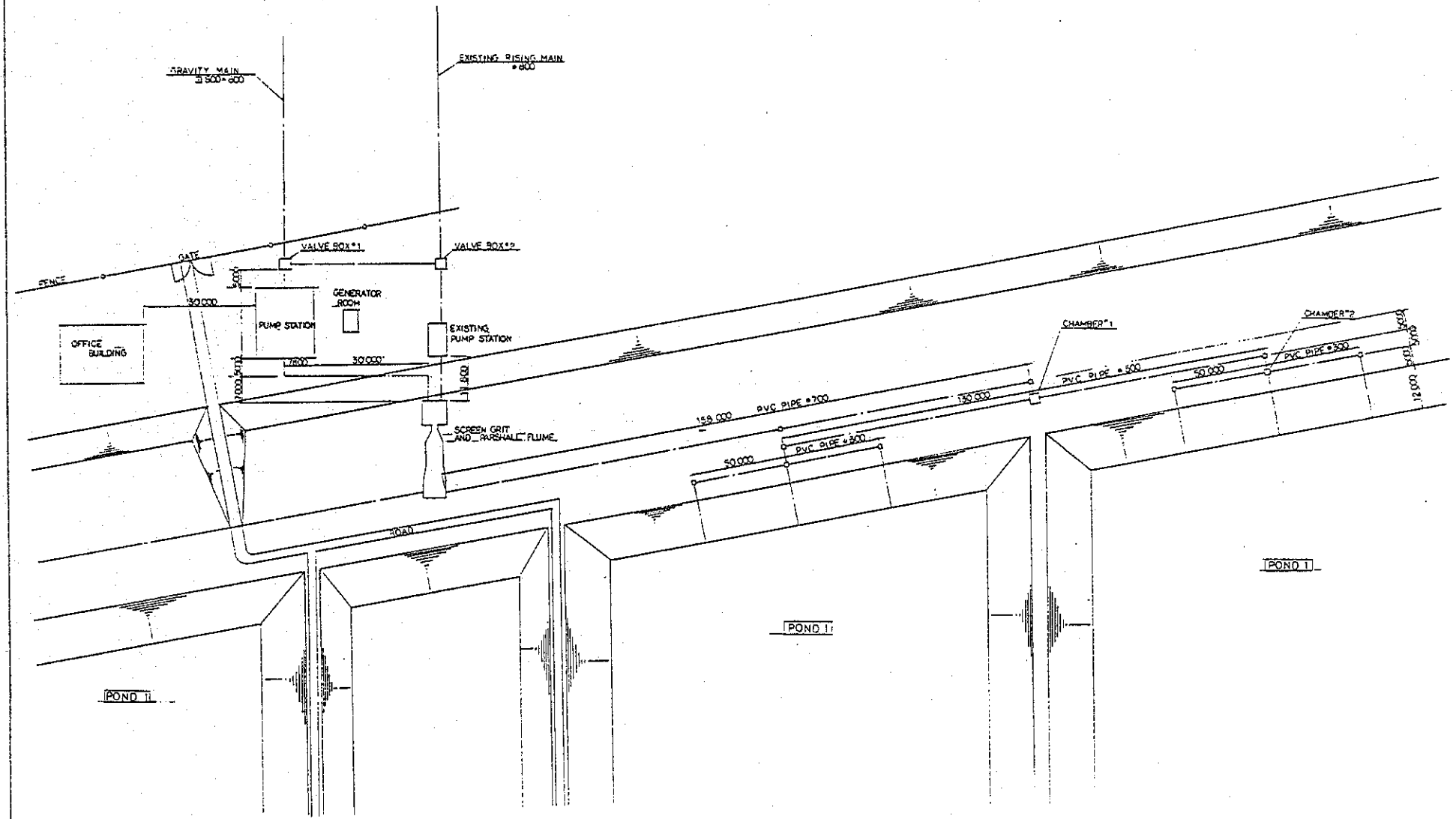
TOTAL LENGTH	LENGTH	INVERT ELEV.	GROUND ELEV.
0.0	0.0	379.07	380
100.0	100.0	378.95 / 378.93	380.37
200.0	100.0	378.86 / 378.86	380.42
300.0	100.0	378.81 / 378.79	380.47
400.0	100.0	378.74 / 378.72	380.52
500.0	100.0	378.67 / 378.65	380.57
600.0	100.0	378.60 / 378.58	380.62
700.0	100.0	378.53 / 378.51	380.67
800.0	100.0	378.46 / 378.44	380.72
900.0	100.0	378.39 / 378.37	380.77
1000.0	100.0	378.32 / 378.30	380.82
1100.0	100.0	378.25 / 378.23	380.87
1200.0	100.0	378.18 / 378.16	380.92
1300.0	100.0	378.11 / 378.09	380.97
1400.0	100.0	378.04 / 378.02	381.02
1500.0	100.0	377.97 / 377.95	381.07
1600.0	100.0	377.90 / 377.88	381.12
1700.0	100.0	377.83 / 377.81	381.17
1800.0	100.0	377.76 / 377.74	381.22
1900.0	100.0	377.69 / 377.67	381.27
2000.0	100.0	377.62 / 377.60	381.32
2100.0	100.0	377.55 / 377.53	381.37
2200.0	100.0	377.48 / 377.46	381.42
2300.0	100.0	377.41 / 377.39	381.47
2400.0	100.0	377.34 / 377.32	381.52
2500.0	100.0	377.27 / 377.25	381.57
2600.0	100.0	377.20 / 377.18	381.62
2700.0	100.0	377.13 / 377.11	381.67
2800.0	100.0	377.06 / 377.04	381.72
2900.0	100.0	376.99 / 376.97	381.77
3000.0	100.0		

(8) GRAVITY MAIN (GREENBELT ~ SOBA S.T.P.)

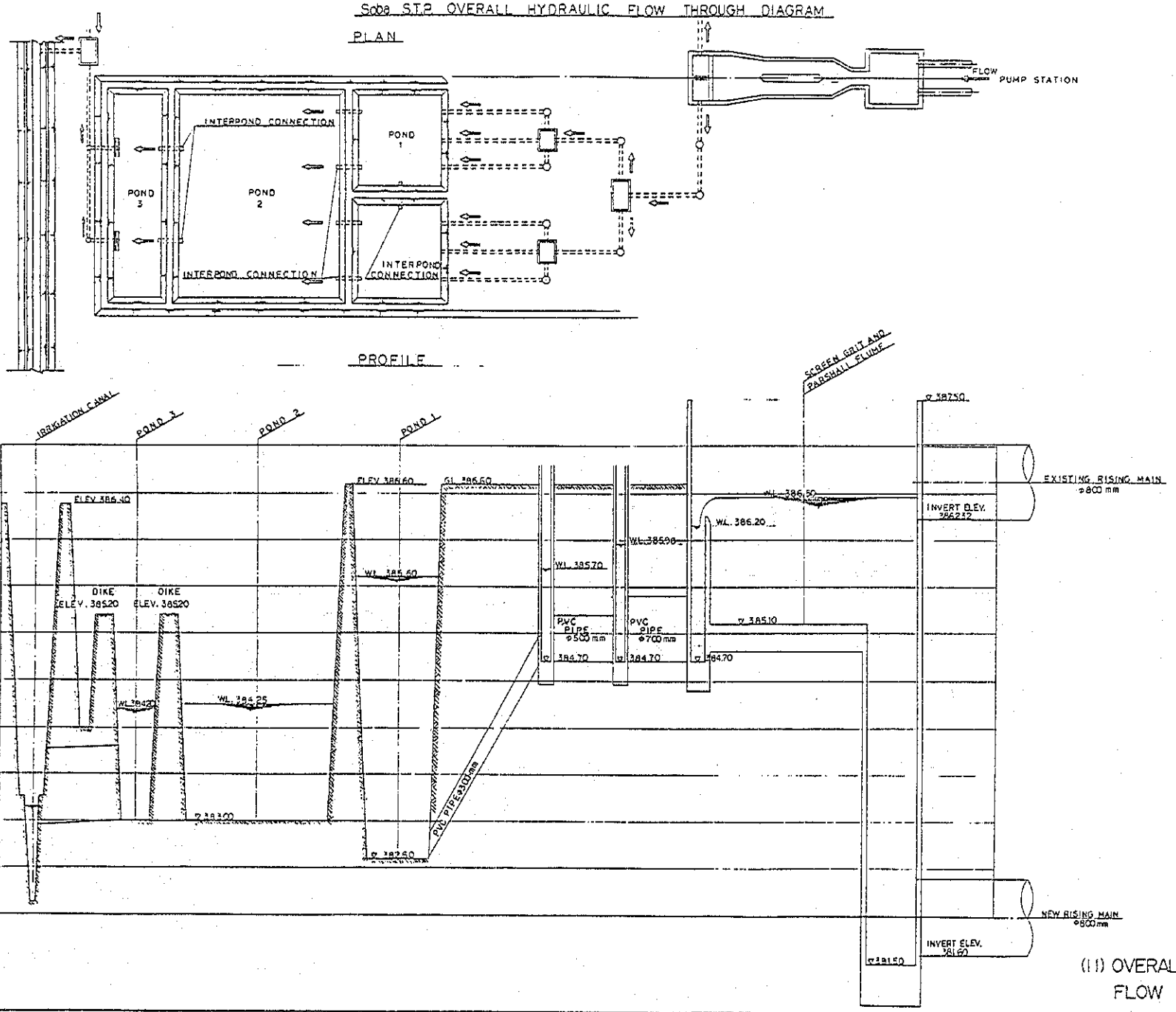


(9) SOBA S.T.P GENERAL PLAN

Sona S.T.P. LAYOUT PLAN S = 1 : 500



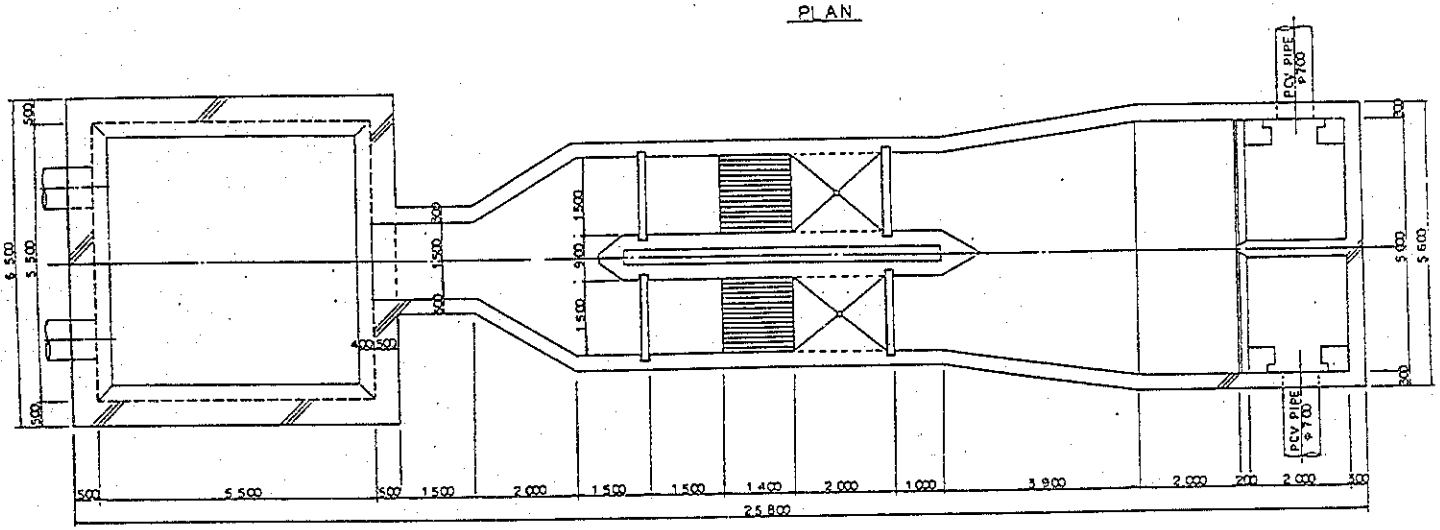
(10) LAYOUT PLAN



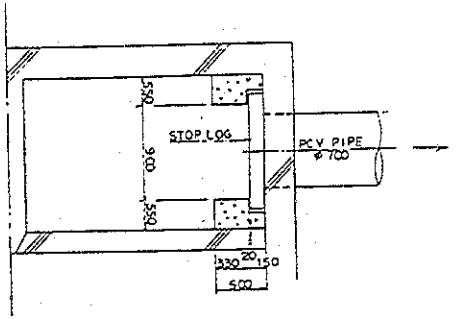
(11) OVERALL HYDRAULIC FLOW THROUGH DIAGRAM

Soba S.T.P SCREEN GRIT AND PARSHALL FLUME S=1:50

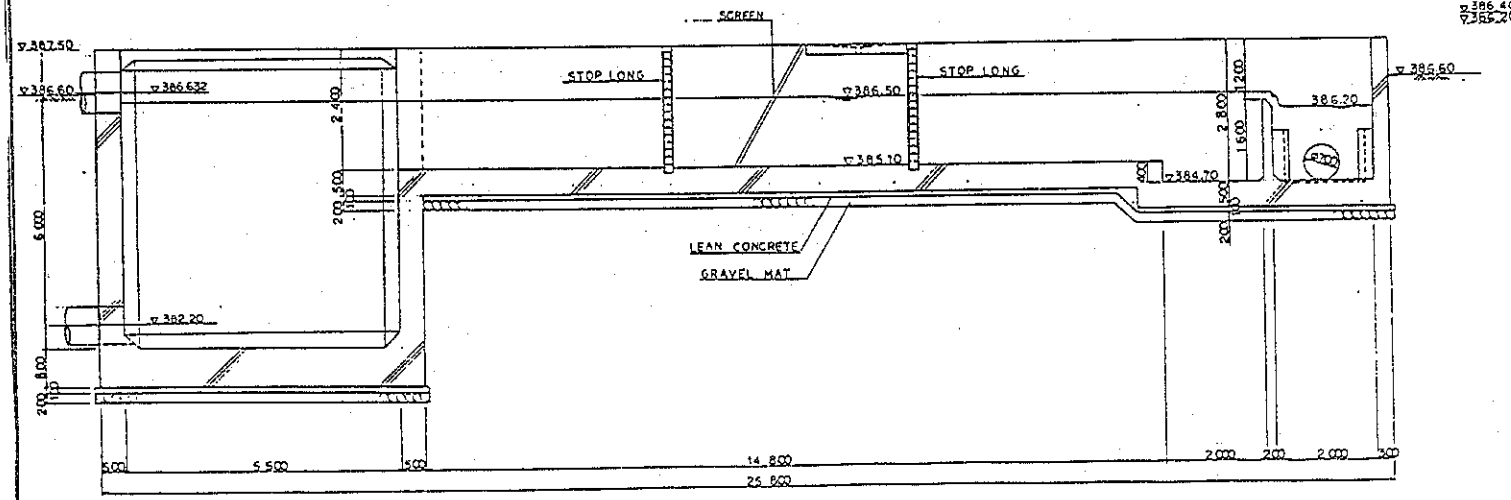
PLAN

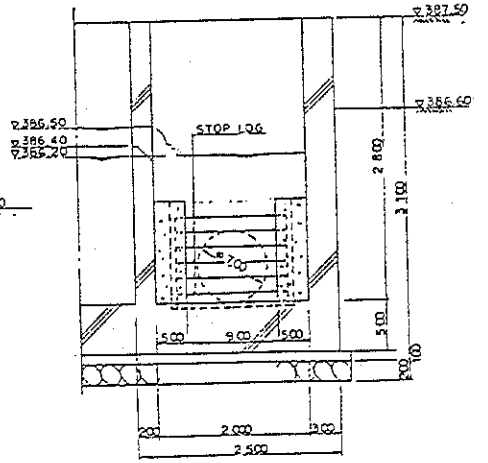


DETAIL S=1:25



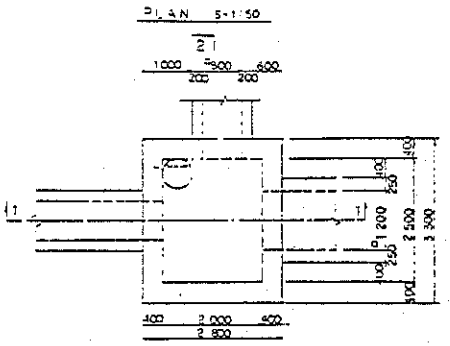
PROFILE

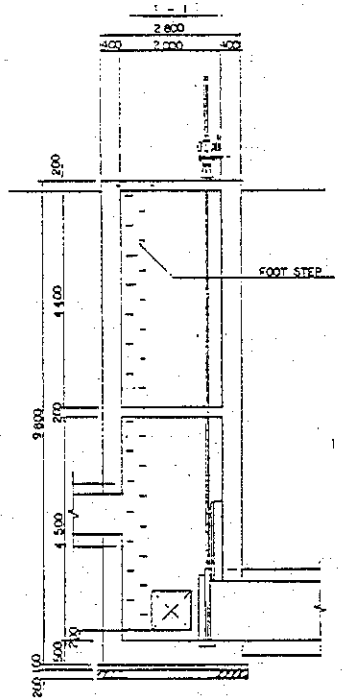


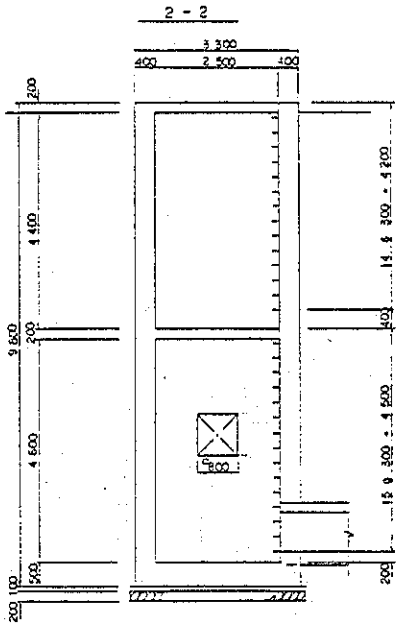


(12) SCREEN GRIT AND PARSHALL FLUME

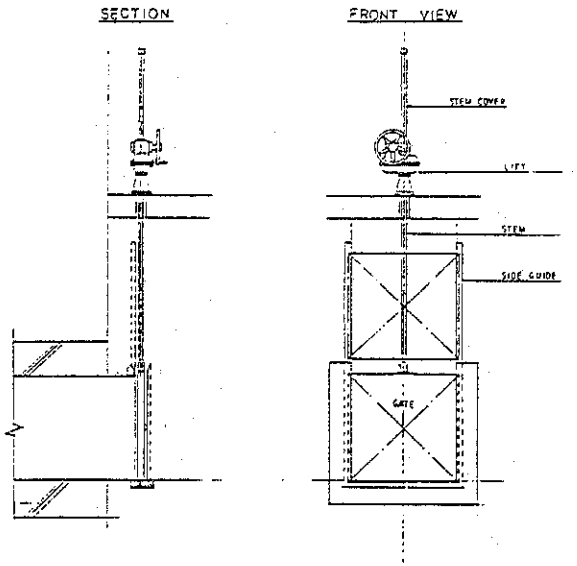
Soba S.T.P. VALVE BOX No.1

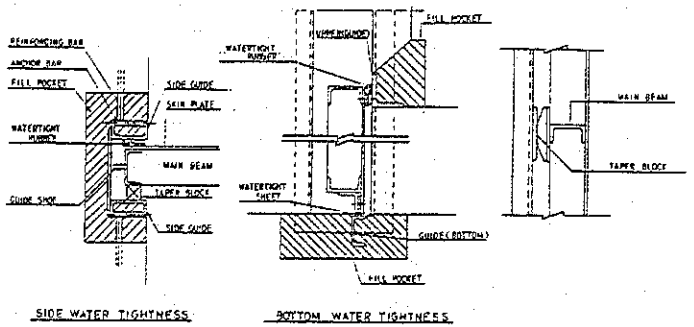






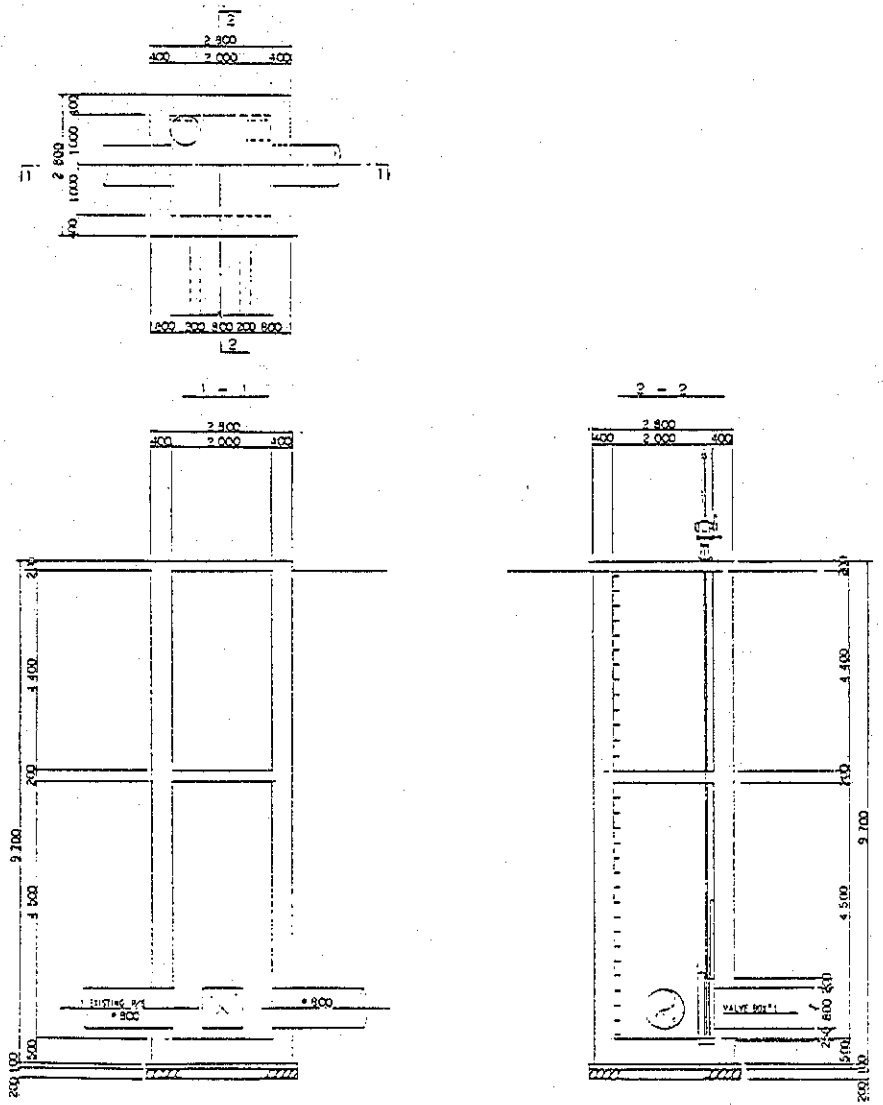
STAINLESS STEEL SLIDE GATE DETAIL





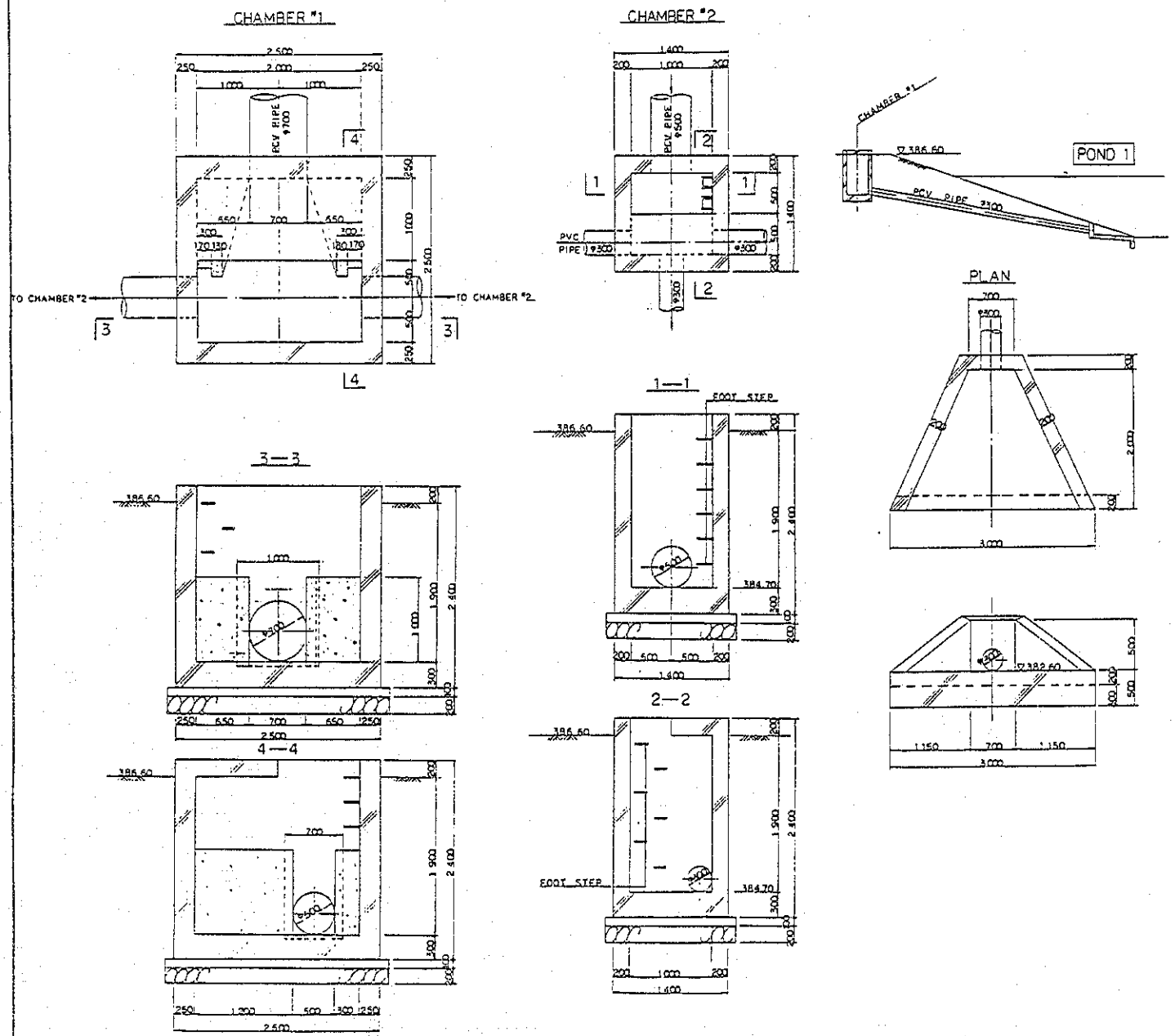
(13) VALVE BOX (1)

VALVE BOX №2 S=1:50



(14) VALVE BOX (2)

DISTRIBUTION CHAMBER S=1:25

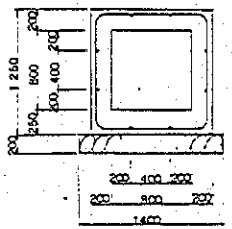


(15) DISTRIBUTION CHAMBER

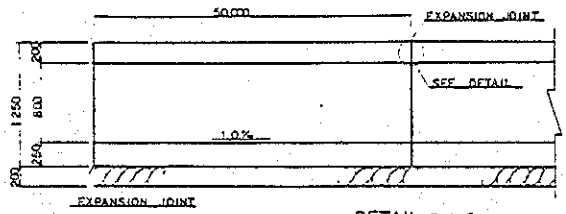
GRAVITY MAIN

BOX CULVERT S=1:25

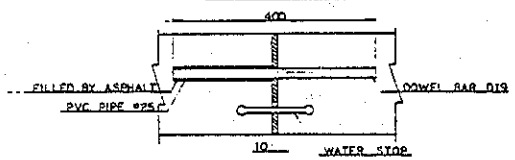
CROSS SECTION



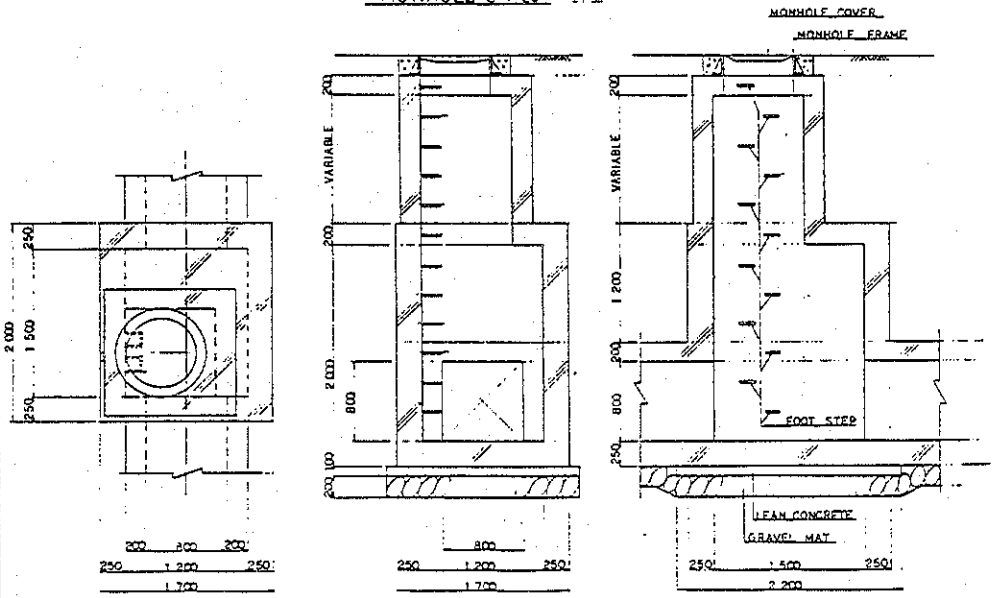
PROFILE

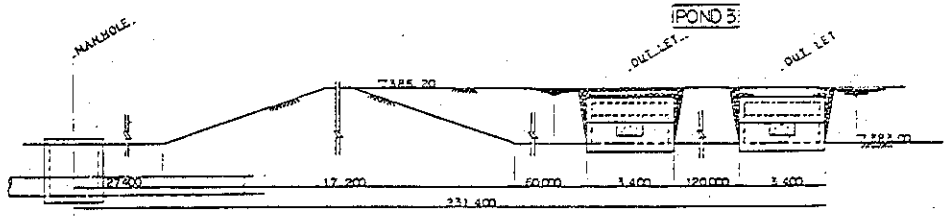


DETAIL S=1:5

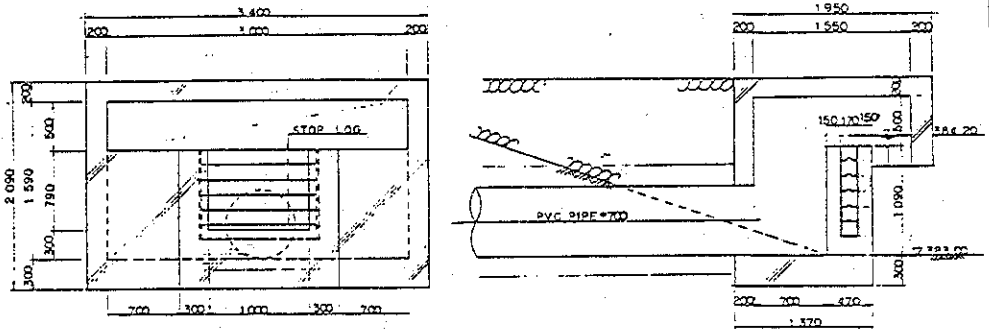


MONHOLE S=1:25

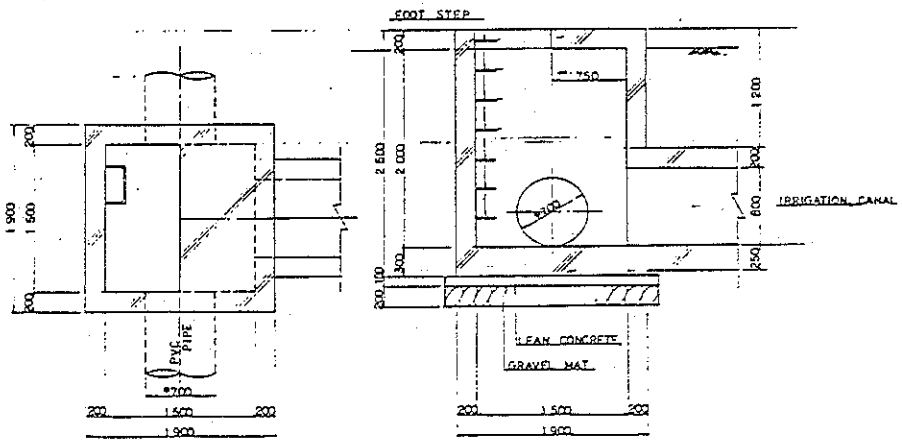




OUT LET DETAIL S=1:25



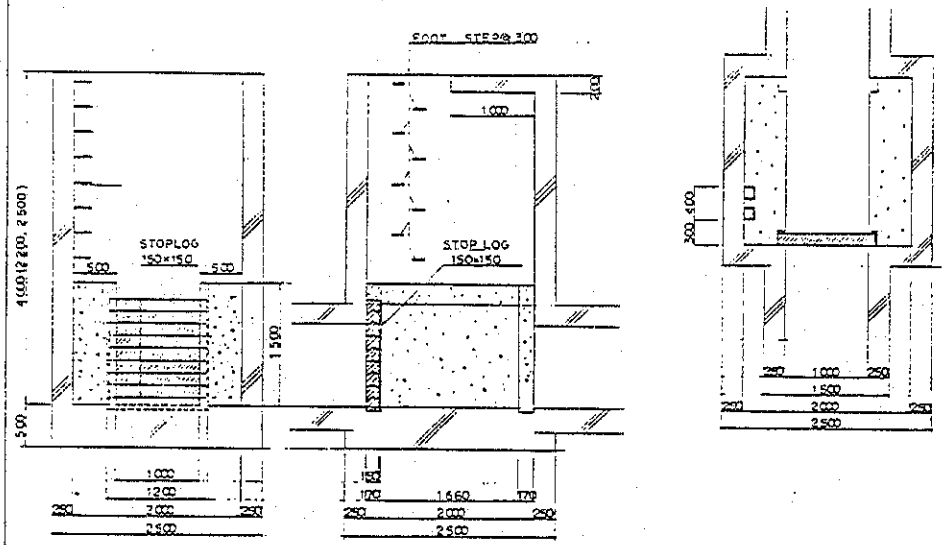
MAN HOLE DETAIL S=1:25



(16) OUT LET

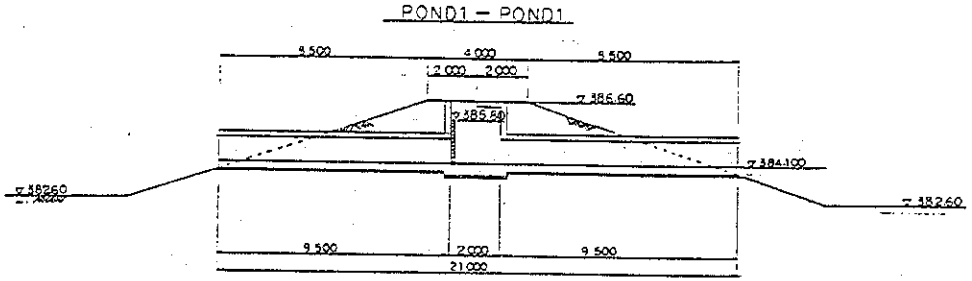
SODA STP INTER POND CONNECTON

MAN HOLE DETAIL S=1:30

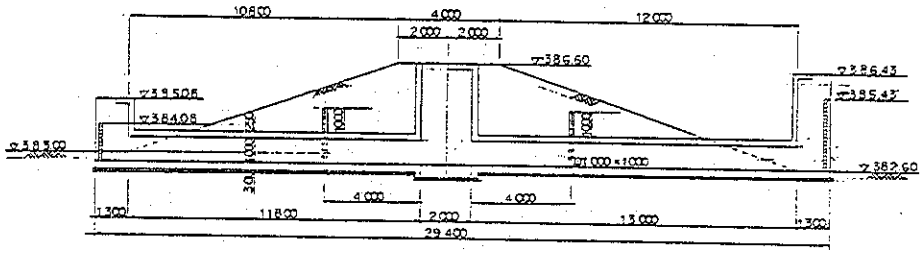


CROSS SECTION S=1:100

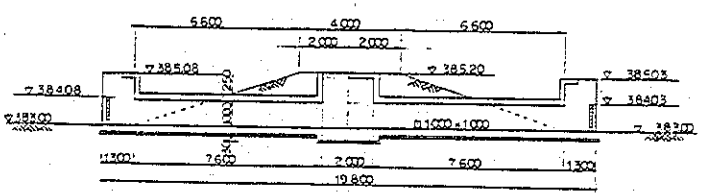
POND1 — POND1



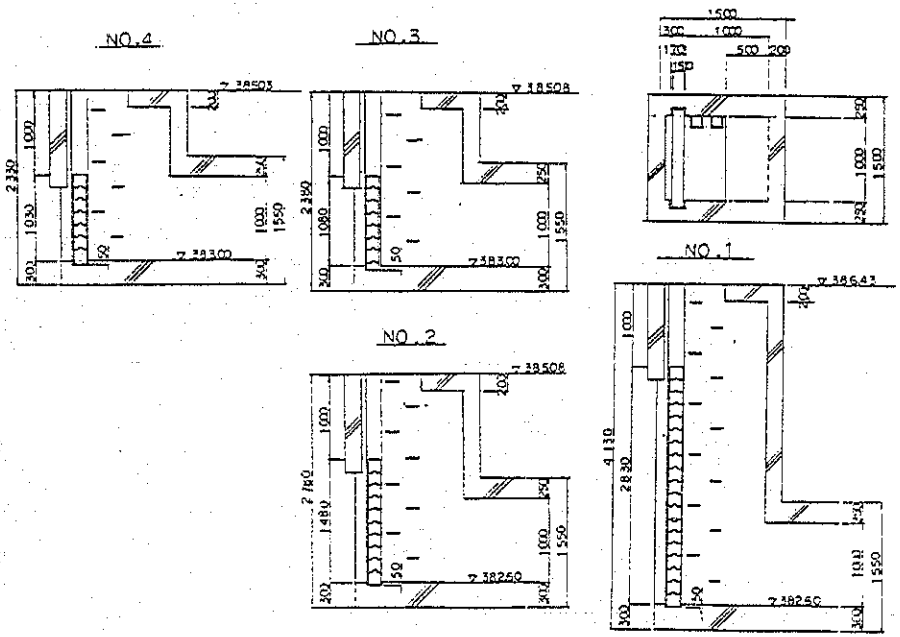
POND2 — POND1

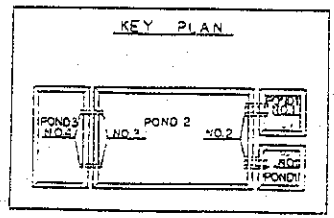


POND2 — POND3



OUER FLOW DETAIL S=1:30





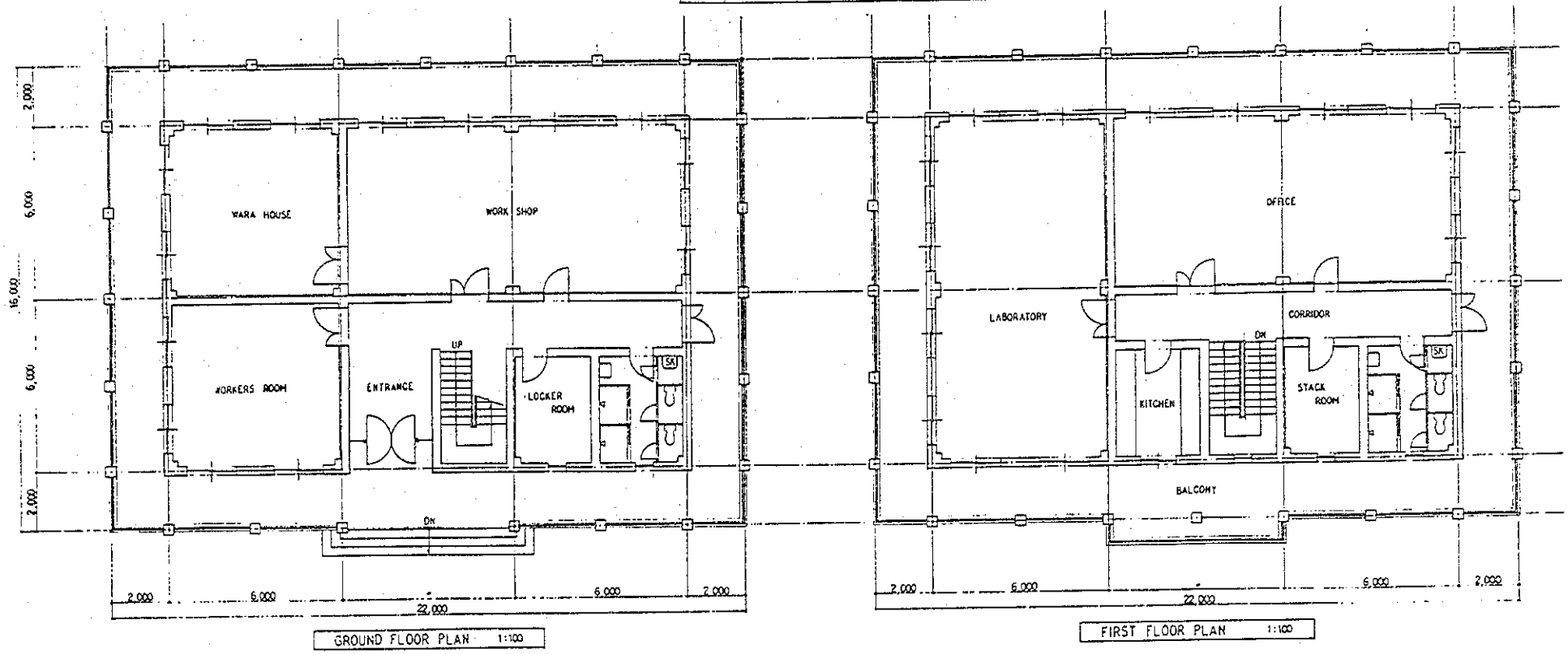
(17) INTER POND CONNECTION

EXTERIOR FINISH SCHEDULE

OFFICE BUILDING	ROOF	SHINGLE IN COLONIAL STYLE
	WALL	ACRYLIC LITHIN FINISH ON CEMENT MORTAR
	WAINSCOT	CEMENT MORTAR
	DOOR AND WINDOW	O.P. ON STEEL FLUSH DOOR ALUMINIUM WINDOW
	BALCONY	HANDRAIL : O.P. ON STEEL PIPE
GENERATOR HOUSE	ROOF	CEMENT MORTAR
	WALL	ACRYLIC LITHIN FINISH ON CEMENT MORTAR
	WAINSCOT	CEMENT MORTAR
	DOOR AND WINDOW	O.P. ON STEEL FLUSH DOOR ALUMINIUM WINDOW

INTERIOR FINISH SCHEDULE

BUILDING	FLOOR	ROOM NAME	FLOOR: PRECAST TERRAZZO 1:2.5	FLOOR: CEMENT MORTAR	FLOOR: VINIL ASBESTOS TILE	FLOOR: CERAMIC TILE	BASEBOARD: VARN. BASEBOARD	BASEBOARD: CEMENT MORTAR	BASEBOARD: PRECAST TERRAZZO 1:2.5	BASEBOARD: CERAMIC TILE	BASEBOARD: HEIGHT	WALL: CEMENT MORTAR	WALL: A.E.P. ON CEMENT MORTAR	WALL: V.P. ON CEMENT MORTAR	CEILING: A.E.P. ON CEMENT MORTAR	CEILING: ACOUSTICAL (ROCK WOOL BOARD)	CEILING: V.P. ON ASBESTOS CEMENT SHEET	CEILING: CEMENT MORTAR	CEILING: HEIGHT	GENERAL NOTES
OFFICE BUILDING	GROUND FLOOR	ENTRANCE	○						○		100		○		○					
		WORKERS ROOM		○				○			100		○		○					
		WORK SHOP		○				○			100		○		○					
		WARE HOUSE		○				○			100	○						○		
		LOCKER ROOM			○		○				100		○		○					
	FIRST FLOOR	LABORATORY			○		○				100		○			○			2,700	
		OFFICE			○		○				100		○			○			2,700	
		KITCHEN				○				○	100			○			○		2,700	KITCHEN SINK UNIT
		STACK ROOM			○		○				100		○		○				2,700	
		TOILET & SHOWER ROOM				○				○	100			○			○		2,700	TOILET & SHOWER BOOTH - CURTAIN RAIL
	COMMON	STAIR			○		○						○		○					HANDRAIL : O.P. ON STEEL PIPE
		CORRIDOR			○		○				100		○		○					
GENERATOR HOUSE		GENERATOR ROOM		○				○			100	○						○		
		STOCK YARD		○				○			100	○						○		

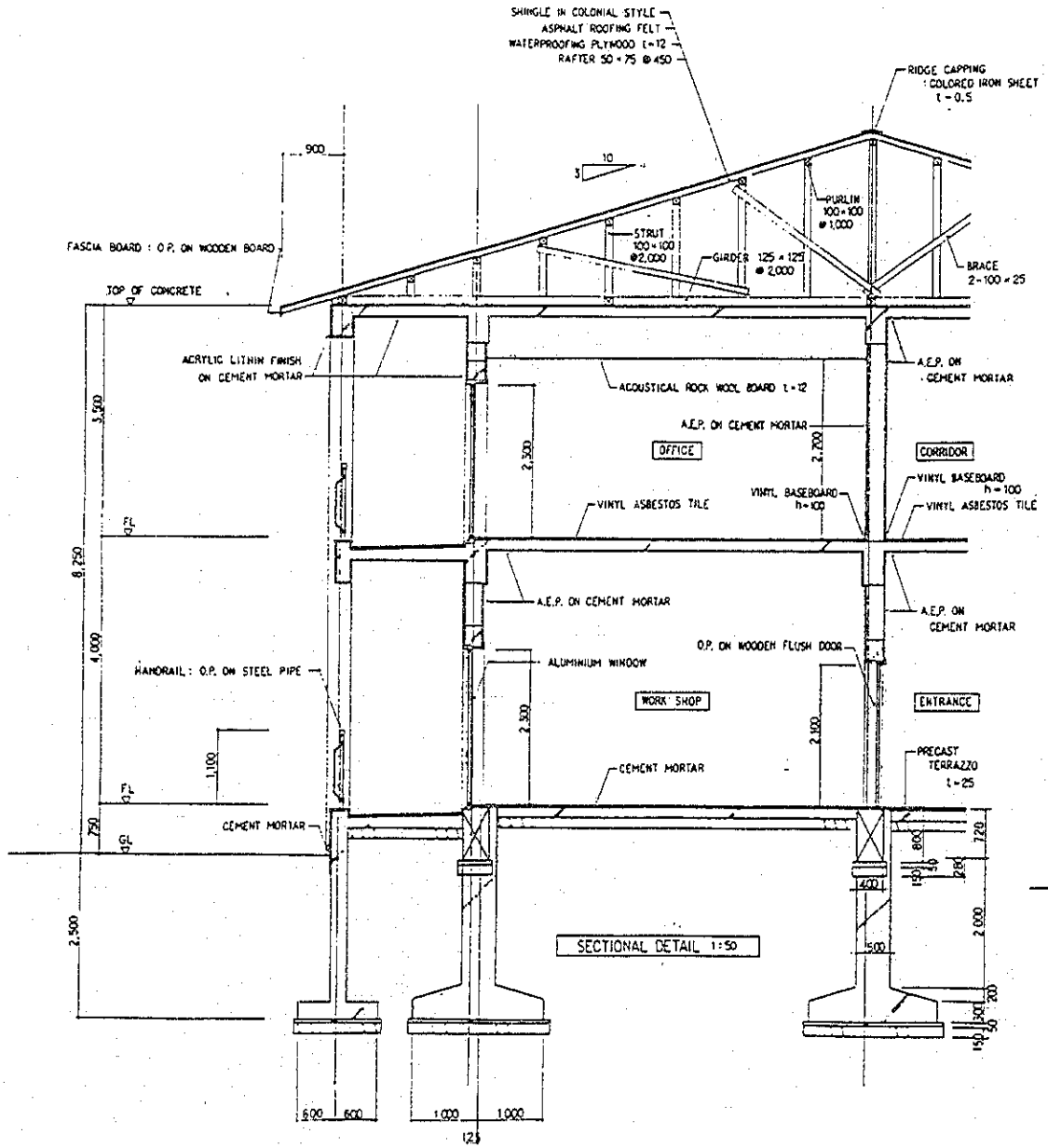


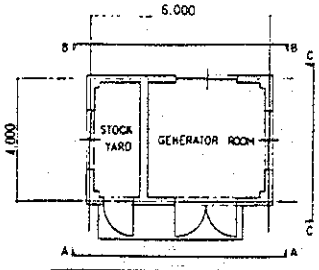
GROUND FLOOR PLAN 1:100

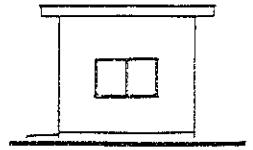
FIRST FLOOR PLAN 1:100

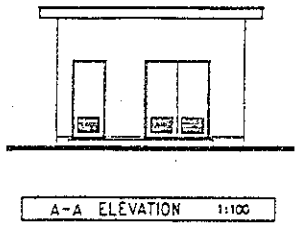
(18) ADMINISTRATION OFFICE

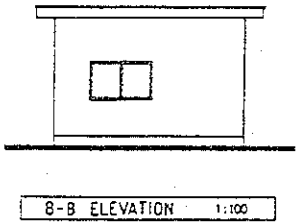
(1)

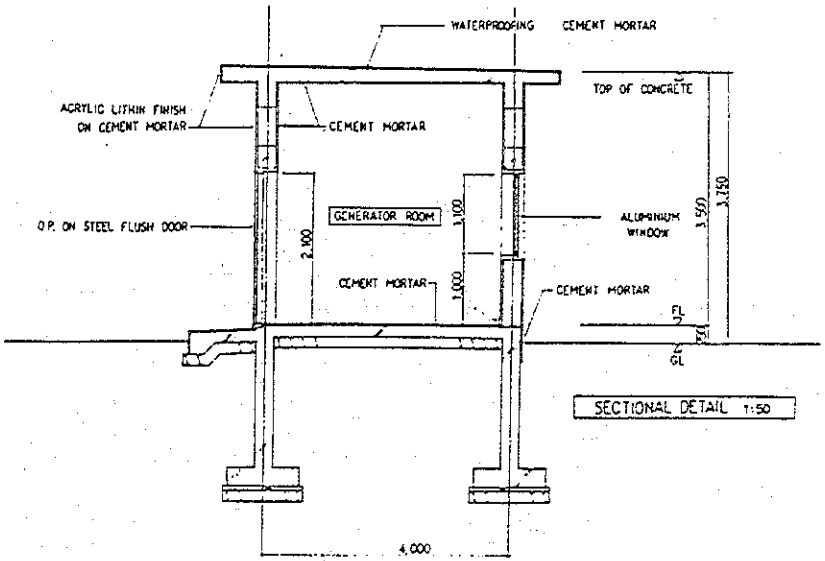




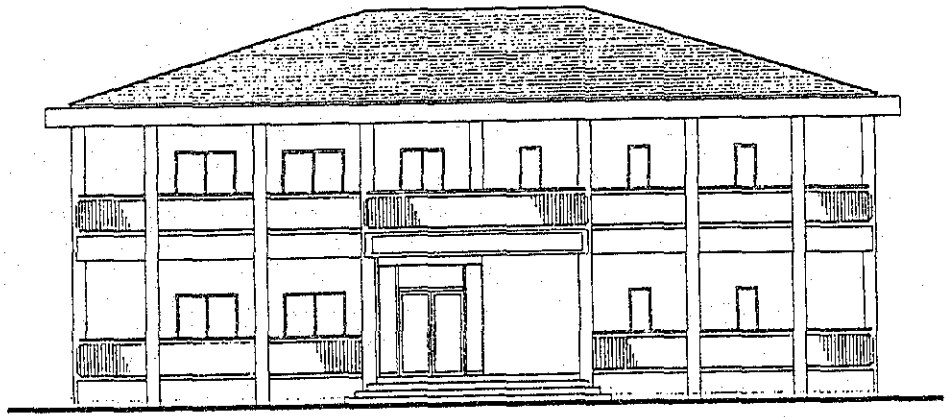




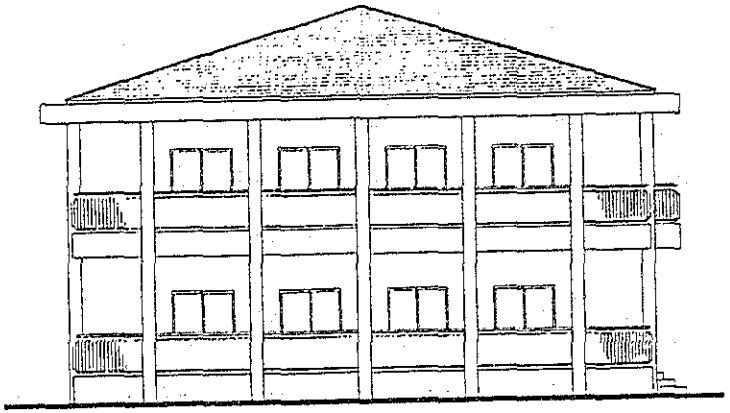




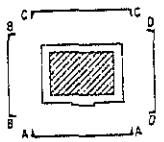
(19) ADMINISTRATION OFFICE
(2)

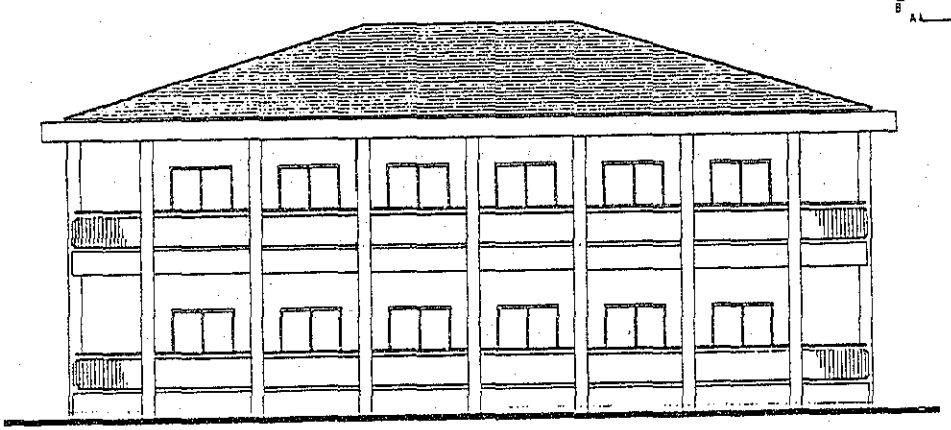


A-A ELEVATION 1:100

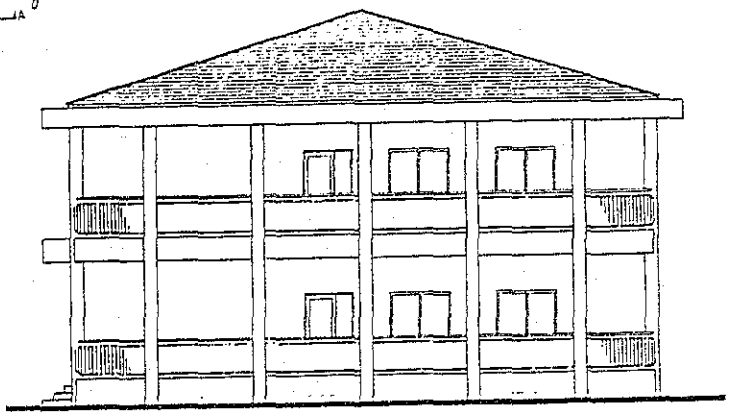


B-B ELEVATION 1:100



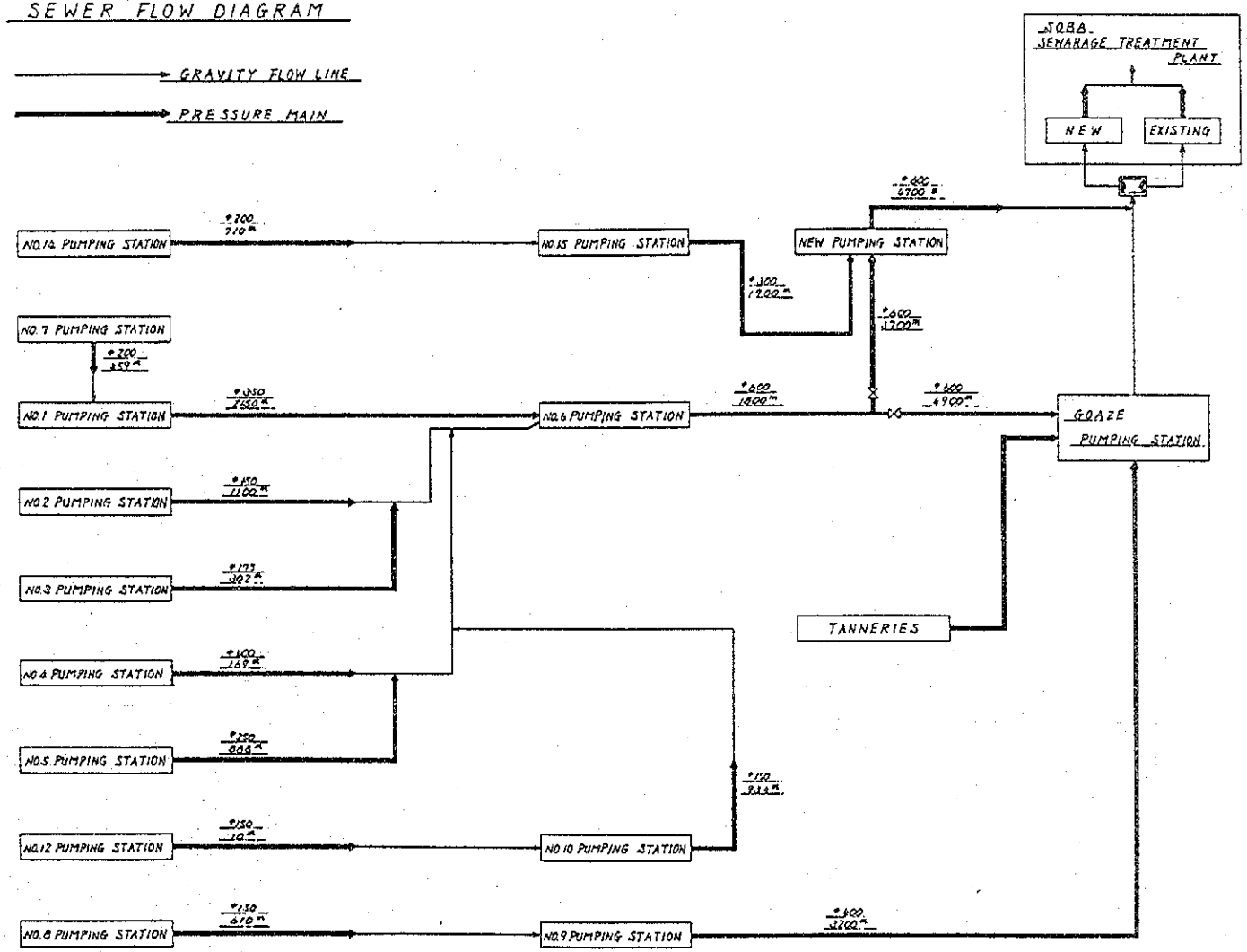


C-C ELEVATION 1:100



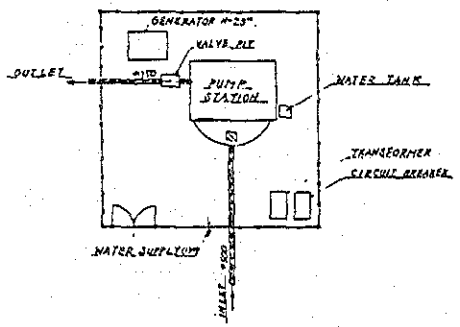
D-D ELEVATION 1:100

(20) ADMINISTRATION OFFICE
(3)

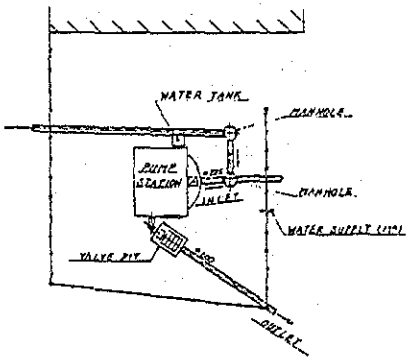


(21) SEWER FLOW DIAGRAM

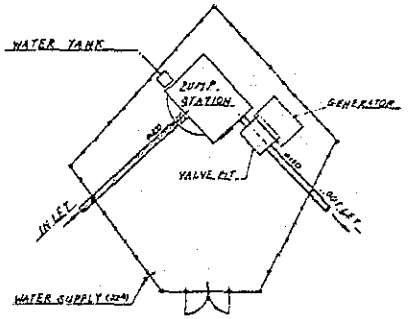
KEY PLAN OF EACH PUMPING STATION



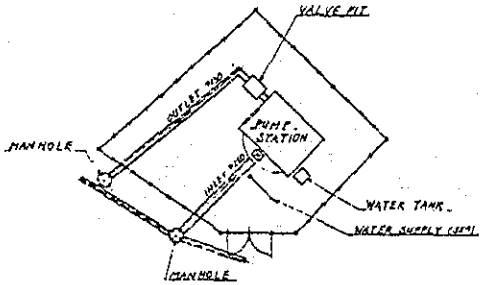
NO.1 PUMPING STATION KEY PLAN (1=1/200)



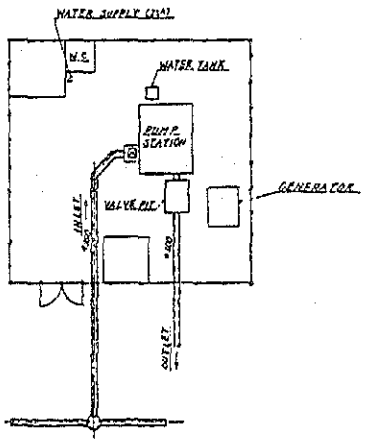
NO.7 PUMPING STATION KEY PLAN (1=1/200)



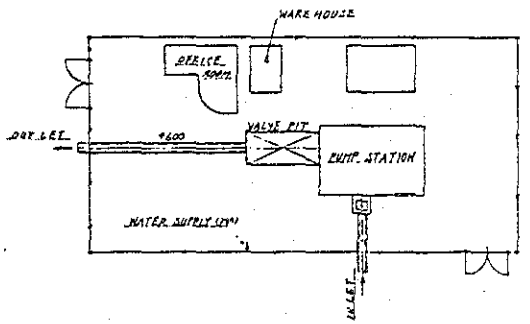
NO.8 PUMPING STATION KEY PLAN (1=1/200)



NO.12 PUMPING STATION KEY PLAN (1=1/200)



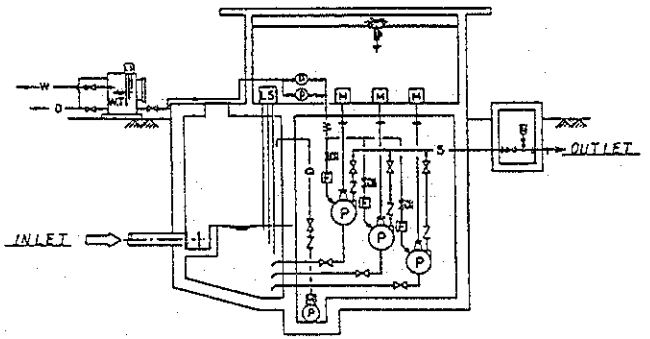
NO.14 PUMPING STATION KEY PLAN (1=1/200)



NO.6 PUMPING STATION KEY PLAN (1=1/200)

(22) KEY PLAN OF EACH PUMPING STATION

NO.1 PUMPING STATION

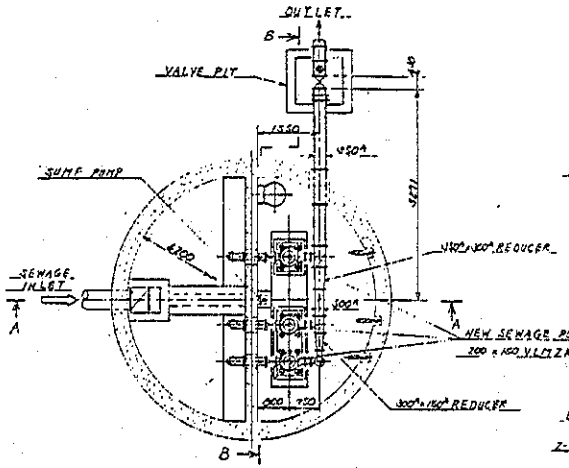


LEGEND

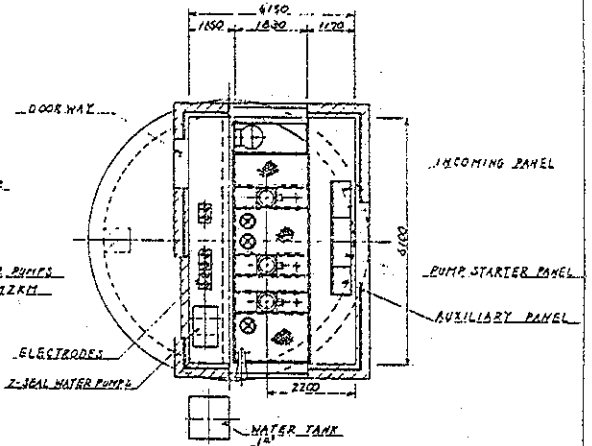
LINE MARK	DESCRIPTION
—S—	SEWAGE
—D—	DRAIN
—W—	SEALING WATER

MARK	TYPE	MARK	TYPE
	GATE VALVE		AIR RELEASE VALVE
	CHECK VALVE		SEALING WATER TANK
P	PUMP		MOTOR VALVE
M	MOTOR	F	FLOW RELAY
LS	LEVEL SWITCH		

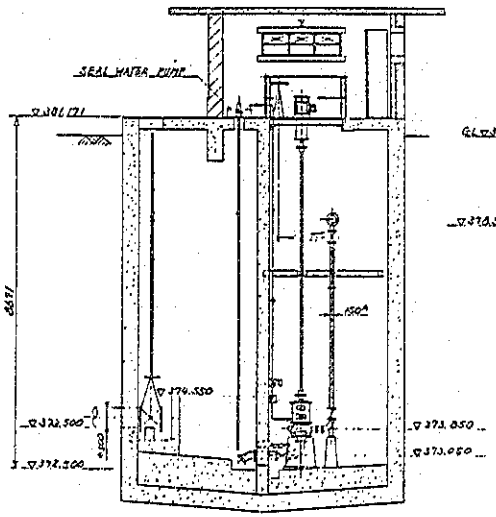
ITEM NO.	NAME OF EQUIPMENT	SPECIFICATION	POWER (KW)	Q'TY	REMARKS
	MAIN PUMP	VERTICAL CENTRIFUGAL φ200×150, 33.5m×25.5m³	30	3	
	SUMP DRAINAGE PUMP	SUBMERSIBLE PUMP φ50, 33.5m×10m	0.4	1	
	SEALING WATER PUMP	SELF PRIMING PUMP φ40, 25.5m×30m	0.75	2	
	SEALING WATER TANK	1 m³ FRP	—	1	
	OVERHEAD CRANE	0.5 TON MANUAL	—	1	EXISTING
	VENTILATION FAN	LINE FAN 20m³/min×10mmAq	0.15	1	
	WATER LEVEL SWITCH		—	2	
	ELECTRICAL PANELS	415V	—	1	

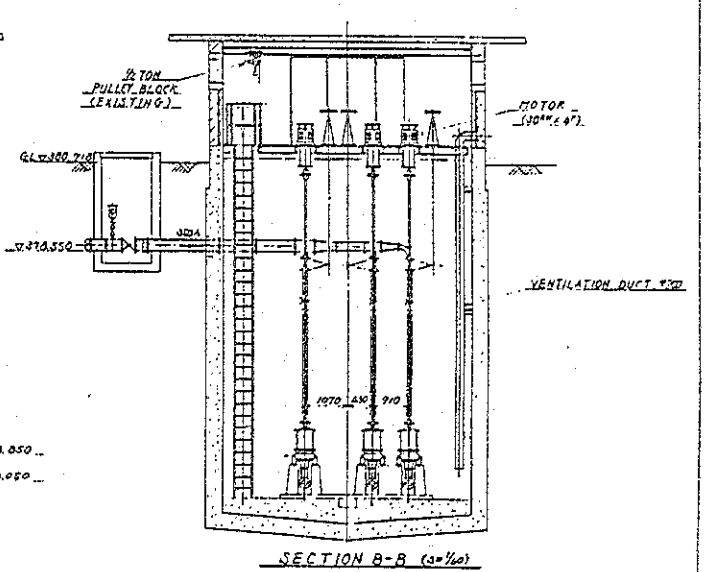


PLAN OF PUMP ROOM (S=1/40)



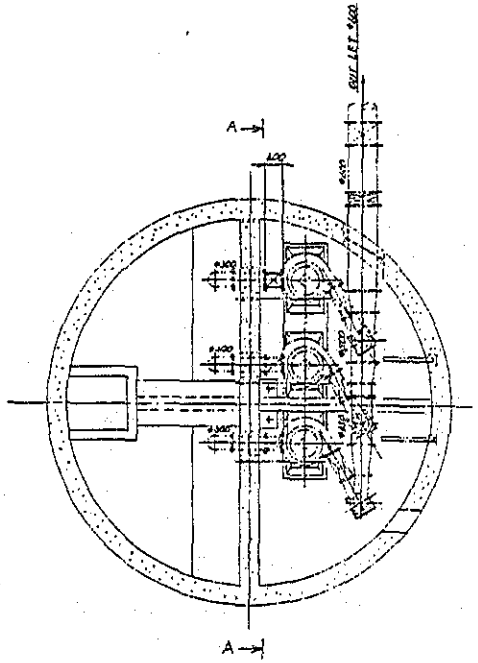
PLAN OF MOTOR ROOM (S=1/40)

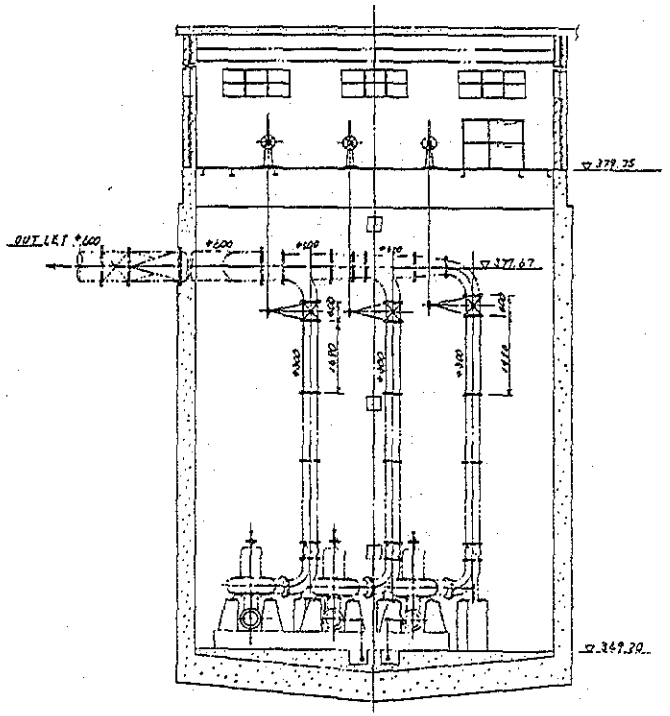




(23) PUMPING STATION NO.1

NO.6 PUMPING STATION





SECTION A-A (1:100)

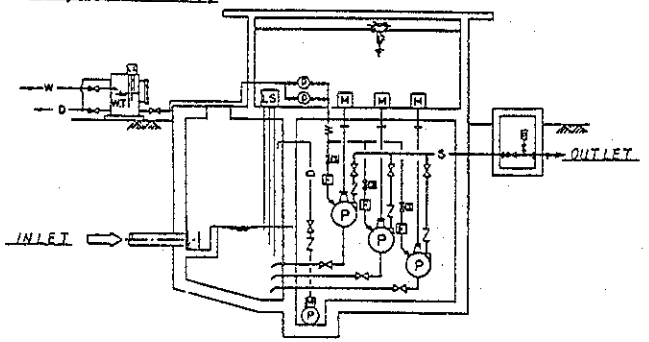
※ ATTENTION NOTES.

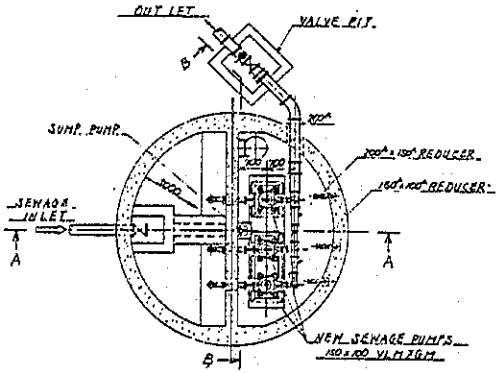
——— NEW.

- - - - EXISTING.

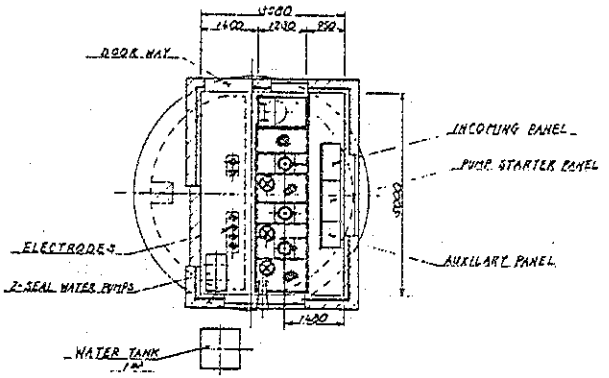
(24) PUMPING STATION NO.6

NO.7 PUMPING STATION





PLAN OF PUMP ROOM (S=1/50)



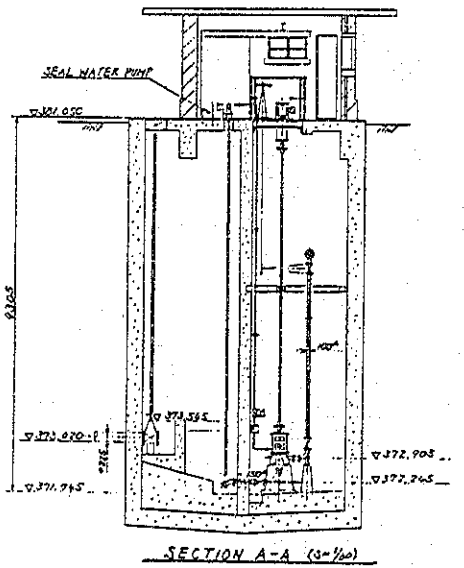
PLAN OF MOTOR ROOM (S=1/50)

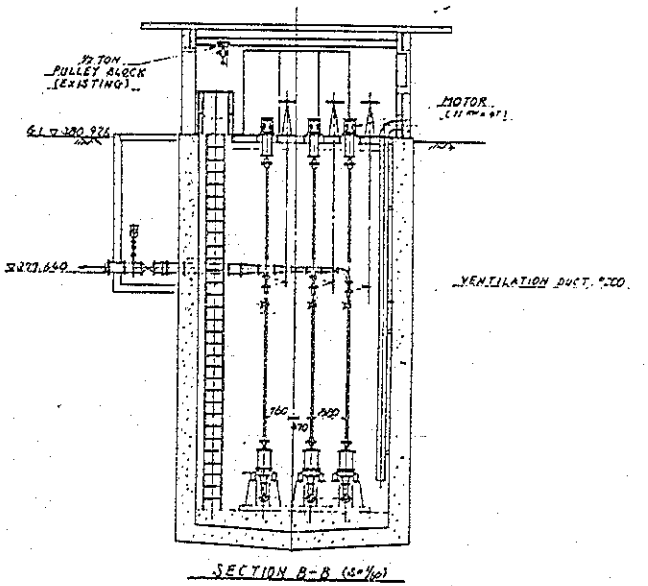
LEGEND

LINE MARK	DESCRIPTION
—S—	SEWAGE
—D—	DRAIN
—W—	SEALING WATER

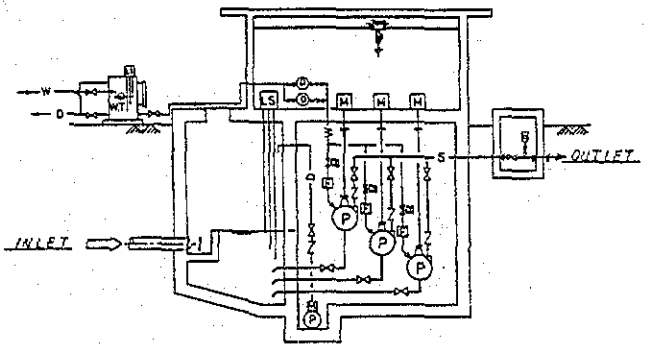
MARK	TYPE	MARK	TYPE
	GATE VALVE		AIR RELEASE VALVE
	CHECK VALVE	WT	SEALING WATER TANK
P	PUMP		MOTOR VALVE
M	MOTOR	F	FLOW RELAY
LS	LEVEL SWITCH		

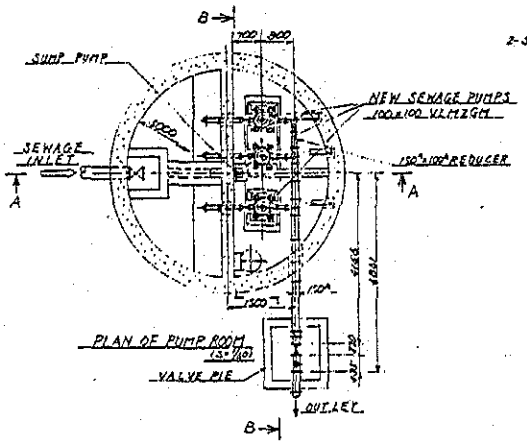
ITEM NO.	NAME OF EQUIPMENT	SPECIFICATION	POWER (KW)	Q'TY	REMARKS
	MAIN PUMP	VERTICAL CENTRIFUGAL φ150×100 1.6m³/m×18m	11	3	
	SUMP DRAINAGE PUMP	SUBMERSIBLE PUMP φ50 50l/m×10m	0.4	1	
	SEALING WATER PUMP	SELF PRIMING PUMP φ32 20l/m×23m	0.4	2	
	SEALING WATER TANK	1 m³ FRP	—	1	
	OVERHEAD CRANE	0.5 TON MANUAL	—	1	EXISTING
	VENTILATION FAN	LINE FAN 20m³/m×10mmAq	0.15	1	
	WATER LEVEL SWITCH		—	2	
	ELECTRICAL PANELS	415V	—	一式	

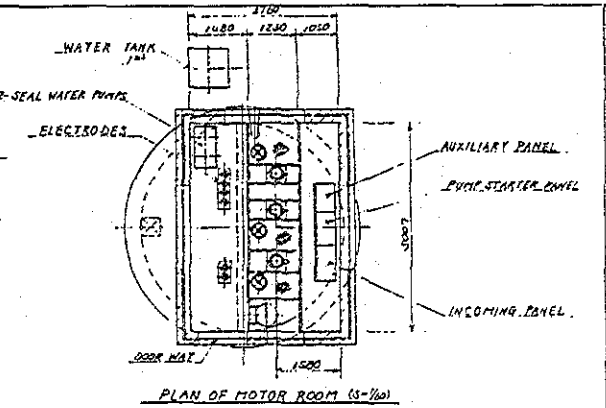




No.8 PUMPING STATION





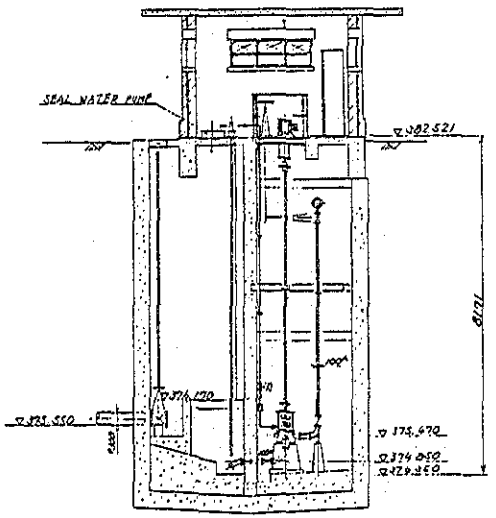


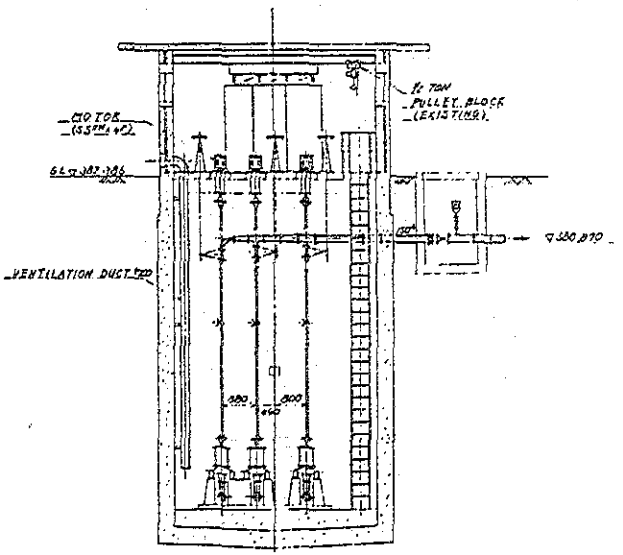
LEGEND

LINE MARK	DESCRIPTION
—S—	SEWAGE
—D—	DRAIN
—W—	SEALING WATER

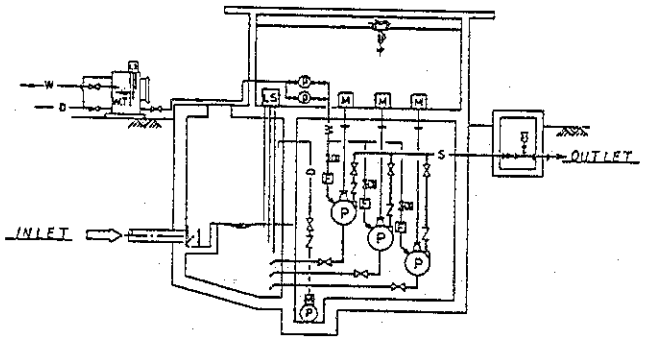
MARK	TYPE	MARK	TYPE
	GATE VALVE		AIR RELEASE VALVE
	CHECK VALVE		SEALING WATER TANK
P	PUMP		MOTOR VALVE
M	MOTOR	F	FLOW RELAY
L	LEVEL SWITCH		

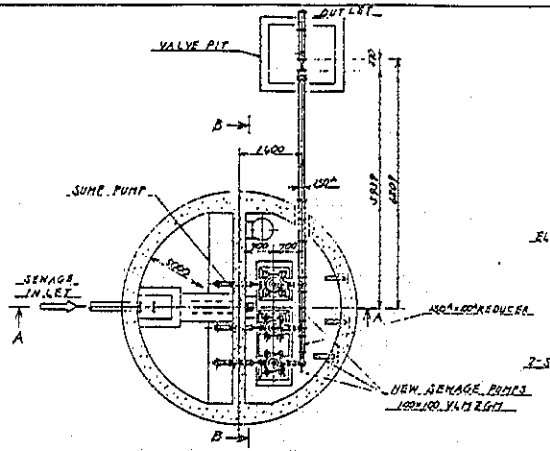
ITEM NO.	NAME OF EQUIPMENT	SPECIFICATION	POWER (KW)	Q'TY	REMARKS
	MAIN PUMP	VERTICAL CENTRIFUGAL φ100 0.5m³/min×15m	5.5	3	
	SUMP DRAINAGE PUMP	SUBMERSIBLE PUMP φ50 50ℓ/m×10m	0.4	1	
	SEALING WATER PUMP	SELF PRIMING PUMP φ32 20ℓ/m×20m	0.4	2	
	SEALING WATER TANK	1 m³ FRP	—	1	
	OVERHEAD CRANE	0.5 TON MANUAL	—	1	EXISTING
	VENTILATION FAN	LINE FAN 20m³/m×10mmAq	0.15	1	
	WATER LEVEL SWITCH		—	2	
	ELECTRICAL PANELS	415V	—	1	



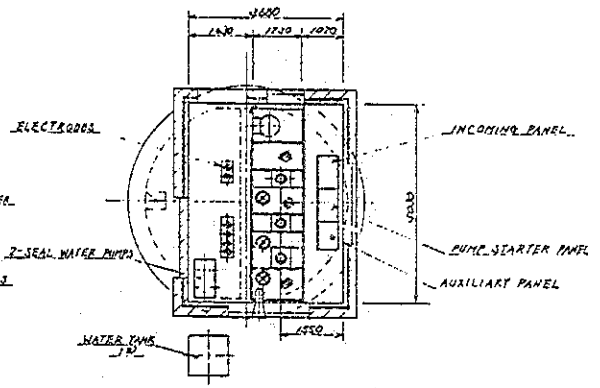


NO.12 PUMPING STATION





PLAN OF PUMP ROOM (S=1/50)



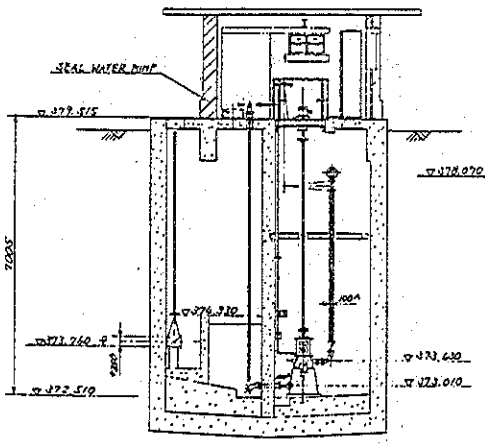
PLAN OF MOTOR ROOM (S=1/50)

LEGEND

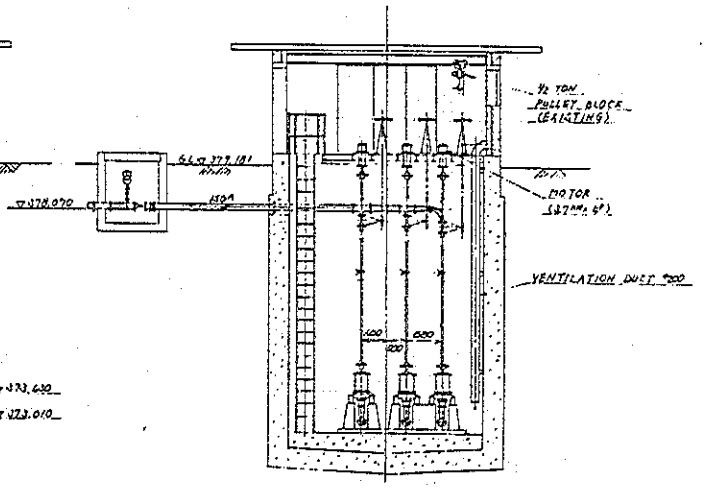
LINE MARK	DESCRIPTION
—S—	SEWAGE
—D—	DRAIN
—W—	SEALING WATER

MARK	TYPE	MARK	TYPE
	GATE VALVE		AIR RELEASE VALVE
	CHECK VALVE		SEALING WATER TANK
P	PUMP		MOTOR VALVE
M	MOTOR	F	FLOW RELAY
LS	LEVEL SWITCH		

ITEM NO.	NAME OF EQUIPMENT	SPECIFICATION	POWER (kW)	Q'TY	REMARKS
	MAIN PUMP	VERTICAL CENTRIFUGAL φ100 0.78㎥/min×6m	3.7	3	
	SUMP DRAINAGE PUMP	SUBMERSIBLE PUMP φ50 50ℓ/min×10m	0.4	1	
	SEALING WATER PUMP	SELF PRIMING PUMP φ25 20ℓ/min×11m	0.2	2	
	SEALING WATER TANK	1 m³ FRP	—	1	
	OVERHEAD CRANE	0.5Ton MANUAL	—	1	EXISTING
	VENTILATION FAN	LINE FAN 20㎥/min×10mmAq	0.15	1	
	WATER LEVEL SWITCH		—	2	
	ELECTRICAL PANELS	415V	—	3/1	

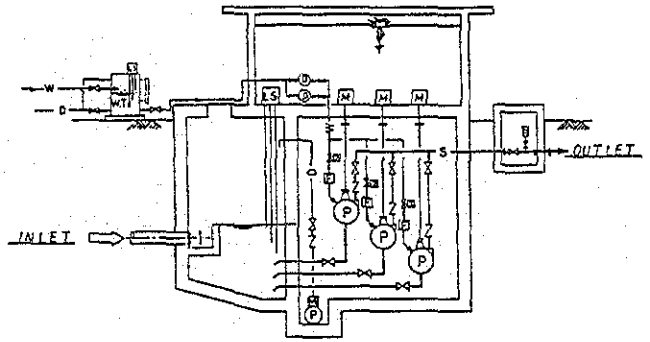


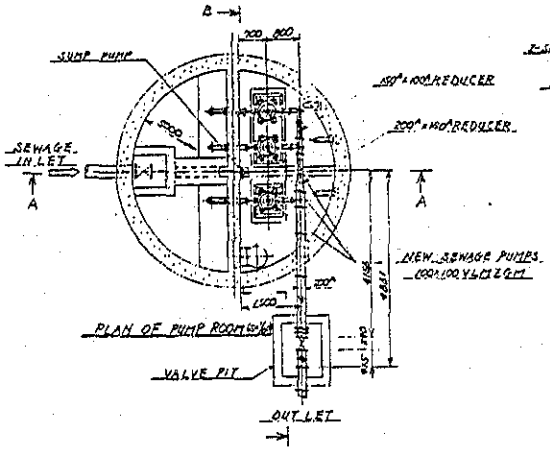
SECTION A-A (S=1/50)

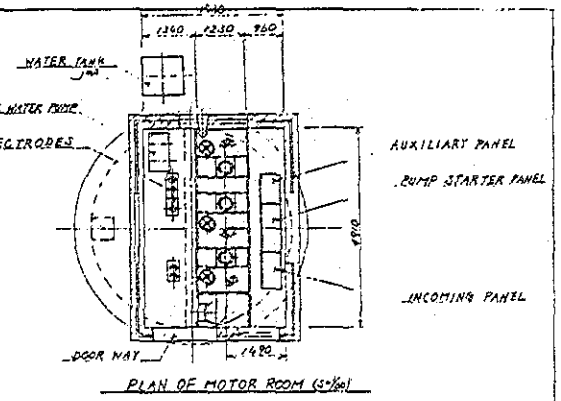


SECTION B-B (S=1/50)

NO.14 PUMPING STATION





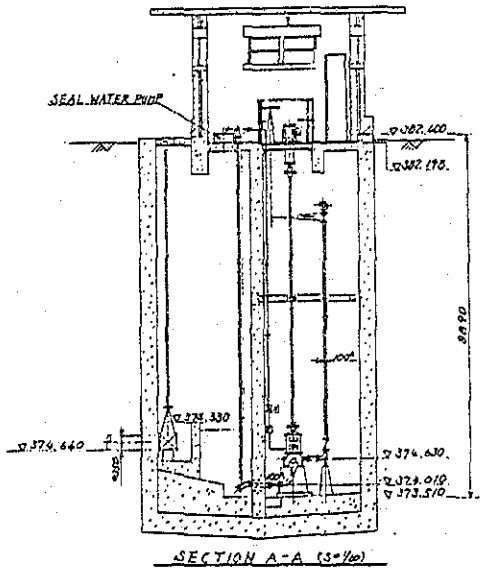


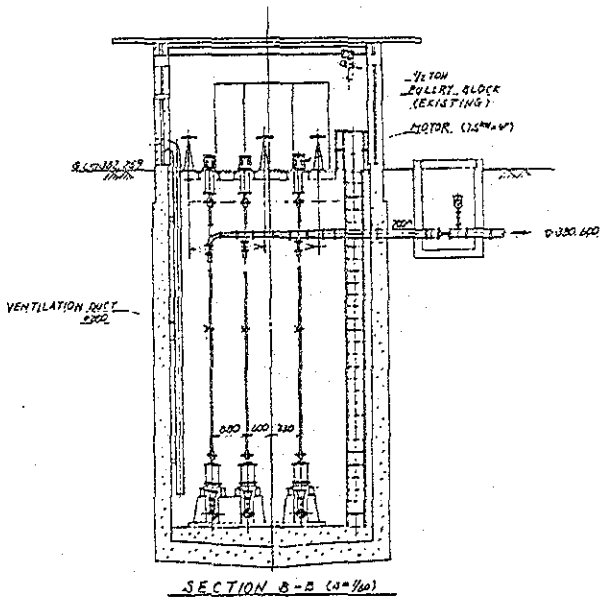
LEGEND

LINE MARK	DESCRIPTION
—S—	SEWAGE
—D—	DRAIN
—W—	SEALING WATER

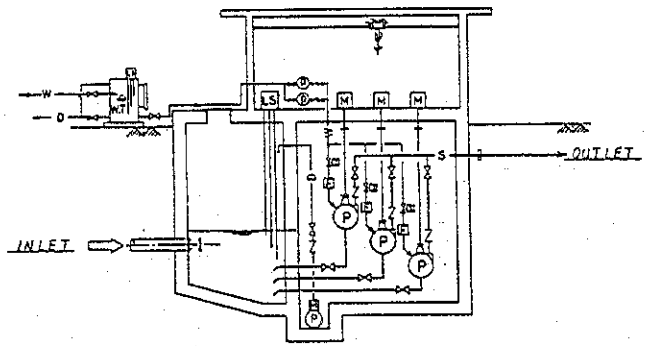
MARK	TYPE	MARK	TYPE
	GATE VALVE		AIR RELEASE VALVE
	CHECK VALVE		SEALING WATER TANK
P	PUMP		MOTOR VALVE
M	MOTOR	F	FLOW RELAY
LS	LEVEL SWITCH		

ITEM NO.	NAME OF EQUIPMENT	SPECIFICATION	POWER (KW)	Q'TY	REMARKS
	MAIN PUMP	VERTICAL CENTRIFUGAL φ100 × 1.8m³/min × 18 m	7.5	3	
	SUMP DRAINAGE PUMP	SUBMERSIBLE PUMP φ50 50l/m × 10m	0.4	1	
	SEALING WATER PUMP	SELF PRIMING PUMP 32Ø 20l/m × 21m	0.4	2	
	SEALING WATER TANK	1 m³ FRP	—	1	
	OVERHEAD CRANE	0.5 TON MANUAL	—	1	EXISTING
	VENTILATION FAN	LINE FAN 200Ø 210m³/min	0.15	1	
	WATER LEVEL SWITCH		—	2	
	ELECTRICAL PANELS	415V	—	1	
	STAND-BY DIESEL GENERATOR SET	50 KVA 415V	—	1	





NO.20 PUMPING STATION

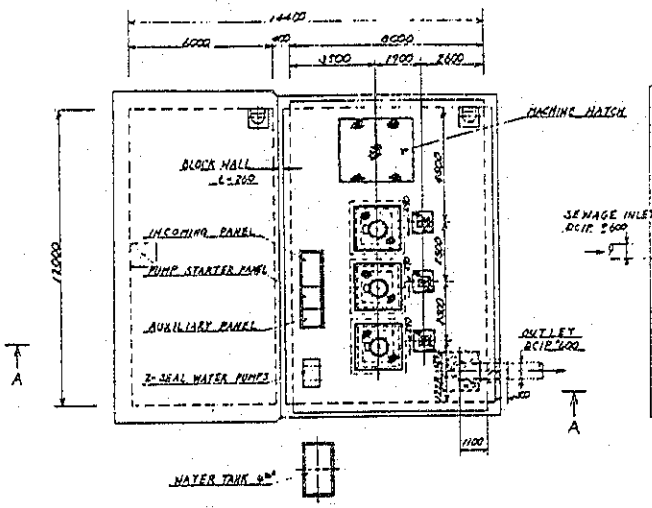


LEGEND

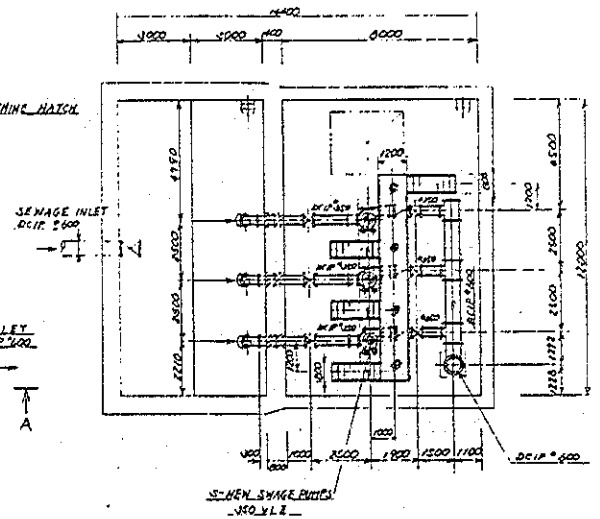
LINE MARK	DESCRIPTION
—S—	SEWAGE
—D—	DRAIN
—W—	SEALING WATER

MARK	TYPE	MARK	TYPE
	GATE VALVE		AIR RELEASE VALVE
	CHECK VALVE		SEALING WATER TANK
P	PUMP		MOTOR VALVE
M	MOTOR	F	FLOW RELAY
LS	LEVEL SWITCH		

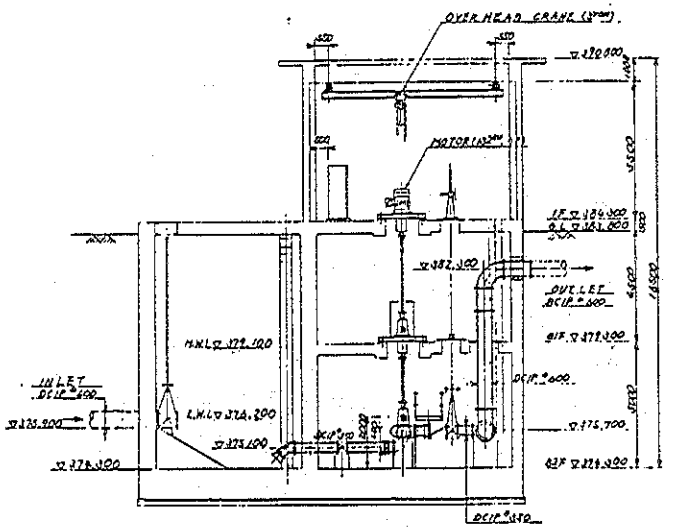
ITEM NO.	NAME OF EQUIPMENT	SPECIFICATION	POWER (KW)	Q'TY	REMARKS
	MAIN PUMP	VERTICAL MIXED FLOW VOLUTE φ350 1637m×29m	132	3	
	SUMP DRAINAGE PUMP	SUBMERSIBLE PUMP φ50 50ℓ/m×10m	0.4	1	
	SEALING WATER POMP	CENTRIFUGAL PUMP φ25 50ℓ/m×34m	1.5	2	
	SEALING WATER TANK	4m³ FRP	—	1	
	OVERHEAD CRANE	3TON MANUAL	—	1	
	VENTILATION FAN	LINE FAN 70m³/min×15mmAq	0.5	1	
	WATER LEVEL SWITCH		—	1	
	ELECTRICAL PANELS	415V	—	1	
	STAND-BY DIESEL GENERATOR SET	500KVA 415V	—	1	



1F PLAN OF MOTOR ROOM (S=1/100)



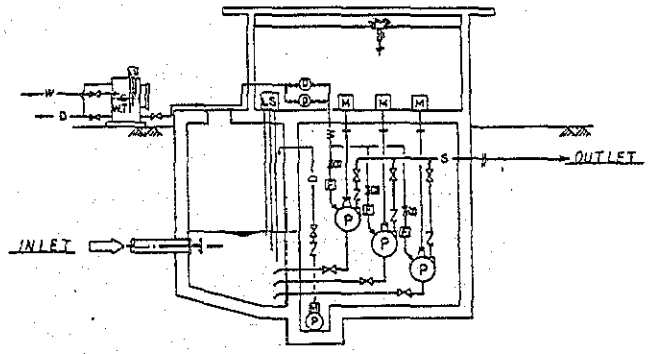
B2F PLAN OF PUMP ROOM (S=1/100)



SECTION A-A (S=1/100)

(29) PUMPING STATION NO. 20

NO. 21 PUMPING STATION

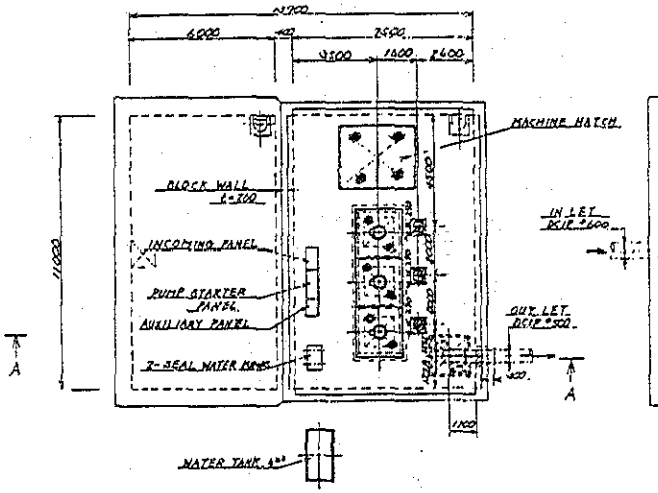


LEGEND

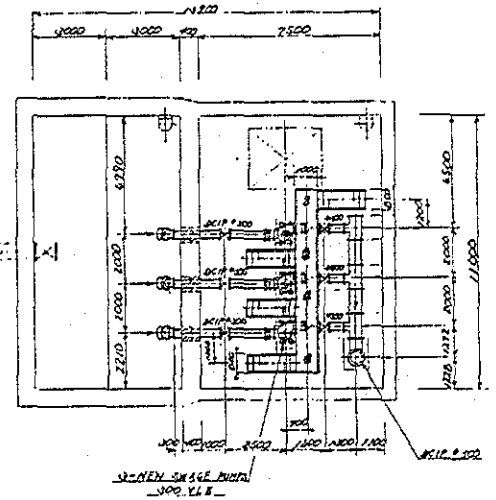
LINE MARK	DESCRIPTION
—S—	SEWAGE
—D—	DRAIN
—W—	SEALING WATER

MARK	TYPE	MARK	TYPE
	GATE VALVE		AIR RELEASE VALVE
	CHECK VALVE		SEALING WATER TANK
P	PUMP	S	MOTOR VALVE
M	MOTOR	F	FLOW RELAY
L	LEVEL SWITCH		

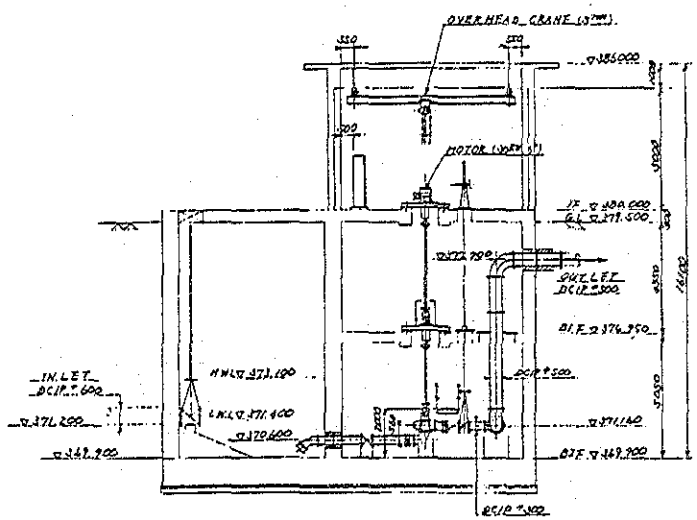
ITEM NO.	NAME OF EQUIPMENT	SPECIFICATION	POWER (KW)	Q'TY	REMARKS
	MAIN PUMP	VERTICAL MIXED FLOW VOLUTE TYPE 3.375 m³/min	30	3	
	SUMP DRAINAGE PUMP	SUBMERSIBLE PUMP 250 50Hz×10M	0.4	1	
	SEALING WATER PUMP	CENTRIFUGAL PUMP 40Φ 42 l/min×15m	0.75	2	
	SEALING WATER TANK	4 m³ FRP	—	1	
	OVERHEAD CRANE	3TON MANUAL	—	1	
	VENTILATION FAN	LINE FAN 700m³/min×15mmAq	0.5	1	
	WATER LEVEL SWITCH		—	1	
	ELECTRICAL PANELS	415V	—	1 SET	
	STAND-BY DIESEL GENERATOR SET	150KVA 415V	—	1	



1F PLAN OF MOTOR ROOM (S=1/100)

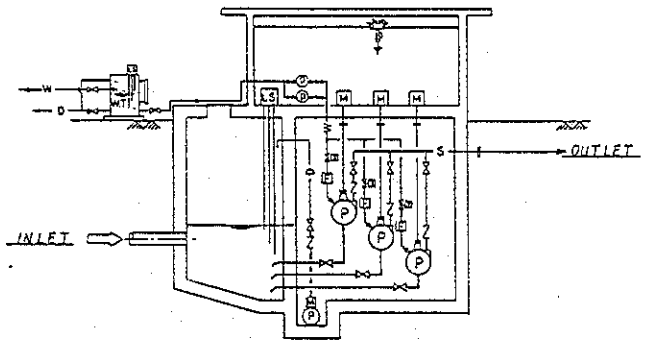


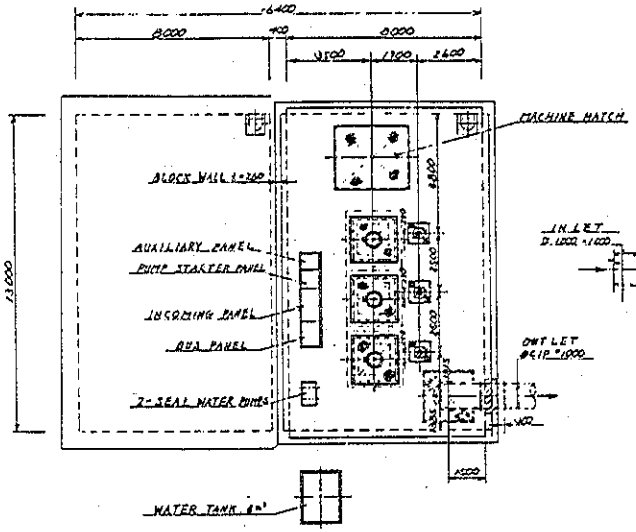
B2F PLAN OF PUMP ROOM (S=1/100)



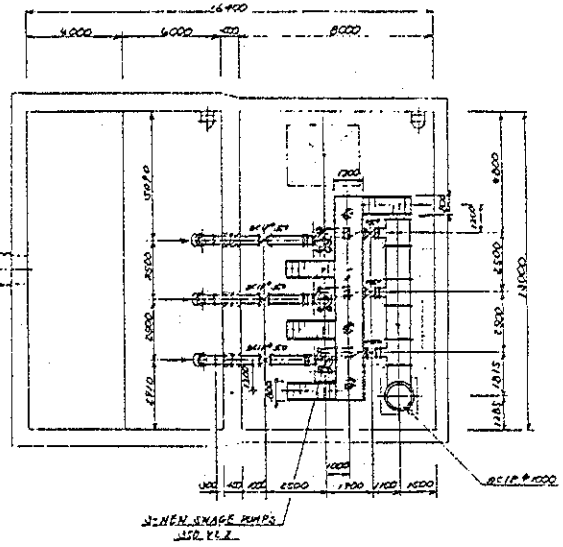
SECTION A-A (S=1/100)

Soba PUMPING STATION





1F PLAN OF MOTOR ROOM (1:100)



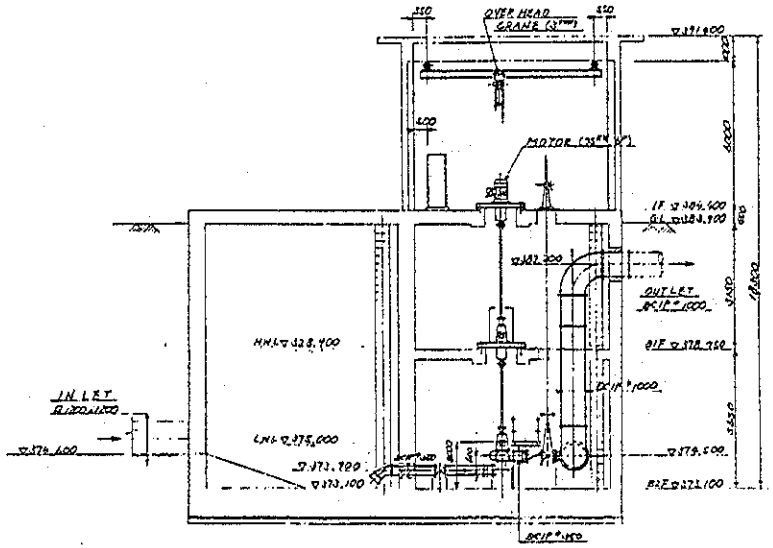
B2F PLAN OF PUMP ROOM (1:100)

LEGEND

LINE MARK	DESCRIPTION
—S—	SEWAGE
—D—	DRAIN
—W—	SEALING WATER

MARK	TYPE	MARK	TYPE
	GATE VALVE	P	AIR RELEASE VALVE
	CHECK VALVE	ST	SEALING WATER TANK
P	PUMP	M	MOTOR VALVE
M	MOTOR	F	FLOW RELAY
LS	LEVEL SWITCH		

ITEM NO.	NAME OF EQUIPMENT	SPECIFICATION	POWER (KW)	Q'TY	REMARKS
	MAIN PUMP	VERTICAL MIXED FLOW VOLUTE ø150 1.2m³/min×m	75	3	
	SUMP DRAINAGE PUMP	SUBMERSIBLE PUMP ø50 80l/min×10m	0.4	1	
	SEALING WATER PUMP	CENTRIFUGAL PUMP ø32 20l/min×20m	0.75	2	
	SEALING WATER TANK	6 m³ FRP	—	1	
	OVERHEAD CRANE	3 TON MANUAL	—	1	
	VENTILATION FAN	LINE FAN 700V/H×15 mmAq	0.5	1	
	WATER LEVEL SWITCH		—	1	
	ELECTRICAL PANELS	415V	—	1 SET	
	STAND-BY DIESEL GENERATOR SET	500KVA 415V	—	1	EXISTING



SECTION A-A (1:100)

(31) SOBA PUMPING STATION

6. Project Implementation Plan

CHAPTER 6 PROJECT IMPLEMENTATION PLAN

6.1 Project Implementation Organization

In National Capital Khartoum, the Engineering Division through its Sanitary Engineering Department is charged with the implementation of the Project. The Road Construction Department, Building Construction Department and the Central Works Department comprise the other principal offices of the Engineering Division.

Within the Sanitary Engineering Department, the Sewage and Maintenance Section shall be accountable for the operation and maintenance of the improved sewerage facilities. The organization chart of the said Department is depicted in Figure 2-2.

6.2 Delineation of Responsibilities

In case Japanese Grant Aid is employed for this project, project tasks for which the Government of Japan shall be responsible are detailed design, civil, architectural, piping, mechanical and electrical works, and supervisory services relative to the rehabilitation of existing sewerage facilities. On the other hand, the Government of Sudan shall take care of the preparation of the construction site and related support infrastructure in addition to the operation and maintenance of the rehabilitated facilities.

The responsibilities of each country are more specifically spelled out as follows:

(1) Responsibilities of the Government of Japan

(a) Sewage Treatment Plant (Soba Sewage Treatment Plant)

(i) Repair of embankment of anaerobic, facultative and maturation ponds.

(ii) Reconstruction/replacement of pipes, a splash box, a flow meter, distribution tanks, inlet-outlet-connection channels

of ponds, discharge channels and related facilities.

(iii) Construction of new Influent Pumping Station, Administration Building and Generator Building.

(iv) Replacement and/or installation of mechanical equipment such as influent pipes, a flow meter, screens and related facilities.

(v) Replacement and/or new installation of electrical equipment such as control panels, generators lighting and related facilities.

(vi) Supply of equipment, instruments and other devices for the Laboratory and Work Shop.

(vii) Construction of maintenance roads in the Plant.

(b) Pumping Stations

(i) Replacement of pumps, electrical, equipment ventilation and other auxiliary equipment of Pumping Stations Nos. 1, 7, 8, 12 and 14.

(ii) Modification on some parts of pipes and electrical equipments.

(iii) Construction of two new pumping stations; Pumping Station No. 20 located between Pumping Station No. 6 and Soba STP and Pumping Station No. 21 located in Goaze.

(c) Sewer System

(i) Replacement of existing rising mains with ductile cast-iron pipes at Pumping Stations Nos. 1, 7, 8, 12 and 14.

(ii) Replacement of existing rising mains of Pumping Station No. 6 with ductile cast-iron pipes between a pumping station and African Road.

(iii) Installation of new rising main with ductile cast-iron pipes from Pumping Station No. 15 to No. 20.

(iv) Replacement of existing rising mains with ductile cast-iron pipes at Pumping Stations Nos. 9 and 10 which are downstream of the pumping stations to be rehabilitated with the Project.

(v) Installation of new gravity main between Green Belt and Soba STP.

(d) Other Facilities

(i) Installation of communication facilities between and among the main office, pumping stations and sewage treatment plant.

(2) Responsibilities of the Government of Sudan

(a) Construction Site

(i) Acquisition and grading of land.
(ii) Acquisition and construction of necessary access roads.
(iii) Removal of unnecessary facilities remaining in the construction site and ground leveling.

(b) Preparation of Relevant Support Infrastructure

(i) Supply and connection of electricity, water, gas and related utilities.

- Electricity :
  Preparation of connections to electric power supply facilities as well as connection to electrical equipment supplied by the Japanese counterpart.
- Water Supply :
  Preparation of connections for water supply facilities both for potable and domestic use at administration building of the sewage treatment plant.

(ii) Land acquisition for temporary offices of NCK and consultants, storage areas.

(c) Cleaning of whole sewerage system.

(d) Operation and maintenance of rehabilitated facilities.

(e) Construction and improvement on irrigation facilities for reuse of discharge from sewage treatment plant.

6.3 Execution Plan

(1) Basic Plan for Execution

The following basic plan will be followed during the implementation of the Project in order not only to lessen the adverse effects and inconveniences during construction, but also to realize an improved living and environmental conditions at the earliest time possible.

(a) Replacement of pump facilities and rising mains will be implemented as a first stage activity to check sewage flooding which stagnates in side-ditches and contributes to the poor sanitary conditions.

(b) Repair and replacement shall be done on pipelines to the Soba STP and existing sewage treatment plant for effective use of the Soba STP.

(c) While the above-mentioned works are being performed, 70 percent of sewage from 60 percent of the sewered area is treated properly.

(d) New construction and replacement works for the unification of the Soba STP will be implemented at the final stage.

Major works involved above are replacement of mechanical and electrical equipment in five (5) pumping stations, construction of three (3) pumping stations, replacement of rising mains in nine (9) different sections with a total length of about 12 km, construction of around 3 km long new gravity main from Goaze area and repair and replacement of facilities in Soba STP. Estimated construction period is two (2) years, divided into Phase I covering Item (a) and Item (b) and Phase II which includes Item (b) and Item (d).

(2) Preparations to be Taken During Execution

(a) Since repair/replacement works on mechanical and electrical equipment in pumping stations will be done as much as possible without significant interruption of sewage treatment, appropriate plans shall be prepared for the temporary cut-off/rerouting of the drainage system before the start of construction.

(b) Existing rising mains shall be kept in operation as new rising mains are being laid. Newly laid rising mains shall be constructed to existing rising mains in pumping stations as soon as practicable.

(c) The soil substrata at the Project Site generally consist of clay and silt which is very hard and strong when dry but loses its strength when wet. It is therefore unstable in the latter state and needs to be adequately shaped or shored especially in deep excavations for safety during construction.

(3) Construction Supervision Plan

Construction supervision, which is a principal responsibility of the Government of Japan, shall be carried out by a resident engineer to mainly supervise the civil and piping works and an architect, a mechanical engineer and an electrical engineer who shall be engaged on an as-required basis to supervise special construction/installation works. They will be assisted in their work by three (3) members of the local staff.

The organization diagram for construction supervision is shown below:

Project Manager (Resident Civil Engineer) (1)

(1)	(1)	(1)	(3)
Architect (asrequired 2 months)	Electrical Engr. (as required 2 months)	Mechanical Engr. (as required 3 months)	Local Staff

(4) Materials Procurement Plan

Materials, if those available in the local market meet the required specifications and quantity, shall essentially be procured in Sudan, with some importations to be made from Japan.

(a) Materials and construction equipment to be procured/supplied locally are:

(i) Materials
Brick, gravel and sand for concrete, crushed gravel, gasoline and kerosene

(ii) Construction equipment
At present situation, construction equipment for rent in Sudan are lacking in Number, and are very expensive, so that rental use of such equipment for long period is not economical. Therefore, most of construction equipment will be imported.

(b) Equipment and Materials to be imported from Japan shall consist of the following:

(i) Mechanical equipment
Pump equipment and accessories

(ii) Piping materials
Ductile cast-iron pipes, PVC pipes, valves

(iii) Electrical equipment
Control panels, generators, cables and accessories

(iv) Reinforcing bar

It is available in the country. However, amount in local markets is limited. Also it is very expensive and is not secure the stable supply.

(v) Fitting for buildings

Local products are limited in shape and wooden fittings.

(vi) Cement

Quantity for this Project is too much to procure at local markets in limited period.

(c) Method of Transportation

Goods from Japan shipped via ocean transport shall be unloaded at Port-Sudan and from there shall be transported by trucks to Khartoum, since the railways is considered a slow and unreliable alternative. The total period required to transport the goods is 5 months, counting 2 months for ocean carriage and 3 months for customs clearance, unloading and inland transportation.

(d) Construction Plan for Works by Sudan

(i) Land acquisition for new structures, temporary areas and open storage yards, as well as land-grading shall be completed at least one month before the start of the construction.

(ii) Arrangement for temporary electricity, water, gas and related utilities shall be completed by start of the construction.

(iii) Arrangement for necessary permanent electricity, gas and related utilities shall be completed by start of the test operations.

6-4 Implementation Schedule

Official Implementation of the Project commences with the signing of a contract between the Japanese Government and Sudanese Government. This is followed by detailed design, tendering, manufacture of materials and

equipment, transportation of equipment and materials, and actual construction.

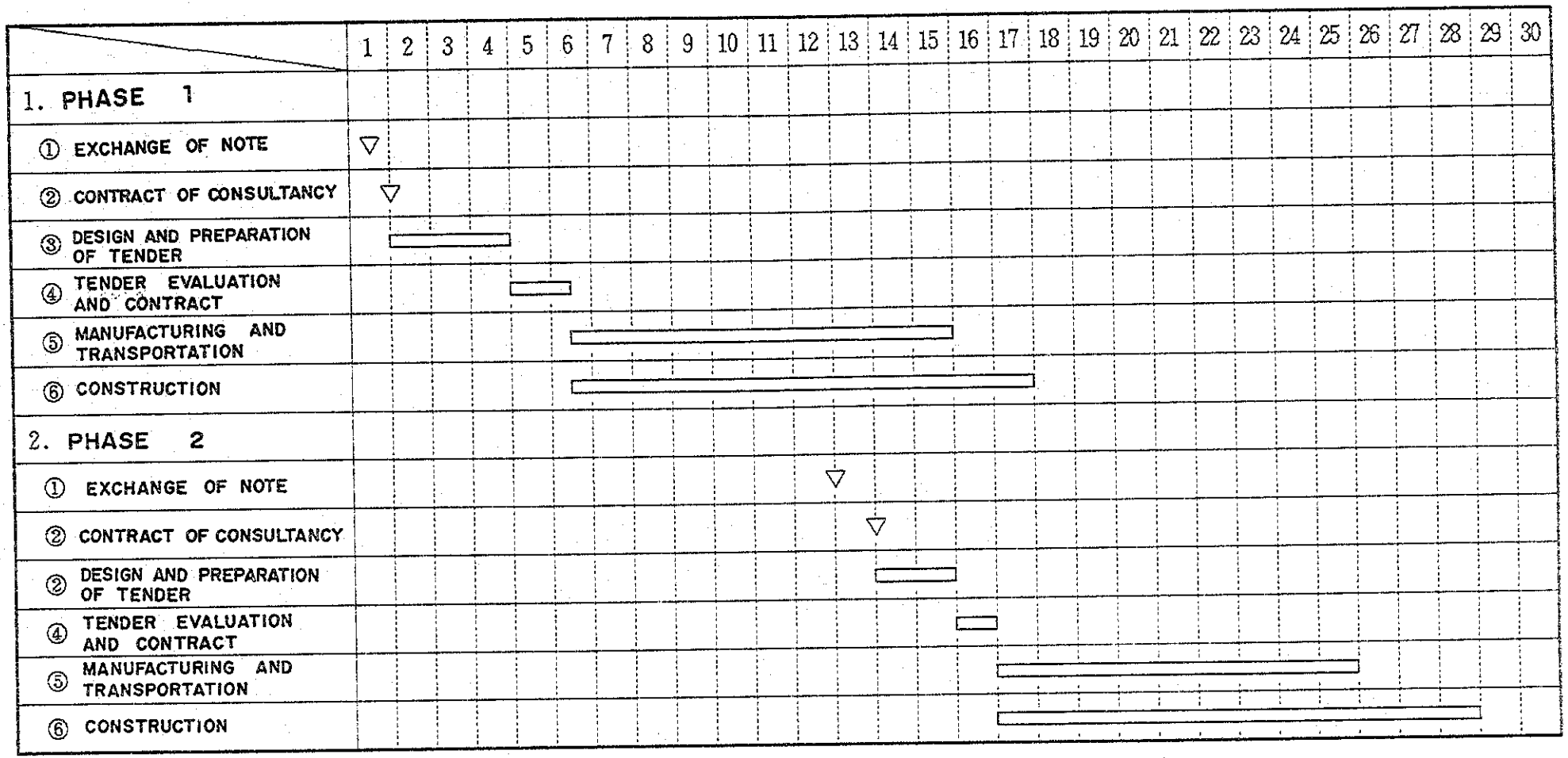
After the ratification of contract between the two governments, a Japan-registered consultant enters into an agreement for detailed design with the Sudanese Government.

6-5 Estimated Project Cost

The estimated cost for the Project born by Sudan is approximately 21 million Yen or 724 thousand £S.

Exchange Rate : US$ 1.00 = £S 4.50 = 130.53 Yen
£S 1.00 = 29.01 Yen

FIGURE 6 - 1 PROJECT IMPLEMENTATION SCHEDULE



7. Operation and Maintenance

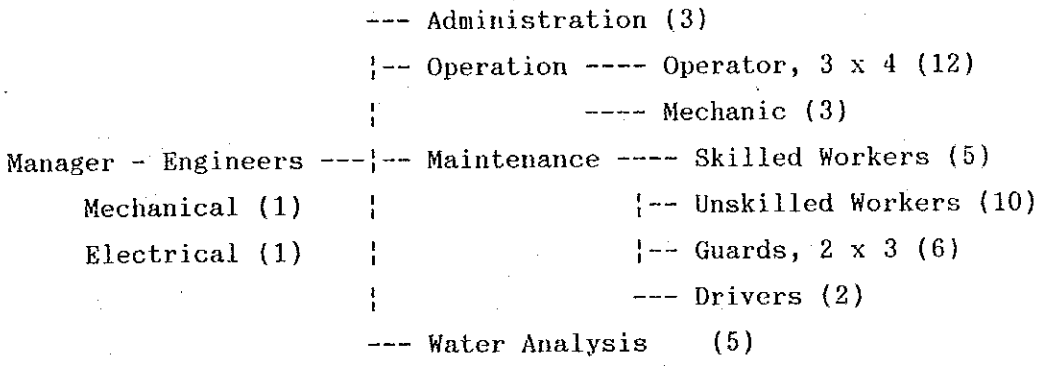
CHAPTER 7 OPERATION AND MAINTENANCE

7.1 Organization for Operation and Maintenance

As shown in Figure 2-2, National Capital Khartoum is headed by a Commissioner General and consists of six (6) divisions, namely: Administration, Finance, Engineering, Health, Education and Agriculture. The implementing farm of the Project is the Sanitary Engineering Department under the Engineering Division, while the Sewage and Maintenance Section of the same department will be responsible for the operation and maintenance of the sewerage system when completed.

The present organization for the operation and maintenance of the Khartoum Sewerage System is made up of 19 engineers and workers for mechanical and electrical equipment and 39 operators (3 operators in one group) who work in three (3) shifts. Two additional groups of operators, each consisting of two (2) mechanical worker, two (2) electrical workers and 12 operators, will be required for the two (2) new pumping stations. Workers and operators from the Goaze STP can be utilized to form the said two (2) new groups.

Some of the 94 remaining employees of the Goaze STP can be transferred to the integrated Soba STP to comprise its operation and maintenance organization. The said organization, which is diagramed below, allows for the manning of a workshop where small-scale disassembling, repair and overhaul of equipment can be done.



7.2 Operation and Maintenance Plan

(1) General Operation and Maintenance

Principal works involved in this activity are the operation and maintenance of pumping stations and a sewage treatment plant and cleaning and repair of sewers, more specific descriptions of which are given in Table 7-1.

Items of water analysis to be tested in the Soba STP shall include atmospheric temperature, water temperature, appearance, odor, transparency, DO, pH, SS, COD, BOD, microscopic inspection, dry solid, ignition residue, coliform group test, ammonia nitrogen and chlorine ion.

(2) Maintenance for Reuse of Treated Water from Soba STP

Sewage treated in the Soba STP by the stabilization pond method is planned by the National Capital Khartoum for reuse as irrigation water for the reforestation of Green Belt. Under the Green Belt Project, which is supported by Finland, a 28 sq.km area south of Khartoum and around Soba STP is to be planted all over with eucalyptus trees. At present, treated water from Goaze STP is supplied by the border check method or direct supply by channels to a 4.5 sq.km area on the western part of Green Belt, which has now a flourishing forest.

Precautions in the use of treated water for irrigation and important pointers in the maintenance of the sewage treatment plant and irrigation channels are given hereunder:

(a) Quality of treated water from the plant is suitable for the irrigation of forest trees, according to standards of the WHO, the World Bank Technical Paper and other countries, but should not be utilized for growing edible crops and fishes.

(b) People shall be cautioned not to get directly in contact with the treated water.

(c) The treated water contains large amounts of chlorophyceaes, surface soils in channels which are deterrent to percolation, hence should be regularly scraped and cleaned.

(d) Gravel filters at the effluent ponds are useful to reduce of chlorophyceases in treated water.

(e) Culturing of certain fish species like Chinese carp, European carp and Tirapius in maturation ponds is effective in controlling the development of chlorophyceaes.

Table 7-1 Operation and Maintenance Works

Facilities	Content
Sewage Treatment Plant	- Operation, inspection and repair of influent pump station - Removal of screenings - Flow measuring - Water analysis - Drying and removal of sludge and screenings in anaerobic ponds - Removal of vegetation on pond embankment - Regular inspection and trial operation of generator - Inspection and repair of electrical equipment and reading of electricity consumption - Recording of above items and operation cost
Pumping Station	- Monitoring of pump operation - Inspection, replacement of part, repair and its recording - Inspection and repair of water level gauge - Regular inspection and trial operation of stand-by pump - Storage and procuement of spare parts, fuels, etc. - Removal of scum in wet pit - Cleaning
Sewers	- Inspection of route of sewers - Regular cleaning of sewers - Repair of damaged sewers

7-3 Operation and Maintenance Cost

(1) Records of Operation and Maintenance Cost

The budgets which had been incurred by the Public Health and Engineering Utilities and General Workshops for the past several years that it had operated and maintained the Khartoum system are listed in Table 7-2.

Table 7-2 Past Budgets of the Public Health and Engineering Utilities and General Workshops

Year	Budget (LS)	Rate of Increase (%)
1983/84	1,178,600	---
84/85	1,393,000	18.2
85/86	1,945,000	39.6
86/87	2,273,400	16.9
87/88	2,908,000	27.9

The above budget figures which cover that for three (3) departments (no breakdown was available for the sewerage system alone), show an average increase of 25 percent annually. In July 1988, the Sanitary Engineering Department was formed with the following initial 1988/89 budget:

Table 7-3 Budget for the Sanitary Engineering Department for 1988/89

	LS
Wages of Employees	842,000
Maintenance Cost	476,400
Khartoum	304,400
Khartoum North	172,000
Total	1,318,400

The details of the budgeted 1988/89 maintenance costs for Khartoum alone are shown in Table 7-4, below:

Table 7-4 Breakdown of Maintenance Cost for Khartoum

Item	Cost (LS)
Maintenance Cost of Pump Stations	65,000
Goaze STP	40,000
Soba STP	20,000
Sewers	60,000
Goaze STP Laboratory	5,000
Temporary Employees	3,000
Safety Equipment	20,000
Safety Clothes	40,000
Tools	1,400
Others	10,000
Bonus	40,000
Total	304,400

(3) Maintenance and Operation Costs after Rehabilitation of the System

The estimated annual operation costs after the rehabilitation of the system, which include principally the cost for the electricity, fuel for generators, spare parts, safety equipment and sewer maintenance is broken down in Table 7-5.

Table 7-5 Annual Operation and Maintenance Costs

Item	Cost (LS)
Electricity Charge	628,000
Water Charge	19,000
Repair Cost	12,200
Fuel for Generators	122,600
Water Analysis	5,000
Maintenance of Sewers	30,000
Temporary Employees	3,000
Safety Equipment	50,000
Bonus	40,000
Total	909,800

The total projected operation and maintenance cost of LS909,800 far exceeds the present figure of LS304,400. However, since the sewerage system does not pay for electricity charges and if it is exempted from payment of such dues, the annual operation and maintenance requirements would only be LS281,800, which can be taken cared of by the present budget.

Initially, some spare parts will be supplied through the Project, but additional expenses for spare parts and electricity will ultimately be required in the future.

The bases for the calculations of operation and maintenance costs are given in detail in the following tables:

- Table 7-6 Consumption of Electricity
- Table 7-7 Electricity Charge
- Table 7-8 Water Charge
- Table 7-9 Cost for Repairs
- Table 7-10 Fuel Cost for Generators

Table 7-6 Consumption of Electricity

Pump Station	Daily Average Flow (cu.m/day)	Specification of Pump (cu.m/min x m x Kw x No.)	Operation Hours (hours/day)	Consumption of Electricity (kwh/day)	Plant Capacity (kw)
No. 1	3,877	3.4 x 25 x 30 x 3 (1)	19.0	570	90
No. 2	7,039	2.1 x 44.4 x 37 x 2.5	16.2	399.4	74
No. 3	1,641	4.8 x 26.4 x 37 x 2	---	---	
		2.4 x 10.8 x 11 x 1	11.4	125.4	85
No. 4	1,121	6.6 x 5.9 x 11 x 2	2.8	30.8	22
No. 5	3,058	4.5 x 17.2 x 22 x 2	11.3	248.6	44
No. 6	18,434	25.5 x 21.5 x 145 x 3 (1)	12.0	1,740	435
No. 7	1,653	1.5 x 19 x 11 x 3 (1)	18.4	202.4	33
No. 8	497	0.5 x 15 x 3.7 x 3(1)	16.6	61.4	11.1
No. 9	7,187	9.1 x 14.2 x 37 x 3	13.2	488.4	111
No. 10	1,915	2.7 x 56 x 55 x 2	11.8	649	110
No. 12	466	0.4 x 7 x 1.5 x 3 (1)	19.4	29.1	4.5
No. 14	1,269	1.1 x 17 x 7.5 x 3(1)	19.2	144	22.5
No. 15	2,799	2.4 x 13.3 x 11 x 1	19.4	213.4	
		6.0 x 33.8 x 55 x 1	---	---	66
No. 20	10,187	16.3 x 29 x 132 x 3 (1)	21.7	2,864.4	396
No. 21	10,187	7.8 x 11 x 30 x 3	21.8	654.0	90
No. 60	31,420	16.0 x 14 x 75 x 3	32.7	2,452.5	
		26.8 x 20 x 151 x (2)	---	---	527

Table 7-7 Electricity Charge

Pump Station	Electricty Consumption (kwh/day)	Unit Rate (Pt/kwh)	Charge of Usage (ES)	Basic Charge (ES)	Electricity Charge (ES)
No. 1	399	21	2,514	108	2,622
No. 2	420	23	2,898	7.5	2,905.5
No. 3	88	21	554	102	656
No. 4	22	26	172	7.5	179.5
No. 5	174	26	1,357	7.5	1,364.5
No. 6	1,218	21	7,673	522	8,195
No. 7	142	26	1,108	7.5	1,115.5
No. 8	43	26	335	7.5	342.5
No. 9	342	21	2,155	133	2,288
No. 10	454	21	2,860	132	2,992
No. 12	20	26	156	7.5	163.5
No. 14	101	26	788	7.5	795.5
No. 15	149	26	1,162	7.5	1,169.5
No. 20	2,005	21	12,635	475	13,107
No. 21	450	21	2,885	108	2,993
Soba	1,717	21	10,817	632	11,449
		Total			52,338 (1,518 Thousand Yen/Month)

* 100 PT = 1.0 ES

Table 7-8 Water Charge for SealingWater of Pumps

Pump Station	Unit Consumption (l/min)	Operating Hours (h/day)	Water Consumption (cu.m/month)	Basic Charge (ES/Month)	Usage Charge (ES/Month)	Water Charge (ES/Mo.)
No. 1	7	19	239	10	168	178
No. 7	7	18.4	232	10	163	173
No. 8	7	16.6	209	10	146	156
No. 12	7	19.4	244	10	172	182
No. 14	7	19.2	242	10	170	180
No. 20	7	21.7	273	10	194	204
No. 21	7	21.8	275	10	195	205
Soba	7	32.7	412	10	298	308
		Total				1,586 (46 Thousand Yen/Month)

Table 7-9 Cost for Repairs

Pump Station	Equipment Cost (Thousand Yen)	Repair Cost (Thousand Yen)
No. 1	21,000	630
No. 2	14,000	420
No. 3	26,000	780
No. 4	27,000	810
No. 5	19,000	570
No. 6	80,000	2,400
No. 7	18,000	540
No. 8	16,500	495
No. 9	60,000	1,800
No. 10	17,000	510
No. 12	12,600	378
No. 14	18,000	540
No. 15	21,000	630
No. 20	81,000	2,430
No. 21	45,000	1,350
Soba	60,000	1,800
	Total	16,083 Thousand Yen/Year

Note: The annual repair cost is estimated as 3 percent of the pump equipment cost.

Table 7-10 Fuel Cost for Generators

Pump Station	Capacity of Gen. (KVA)	Engine Output (PS)	Fuel Consumption (l/hour)	Fuel (l/month)	Unit Price (£S/Month)	Fuel Costs (£S/Mo.)
No. 6	500	590	134	1,608	1.6	2,573
No. 9	200	250	80	960	1.6	1,536
No.20	500	590	134	1,608	1.6	2,573
No.21	150	180	50	600	1.6	960
Soba	500	590	134	1,608	1.6	2,573
		Total				5,146 (149 Thousand Yen/Month)

Note: Frequency of power interruption is assumed at 3 times a week and 3 hours duration each time. The pump capacity, motor output, amount of influent and fuel cost for generators were computed in consideration of the said power suspension.

8. Project Evaluation

CHAPTER 8 PROJECT EVALUATION

8.1 Expected Benefits from the Project

The project is aimed at the general improvement of the sewerage system of Khartoum through the repair, rehabilitation, replacement and upgrading of deteriorated existing structures, equipment, machinery and related facilities. When fully implemented, the Project is expected to restore the capacity and functions of the sewerage system as originally designed, to uplift environmental conditions and to promote public health and sanitation as well as functions of city life.

In "Review on Water Supply and Sanitation Sector in the Republic of the Sudan", the Regional Water and Sanitation Group of UNDP/ World Bank Project suggested that urgent rehabilitation shall be implemented for deteriorated existing facilities of sewerage system in Khartoum. It is also mentioned in "The Four Year Salvation, Recovery and Development Programme 1988/89 - 1991/92" that water supply and sewerage systems are important as infrastructures and environment protection, and existing facilities shall be utilized effectively. (refer to Appendix-7 and 8)

The social and economic benefits to brought out by upgraded living standards are intangible or are difficult to evaluate in terms of monetary value.

Benefits derived from the improvement of the sewerage system which has direct or indirect impact on socio-economic development are:

(1) Enhancement of Living Conditions and Environmental Sanitation etc.

Reduced pump operations due to the deterioration of pump facilities have caused the accumulation of sewage and have hindered effective drainage flow. Moreover, sewage overflows, brought about by pipe leakages occur frequently aggravating the already adverse environmental conditions and further endangering public health. In terms of the improvement of living and environmental sanitation conditions, therefore, the Project will benefit an

estimated 72,000 permanent residents and around 200,000 people who come from other places and work during the daytime. In Khartoum, particularly in the Project Area, the various central and local government offices and public corporations are concentrated as well as largest commercial center is located. However, traffic retardation is accelerated due to frequent sewage floods and repair works of damaged pipes. The implementation of the Project will take effect on these kinds of subsidiary problems.

(2) Improvement of Existing Sewerage Facilities

(a) Existing pump facilities, sewage treatment facilities and rising mains, having outlived their usefulness because of age, are either operating at very much reduced efficiency or have completely ceased functioning. Upon completion of the Project, normal operations of the sewerage system as was originally planned will resume. Through appropriate improvement measures and proper maintenance, the use of existing pipes with inadequate capacity can be optimized or extended to the full extent.

(b) Presently, the removal of wastewater cannot be smoothly carried out because of leakage in the rising mains and insufficiency of pumping capacity. With the Project, proper drainage of wastewater will be attained for a 1,175 hectares of service area, which excludes an area where rehabilitation work is being undertaken through another fund. Also, 70 percent of the 60,000 £S annual budget for maintenance can be cut down since costly sewer repairs will be eliminated and most expenses will be only for maintenance and cleaning of sewer pipes.

(c) With the abolition of the Goaze STP and the integration of all sewage treatment at the Soba STP, the amount of £S 65,000 which represents the annual budget for maintenance labor for the former will be saved. The 45-man maintenance crew of the Goaze STP to be displaced by the proposed integration can be assigned to work in the pumping stations and

in the Khartoum North sewerage system which is now under rehabilitation.

(3) Lower Incidence of Communicable Diseases

The promotion of living and sanitation conditions which accompanies the improvement of the sewerage system will subsequently result to the reduction of incidence and spread of contagious or communicable diseases.

In 1985, 1986 and 1987, numbers of patients of waterborne diseases such as dysentery, diphtheria etc. were 80,400, 85,200, 65,150 respectively. Also, numbers of dead persons related to these water borne diseases were 706, 610, 336 respectively. The number of patients indicates more than five percents of total population of National Capital, and rehabilitation of sewerage system will reduce a cause of waterborne diseases.

Based on the report of the survey made on October 1988 which is shown in Table 3-2, water-borne diseases (excluding the figure for malaria) comprise 63 percent of the total number of cases of leading contagious diseases.

It is difficult to make an accurate assessment of the disease reduction to be brought by the Project, but it is roughly estimated that the incidence of water-borne diseases will go down to 10 percent within the sewerage service area in Khartoum.

(4) Expansion of Green Belt

The creation of a large Green Belt in the southern part of Khartoum is currently being planned.

Some 10,000 cu.m/day of treated water from the Goaze STP is now being channeled to the existing 4 sq.km Green Belt for irrigation purposes and eucalyptus cultivation. Through this Project, a bigger volume of treated water (30,000 cu.m/day) will be made available for irrigation use, the proposed integrated Soba STP

being located in the Green Belt area itself. With the additional irrigation water, the present Green Belt can be expanded to 12 sq.km, which represents almost 50 percent of the area ultimately planned for the Green Belt.

(5) Effective Usage of Goaze STP

Though expansion of urbanized area in Khartoum, surroundings of Goaze STP is being developed as residential areas. On the other hand, since existing facilities in the STP do not operate properly, flies, mosquitoes, bad oder deteriorates a living environment of residents in its surrounding area.

Goaze STP will abolish in this Project and the above mentioned problems will solve, and the area will be used as residential areas. This will be also a large benefit of urban planning in Khartoum.

8.2 Justification for the Project

The original request of the Government of Sudan for grant-aid assistance was mainly for the rehabilitation of 5 pumping stations and 2 sewage treatment plants, and the repair/improvement of rising mains and appurtenant facilities. Field surveys which was conducted by the Study Team essentially confirmed the validity of the said request since it was observed in these surveys that most of the pumps, treatment facilities and rising mains are running under deteriorated condition or are no longer functioning. In short, the performance level of the sewerage system has dipped so low that sewage overflows are becoming frequent occurrences.

In order to remedy the above situation, there is an urgent need for the restoration of the original capacity and efficiency of existing facilities, hence the required rehabilitation works should be immediately carried out. Total rehabilitation would involve the replacement of mechanical and electrical facilities of five pumping stations, and the

replacement of rising mains with inadequate capacities located downstream of these pumping stations.

Based on current budget allocations for maintenance purposes, it is deemed very difficult to obtain sufficient funding for necessary spare parts, consumable goods, payment of electric power consumption charges, and related expenses for long-term operation. To reduce on these expenditure items, rehabilitation of the existing standard trickling filter treatment facility was not considered as an improvement measure for the Goaze STP. Instead, it will be integrated with the Soba STP where the treatment of sewage will be by the stabilization pond method, which is comparatively easy to maintain and requires lower operation costs.

On the other hand, although the Soba STP has a large treatment capacity, it has been rendered useless because of damages to the rising mains. Thus, for the integrated sewerage system to be effective, there is a need to construct two new pumping stations, and rehabilitate existing facilities in the Soba STP apart from repairing damaged or leaking rising mains. An integrated scheme is regarded more advantageous than a plan employing both the Goaze STP and Soba STP from the viewpoint of economy in construction, operation and maintenance and relevant facility required for operation and maintenance; and should therefore be adopted.

9. Conclusion and recommendation

CHAPTER 9 CONCLUSIONS AND RECOMMENDATIONS

9-1 Conclusion

In an attempt to solve the worsening sewerage problems in Khartoum, the Government of the Republic of the Sudan engaged the technical expertise of a British consulting firm to conduct necessary studies in pursuit of the said objective. The result of these efforts was a "Master Plan for Khartoum and Omdurman Sewerage and Sewage Treatment Project", which called for the extensive improvement of existing facilities and the expansion of the sewerage service area. Moreover, the Regional Water and Sanitation Group - Eastern Africa, UNDP/World Bank Project and the Four Year Salvation, Recovery and Development Programme had also taken up the same recommendation. However, only few of the recommended works were implemented due to budgetary limitations, hence the existing sewerage system and the living and sanitary conditions have gradually deteriorated. These situation have farther lead to cause epidemic of water-borne diseases to about five percent of population in Khartoum.

In addition, the degradation of sewerage system in Khartoum, where many government offices, embassies, public and private companies situate and is the largest commercial center in the Sudan, is subsequently related to deterioration of urban activities.

Judging from the present conditions, the urgent rehabilitation of sewerage facilities will contribute to improve living environment and hygienic conditions of residents and people working in the subject area. This will further relay to depress epidemic of water-borne diseases, recovery of public services in urban area, etc.

It is believed that the above circumstances adequately justify the necessity for the Khartoum Sewerage Rehabilitation Project and assistance for implementation be extended by the Government of Japan to the Government of Sudan through a grant-aid program.

9-2 Recommendation

The following recommendations are proposed to ensure effective and smooth implementation of the Project as well as to provide its future improvement.

(1) Improvement of sewers contemplated under the Project is limited to urgent priority areas. Drastic overall rehabilitation has not been considered. In order to have a more effective system, it is desirable to implement such intensive improvements as may be required after a review of the existing Master Plan and related future plans. Moreover, some existing sewers which were found out to be inadequate in capacity shall be rehabilitated at an early stage.

(2) Although a separate system of storm water drainage and sanitary sewer is adopted in Khartoum, there is a large possibility that storm runoff flow will enter the sanitary sewers and consequently increase the amount of sewage to more than the capacity of the sewers and pump stations since the drainage system is generally in a poor condition. Proper operation of the sewerage system will therefore be required upon the construction of the drainage system in conjunction with the implementation of the sewerage system.

(3) Operation of pumps in pumping stations is done manually depending upon the water level at the wet pits and some pumping stations were not operated for a long period of time because of poor management of the total sewerage system. Manuals should be prepared for the proper operation and maintenance of pumps as well as establishment of an appropriate management organization.

(4) Lack of spare parts and maintenance are regarded as major causes of the deterioration of existing facilities. The quantity of spare parts and accessories supplied under the Project is limited, but their continuous and sufficient supply will be necessary for the long-term operation of these facilities. A sustained adequate budget for the procurement of materials and for maintenance purposes is, therefore, indispensable. It is also desirable that

experts are to be dispatched to train employees on the proper techniques in the repair, replacement and overhauling of facilities for effective maintenance.

Appendix

(Appendix - 1)

List of Persons Interviewed and Itinerary of the Study Team

1. List of Members of the Study Team

(1) Team Members of the Basic Study Team

Ichiro Setoh	Senior Officer /Urban Development Construction Dep. Japan Regional Development Corporation
Haruo Iwahori	Project Coordinator JICA Expert Japan International Cooperation Agency
Atushi Odera	Sewerage Planning Nippon Jogesuido Sekkei Co., Ltd.
Shinichi Osaka	Sewerage Treatment Planning Nippon Jogesuido Sekkei Co., Ltd.
Masanao Yamada	Pumping Facilities Nippon Jogesuido Sekkei Co., Ltd.
Takashi Watanabe	Sewer System Planning Nippon Jogesuido Sekkei Co., Ltd.
Hiroshi Kitaichi	Electrical System Planning Nippon Jogesuido Sekkei Co., Ltd.

(2) Team Members of Explanation of the Draft Final Report

Ichiro Setoh	Senior Officer /Urban Development Construction Dep. Japan Regional Development Cooperation
Atushi Odera	Sewerage Planning Nippon Jogesuido Sekkei Co., Ltd.
Shinichi Osaka	Sewerage Treatment Planning Nippon Jogesuido Sekkei Co., Ltd.

2. Itinerary of the Study Team

(1) Basic Design Study

Nov. 19, 1988 - Dec. 22, 1988

Days	Date	Activities
1.	Nov. 19 (Sat)	Setoh, Odera, Osaka, Yamada, Watanabe left Narita
2.	20 (Sun)	Arrival at Amsterdam
3.	21 (Mon)	Departure from Amsterdam Arrival at Khartoum

4.		22 (Tue)	Courtesy Visit to Embassy of Japan, Ministry of Finance and Economic Planning, National Capital Khartoum
5.		23 (Wed)	Explanation of Inception report
6.		24 (Thu)	Field Survey (PS/Goaze STP)
7.		25 (Fri)	Field Survey (Soba STP/Sewer Mains)
8.		26 (Sat)	Meeting with NCK/Request for the Data
9.		27 (Sun)	Drawing the Minutes/Field Survey (PS)
10.		28 (Mon)	Discussion over Minutes
11.		29 (Tue)	Signing the Minutes /Field Survey (PS No.6, Sewer Mains)
12.		30 (Wed)	Setoh and Iwahori visited Embassy of Japan and left Khartoum to Tokyo /Study on Population and Sewage Flow
13.	Dec.	1 (Thu)	Confirming the answer for the Questionair / Field Survey (Rising Mains)
14.		2 (Fri)	Team Discussion
15.		3 (Sat)	Discussion with Water Supply Dep. / Data Arrangement
16.		4 (Sun)	Discussion with Finnish Planting Team and Boring Expert in Khartoum Univ. / Field survey (Goaze STP)
17		5 (Mon)	Discussion with Water Supply Dep. / Water Analysis (Goaze STP) Kitaichi arrived Khartoum.
18.		6 (Tue)	Discussion (Min. of Finance and Economic Planning / Surveyor) /Field Survey (STP)
19.		7 (Wed)	Discussion (Min. of Works, Housing Planning and Public Utilities, Min. of Survey) /Field Survey (STP)

20.	8 (Thu)	Discussion (Min. of Irrigation, Min. of Public Service, Cement Company) / Field Survey (PS)
21.	9 (Fri)	Team Discussion
22.	10 (Sat)	Discussion (Min. of Health) /Field Survey (Electric Facilities)
23.	11 (Sun)	Water Analysis (Goaze STP)
24.	12 (Mon)	Data Arrengement
25.	13 (Tue)	Discussion (Khartoum Univ.) /Field survey (Soba STP)
26.	14 (Wed)	Discussion (Min. of Commerce, Water Supply Dep.) /Research on Market Prices
27.	15 (Thu)	Discussion / Market Price Research
28.	16 (Fri)	Water Analysis / Team Discussion
29.	17 (Sat)	Discussion (Finnish Planting Team) / Field Survey (Irrigation Canals)
30.	18 (Sun)	Discussion (Embassy of Japan, Electricity Dep.) / Data Arrangement
31.	19 (Mon)	Visit on Embassy of Japan Site Survey (Soba STP)
32.	20 (Tue)	Odera, Osaka, Yamada, Watanabe, Kitaichi left Khartoum /Arrival at Paris
33.	21 (Wed)	Departure from Paris
34.	22 (Thu)	Arrival at Narita

(2) Explanation of Draft Final Report

Feb. 26, 1989 - Mar. 9, 1989

Days	Date	Activities
1.	Feb. 26 (Sun)	Setoh, Odera, Osaka, left Narita
2.	27 (Mon)	Departure from Paris
3.	28 (Tue)	Arrival at Khartoum Courtesy Visit to Embassy of Japan Ministry of Finance and Economic Planning, National Capital Khartoum

4.	Mar.	1 (Wed)	Explanation of Draft Final Report
5.		2 (Thu)	Field Survey (Khartoum North, PS No. 3, 6 and 9)
6.		3 (Fri)	Team Discussion
7.		4 (Sat)	Courtesy Visit of Commissioner General of NCK
8.		5 (Sun)	Drawing the Minutes
9.		6 (Mon)	Signing of the Minutes
10.		7 (Tue)	Departure from Khartoum /Arrival at London
11.		8 (Wed)	Departure from London
12.		9 (Thu)	Arrival at Narita

3. List of Persons Interviewed

(1) Embassy of Japan

Hikaru Oka	Ambassador Extraordinary and Plenipotentiary
Toshio Kaneko	First Secretary
Yoshihiko Sato	Second Secretary

(2) Government of Republic of the Sudan

Fatih Abdoon	: Commissioner General
Mamoun Sharif	: Commissioner for Engineering & Health
Mohamed Elamin Saeed	: Director General, Engineering Commissioner
Ibrahim A. R. Elgaizoul	: Director, Sanitary Engineering Dept.
Ibrahim M. K. Suareldahab	: Advisor, Sanitary Engineering Dept.
Fadlalla Osman Sobeir	: Civil Engineer
Admed Abdallo el Hassan	: Mechanical Engineer
Rafi Gubartalla	: Electrical Engineer

1) National Capital Khartoum

Mamoun Sharif Commissioner for Engineering & Health

Mohamed Elamin Saeed
Director General Engineering
Commissioner

Ibrahim A.R. Elgaizouli
Director, Sanitary Engineering Dept.

Ibrahim M.K. Suareldahab
Advisor Sanitary Engineering Dept.

Fadlalla Osman Sobeir
Civil Engineer

Ahmed Abdallo El Hassan
Mechanical Engineer

Refi Gubartalla
Electrical Engineer

2) Ministry of Finance and Economic Planning

Omer Nur El-Daim
Minister

Mohamed Ali Omer
Deputy Undersecretary for Planning

Mohamed Kheir Ell-Zubear
Acting Undersecretary for Planning

Salha Abdalsalam
Assistant Undersecretary for Planning

Hashim Mohamed Zaiwi
ditto (Successor)

3) Ministry of Health

Mohamed H. A. Elshellali
Director, Malaria Programme

4) Ministry of Construction

Abdel Wahab Khalid
Director, Municipal Engineering

5) National Urban Water Corporation

Abdel bakr El Siddig Abd Aiia
Khartoum Area Manager

6) Irrigation Department

Appendix - 2

Minutes of Discussion

Minuetes (1)

MINUTES OF DISCUSSION
ON
THE BASIC DESIGN STUDY
ON
THE PROJECT FOR KHARTOUM SEWERAGE REHABILITATION
IN
THE REPUBLIC OF THE SUDAN.

In response to the request of the Government of the Republic of the Sudan for Khartoum Sewerage Rehabilitation Project (hereinafter referred to as "the Project"), the Government of Japan decided to conduct a Basic Design Study on the Project and entrusted the Japan International Cooperation Agency (JICA) to send the Basic Design Study Team (hereinafter referred to as "the Team") headed by Ichiro Setoh, Official of Area Promotion and Improvement Public Corporation, from November 21 to December 20, 1988.

The Team has a series of discussion with the authorities concerned of the Government of the Republic of the Sudan, and conducted a field survey.

As a result of the Study, both parties have agreed to recommend to their respective Governments that the major points of understanding reached between them as attached herewith, should be examined towards the realization of the Project.

November 29, 1988.

瀬藤一郎

Ichiro Setoh
Team Leader
of the Basic Design
Study Team, Japan
International
Cooperation Agency.

For Mohamed Kheir El-Zubear
Acting Undersecretary
for Planning, Ministry
of Finance and Economic
Planning.

Mamoun Sharfi
National Capital
Commissioner for
Engineering & Health.

A T T A C H M E N T S .

1. The objective of the project is to rehabilitate the sewerage system at Khartoum in order to ensure the existing capacity of the system.

2. The project area is the Khartoum, which is shown in Annex I.

3. National Capital Commissioner is responsible for the administration and the execution of the Project.

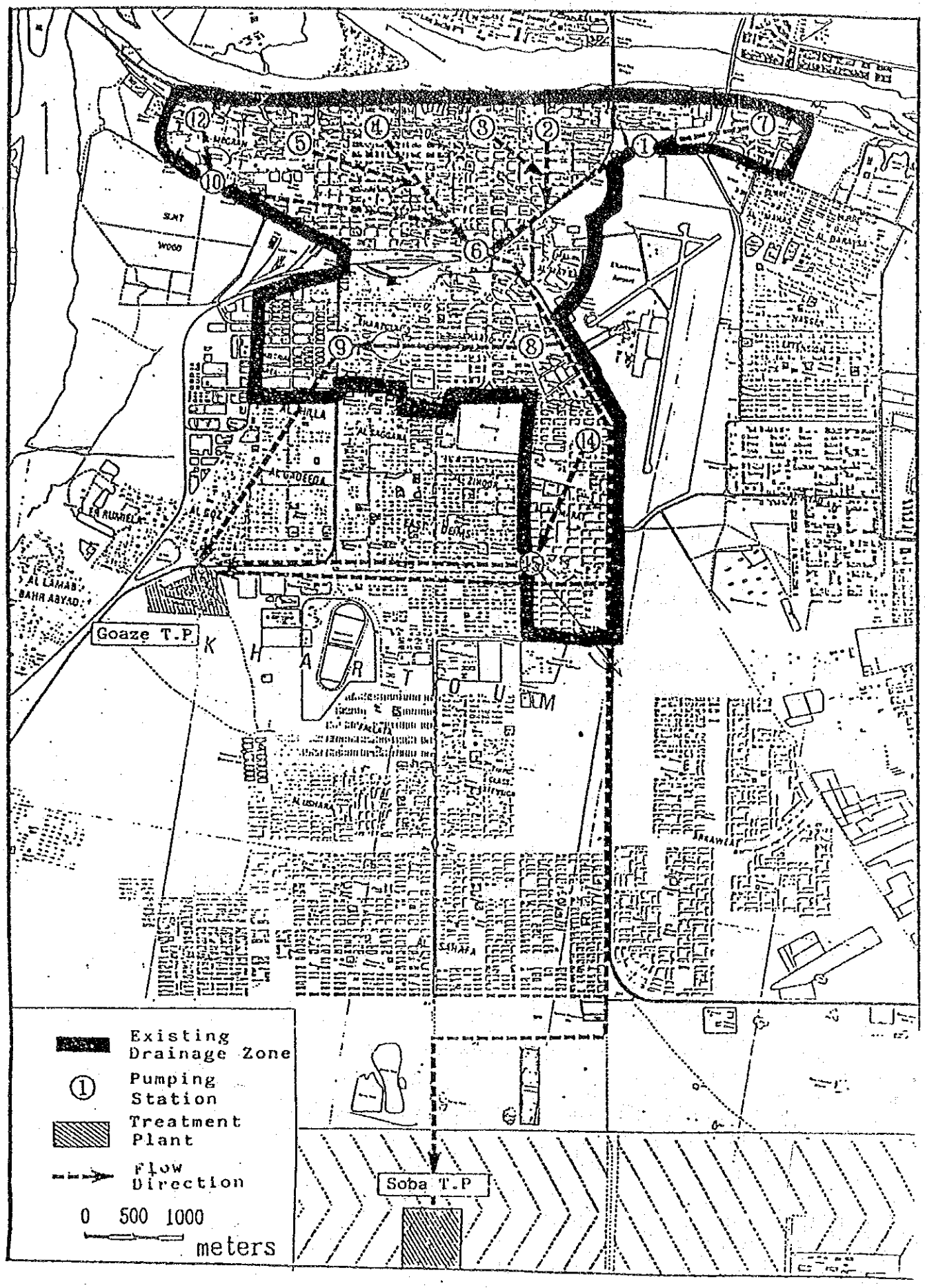
4. The Team will convey to the Government of Japan the desire of the Government of the Republic of the Sudan which is listed in Annex II under the Japan's Grant Aid Scheme.

5. Comments by the team on these requests in Annex II are listed in Annex III

6. The Government of the Republic of the Sudan understood Japan's Grant Aid System as explained by the Team.

7. The Team strongly requested to the Government of the Republic of the Sudan to take necessary measures which is listed in Annex IV on condition that Grant Aid by the Government of Japan is extended to the Project.

8. The Government of the Republic of the Sudan will take necessary measures listed in Annex V, considering also above mentioned Annex IV, on condition that Grant Aid by the Government of Japan is extended to the Project.


Goaze T.P
KHARTOUM
Soba T.P
Existing Drainage Zone
Pumping Station
Treatment Plant
Flow Direction
0 500 1000
meters

Annex II

Requests made by the Government of the Republic of the Sudan for the Project under Japan's Grant Aid are as follows:-

(Phase I)

(a) Modification to pipe work in pumping station No.6

(b) New electrical swichgear and controls

(c) New main sewers at Western part in Zone J

(d) Modification to pumping mains

(e) Lighting and safety access ladders in pumping stations.

(f) Sump pumps.

(g) Rehabilitation of Goaze Sewage Treatment Plant.

- Pumps (sludge pumps, final effluent pumps, recirculating pumps, grit pumps).
- Biofilter rotating arms
- Flow meter for inflow and final effluent
- Sludge scrapers (Primary sedimentation and humus tanks)
- Grit chamber structure.

(h) Equipment, instruments and chemicals for Goaze Sewage Treatment Plant laboratory.

(i) Rehabilitation of P.S. No. 1, 7, 8, 12 and 14

(j) Pressure main of P.S. No. 15 to Goaze Sewage Treatment Plant.

(k) Pressure main of P.S. No. 1 to P.S. No.6

(Phase II)

(l) 4.5 km rising main to Soba Sewage Treatment Plant.

(m) Construction of a new pumping station on pressure main from P.S. No.6, which is 4.5 km from Soba Sewage Treatment Plant.

(n) Rehabilitation of Soba Sewage Treatment Plant.

Annex III

Comments by the Team on these requests.

1. Comments up to now are as follows:-

(1) Capacity to be rehabilitated at Goaze and Soba Sewerage Treatment Plant (S.T.P.) will be up to the existing capacity.

Goaze S.T.P. : 14,550 m^3/day

Soba S.T.P. : 20,450 m^3/day

(2) Construction of a new pumping station on sewer main will be between P.S. No.6 and the beginning point of gravity flow.

(3) Existing gravity flow sewer main (4.5 km) to Soba S.T.P. will be available.

2. All the requests will be reviewed and commented in the Basic Design Study.

Annex IV

Requests by the Team to the
Government of the Republic of the Sudan.

1. To ensure prompt unloading, tax exemption and customs clearance at port of disembarkation and prompt internal transportation therein of the products purchased under the grant, to keep the construction schedule.

2. To improve operation and maintenance system to use mechanical and electrical facilities properly and effectively for long period.

3. To ensure enough maintenance budget to use mechanical and electrical facilities properly and effectively for long period.

Annex V

Arrangements to be taken by the
Government of the Republic of the Sudan.

1. To secure land necessary for the construction of the facilities and to clear, fill and level the site as needed before the start of the construction.

2. To construct and prepare the access road to the project site, if necessary.

3. To provide facilities for the distribution of electricity, gas, telephone and other incidental facilities.

4. To provide the land space necessary for temporary offices, working areas, stock yards and others.

5. To ensure Annex IV, 1.

6. To exempt Japanese nationals engaged on the Project from customs duties, internal taxes and other fiscal levies which may be imposed in the Republic of the Sudan with respect to the supply of the products and the services under the verified contracts.

7. To accord without delay to Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contract such facilities as may be necessary for their entry into the Republic of the Sudan and their entry into the performance of their work.

8. To ensure Annex IV, 2.

9. To ensure Annex IV, 3.

10. To bear all the expenses, other than those to be borne by the grant, necessary for the construction of the facilities.

11. To remove sludge in the treatment plants before the start of the construction.

Minutes of Discussions

The Draft Final Report of the Basic Design on The Project for Khartoum Sewerage Rehabilitation in The Republic of the Sudan

In response to the request made by the Government of the Republic of the Sudan, the Government of Japan decided to conduct a basic design study on the Project for Khartoum Sewerage Rehabilitation (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the Republic of the Sudan the study team from November 19 to December 22, 1988.

As a result of the study, JICA prepared a draft report and dispatched a mission, headed by Mr. Ichiro Setoh, Senior Officer, the Urban Development Construction Department of the Japan Regional Development Cooperation to explain and discuss it from February 26 to March 9, 1989.

The team had series of discussions on the Project with the officials concerned of the Government of Sudan headed by Mr. Mohamed Ali Omer Deputy ~~Acting~~ Undersecretary for planning, Ministry of Finance and Economic Planning.

After clarifying its contents, both parties had agreed to recommended to their respective governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

March 6, 1989

瑞 勝 一 郎

Ichiro Setoh
Team Leader
Draft Report Team of
Basic Design Study
JICA

Mohamed Ali Omer
Deputy ~~Acting~~ Undersecretary
for Planning,
Ministry of Finance and
Economic Planning

MHSaid

Mamoon Sharfy
Commissioner for
Engineering & Health,
National Capital Khartoum

Major Points of Understanding:

1. The Sudanese side agreed in principle to the basic design proposed in the Draft Final Report.

2. The Sudanese side understood the system of Japan's Grant Aid Program and confirmed the measures to be taken by the Sudanese side towards the realization of the Project as agreed upon in the "Minutes of discussions" dated November 29, 1988.

3. The Final Report (10 Copies written in English) on the Project will be submitted to the Republic of the Sudan in April 1989.

4. The Sudanese side agreed to complete all rehabilitation works on Pumping Station No.2, 3, 4, 5, 9, 10 and 15 by the end of 1990.