residential and commercial purposes. For safety against flood, reckless development in the riparian area should be suitably controlled by the Municipality. In particular, any changing of the channel section or construction along the river course requires assessment of its influence on flood conditions.

Mining ponds have natural storage functions in mitigating flood peak discharge. Thus it is recommended to retain the ponds as they are to avoid unanticipated disasters in future.

(2) Flood Forecasting and Warning System

At Phuket airport, a radar raingauge will be operated soon. The detailed specification such as type of equipment, accuracy and coverage of area etc. has not yet been confirmed by the Study Team. This station is managed by the Meteorological Department.

It is noted that the radar rainfall data would be very helpful for forecasting of rainfall in the Bang Yai river basin. It may be possible to forecast floods by a flood forecasting system for the Phuket municipality. The system is composed of a data collection system, data management system, analysis system and data dissemination system. All systems are functioned by computer and telecommunication network.

Even if a flood exceeding design flood attacks the municipality, the system could give time for the citizens to fight the flood and to escape under the guidance of executing agencies of flood forecasting.

8.6 Hydraulic Condition of Bridges over Bang Yai River

Replacement of the bridges in the Municipality is recommended in the Chapter 8.2 to mitigate local floods from the residual basin. In response to the request of the Phuket Municipality to review the necessity of the replacement of bridges, flow conditions at bridges were restudies by non-uniform calculation using cross sections of bridges which are prepared by the Phuket Municipality.

As a result, water surface of the probable floods which are more than 5 year flood will exceed the bottom elevation of bridge girder at three bridges, Pra-Aram, Phang Nga and Toan pradit bridges as shown in Annex Fig. 8.1. Therefore it is recommended to reconstruct such bridges. As for other bridges, freeboard of Phoonphol, Taling Chang and Thepkrasattri bridges is less than 50 cm. It is recommended to study the necessity of the replacement of these bridges in more detail at the detailed design stage.

CHAPTER 9

ORGANIZATION

CHAPTER 9 : ORGANIZATION

9.1 Executing Agency for Construction

The construction of the drainage and flood control systems will be under the responsibility of the Public Works Department (PWD). The PWD, which is under the Ministry of Interior, is in charge of the development of infrastructures such as roads, bridges and utilities for water supply and sewerage. With regard to sewerage and flood control for second class rivers, the PWD takes responsibility mainly in the planning, surveying, designing, construction and personnel training for the projects.

9.2 Executing Agency for Operation and Maintenance Works

Since there is no basic law that regulates the implemention and operation and management of sewage works in both the central and local level, it is necessary to enact laws for sewage works. With reference to such regulations for sewage works, the recommendation is presented in the Master Plan report.

In the initial stage of construction of the sewage treatment plant and trunk sewers works, the PWD will support and assist the city in the financial and technical aspects. After the completion of those facilities, the city has to undertake the various works involved in the construction of branch sewers and house connections where existing drains are not connected yet to the street gutters, discharging to the rivers or canals directly. Such works will be done by the engineering section in the City as is presently practiced. However, as these works will be interdependent with the other works of the project, a particular section might be affected by the developments in the other portions of the work.

To avoid the occurrence of such problem, therefore, it is recommended to establish a new division to exclusively implement the sewerage system project. Special attention shall be paid to the operation and management of the public sewerage system, because at present the management and maintenance of the drainage and sludge

removal service for sewage in the cesspools and septic tanks is delegated to the city's public health section in the city. Including these services, the new division to be established shall take responsibility for the management as well as operation and maintenance of the sewerage system.

As for the monitoring of floods, the PWD will also support and assist the city on the financial and technical aspects of this task. After the completion of the flood control structures, the city has to take responsibility for all management works in order to maintain the surroundings of the river as well as the drainage facilities. It is recommended that the city tie in closely with the people in the flood-affected area to foster better understanding and cooperation of the residents.

CHAPTER 10

PROJECT EVALUATION

CHAPTER 10: PROJECT EVALUATION

10.1 Economic Analysis

10.1.1 General

The Project evaluation is carried out in order to ascertain the feasibility of the project in view of economic, financial and socio-economic aspects. This section is to cover principally the economic analysis by calculating the economic internal rate of return (EIRR) on the foregoing study of the Project.

The Economic benefits for sewerage project are principally used to be evaluated by:

1) Health and welfare improvement benefit
   Such as improvement of hygiene/health and reduction in those disease

2) Environmental improvement benefit
   Such as conservation of agriculture and fishery, development of water resources and preservation of sound environment including leisure and recreation

3) Other economic benefit
   Such as decrease of flood damages, development of land use, increase of land value, promotion of local industry and resources including reuse of treated water and saving of water supply costs

Taking those circumstances, in the case of this Project, the particular conditions in Phuket City could afford to scarcely quantify those economic benefits. However, since an institutional nature of infrastructure project, even if those benefits are not awfully enough to conform the project costs namely unprofitable, the project is apt to be implemented from socio-economic and or political viewpoints essentially for a part of basic human needs as described in Section 10.3, indirect benefit and socio-economic

impact. Accordingly, the economic analysis is made only for flood control scheme. While the project justifications including financial aspect and indirect benefit and socio-economic impact are conducted for the sewerage schemes.

For the economic evaluation, the following basic assumptions are established.

1) The economic useful life of the Project is taken as 50 years for flood control scheme respectively from completion of the construction.

2) At the beginning of the above project life, 4 years from 1991 for flood control scheme is required for design, preparation procedure and construction.

3) The current prices as of December 1989 are used in this evaluation.

4) The exchange rate of Thailand Baht is taken to be 5.7 Japanese Yen or 0.0399 U.S. Dollars equivalent to 1 Thai Baht based on the foreign exchange middle rate of the Bank of Thailand at the year end of 1989.

5) Only direct benefits of flood control are counted in the evaluation. Indirect and/or intangible benefits are excluded and separately described in Section 10.3.

   As the direct benefit of drainage scheme is seemed more unquantifiable, the appraisal of this scheme itself is to be covered in Section 10.4.

10.1.2 Economic Prices

For evaluation of economic resources, the economic price out of the market price is made under the criteria mentioned hereunder.

Table 10.1 Summary of Country Parameters for Thailand

Efficiency Pricing Parameters	Central value	Sensitivity range
Standard Conversion Factor (SCF)	0.92	0.91 - 0.94
Consumption Goods Conversion Factor (CGCF)	0.95	0.77 - 0.98
Intermediate Goods Conversion Factor (IGCF)	0.94	0.90 - 1.09
Capital Goods Conversion Factor (KGCF)	0.84	0.83 - 0.96
Construction Conversion Factor (CCF)	0.88	0.86 - 0.92
Electricity Conversion Factor (ECF)	0.90	0.88 - 0.93
Transportation Conversion Factor (TCF)	0.87	0.85 - 0.90
Labor Conversion FActor (LCF)	0.92	0.91 - 0.94
Marginal Productivity of Capital (q)	0.16	0.12 - 0.20
Rice Conversion Factor (RCF)	1.11	0.92 - 1.49

Source: Shadow Prices for Economic Appraisal of Projects, An Application to Thailand, World Bank Staff Working Papers No. 609

Those well matured parameters have been prevailing since early 1980s. Even now, because of steady growth of the national economy, they are still enough in force provided with the following justifications to properly settle within the said sensitivity range.

(1) Standard Conversion Factor (SCF)

Tariff and trade restrictions introduce a distortion in the price relationships between traded goods and non-traded goods. In order to evaluate the project cost and benefit comparable to the world market price, a SCF is applied to the price of non-traded goods and services. In the absence of trade restrictions, SCF is figured at 0.93, according to the actual trend of the foreign trade, taxation and surcharges in Thailand for the last 5 years as per Table 10.2.

Table 10.2 Estimation of Standard Conversion Factor out of Foreign Trade Balance 1984 - 1988

(Unit: Thousands of Baht)

Year:	1984	1985	1986	1987	1988	Total: 1984 - 1988
Trade amount						
1. Export F.O.B.	175,237,200	193,365,507	231,224,934	299,853,086	405,569,839	1,305,250,566
2. Import C.I.F.	245,155,025	251,169,435	241,357,738	334,208,962	513,114,323	1,585,005,483
3. Total 1 + 2	420,392,225	444,534,942	472,582,672	634,062,048	918,684,162	2,890,256,049
Duties						
4. Export duty	2,176,805	1,322,798	560,697	1,321,288	1,058,479	6,440,067
5. Import duty	30,658,347	30,503,434	30,329,106	37,108,434	54,152,710	182,752,031
6. Import excise tax	1,496,257	1,534,236	3,758,134	8,629,879	9,284,425	24,702,931
7. Sub-total 5 + 6	32,154,604	32,037,670	34,087,240	45,738,313	63,437,135	207,454,962
Conversion factor						
8. S.C.F. (rate)	0.93	0.94	0.93	0.93	0.94	0.93

Remark: S.C.F. (Standard Conversion Factor) =

$$\frac{\text{Export amount + Import amount}}{\text{Export amount - Export duty + Import amount + Import duty \& tax}}$$

Source: Statistical Yearbook Thailand No. 35/36 1988/1989, NSO-OPM

(2) Construction Conversion Factor (CCF)

The construction of project facilities is carried out by equipment, materials, skilled and unskilled labors. Based on our cost structure, the construction conversion factor is assumed at 0.898 as below:

Table 10.3 Conversion Factors

Commodity	Share (%)	Conversion factor	Weighted average
Traded goods	34.4	1.0	34.4
Non-traded:			
Capital goods	31.7	0.84	26.628
Intermediate goods	2.1	0.94	1.974
Transportation service	15.1	0.87	13.137
Skilled labor	1.5	0.92	1.38
Unskilled labor	5.4	0.61	3.294
Miscellaneous	9.8	0.92	9.016
Total	100.0		89.829 (%)

10.1.3 Economic Costs

The capital cost broadly comprises:

i) Cost for preparatory works,
ii) Construction cost for project facilities including the contractor's overhead costs, profit and contract tax,
iii) Cost for land acquisition and compensation,
iv) Administration expenses,
v) Engineering services,
vi) Physical contingencies, and
vii) Price contingencies.

Among the costs mentioned above, all the costs except the contractor's profit, contract tax and price contingencies are counted as the net capital cost to be considered in the economic evaluation.

Whereas, the breakdown of land acuisition and compensation for sewerage scheme is shown on Table 10.4. And the subjected land for sewer treatment plan is a dumping ground belonged to the City and to be applied for this purpose at free of charge. Thus, such land cost is not borne financially but is to be counted as an economic cost.

Table 10.4 Outline of Land Acquisition Cost for Sewerage Scheme

Description	Land space	Financial cost	Total
Phase 1			
Pumping station	1,520 m^2	@ 11,000 Baht/4m^2	4,180 10^3 Baht
Sewer treatment Plant	27,700 m^2	@ 2,300 "	15,928 "
Sub-total :	29,220 m^2		20,108 10^3 Baht
Phase 2			
Sewer treatment Plant	4,000 m^2	@ 2,300 Baht/4m^2	2,300 10^3 Baht
Total :	33,220 m^2		22,428 10^3 Baht

This net capital cost is further converted into the economic capital cost by applying the CCF specified in Section 10.1.2.

The economic capital cost thus estimated and its annual disbursement as well as operation and maintenance cost for each scheme are as shown below:

Table 10.5 Economic Capital Cost

(Unit: thousands of Baht)

Year	Sewerage Scheme	Flood Control Scheme	Total
1991	(Phase 1)	(30-year probable flood)	
1992	28,322	8,910	37,232
1993	9,685	11,360	21,045
1994	40,995	91,440	132,435
1995			131,572
	(Phase 2)		
1998	3,076		3,076
1999	21,680		21,680
2000	20,305		20,305

Table 10.6 Economic Anuual Operation & Maintenance Cost

Sewerage Scheme		Flood Control Scheme	Total
Phase 1	4,687	(30-year probable flood)	
Phase 2	607		
Annual	5,294	540	5,834

10.1.4 Economic Benefits

As the particular nature of social infrastructure, this project bears several problems and difficulties such as:

i) Low elevation flat city area faced to the bay and surrounded by hills

ii) High population density in down town alongside of a straight stream, Bang Yai river

iii) The river is not large enough for water transportation, floating market, fishing and leisure purposes, and rather remains useless with disposals and pollutions.

iv) The projected sewer treatment plant locates near by the river mouth and the reuse of the output as household living and/or industrial water can not be expected.

Under the circumstances, all the benefits are apt to be not wholly quantifiable. Thus, the benefits to be derived from flood control of Bang Yai river will be grouped into 2 categories, namely (1) Induced benefit for sewerage system and (2) Flood control benefit.

(1) Induced Benefit

In socio-economic view of this project, an contribution to tourism by environmental improvement is quantified in terms of incremental surplus of regional economy, which should be otherwise nonentity if the project might be not realized.

Recent success in tourism in Phuket City is represented as per the drastic increase of travelers' expenditures in Table 10.7, and have boosted up the relevant industries in the City (Ref. Table 10.8).

In comparison of the development between Trade and Service sectors in Gross Municipal Development Product (GMDP) and the correspond-

ing added value productivity by tourism revenue, the growth of the latter is more faster and will overcome the former at the extension by regression analysis of those trends.

The local trade and service sectors are not fully for tourism and such reversals might be absorbed into the relevant sectors.

However, the most possible extent of the respective growths will logically mark up an excess on the economic projection as the fruits of commercial efforts and infrastructural development.

Throughout interviews with government authorities and field reconnaissances, it is obviously emphasized the apprehension to economic depression by the pollution and deterioration of the environment as well as an inevitable decline of the reputation of Phuket City.

Thus, a half of such incremental surplus by tourism over the sum of trade and service sectors is accounted as the induced benefit of this project.

Table 10.7 Revenue from tourists in Phuket City 1984 - 1988

(Millions of Baht)

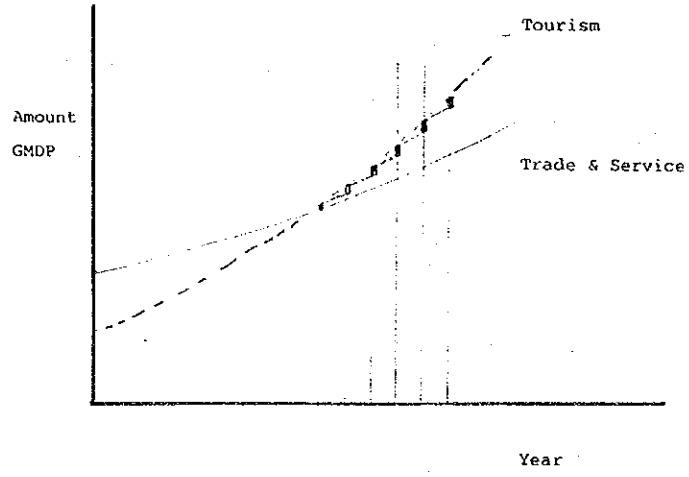
Description	Year :	1984	1985	1986	1987	1988	Average (%)	'84/88 *1 (%)
Numbers of Tourist arrival in Phuket Province	persons	340,950	345,268	476,954	546,949	726,173		20.81
Foreign	persons	144,601	156,174	253,731	334,889	509,322		37.00
Domestic	persons	196,349	189,094	223,223	212,060	216,851		2.51
Avr. length of stay	days	4.38	3.55	3.63	3.61	4.44		0.34
Avr. personal expenditure:								
Foreign	baht/day	2,128	2,335	2,233	2,370	2,533		4.45
Domestic	baht/day	1,064	1,168	1,117	1,185	1,267		4.45
Distribution of expenditure:	%	100.00	100.00	100.00	100.00	100.00	100.00	
Accommodation	%	28.12	25.62	26.63	26.81	24.05	26.25	
Food & drink	%	20.53	19.14	16.93	18.02	15.90	18.10	
Shopping	%	30.16	33.66	27.39	26.82	38.53	31.31	
Entertainment	%	10.43	11.64	10.02	12.12	6.64	10.17	
Local transport & tour	%	8.48	7.82	15.59	13.36	13.09	11.67	
Miscellaneous	%	2.28	2.12	3.44	2.87	1.79	2.50	
Revenue from tourists in Phuket City:	(Mil. baht)							
Hotel guests in the City		453	416	592	754	1,390		32.37
Foreign		270	259	411	573	1,146		43.58
Domestic		183	157	181	181	244		7.44
Guests from outside the City		294	333	464	594	890		31.92
Foreign		175	207	322	451	734		43.09
Domestic		119	126	142	143	156		7.08
Total revenue	Mil. baht	746	749	1,056	1,349	2,279		32.20

Remark: *1 - Commpound annual growth rate 1984/1988 in percentage
Source: Annual Statistical Report on Tourism in Thailand 1985 - 1988
Tourism Authority of The Thailand

Table 10.8 : Estimated GMDP - Phuket Municipality out of GPDP - Phuket Province for 1975 - 1987 by industrial origin at currrent prices (millions of Baht) and their Sectoral Distribution (%) & Annual Growth Rate (%)

Year	:1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Industrial origin													
Agriculture	225	311	384	401	494	511	500	466	646	560	513	455	469
Crops	95	126	139	196	193	225	212	207	253	241	234	218	221
Livestock	24	21	36	33	35	44	57	53	118	90	75	63	93
Fisheries	101	153	207	164	244	243	231	194	247	216	191	161	137
Foresitry	4	11	1	8	22	0	0	12	28	12	13	13	18
Mining & quarrying	398	338	522	545	687	753	527	485	495	513	544	551	537
Manufacturing	70	65	104	121	142	170	145	134	122	134	143	150	163
Construction	57	53	110	91	429	217	173	165	202	231	241	326	491
Elec. & water supply	37	37	38	48	55	51	87	117	111	123	133	148	161
Transport. & communi	107	160	143	178	229	328	376	432	440	488	577	681	803
Wholesale & retails	228	269	341	367	586	513	564	563	596	646	670	770	873
Bank. insu. & estate	55	65	80	108	146	212	246	308	352	390	433	494	534
Dwellings	9	10	11	13	15	17	20	24	29	32	35	56	82
Admin. & defence	46	53	58	71	87	111	119	142	163	162	176	189	226
Service	161	180	279	353	324	375	428	482	512	537	579	611	894
GPDP, Phuket Prov.	1393	1650	2071	2283	3193	3257	3184	3319	3667	3814	4045	4661	5233
GPDP per capita Baht	11901	13000	16701	18056	24373	24309	23071	23373	25291	25596	26439	28595	32913
Manufacturing	21	20	31	36	43	51	44	40	37	40	43	45	49
Construction	17	16	33	27	129	65	52	50	61	69	72	98	147
Elec. & water supply	11	11	11	14	17	15	26	35	33	37	40	44	48
Transport. & communi	32	48	43	53	69	98	113	130	132	146	173	204	241
Wholesale & retails	114	135	171	184	293	257	282	282	298	323	335	385	437
Bank. insu. & estate	28	33	40	54	73	106	123	154	176	195	217	247	267
Dwellings	5	5	6	7	8	9	10	12	15	16	18	28	41
Admin. & defence	23	27	29	36	44	56	60	71	82	81	88	95	113
Service	81	90	140	177	162	188	214	241	256	269	290	306	447
GMDP, Phuket Munici.	331	383	503	587	836	844	923	1014	1089	1176	1275	1452	1790
GMDP per capita Baht						18724	20317	22022	23706	25211	27191	30603	37446
Distribution by sector:													
Manufacturing	6.35	5.09	6.20	6.18	5.10	6.04	4.71	3.96	3.36	3.42	3.37	3.10	2.73
Construction	5.17	4.15	6.56	4.65	15.40	7.72	5.62	4.88	5.57	5.89	5.67	6.74	8.23
Elec. & water supply	3.36	2.90	2.27	2.45	1.97	1.81	2.83	3.46	3.06	3.14	3.13	3.06	2.70
Transport. & communi	9.70	12.53	8.53	9.09	8.22	11.66	12.22	12.76	12.13	12.45	13.58	14.08	13.46
Wholesale & retails	34.46	35.12	33.90	31.24	35.07	30.40	30.56	27.76	27.38	27.46	26.28	26.52	24.39
Bank. insu. & estate	8.31	8.49	7.95	9.19	8.74	12.56	13.33	15.19	16.17	16.58	16.98	17.02	14.92
Dwellings	1.36	1.31	1.09	1.11	0.90	1.01	1.08	1.18	1.33	1.36	1.37	1.93	2.29
Admin. & defence	6.95	6.92	5.77	6.04	5.21	6.58	6.45	7.00	7.49	6.89	6.90	6.51	6.31
Service	24.33	23.50	27.73	30.05	19.39	22.22	23.19	23.77	23.52	22.83	22.71	21.05	24.97
GMDP, Phuket Munici.	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Year	:1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1981/84	1984/87
Annual growth :										(Previous year = 100)			(Annual aver.)	
Manufacturing	92.86	160.00	116.35	117.36	119.72	85.29	92.41	91.04	109.84	106.72	104.90	108.67	-2.60	6.75
Construction	92.98	207.55	82.73	471.43	50.56	79.72	95.38	122.42	114.36	104.33	135.27	150.61	10.12	28.57
Elec. & water supply	100.00	102.70	126.32	114.58	92.73	170.59	134.48	94.87	110.81	108.13	111.28	108.78	12.24	9.39
Transport. & communi	149.53	89.38	124.48	128.65	143.23	114.63	114.89	101.85	110.91	118.24	118.02	117.91	9.08	18.06
Wholesale & retails	117.98	126.77	107.62	159.67	87.54	109.94	99.82	105.86	108.39	103.72	114.93	113.38	4.63	10.56
Bank. insu. & estate	118.18	123.08	135.00	135.19	145.21	116.04	125.20	114.29	110.80	111.03	114.09	108.10	16.60	11.04
Dwellings	111.11	110.00	118.18	115.38	113.33	117.65	120.00	120.83	110.34	109.38	160.00	146.43	16.96	36.84
Admin. & defence	115.22	109.43	122.41	122.54	127.59	107.21	119.33	114.79	99.39	108.64	107.39	119.58	10.83	11.74
Service	111.80	155.00	126.52	91.78	115.74	114.13	112.62	106.22	104.88	107.82	105.53	146.32	7.86	18.52
GMDP, Phuket Munici.	115.78	131.33	116.78	142.24	100.99	109.36	109.87	107.36	108.07	108.37	113.87	123.31	8.43	15.02
GMDP per capita Baht						108.51	108.39	107.65	106.35	107.85	112.55	122.38	7.46	14.10



(2) Flood Control Benefit

The flood control benefit is evaluated as an economic counteref-fect involved by flood damages on houses, household articles, stock assets of offices and shops and public facilities. As described in chapter 8, the aforesaid flood control benefit there-of is so estimated on the basis of international boarder price or so bearable against economic evaluation that such assumption can be applied commonly to this economic benefit.

(3) Total Benefits

All the above economic benefits after completion of the built-up are described in Table 10.9.

10.1.5 Economic Internal Rate of Return (EIRR)

Thus and so, the economic cost and benefit stream is prepared as per Table 10.9.

Then the economic analysis is made which results EIRR of 12.5% for flood control scheme (30-year probable flood).

Table 10.9 Cost Benefit Stream for Flood Control Scheme

30 year probable flood Unit: B1,000

No.	Fiscal Year	Cost F/C	Cost L/C	Cost O&M (L/C)	Cost Total	Benefit	Net Benefit
1	1989 /90				0	0	0
2	1990 /91				0	0	0
3	1991 /92	3,620	5,270		8,890	0	-8,890
4	1992 /93	910	10,400		11,310	0	-11,310
5	1993 /94	63,860	27,610		91,470	0	-91,470
6	1994 /95	31,390	10,780		42,170	0	-42,170
7	1995 /96			540	540	22,100	21,560
8	1996 /97			540	540	22,100	21,560
9	1997 /98			540	540	22,100	21,560
10	1998 /99			540	540	22,100	21,560
11	1999 / 0			540	540	22,100	21,560
12	2000 / 1			540	540	22,100	21,560
13	2001 / 2			540	540	22,100	21,560
14	2002 / 3			540	540	22,100	21,560
15	2003 / 4			540	540	22,100	21,560
16	2004 / 5			540	540	22,100	21,560
17	2005 / 6			540	540	22,100	21,560
18	2006 / 7			540	540	22,100	21,560
19	2007 / 8			540	540	22,100	21,560
20	2008 / 9			540	540	22,100	21,560
21	2009 /10			540	540	22,100	21,560
22	2010 /11			540	540	22,100	21,560
23	2011 /12			540	540	22,100	21,560
24	2012 /13			540	540	22,100	21,560
25	2013 /14			540	540	22,100	21,560
26	2014 /15			540	540	22,100	21,560
27	2015 /16			540	540	22,100	21,560
28	2016 /17			540	540	22,100	21,560
29	2017 /18			540	540	22,100	21,560
30	2018 /19			540	540	22,100	21,560
31	2019 /20			540	540	22,100	21,560
32	2020 /21			540	540	22,100	21,560
33	2021 /22			540	540	22,100	21,560
34	2022 /23			540	540	22,100	21,560
35	2023 /24			540	540	22,100	21,560
36	2024 /25			540	540	22,100	21,560
37	2025 /26			540	540	22,100	21,560
38	2026 /27			540	540	22,100	21,560
39	2027 /28			540	540	22,100	21,560
40	2028 /29			540	540	22,100	21,560
41	2029 /30			540	540	22,100	21,560
42	2030 /31			540	540	22,100	21,560
43	2031 /32			540	540	22,100	21,560
44	2032 /33			540	540	22,100	21,560
45	2033 /34			540	540	22,100	21,560
46	2034 /35			540	540	22,100	21,560
47	2035 /36			540	540	22,100	21,560
48	2036 /37			540	540	22,100	21,560
49	2037 /38			540	540	22,100	21,560
50	2038 /39			540	540	22,100	21,560
51	2039 /40			540	540	22,100	21,560
52	2040 /41			540	540	22,100	21,560
53	2041 /42			540	540	22,100	21,560
54	2042 /43			540	540	22,100	21,560
55	2043 /44			540	540	22,100	21,560
56	2044 /45			540	540	22,100	21,560

EIRR= 12.5%

10.1.6 Sensitivity Analysis

In order to evaluate further the soundness of the Project to possible changes of economic situations in future, the economic sensitivity analyses are made in terms of EIRR under the condition of:

Both of project cost and benefit are increased or decreased by 0, 5 & 10% in combination.

Table 10.10 EIRR in Sensitivity Analysis
(Flood control (30-year flood) scheme)

	Cost:	-10%	-5%	0%	+5%	+10%
Benefit	-10%	12.5%	11.9%	11.3%	10.8%	10.3%
	- 5%	13.2%	12.5%	11.9%	11.4%	10.9%
	0%	13.8%	13.1%	12.5%	11.9%	11.4%
	+ 5%	14.4%	13.7%	13.1%	12.5%	12.0%
	+10%	15.0%	14.3%	13.7%	13.1%	12.5%

10.2 Financial Aspect

10.2.1 General

The financial feasibility of the project is evaluated principally from the viewpoint of national economy in Phuket City. In this connection, an assumption of the prospective sewerage charge to be borne by the beneficiaries is made on preliminary basis. The study on the capability of foreign capital cost repayment of sewerage scheme is also made on the project level provided with the cash flow table.

10.2.2 Financial Cost

Based on the current market prices as of December 1989, the financial construction cost of the Project is estimated as respec-

tively shown in Chapter 8 for flood control scheme and Table 10.2 for sewerage scheme.

In this estimate, the price contingencies of 2% per annum for the foreign currency portion and 10% per annum for the local currency portion are considered to be added.

In addition, annual operation and maintenance (O & M) cost in financial price is to be:

Table 10.11 O & M Cost

Sewerage scheme		Flood control scheme	Total
Phase 1	5,326	(30-year probable flood)	
Phase 2	690		
	6,016	614	6,630

(Unit: Thousands of Baht)

10.2.3 Sewerage Charge

After commencement of sewerage service, if the sewerage charge is not collected as usual, all the cost of the Project will have to be financed by the Government, and such expenditure will become a heavy burden to the country. It is generally understood that the sewerage charge is imposed to the beneficial users, and the sewerage charges thus collected is spent for payment of O & M expenditures incurred to the Project and/or for repayment of the capital cost of the Project. In Thailand, however, the users traditionally are not used to pay sewerage charge directly.

Under such circumstances, a maximum coverage by individuals is seemed an extent of O & M expenditures or a little more. Thus, as an immediate criterion, one (1) Baht per cubic meter of sewer flow is set down to recommend.

In view from project side, calculation is made as follows:

Investment:

i) Annualized capital investment by means of capital recovery coefficient

$$T \times \left(i + \frac{i}{(1+i)^{n}-1}\right) = 35{,}215\ 10^3 \text{ Bahts} \quad \text{---- (1)}$$

Where, T= 573,614 10^3 Bahts: Total capital investment
i= 4.5%: Interest rate of cost allocation by IBRD
n= 30 years: Project life

ii) Annual O& M cost 6,016 10^3 Bahts ----- (2)

Annual total (i)+(ii) 41,231 10^3 Bahts (100%)

Revenue:

Annual sewerage charge

1 x 18,300 cu.m x 365 days = 6,680 10^3 Bahts (16.2%)

This means that the beneficiaries bear merely 16.2% of the total obligation and rather rejoice the balance 83.8% as "Consumer's Surplus".

On the other hand, in comparison with household income and expenditure survey in Table 10.13, this sewerage charge will result to add a small share, on their household expenditure respectively as follows:

Monthly sewerage charge:

1 Baht/m^3 x 350 lpcd x 3.6 persons/H•H x 30 days
= 37.8 Baht/mt

equivalent to 15.4% of fuel & light expenditure 246 Baht
or 0.65% of household total expenditure 5,817 Baht

Annual sewerage charge:

1 Baht x 350 lpced x 3.6 persons x 365 days = 459.90 Baht

So far, it is to say this amount is obviously marked within the citizen's "Ability to Pay".

Table 10.12 Average Monthly Income and Expenditure per Household in 1986 by Socio-Economic Class in Southern Region & Municipal Area

(Unit: Baht)

Zonal Average	Municipal Area	Distribution (%)		Southern Region	Distribution (%)	
No. of household (10^3)	168	(12.6)		1,330	(100.0)	
Family size (person/household)	3.6			4.2		
TOTAL MONTHLY INCOME	6,621	128.2	(113.8)	3,657	103.0	(93.7)
TOTAL MONTHLY EXPENDITURE	5,817	112.6	(100.0)	3,901	109.9	(100.0)
Consumption Expenditure:	5,164	100.0	(88.8)	3,549	100.0	(91.0)
Foods	2,058	39.9		1,519	42.8	
Apparel	285	5.5		287	8.1	
Cloth & clothing	237	4.6		240	6.8	
Footwear	48	0.9		47	1.3	
Housing	1,369	26.5		804	22.7	
Shelter	591	11.4		229	6.5	
Rental value of owned home	362	7.0		291	8.2	
Fuel & light	246	4.8		160	4.5	
Textile housefurnishings	27	0.5		36	1.0	
Minor equipment	15	0.3		16	0.5	
Major equipment	55	1.1		27	0.8	
Cleaning supply	64	1.2		38	1.1	
Domestic servants	9	0.2		7	0.2	
Medical Care	126	2.4		131	3.7	
Drugs & medicines	34	0.7		30	0.8	
Medical services	92	1.8		101	2.8	
Personal Care	162	3.1		103	2.9	
Personal care items	123	2.4		80	2.3	
Personal services	39	0.8		23	0.6	
Transportation & Communication	621	12.0		402	11.3	
Local transportation	102	2.0		60	1.7	
Travel out of area	185	3.6		96	2.7	
Vehicle operations	205	4.0		131	3.7	
Vehicle purchase	95	1.8		101	2.8	
Communications	34	0.7		14	0.4	
Recreation & Reading	194	3.8		82	2.3	
Admissions	16	0.3		9	0.3	
Sports equipment	39	0.8		18	0.5	
Musical equipment	31	0.6		20	0.6	
Reading materials	37	0.7		11	0.3	
Religious activities	71	1.4		24	0.7	
Education	120	2.3		56	1.6	
Miscellaneous	41	0.8		39	1.1	
Non-Consumption Expenditure:	653	12.6	(11.2)	352	9.9	(9.0)
Direct Taxes	62	1.2		15	0.4	
Gifts & Cotributions	353	6.8		230	6.5	
Insurance Premiums	44	0.9		20	0.6	
Lottery Tickets	106	2.1		51	1.4	
Interest on Debts & Shares	63	1.2		29	0.8	
Other Expenses	25	0.5		7	0.2	

Source : 1986 Household Socio-Economic Survey Report, Southern Region by National Statistical Office

10.2.4 Repayment of Project Cost

The financial evaluation of the Project is made by examining the repayment capability for the capital cost of the Project. For the examination, a financial cash flow statement for the project development plan using the anticipated project revenue and fund requirement is prepared as shown in Table 10.14.

In the examination of repayment capability, it is assumed that the capital required for the project implementation will be arranged under the following conditions:

(1) For the foreign currency portion, the capital is financed by bilateral or international organization with an interest rate of 3.5% per annum for a repayment period of 30 years including a grace period of 10 years.

(2) For the local currency portion, the capital is financed by the budget allocation of the Government without interest and repayment.

Table 10.13 Financial Cash Flow Statement for Proposed Sewerage Scheme

(Unit: Thousands of Baht)

Year in Order	Year	Capital Cost			Foreign loan accumulate	Cash Outflow *3				Cash Inflow			Balance
		F.C. *1	L.C. *2	Total		O & M Cost	Repayment of loan Interest	Repayment of loan Capital	Total (A)	Sewerage charge	Government subsidy	Total (B)	(A) - (B)
1	1991	9,667	6,813	16,480	9,667		0		0		0	0	0
2	1992	9,860	1,375	11,235	19,527		338		338		338	338	0
3	1993	1,437	70,088	71,525	20,964		683		683		683	683	0
4	1994	50,069	99,358	149,427	71,033		734		734		734	734	0
5	1995	73,227	148,981	222,208	144,260		2,486		2,486		2,486	2,486	0
6	1996				144,260	5,326	5,049		10,375	5,767	4,608	10,375	0
7	1997				144,260	5,326	5,049		10,375	5,767	4,608	10,375	0
8	1998		2,726	2,726	144,260	5,326	5,049		10,375	5,767	4,608	10,375	0
9	1999	12,308	38,292	50,600	156,568	5,326	5,049		10,375	5,767	4,608	10,375	0
10	2000	12,534	36,880	49,414	169,102	5,326	5,480		10,806	5,767	5,039	10,806	0
11	2001				160,647	6,016	5,919	8,455	20,390	6,680	13,710	20,390	0
12	2002				152,192	6,016	5,623	8,455	20,094	6,680	13,414	20,094	0
13	2003				143,737	6,016	5,327	8,455	19,798	6,680	13,118	19,798	0
14	2004				135,282	6,016	5,031	8,455	19,502	6,680	12,822	19,502	0
15	2005				126,827	6,016	4,735	8,455	19,206	6,680	12,526	19,206	0
16	2006				118,371	6,016	4,439	8,455	18,910	6,680	12,231	18,910	0
17	2007				109,916	6,016	4,143	8,455	18,614	6,680	11,935	18,614	0
18	2008				101,461	6,016	3,847	8,455	18,318	6,680	11,639	18,318	0
19	2009				93,006	6,016	3,551	8,455	18,022	6,680	11,343	18,022	0
20	2010				84,551	6,016	3,255	8,455	17,726	6,680	11,047	17,726	0
21	2011				76,096	6,016	2,959	8,455	17,430	6,680	10,751	17,430	0
22	2012				67,641	6,016	2,663	8,455	17,134	6,680	10,455	17,134	0
23	2013				59,186	6,016	2,367	8,455	16,839	6,680	10,159	16,839	0
24	2014				50,731	6,016	2,071	8,455	16,543	6,680	9,863	16,543	0
25	2015				42,276	6,016	1,776	8,455	16,247	6,680	9,567	16,247	0
26	2016				33,820	6,016	1,480	8,455	15,951	6,680	9,271	15,951	0
27	2017				25,365	6,016	1,184	8,455	15,655	6,680	8,975	15,655	0
28	2018				16,910	6,016	888	8,455	15,359	6,680	8,679	15,359	0
29	2019				8,455	6,016	592	8,455	15,063	6,680	8,383	15,063	0
30	2020					6,016	296	8,455	14,767	6,680	8,088	14,767	0
31	2021					6,016			6,016	6,680		6,680	664

Remarks : *1 Foreign currency portion
*2 Local currency portion
*3 Repayment period of 30 years including grace period of 10 years, with interest of 3.5% per annum

10.3 Indirect Benefit and Socio-Economic Impact

In addition to the direct benefits mentioned above, this section describes the positive or negative indirect and/or intangible benefits and socio-economic impacts to be borne by improvement of sewerage and drainage systems and flood control of Bang Yai river.

The study, including socio-economic reconnaissances and foreign/domestic tourist interviews, is made principally in three viewpoints such as community well-being, economic contribution and project implementation.

The most obvious impact of the project will be the improvements expected in the public health of the inhabitants and visitors to Phuket City through the provision of the new sewerage system with no flood measure. All the wastewater currently infiltrated into the river or ground will be shut off and collected by the sewers, and then treated at the treatment plant to the level acceptable to the environs.

Even the retribution between contamination of groundwater or river water and higher incidence rate of food & water borne diseases in Phuket is still unclear, the introduction of a modern sewerage system will be quite helpful to improve those situation. Furthermore, the recovery of the amenity alongside of Bang Yai river will be also very worthy likewise relocation of "Green Park" into down town, which comprises 56 hectares of ponds & playground to accept daily 500 of sports visitors and costs 5 million Bahts for reclamation and monthly 10 thousand Bahts for maintenance of the park. Thereby, more healthy and comfort community can be achieved.

In a similar vein, this modernization and improvement of urban environment is indispensable for the City as a tourism national center, though which the largest apprehension in local economy will be entirely released.

Under successful reconstruction of industrial structure from tin & plantation to tourism oriented industry, all of the citizens and

activities are closely related to the tourism either direct or indirect. In 1988, 726,172 tourists, 4.7 times of inhabitants, have been visited Phuket Province and the expenditure by foreign travelers reached up 5.72 billion Bahts corresponding to about 3 times of total productivity of Phuket City.

This development policy is in conformity with the national strategies, hence such local revenue contribute to share 1.26 % of the national total service receipt in Balance of Payment and will certainly be progressed far more extent. (Ref. Table 10.12 and 10.14)

Since the sewage treatment plant construction site is selected at an isolated area far from the residential and commercial districts of the city, the impact to environment by the treatment facilities will not be significant. Construction activities of the treatment plant may not affect to the nearby inhabitants.

Excavations for sewers and pumping stations throughout the project area will cause traffic interruption for some times, however, this problem can be avoided as much as possible by the well scheduled construction programs. The excavations may also cause soil erosion, but such erosion will be limited by minimizing excavation on steeply sloping the land and by requiring reasonable soil conservation measures by the contractors.

Despite of such inconveniences during the construction, more opportunities to work, recovery of amenity and prospective expansion of activity quotas are much more expected by the City.

Table 10.14 Revenue from Foreign Tourists, 1984 - 1988

(Unit: Millions of Baht)

Year:		1984	1985	1986	1987	1988	'84/'88 Compound annual growth rate (%)
Item	Description						
1.	Balance of Payment:						
a	Service receipts	73,643	85,880	87,665	107,187	149,089	19.3
2.	Revenu from foreign tourists:						
b	Whole Thailand	28,654	31,768	37,321	50,023	78,859	28.8
c	Phuket Province	1,348	1,295	2,057	2,865	5,728	43.6
d	Phuket City	445	566	733	1,024	1,880	43.4
3.	Distribution:						
a.	Service receipts	100.00 (257.0)	100.00 (270.3)	100.00 (234.9)	100.00 (214.3)	100.00 (189.1)	0.0
b.	Whole Thailand	38.91 (100.0)	36.99 (100.0)	42.57 (100.0)	46.67 (100.0)	52.89 (100.0)	8.0
c.	Phuket Province	1.83 (4.7)	1.51 (4.1)	2.35 (5.5)	2.67 (5.7)	3.84 (7.3)	20.4
d.	Phuket City	0.60 (1.6)	0.54 (1.5)	0.84 (2.0)	0.96 (2.1)	1.26 (2.4)	20.2

Source : Statistical Yearbook Thailand No. 35/36 1988/1989, National Statistics Office, The Office of Prime Minister
Annual Statsitical Report on Tourism in Thailand 1985 - 1988, Tourism Authority of The Thailand

10.4 Project Justification

(1) Sewerage Improvement Project

Thailand's economy is currently developing extensively. However, it is bringing about an environmental pollution in the developing districts, especially in the resort areas. Consequently, special emphasis has been placed on the environmental improvement in the National Economic and Social Development Plan and also Tourism Development plan of Thailand in line with the world wise tendencies.

Phuket Island is a famous resort in the south of Thailand. Being blessed with beautiful scenery, it is one of the most popular tourist spot and Phuket City is a center of the island as its provincial capital town. However, destruction of the City's environmental condition, the river and the sea water pollution, has caused by the wastewater discharged from the various economical activity like hotels and tourism industries as well as residents in the area. Delay of the execution of the water pollution control on the excessive discharging loads is over the natural purification capacity in the area.

In the background of such circumstance, conservation of the environmental condition is one of the most important and urgent tasks due consideration to the national policy that is not only for impress appealing the natural resources as a famous resort in the south of Thailand, but also for a public health and sanitation in the study area.

According to an estimation on the water quality of the Bang Yai river in 2006, the BOD value of the river is expected to be improved into one-half as much as the present, provided this project will be fully implemented. Suppose any other countermeasure will not be done the value is forecasted to be approximately 2.5 times as much as the present. In addition to this such offensive surroundings that wastewater is staying and rotter in the canals due to affect by the back flow of sea water, are considerably improved

When the project is carried out on schedule.

The results of analysis and study show that the Project is economically feasible and is financially viable, too, as above.

The socio-economic and environment studies is also found positive.

Hence, from economic, financial and socio-environmental viewpoints, the project is qualifiable for launching.

The observation of existing situation on environment and building boom and assumed tangible benefits apparently lead to a conclusion that the proposed sewerage development project is justifiable and then needed to introduce as much as earlier. If no sewerage system were provided in the area, sanitary conditions, which are already deplorable in some areas in the city, will become progressively worse and degraded in the tourism. Moreover, if this project is not undertaken at this time, the building boom will be in more heat in the area and so the cost escalation might hamper the project implementation at later stage.

It is desirable that the project start as earliest as possible as this project insures to create great benefit to Phuket island as well as the city in terms of improvement of the economy, society and living standards of the people in the areas. Likewise, the project is expected to expand the potentiality of the further development of related public facilities and private services industries as an international resort center in the southern Thailand.

(2) Drainage Improvement Project

In order to improve the drainage system in the study area, it should be developed paying due consideration to reflect the flood control, because the more rising of water in the river, the less capacity of the drainage. The flow capacity of the Bang Yai river is estimated at 20 to 70 m^3/sec depend on locations. Consequently, for measures against a heavy rain like a probable rainfall

more than two-year, the improvement plan of the drainage system should be on premise of the implementation of the flood control.

Aiming to design as a whole for effective use of the existing facility, the improvement of the drainage is planned to manage the probable rainfalls with five-year return period for main drains and canals, and two-year return period for lateral drains. Reconstruction works for improvement of the drains have been undertaking by the city's budget, which are almost the same way to the proposed improvement plans in this study.

Observing the existing situation of drainage system and assuming the frequent inundation in the city, the proposed drainage improvement plan is justifiable. Since it is insured that the improvement of the drainage system will be provide through local, special emphasis is given to the implementation of the flood control scheme as earlier as possible.

The magnitude of flood damage will increase remarkably and economic growth will be disturbed, suppose no flood control measure are implemented.

The economic internal rate of return (EIRR) of the flood control project for 30 year probable flood is the highest among the alternative schemes. Note is taken that the difference of the project costs between the scheme for 30 year probable flood and that for 5 year probable flood is only 8% out of the total. Therefore it is recommended to implement the project to control 30 year rains which is the target flood for the Master Plan.

ANNEX : TABLES

Table 4.1 Flow Calculation of Trunk Sewers

(1)

No of Sewers		Area		Length		Westewater Flow							Designed Sewer							Remarks
							Population			Others										
		Increment	Total	Increment	Total	Population Density	Increment	Total	Flow (Peak)	Increment	Total	Total Design Flow	Diameter	Slope	Velosity	Capasity(Full)	Ground Elevation	Invert Elevation	Earth Cover	
		ha	ha	m	m	P/ha	Persons	Persons	m^3/s	m^3/s	m^3/s	m^3/s	m/m	‰	m/s	m^3/s	M	M	m	
IN 1021	1023	31.47	31.47	5	5	47.00	1480	1480	0.024			0.024	⊙ 200	3.50	0.80	0.025	9.92 9.92	7.870 7.753	1.84 1.96	
IN 1022		1.02	1.02	5	5	33.30	34	34	0.001			0.001	⊙ 100	7.00	0.72	0.006	9.92 9.92	7.880 7.845	1.03 1.07	
1023	1024 B	0.00	32.49	30	35	0.00	0	1514	0.024			0.024	⊙ 200	3.50	0.80	0.025	9.92 9.92	4.014 4.025	5.40 5.68	
IN1024A		14.90	14.90	5	5	57.20	853	853	0.014			0.014	⊙ 150	5.00	0.79	0.014	9.92 9.92	6.500 6.483	3.25 3.28	
1024 B	1025	0.00	47.39	180	215	0.00	0	2366	0.038			0.038	⊙ 250	2.60	0.80	0.039	9.92 8.75	8.657 7.487	1.00 1.00	
1025		25.37	25.37	120	120	73.20	1858	1858	0.030			0.030	⊙ 250	2.60	0.80	0.039	9.80 8.75	7.700 7.388	1.84 1.10	
1026	1028	0.00	72.76	1740	1955	0.00	0	4223	0.068			0.068	⊙ 400	2.50	0.83	0.104	8.75 5.24	7.238 2.889	1.05 1.89	
IN 1027		42.78	42.78	5	5	54.40	2328	2328	0.037	0.011	0.011	0.048	⊙ 300	3.50	0.81	0.057	5.24 5.24	4.100 4.083	0.79 0.81	
1028	102	39.52	155.06	10	1965	33.30	1316	7866	0.126		0.011	0.137	⊙ 500	2.00	0.86	0.169	5.24 5.24	2.789 2.769	1.88 1.90	
IN 1015	101	2.77	2.77	5	5	33.30	93	93	0.001			0.001	⊙ 100	7.00	0.72	0.006	5.53 5.60	4.630 4.593	0.80 0.90	

No of Sewers		Area Increment (ha)	Area Total (ha)	Length Increment (m)	Length Total (m)	Westewater Flow: Population Density (P/ha)	Population Incre-ment (Pers-ons)	Population Total (Perso-ns)	Flow (Peak) (m³/s)	Others Increment (m³/s)	Others Total (m³/s)	Total Design Flow (m³/s)	Designed Sewer: Diameter (mm)	Slope (‰)	Velocity (m/s)	Caposity(Full) (m³/s)	Ground Elevation (M)	Invert Elevation (M)	Eerth Cover (m)	Remarks
IN 1016		189.13	189.13	5	5	33.30	6299	6299	0.101	0.004	0.004	0.105	⊙ 500	2.00	0.86	0.169	5.53 5.60	4.210 4.200	0.75 0.83	
101		0.00	191.90	20	25	0.00	0	6391	0.103		0.004	0.107	⊙ 300	0.00	1.51	0.107	5.60 5.24	0.650 0.650	4.60 4.24	
102	103	0.00	346.96	230	2195	0.00	0	14256	0.229		0.015	0.244	⊙ 600	1.90	0.95	0.268	5.24 4.55	2.532 2.096	2.03 1.78	
IN 1031	1033	13.09	13.09	5	5	33.30	436	436	0.007	0.001	0.001	0.008	⊙ 150	5.00	0.79	0.014	4.55 4.55	3.240 3.215	1.15 1.18	
IN 1032		4.89	4.89	5	5	33.30	163	163	0.003			0.003	⊙ 100	7.00	0.72	0.006	4.55 4.55	3.260 3.225	1.19 1.22	
1033	103	0.00	17.98	30	35	0.00	0	599	0.010		0.001	0.011	⊙ 150	5.00	0.79	0.014	4.55 4.55	2.113 1.963	2.28 2.43	
IN 1034		1.15	1.15	5	5	33.30	39	39	0.001			0.001	⊙ 100	7.00	0.72	0.006	4.55 4.55	3.840 3.805	0.61 0.64	
103	104	0.00	366.09	115	2310	0.00	0	14893	0.239		0.016	0.255	⊙ 600	1.90	0.95	0.268	4.55 4.40	1.863 1.645	2.01 2.08	
IN 1041		1.91	1.91	5	5	33.30	64	64	0.001			0.001	⊙ 100	7.00	0.72	0.006	4.40 4.40	3.660 3.625	0.64 0.67	
104	105	0.00	368.00	25	2335	0.00	0	14957	0.240		0.016	0.256	⊙ 600	1.90	0.95	0.268	4.40 4.40	1.645 1.597	2.08 2.13	
IN 1051		2.14	2.14	5	5	33.30	72	72	0.001			0.001	⊙ 100	7.00	0.72	0.006	4.40 4.40	3.660 3.625	0.64 0.67	

No of Sewers		Area		Length		Westewater Flow							Designed Sewer							Remarks
							Population			Others										
		Increment	Total	Increment	Total	Population Density	Increment	Total	Flow (Peak)	Increment	Total	Total Design Flow	Diameter	Slope	Velosity	Capasity(Full)	Ground Elevation	Inveri Elevation	Earth Cover	
		ha	ha	m	m	P/ha	Persons	Persons	m^3/s	m^3/s	m^3/s	m^3/s	mm	‰	m/s	m^3/s	M	M	m	
105	106	0.00	370.14	105	2440	0.00	0	15028	0.242		0.016	0.258	⊙ 600	1.90	0.95	0.268	4.40 4.26	1.597 1.397	2.13 2.19	
IN 1061	1063	5.76	5.76	5	5	33.30	192	192	0.003	0.002	0.002	0.005	⊙ 100	7.00	0.72	0.006	4.26 4.26	3.210 3.175	0.95 0.98	
IN 1062		3.34	3.34	5	5	33.30	112	112	0.002			0.002	⊙ 100	7.00	0.72	0.006	4.26 4.26	3.010 2.975	1.15 1.18	
1063		0.00	9.10	25	30	0.00	0	304	0.005		0.002	0.007	⊙ 150	5.00	0.79	0.014	4.26 4.26	1.490 1.365	2.61 2.74	
106	107	0.00	379.24	170	2610	0.00	0	15331	0.246		0.018	0.264	⊙ 600	1.50	0.95	0.268	4.26 3.96	1.265 0.941	2.32 2.34	
IN 1074	1076	1.45	1.45	5	5	33.30	49	49	0.001	0.002	0.002	0.003	⊙ 100	7.00	0.72	0.006	4.81 4.81	2.930 2.895	1.77 1.81	
IN 1075		1.34	1.34	5	5	184.20	247	247	0.004			0.004	⊙ 100	7.00	0.72	0.006	4.81 4.81	2.940 2.905	1.76 1.80	
1076	107	0.00	2.79	180	185	0.00	0	296	0.005		0.002	0.007	⊙ 150	5.00	0.79	0.014	4.81 3.96	2.845 1.945	1.81 1.86	
IN 1071	1073	19.22	19.22	5	5	33.30	641	641	0.010	0.012	0.012	0.022	⊙ 200	3.50	0.80	0.025	3.96 3.96	2.120 2.103	1.63 1.65	
IN 1072		5.25	5.25	5	5	184.20	968	968	0.016			0.016	⊙ 200	3.50	0.80	0.025	3.96 3.96	2.660 2.643	1.09 1.11	

No of Sewers		Area		Length		Westewater Flow							Designed Sewer							Remarks
							Population			Others										
		Increment	Total	Increment	Total	Population Density	Increment	Total	Flow (Peak)	Increment	Total	Total Design Flow	Diameter	Slope	Velosity	Caposity(Full)	Ground Elevation	Invert Elevation	Earth Cover	
		ha	ha	m	m	P/ha	Persons	Persons	m³/s	m³/s	m³/s	m³/s	mm	‰	m/s	m³/s	M	M	m	
1073		0.00	24.47	25	30	0.00	0	1608	0.026		0.012	0.038	⊙ 250	2.60	0.80	0.039	399.6 396	0932 0867	277 283	
107	108	0.00	406.50	450	3060	0.00	0	17234	0.277		0.032	0.309	⊙ 800	1.50	1.02	0.512	396 393	0767 0092	230 204	
IN 1081		5.71	5.71	5	5	184.20	1052	1052	.017			0.017	⊙ 200	3.50	0.80	0.025	393 393	1780 1763	104 106	
108	109	0.00	412.21	15	3075	0.00	0	18285	0.294		0.032	0.326	⊙ 800	1.50	1.02	0.512	393 393	-0667 -0589	280 282	
IN 1091		7.74	7.74	5	5	184.20	1426	1426	.023			0.023	⊙ 200	3.50	0.80	0.025	393 393	0950 0930	187 189	
109	110	0.00	419.95	15	3090	0.00	0	19711	0.317		0.032	0.349	⊙ 800	1.50	1.02	0.512	393 390	-0689 -0712	282 272	
IN 1101		1.19	1.19	5	5	184.20	220	220	.004			0.004	⊙ 100	7.00	0.72	0.006	390 390	1890 1855	091 094	
110	111	0.00	421.14	45	3135	0.00	0	19930	0.320		0.032	0.352	⊙ 800	1.50	1.02	0.512	390 264	-0712 -0780	272 253	
IN 1112	1114	19.49	19.49	5	5	33.30	650	650	.010			0.010	⊙ 150	5.00	0.79	0.014	478 478	3623 3598	100 103	
IN 1113		0.94	0.94	5	5	184.20	174	174	.003			0.003	⊙ 100	7.00	0.72	0.006	478 478	3045 3045	163 163	
1114	1117 B	0.00	20.43	255	260	0.00	0	823	0.013			0.013	⊙ 150	5.00	0.79	0.014	478 330	2995 1617	163 153	

No of Sewers		Area Increment (ha)	Area Total (ha)	Length Increment (m)	Length Total (m)	Population Density (P/ha)	Population Increment (Persons)	Population Total (Persons)	Flow (Peak) (m³/s)	Others Increment (m³/s)	Others Total (m³/s)	Total Design Flow (m³/s)	Diameter (mm)	Slope (‰)	Velocity (m/s)	Capasity (Full) (m³/s)	Ground Elevation (M)	Invert Elevation (M)	Eerth Cover (m)	Remarks
IN 1115	1117 A	3.11	3.11	5	5	184.20	573	573	0.009			0.009	⊙ 150	5.00	0.79	0.014	3.25 3.25	2.750 2.725	0.34 0.37	
IN 1116		0.41	0.41	5	5	184.20	76	76	0.001			0.001	⊙ 100	7.00	0.72	0.006	3.25 3.25	2.750 2.715	0.40 0.43	
1117 A		0.00	3.52	50	55	0.00	0	649	0.010			0.010	⊙ 150	5.00	0.79	0.014	3.25 3.30	2.093 1.843	1.00 1.30	
1117 B	1119 C	0.00	23.95	180	440	0.00	0	1471	0.024			0.024	⊙ 200	3.50	0.80	0.025	3.30 2.64	1.567 0.937	1.52 1.49	
IN 1118	1119 B	1.54	1.54	5	5	184.20	284	284	0.005	0.003	0.003	0.008	⊙ 150	5.00	0.79	0.014	3.93 3.93	2.100 2.075	1.67 1.70	
IN11 19A		2.38	2.38	5	5	184.20	439	439	0.007			0.007	⊙ 150	5.00	0.79	0.014	3.93 3.93	1.780 1.755	1.99 2.02	
1119 B		0.00	3.92	100	105	0.00	0	723	0.012		0.003	0.015	⊙ 200	3.50	0.80	0.025	3.93 2.64	1.705 1.355	2.02 1.08	
1119 C	1119 I	0.00	27.87	165	605	0.00	0	2193	0.035		0.003	0.038	⊙ 250	2.60	0.80	0.039	2.64 2.64	0.887 0.459	1.49 1.92	
1119 D	1119 H	0.88	0.88	135	135	184.20	163	163	0.003	0.005	0.005	0.008	⊙ 150	5.00	0.79	0.014	3.16 2.77	1.530 0.855	1.47 1.76	
IN11 19E	1119 G	0.82	0.82	5	5	184.20	152	152	0.002			0.002	⊙ 100	7.00	0.72	0.006	2.70 2.70	2.150 2.115	0.44 0.48	

No of Sewers		Area: Increment (ha)	Area: Total (ha)	Length: Increment (m)	Length: Total (m)	Wastewater Flow: Population Density (P/ha)	Population: Increment (Persons)	Population: Total (Persons)	Flow (Peak) (m³/s)	Others: Increment (m³/s)	Others: Total (m³/s)	Total Design Flow (m³/s)	Designed Sewer: Diameter (mm)	Slope (‰)	Velocity (m/s)	Capacity (Full) (m³/s)	Ground Elevation (M)	Invert Elevation (M)	Earth Cover (m)	Remarks
IN11 19F		18.09	18.09	5	5	184.20	3333	3333	.054			0.054	⊙ 300	3.50	0.81	0.057	2.70 / 2.70	0.960 / 0.943	1.39 / 1.41	
1119 G		0.00	18.91	125	130	0.00	0	3484	0.056			0.056	⊙ 300	3.50	0.81	0.057	2.70 / 2.77	0.943 / 0.505	1.41 / 1.91	
1119 H		0.00	19.79	145	280	0.00	0	3646	0.059		0.005	0.064	⊙ 400	2.50	0.83	0.104	2.77 / 2.64	0.405 / 0.043	1.90 / 2.14	
1119 I	1119 R	0.00	47.66	50	655	0.00	0	5838	0.094		0.008	0.102	⊙ 400	2.50	0.83	0.104	2.64 / 2.64	0.043 / -0.082	2.14 / 2.26	
1119 J	1119 N	1.50	1.50	70	70	184.20	277	277	.004			0.004	⊙ 100	8.00	0.76	0.006	3.06 / 2.50	1.550 / 0.990	1.40 / 1.40	
IN11 19K	1119 M	1.30	1.30	5	5	184.20	240	240	.004			0.004	⊙ 100	7.00	0.72	0.006	3.16 / 3.16	1.110 / 1.075	1.95 / 1.98	
IN11 19L		1.59	1.59	5	5	184.20	293	293	.005			0.005	⊙ 100	7.00	0.72	0.006	3.16 / 3.16	1.310 / 1.275	1.75 / 1.78	
1119 M		0.00	2.89	20	25	0.00	0	533	0.009			0.009	⊙ 150	5.00	0.79	0.014	3.16 / 2.50	1.025 / 0.925	1.98 / 1.42	
1119 N	1119 P	0.00	4.39	320	390	0.00	0	809	0.013			0.013	⊙ 150	5.00	0.79	0.014	2.50 / 2.64	0.925 / -0.674	1.42 / 3.16	
IN11 190		1.02	1.02	5	5	184.20	188	188	.003			0.003	⊙ 100	20.00	1.21	0.009	2.74 / 2.64	1.635 / 1.535	1.00 / 1.00	
1119 P	1119 R	0.00	5.41	15	405	0.00	0	997	0.016			0.016	⊙ 200	3.50	0.80	0.025	2.64 / 2.64	-0.724 / -0.776	3.15 / 3.21	

No of Sewers		Area: Increment (ha)	Area: Total (ha)	Length: Increment (m)	Length: Total (m)	Wastewater Flow: Population Density (P/ha)	Population: Increment (Persons)	Population: Total (Persons)	Flow (Peak) (m³/s)	Others: Increment (m³/s)	Others: Total (m³/s)	Total Design Flow (m³/s)	Designed Sewer: Diameter (mm)	Slope (‰)	Velocity (m/s)	Capasity (Full) (m³/s)	Ground Elevation (M)	Invert Elevation (M)	Eerth Cover (m)	Remarks
IN11 19Q		3.02	3.02	5	5	184.20	557	557	.009			0.009	⊙ 150	5.00	0.79	0.014	2.64 / 2.64	1.483 / 1.458	1.00 / 1.03	
1119 R	(111)	0.00	56.09	90	745	0.00	0	7391	0.119		0.008	0.127	⊙ 250		2.59	0.127	2.64 / 2.64	2.280 / 1.385	0.10 / 1.00	
IN 1111		1.01	1.01	5	5	184.20	187	187	.003			0.003	⊙ 100	7.00	0.72	0.006	2.64 / 2.64	0.950 / 0.915	1.59 / 1.62	
(111)	(112)	0.00	478.24	150	3285	0.00	0	27507	0.442		0.040	0.482	⊙ 800	1.50	1.02	0.512	2.64 / 2.74	-0.780 / -1.005	2.53 / 2.85	
IN 1121	1123	3.32	3.32	5	5	184.20	612	612	.010	0.011	0.011	0.021	⊙ 200	3.50	0.80	0.025	2.74 / 2.74	0.950 / 0.933	1.58 / 1.60	
IN 1122		1.18	1.18	5	5	184.20	218	218	.004			0.004	⊙ 100	7.00	0.72	0.006	2.74 / 2.74	1.370 / 1.335	1.27 / 1.30	
1123		0.00	4.50	25	30	0.00	0	829	0.013		0.011	0.024	⊙ 200	3.50	0.80	0.025	2.74 / 2.74	0.933 / 0.846	1.60 / 1.68	
(112)	(113)	0.00	482.74	120	3405	0.00	0	28336	0.456		0.051	0.507	⊙ 800	1.50	1.02	0.512	2.74 / 2.36	-1.005 / -1.185	2.85 / 2.65	
1131		0.35	0.35	20	20	184.20	65	65	.001			0.001	⊙ 100	10.00	0.85	0.007	2.56 / 2.36	1.500 / 1.300	0.95 / 0.95	
(113)	(114)	0.00	483.09	270	3675	0.00	0	28400	0.457		0.051	0.508	⊙ 800	1.50	1.02	0.512	2.35 / 2.02	-1.185 / -1.590	2.65 / 2.72	

No of Sewers		Area Increment (ha)	Area Total (ha)	Length Increment (m)	Length Total (m)	Westewater Flow: Population Density (P/ha)	Population Incre-ment (Pers-ons)	Population Total (Perso-ns)	Flow (Peak) (m³/s)	Others Increment (m³/s)	Others Total (m³/s)	Total Design Flow (m³/s)	Designed Sewer: Diameter (mm)	Slope (‰)	Velosity (m/s)	Capasity (Full) (m³/s)	Ground Elevation (M)	Invert Elevation (M)	Eerth Cover (m)	Remarks
1142	(114)	0.16	0.16	50	50	184.20	30	30	.001			0.001	⊙ 100	7.00	0.72	0.006	1.71 2.02	0.990 0.640	0.62 1.27	
IN 1141		1.71	1.71	5	5	184.20	315	315	.005	0.021	0.021	0.026	⊙ 250	2.60	0.80	0.039	1.71 2.02	0.950 0.937	0.50 0.82	
(114)	(115)	0.00	484.96	65	3740	0.00	0	28745	0.462		0.072	0.534	⊙ 1000	1.30	1.10	0.864	2.02 1.70	-1.790 -1.874	2.70 2.46	
1151	1153	3.83	3.83	15	15	184.20	706	706	.011	0.001	0.001	0.012	⊙ 150	5.00	0.79	0.014	2.22 2.22	1.140 1.065	0.92 1.00	
IN 1152		3.15	3.15	5	5	184.20	581	581	.009			0.009	⊙ 150	5.00	0.79	0.014	2.22 2.22	1.070 1.045	0.99 1.02	
1153	1159 F	0.00	6.98	430	445	0.00	0	1286	0.021		0.001	0.022	⊙ 200	3.50	0.80	0.025	2.22 2.19	0.995 -0.510	1.02 2.49	
IN 1154	1156	0.34	0.34	5	5	184.20	63	63	.001			0.001	⊙ 100	7.00	0.72	0.006	1.79 1.79	0.990 0.955	0.69 0.73	
IN 1155		1.10	1.10	5	5	184.20	203	203	.003	0.008	0.008	0.011	⊙ 150	5.00	0.79	0.014	1.79 1.79	0.990 0.955	0.64 0.68	
1156	1159 B	3.53	4.97	130	135	184.20	650	916	.015		0.008	0.023	⊙ 200	3.50	0.80	0.025	1.79 1.88	0.580 0.124	1.00 1.55	
IN 1157	1159 A	0.28	0.28	5	5	184.20	52	52	.001			0.001	⊙ 100	7.00	0.72	0.006	1.88 1.88	1.000 0.965	0.77 0.81	

No of Sewers		Area: Increment	Area: Total	Length: Increment	Length: Total	Westewater Flow: Population Density	Population: Incre-ment	Population: Total	Flow (Peak)	Others: Increment	Others: Total	Total Design Flow	Designed Sewer: Diameter	Slope	Velosity	Caposity (Full)	Ground Elevation	Invert Elevation	Eerth Cover	Remarks
		ha	ha	m	m	P/ha	Pers-ons	Perso-ns	m³/s	m³/s	m³/s	m³/s	mm	‰	m/s	m³/s	M	M	m	
IN 1158		0.89	0.89	5	5	184.20	164	164	.003			0.003	⊙ 100	7.00	0.72	0.006	1.88 1.88	1.000 0.965	0.77 0.81	
1159 A		0.00	1.17	15	20	0.00	0	216	0.003			0.003	⊙ 100	7.00	0.72	0.006	1.88 1.88	0.775 0.670	1.00 1.10	
1159 B	1159 E	0.19	6.33	15	150	184.20	35	1166	.019		0.008	0.027	⊙ 250	2.60	0.80	0.039	1.88 1.88	0.074 0.035	1.54 1.58	
IN11 59C	1159 E	1.54	1.54	5	5	184.20	284	284	.005			0.005	⊙ 100	7.00	0.72	0.006	1.88 1.88	0.990 0.955	0.78 0.82	
IN11 59D		0.82	0.82	5	5	184.20	152	152	.002			0.002	⊙ 100	7.00	0.72	0.006	1.88 1.88	1.000 0.965	0.77 0.81	
1159 E		0.00	8.69	100	250	0.00	0	1601	0.026		0.008	0.034	⊙ 250	2.60	0.80	0.039	1.88 2.19	0.035 -0.225	1.58 2.15	
1159 F	1159 L	0.00	15.67	25	470	0.00	0	2887	0.046	0.001	0.010	0.056	⊙ 300	3.50	0.81	0.057	2.19 1.95	-0.610 -0.698	2.45 2.30	
IN11 59G	1159 J	24.53	24.53	5	5	184.20	4519	4519	.073	0.003	0.003	0.076	⊙ 400	2.50	0.83	0.104	1.94 1.94	0.980 0.968	0.50 0.51	
IN11 59H		6.00	6.00	5	5	184.20	1106	1106	.018			0.018	⊙ 200	3.50	0.80	0.025	1.94 1.94	0.990 0.973	0.74 0.76	
1159 I	1159 K	1.12	31.65	105	110	184.20	206	5830	.094		0.003	0.097	⊙ 400	2.50	0.83	0.104	1.94 2.19	0.480 0.218	1.00 1.51	

No of Sewers		Area		Length		Westewater Flow						Designed Sewer							Remarks
		Increment	Total	Increment	Total	Population Density	Population Increment	Population Total	Flow (Peak)	Others Increment	Others Total	Total Design Flow	Diameter	Slope	Velosity	Capasity(Full)	Ground Elevation	Invert Elevation	Eerth Cover	
		ha	ha	m	m	P/ha	Persons	Persons	m³/s	m³/s	m³/s	m³/s	mm	‰	m/s	m³/s	M	M	m	
1159 J		0.31	0.31	45	45	184.20	58	58	.001			0.001	⊙ 100	7.00	0.72	0.006	196.1 195.9	0.505 0.190	1.00 1.90	
1159 K		0.00	31.96	75	185	0.00	0	5888	0.095		0.003	0.098	⊙ 400	2.50	0.83	0.104	195.9 195.5	-0.110 -0.297	1.84 1.79	
1159 L	1159 N	0.00	47.63	20	490	0.00	0	8774	0.141		0.013	0.154	⊙ 500	2.00	0.86	0.169	195.5 195.5	-0.898 -0.938	2.28 2.32	
IN11 59M		0.23	0.23	5	5	184.20	43	43	.001			0.001	⊙ 100	7.00	0.72	0.006	195.5 195.5	1.000 0.965	0.85 0.88	
1159 N	1159 P	0.00	47.86	20	510	0.00	0	8816	0.142		0.013	0.155	⊙ 500	2.00	0.86	0.169	195.5 195.5	-0.938 -0.978	2.32 2.36	
IN11 59O		1.27	1.27	5	5	184.20	234	234	.004			0.004	⊙ 100	7.00	0.72	0.006	195.5 195.5	1.110 1.075	0.74 0.77	
1159 P	1159 R	0.00	49.13	35	545	0.00	0	9050	0.145		0.013	0.158	⊙ 500	2.00	0.86	0.169	195.5 195.5	-1.084 -1.154	2.46 2.53	
IN11 59Q		2.37	2.37	5	5	184.20	437	437	.007			0.007	⊙ 150	5.00	0.79	0.014	195.5 195.5	1.170 1.145	0.62 0.65	
1159 R	(115)	0.00	51.50	25	570	0.00	0	9487	0.153		0.013	0.166	⊙ 500	2.00	0.86	0.169	195.5 170.0	-1.154 -1.204	2.53 2.33	
IN11 59S		2.80	2.80	5	5	184.20	516	516	.008	0.013	0.013	0.021	⊙ 200	3.50	0.80	0.025	170.0 170.0	0.970 0.953	0.52 0.54	
(115)	(116)	0.00	539.26	265	4005	0.00	0	38747	0.623		0.098	0.721	⊙ 1000	1.30	1.10	0.864	170.0 22.7	-1.874 -2.219	2.46 3.38	

No of Sewers		Area: Increment (ha)	Area: Total (ha)	Length: Increment (m)	Length: Total (m)	Westewater Flow: Population Density (P/ha)	Population: Incre-ment (Persons)	Population: Total (Persons)	Flow (Peak) (m³/s)	Others: Increment (m³/s)	Others: Total (m³/s)	Total Design Flow (m³/s)	Designed Sewer: Diameter (mm)	Slope (‰)	Velocity (m/s)	Capasity (Full) (m³/s)	Ground Elevation (M)	Invert Elevation (M)	Eerth Cover (m)	Remarks
IN 1161		3.42	3.42	5	5	184.20	630	630	.010			0.010	⊙ 150	5.00	0.79	0.014	2.27 / 2.27	1.020 / 0.985	1.09 / 1.13	
116	117	0.00	542.68	160	4165	0.00	0	39377	0.633		0.098	0.731	⊙ 1000	1.30	1.10	0.864	2.27 / 2.81	-2.219 / -2.427	3.38 / 4.13	
IN 1171	1173	0.96	0.96	5	5	184.20	177	177	.003			0.003	⊙ 100	7.00	0.72	0.006	2.90 / 2.90	2.400 / 2.365	0.40 / 0.43	
IN 1172		0.43	0.43	5	5	184.20	80	80	.001			0.001	⊙ 100	7.00	0.72	0.006	2.90 / 2.90	2.400 / 2.365	0.40 / 0.43	
1173	117	0.00	1.39	115	120	0.00	0	257	0.004			0.004	⊙ 100	7.00	0.72	0.006	2.90 / 2.81	1.795 / 0.990	1.00 / 1.71	
IN 1174		1.61	1.61	5	5	184.20	297	297	.005			0.005	⊙ 100	7.00	0.72	0.006	2.81 / 2.81	1.000 / 0.965	1.70 / 1.74	
117		0.00	545.68	80	4245	0.00	0	39929	0.642		0.098	0.740	⊙ 1000	1.30	1.10	0.864	2.81 / 2.82	-2.427 / -2.927	4.13 / 4.64	
118	119	1.39	547.07	270	4515	184.20	257	40186	.646		0.098	0.744	⊙ 1000	1.30	1.10	0.864	2.82 / 1.84	-2.927 / -3.278	4.64 / 4.01	
IN 207		452.04	452.04	5	5	41.00	18534	18534	.298	0.015	0.015	0.313	⊙ 800	1.50	1.02	0.512	1.84 / 1.84	-3.056 / -3.063	4.00 / 4.01	
119		0.46	999.57	60	4575	82.60	38	58757	0.945	0.002	0.115	1.060	⊙ 1200	1.10	1.14	1.293	1.84 / 1.74	-3.478 / -3.544	3.99 / 3.96	
120		1.35	1000.92	55	4630	151.90	205	58962	.948		0.115	1.063	⊙ 1200	1.10	1.14	1.293	1.74 / 1.64	-3.544 / -3.604	3.96 / 3.92	
121		1.25	1002.17	55	4685	149.60	187	59149	.951		0.115	1.066	⊙ 1200	1.10	1.14	1.293	1.64 / 1.51	-3.604 / -3.665	3.92 / 3.85	

No of Sewers		Area		Length		Westewater Flow							Designed Sewer							Remarks
							Population			Others										
		Increment	Total	Increment	Total	Population Density	Increment	Total	Flow (Peak)	Increment	Total	Total Design Flow	Diameter	Slope	Velosity	Capasity(Full)	Ground Elevation	Invert Elevation	Earth Cover	
		ha	ha	m	m	P/ha	Persons	Persons	m³/s	m³/s	m³/s	m³/s	mm	‰	m/s	m³/s	M	M	m	
122	123	1.67	100.84	130	48.15	141.90	237	5938	.955			0.115	1.070	⊙ 1200	1.10	1.14	1.293	151 278	-36.65 -38.08	38.5 52.0	
IN 3051	3053	1.87	1.87	5	5	184.20	345	345	.006	0.003	0.003	0.009	⊙ 150	5.00	0.79	0.014	270 270	21.00 20.75	0.44 0.47	
IN 3052		3.51	3.51	5	5	184.20	647	647	.010	0.005	0.005	0.015	⊙ 200	3.50	0.80	0.025	270 270	15.65 15.18	0.92 0.94	
3053	3055	0.00	5.38	390	395	0.00	0	991	0.016			0.008	0.024	⊙ 200	3.50	0.80	0.025	270 249	14.90 0.125	1.00 2.16	
3054		10.42	10.42	100	100	184.20	1920	1920	.031	0.021	0.021	0.052	⊙ 300	3.50	0.81	0.057	236 249	1.0.10 0.650	1.00 1.48	
3055	305	0.00	15.80	120	515	0.00	0	2911	0.047			0.029	0.076	⊙ 400	2.50	0.83	0.104	249 245	-0.075 -0.375	2.11 2.37	
IN 3041	3043	1.35	1.35	5	5	184.20	249	249	.004			0.004	⊙ 100	7.00	0.72	0.006	200 200	1.0.00 0.965	0.90 0.93	
IN 3042		23.90	23.90	5	5	30.60	732	732	0.012			0.012	⊙ 150	5.00	0.79	0.014	200 200	11.30 11.05	0.71 0.74	
3043	304	0.30	25.55	80	85	184.20	55	1036	.017			0.017	⊙ 200	3.50	0.80	0.025	200 224	0.790 0.510	1.00 1.52	
3044	304	0.26	0.26	75	75	184.20	48	48	.001			0.001	⊙ 100	7.00	0.72	0.006	224 224	11.35 0.609	1.00 1.53	

No of Sewers		Area		Length		Westewater Flow							Designed Sewer							Remarks
							Population			Others										
		Increment	Total	Increment	Total	Population Density	Increment	Total	Flow (Peak)	Increment	Total	Total Design Flow	Diameter	Slope	Velosity	Caposity (Full)	Ground Elevation	Invert Elevation	Earth Cover	
		ha	ha	m	m	P/ha	Persons	Persons	m³/s	m³/s	m³/s	m³/s	mm	‰	m/s	m³/s	M	M	m	
IN 303		2.5830	2.5830	5	5	16.60	4288	4288	0.069	0.011	0.011	0.080	⊙ 400	2.50	0.83	0.104	1.87 1.87	-1.408 -1.420	2.82 2.83	
304		0.000	2.8411	135	220	0.00	0	5371	0.086		0.011	0.097	⊙ 400	2.50	0.83	0.104	1.87 2.45	-1.420 -1.758	2.83 3.75	
305		0.000	2.9991	60	575	0.00	0	8282	0.133		0.040	0.173	⊙ 300		2.45	0.173	2.45 2.40	-1.40 -1.090	1.00 1.00	
306	307	0.000	2.9991	525	1100	0.00	0	8282	0.133		0.040	0.173	⊙ 600	1.90	0.95	0.268	2.40 2.72	-0.725 -0.273	1.00 2.82	
IN 3071	307	1.883	1.883	5	5	184.20	3469	3469	1.056	0.016	0.016	0.072	⊙ 400	2.50	0.83	0.104	2.72 2.72	-0.950 -0.938	1.31 1.32	
IN 3072		1.066	1.066	5	5	133.10	1419	1419	1.023			0.023	⊙ 200	3.50	0.80	0.025	2.72 2.72	-1.000 -0.983	1.51 1.53	
307	308	0.000	3.2940	50	1150	0.00	0	13169	0.212		0.056	0.268	⊙ 600 ⊙ 500 ⊙ 600	1.90 0.00 1.90	0.95 1.35 0.95	0.268 0.268 0.268	2.72 2.52	-0.273 -0.523	2.42 2.47	
IN 3081		1.366	1.366	5	5	153.30	2095	2095	1.034			0.034	⊙ 250	2.60	0.80	0.039	2.52 2.52	-0.970 -0.957	1.29 1.30	
308	309	0.000	3.4306	475	1625	0.00	0	15263	0.245		0.056	0.301	⊙ 800	1.50	1.02	0.512	2.52 3.20	-0.823 -1.535	2.45 3.84	
IN 3091	3093	1.097	1.097	5	5	184.20	2021	2021	1.032	0.010	0.010	0.042	⊙ 300	3.50	0.81	0.057	2.87 2.87	-1.320 -1.303	1.20 1.22	

No of Sewers		Area		Length		Westewater Flow						Designed Sewer							Remarks
							Population			Others									
		Increment	Total	Increment	Total	Population Density	Increment	Total	Flow (Peak)	Increment	Total	Total Design Flow	Diameter	Slope	Velosity	Capasity (Full)	Ground Elevation	Invert Elevation	Earth Cover	
		ha	ha	m	m	p/ha	Persons	Persons	m^3/s	m^3/s	m^3/s	m^3/s	mm	‰	m/s	m^3/s	M	M	m	
IN 3092		3.00	3.00	5	5	184.20	55	55	3.009			0.009	⊙ 150	5.00	0.79	0.014	28.7 28.7	14.00 13.75	13.1 13.4	
3093		0.00	13.97	525	530	0.00	0	2574	0.041			0.010	0.051	⊙ 300	3.50	0.81	0.057	28.7 32.0	12.25 -0.513	12.9 32.6	
309	310	0.00	35.703	245	1870	0.00	0	17836	0.287			0.066	0.353	⊙ 800	1.50	1.02	0.512	32.0 26.8	-1.535 -1.303	33.4 33.9	
IN 3101	3103	0.73	0.73	5	5	184.20	135	135	1.002			0.002	⊙ 100	7.00	0.72	0.006	25.6 25.6	14.30 13.95	10.2 10.6	
IN 3102		0.81	0.81	5	5	184.20	150	150	1.002			0.002	⊙ 100	7.00	0.72	0.006	25.6 25.6	15.30 14.95	09.2 09.6	
3103	3105	0.00	1.54	165	170	0.00	0	284	0.005			0.005	⊙ 100	7.00	0.72	0.006	25.6 21.5	13.95 02.40	11.06 18.1	
3104		0.57	0.57	25	25	184.20	105	105	1.002			0.002	⊙ 100	7.00	0.72	0.006	30.6 21.5	15.50 13.75	14.0 06.7	
3105	3107	0.00	2.11	20	190	0.00	0	389	0.006			0.006	⊙ 100	7.00	0.72	0.006	21.5 21.5	02.40 01.00	18.1 19.5	
IN 3106		5.81	5.81	5	5	184.20	1071	1071	1.017	0.016	0.016	0.033	⊙ 250	2.60	0.80	0.039	21.5 21.5	09.50 09.37	09.4 09.5	
3107	3109 A	0.00	7.92	30	220	0.00	0	1459	0.023			0.016	0.039	⊙ 250	2.60	0.80	0.039	21.5 21.5	-0.050 -0.128	19.4 20.2	
IN 3108		1.37	1.37	5	5	184.20	253	253	1.004	0.013	0.013	0.017	⊙ 200	3.50	0.80	0.025	21.5 21.5	09.50 09.33	09.9 10.1	

No of Sewers		Area		Length		Westewater Flow						Designed Sewer							Remarks
		Increment	Total	Increment	Total	Population Density	Population		Flow (Peak)	Others		Total Design Flow	Diameter	Slope	Velosity	Capasity(Full)	Ground Elevation	Invert Elevation	Earth Cover	
							Increment	Total		Increment	Total									
		ha	ha	m	m	P/ha	Persons	Persons	m³/S	m³/S	m³/S	m³/S	mm	‰	m/S	m³/S	M	M	m	
3109 A	3109 C	0.00	9.29	300	520	0.00	0	1712	0.028		0.029	0.057	⊙ 300	3.50	0.81	0.057	2.15 2.50	-0.178 -1.228	1.98 3.38	
3109 B		2.21	2.21	235	235	184.20	408	408	.007	0.018	0.018	0.025	⊙ 200	3.50	0.80	0.025	2.33 2.50	1.030 0.207	1.09 2.08	
3109 C	3109 F	0.00	11.50	45	565	0.00	0	2119	0.034		0.047	0.081	⊙ 400	2.50	0.83	0.104	2.50 2.50	-1.328 -1.440	3.37 3.48	
IN31 09D	3109 F	4.66	4.66	5	5	184.20	859	859	.014			0.014	⊙ 150	5.00	0.79	0.014	2.50 2.50	0.925 0.950	1.42 1.39	
IN31 09E		9.06	9.06	5	5	184.20	1669	1669	.027	0.001	0.001	0.028	⊙ 250	2.60	0.80	0.039	2.50 2.50	0.980 0.967	1.26 1.27	
3109 F	3109 H	0.00	25.22	20	585	0.00	0	4646	0.075		0.048	0.123	⊙ 500	2.00	0.86	0.169	2.50 2.50	-1.540 -1.580	3.47 3.51	
IN31 09G		9.83	9.83	5	5	184.20	1811	1811	.029	0.002	0.002	0.031	⊙ 250	2.60	0.80	0.039	2.50 2.50	0.950 0.937	1.29 1.30	
3109 H		0.00	35.05	405	990	0.00	0	6457	0.104		0.050	0.154	⊙ 500	2.00	0.86	0.169	2.50 2.68	-1.580 -2.390	3.51 4.50	
310	311	0.00	392.08	335	2205	0.00	0	24293	0.391		0.116	0.507	⊙ 800	1.50	1.02	0.512	2.68 2.25	-2.690 -3.193	1.48 4.55	
IN 3111	311	4.66	4.66	5	5	184.20	859	859	.014			0.014	⊙ 150	5.00	0.79	0.014	2.25 2.25	1.000 0.975	1.09 1.12	

No of Sewers		Area		Length		Westewater Flow							Designed Sewer							Remarks
		Increment	Total	Increment	Total	Population Density	Population		Flow (Peak)	Others		Total Design Flow	Diameter	Slope	Velosity	Caposity (Full)	Ground Elevation	Invert Elevation	Eerth Cover	
							Incre-ment	Total		Increment	Total									
		ha	ha	m	m	P/ha	Pers-ons	Perso-ns	m³/s	m³/s	m³/s	m³/s	mm	‰	m/s	m³/s	M	M	m	
IN 3112		8.38	8.38	5	5	95.20	798	798	0.013	0.006	0.006	0.019	⊙ 200	3.50	0.80	0.025	2.25 2.25	0.970 0.953	1.07 1.09	
(311)		0.00	405.12	85	2290	0.00	0	25949	0.417		0.122	0.539	⊙ 1000	1.30	1.10	0.864	2.25 2.20	-3.393 -3.503	4.53 4.59	
(312)		0.00	405.12	40	2330	0.00	0	25949	0.417		0.122	0.539	⊙ 1000	1.30	1.10	0.864	2.20 2.78	-3.594 -3.647	4.58 5.32	
(123)	(124)	2.20	1411.16	210	5025	108.20	233	85573	1.376		0.237	1.613	⊙ 1500	0.90	1.20	2.121	2.78 2.50	-4.147 -4.336	5.28 5.19	
IN 1241		44.84	44.84	5	5	29.60	1328	1328	0.021			0.021	⊙ 200	3.50	0.80	0.025	2.50 2.50	1.290 1.272	1.00 1.02	
(124)	T.PL ANT	0.00	1456.00	1120	6145	0.00	0	86900	1.397		0.237	1.634	⊙ x2 800		1.63	1.634	2.50 2.00	0.690 0.190	1.00 1.00	

Table 4.2 Calculation of Capacity for Sewage treatment Facility

I Pumping Station (PS-1)

Calculation of Capacity

	Most Urgent Plan	F/S Plan	Master Plan
1. Design Wastewater Flow			
(1) Design Mean Dry Weather Flow per Day Wastewater Ground water	15,800m^3/d x 0.8 = 12,640 m^3/d 15,800m^3/d x 0.2 = 3,160 m^3/d q_1' = 15,800 m^3/d ≒ 658 m^3/hr≒11.0 m^3/min	18,300 m^3/d x 0.8 = 14,640 m^3/d 18,300 m^3/d x 0.2 = 3,660 m^3/d q_1 = 18,300 m^3/d ≒ 763 m^3/hr≒12.7 m^3/min	30,500 m^3/d x 0.8 = 24,400 m^3/d 30,500 m^3/d x 0.2 = 6,100 m^3/d Q_1 = 30,500 m^3/d ≒ 1,271 m^3/hr≒21.2 m^3/min
(2) Design Maximum Dry Weather Flow per Day	q_2' = 12,640 x 1.2 + 3,160 ≒ 18,330 m^3/d ≒ 764m^3/hr ≒ 12.7 m^3/min	q_2 = 14,640 x 1.2 + 3,660 ≒ 21,230 m^3/d ≒ 885 m^3/hr≒ 14.7 m^3/min	Q_2 = 24,400 x 1.2 + 6,100 ≒ 35,380 m^3/d ≒ 1,474 m^3/hr≒ 24.6 m^3/min
(3) Design Maximum Hourly Wastewater Flow	q_3' = 12,640 x 1.2 x1.4 + 3,160 ≒ 24,400 m^3/d ≒ 1,017m^3/hr ≒ 16.9 m^3/min	q_3' = 12,640 x 1.2 x 1.4 + 3,660 ≒ 28,260 m^3/d ≒ 1,178 m^3/hr≒ 19.6 m^3/min	Q_3 = 24,400 x 1.2 x 1.4 + 6,100 ≒ 47,090 m^3/d ≒ 1,962 m^3/hr≒ 32.7 m^3/min
(4) Design Wet Weather Maximum Hourly Wastewater Flow	$3q_3'$ = 24,400 x 3 = 73,200m^3/d = 3,050m^3/hr≒ 50.8 m^3/min	$3q_3$ = 28,260 x 3 = 84,780 m^3/d = 3,533 m^3/hr ≒ 58.9 m^3/min	$3Q_3$ = 47,090 x 3 = 141,270 m^3/d = 5,886 m^3/hr ≒ 98.1 m^3/min

	Most Urgent Plan	F/S Plan	Master Plan
2. Grit Chamber			
Design removal article Dry Weather	Specific gravity 2.65 Grain size 0.2mm Settling velocity V = 0.021m/min	same as left	same as left
Surface loading	1,800m^3/m^2/day (Design Maximum Flow)	same as left	same as left
Wet Weather	Specific gravity 2.65 Grain Size 0.6mm Settling velocity V = 0.063m/min	same as left	same as left
Surface loadinga	5,400m^3/m^2/day (Design Wet weather Maximum Hourly Flow)	same as left	same as left
Configuration 1) Dry Weather	W 1.2 m x L 8.0 m x D 0.35 x 1 Channel	W 1.2 m x L 8.0 m x D 0.55 x 1 Channel	W 1.2 m x L 8.0 m x D 0.65 x 2 Channel
(Surface) (Volume)	9.6 m^2 3.4 m^3	9.6 m^2 5.3 m^3	19.2 m^2 12.5 m^3
Study Surface loading	$\frac{18,330}{9.6}$ = 1,909 m^3/m^2/day	$\frac{21,230}{9.6}$ = 2,211 m^3/m^2/day	$\frac{35,380}{19.2}$ = 1,843 m^3/m^2/day
Mean velocity	18,330/86,400 x 1.2 x 0.35 = 0.51 m/sec	21,230/86,400 x 1.2 x 0.55 = 0.37 m/sec	35,380/86,400 x 1.2 x 0.65 = 0.26 m/sec
Sedimentation time	3.4 x 86,400/18,330 ≒ 16 sec	5.3 x 86,400/21,230 ≒ 22 sec	12.5 x 86,400/35,380 ≒ 31 sec

	Most Urgent Plan	F/S Plan	Master Plan
Settling time	0.35/0.021≒ 17 sec	0.55/0.021≒ 26 sec	0.65/0.021≒ 31 sec
Removal efficiency	$\left\{ 1 - \frac{1}{1 + 16/17} \right\} \fallingdotseq 48\%$	$\left\{ 1 - \frac{1}{1 + 22/26} \right\} \times 100 \fallingdotseq 46\%$	$\left\{ 1 - \frac{1}{1 + 31/31} \right\} \times 100 \fallingdotseq 50\%$
2) Wet weather	W 1.2 m x L 8.0 m x D 0.70 x 2 channel	W 1.2 m x L 8.0 m x D 0.90 x 2 channel	W 1.2 m x L 8.0 m x D 1.20 x 3 channel
(Surface)	19.2 m^2	19.2 m^2	28.8 m^2
(Volume)	13.4 m^3	17.3 m^3	34.6 m^3
Study			
Surface loading	73,200/19.2 = 3,813 m^3/m^2/day	84,780/19.2 = 4,416 m^3/m^2/day	141,270/28.8≒4,905 m^3/m^2/day
Mean velocity	73,200/86,400 x 1.2 x 0.7 x 2 = 0.50 m/sec	84,780/86,400 x 1.2 x 0.9 x 2 = 0.45 m/sec	141,270/86,400 x 1.2 x 1.2 x 3 = 0.38 m/sec
Sedimentation time	13.4 x 86,400/73,200≒ 16 sec	17.3 x 86,400/84,780≒ 18 sec	34.6 x 86,400/141,270 ≒ 21 sec
Settling time	0.7/0.063 ≒ 11sec	0.9/0.063 ≒ 14sec	1.2/0.063 ≒ 19sec
Removal efficiency	$\left\{ 1 - \frac{1}{1 + 16/11} \right\} \fallingdotseq 59\%$	$\left\{ 1 - \frac{1}{1 + 18/14} \right\} \times 100 \fallingdotseq 56\%$	$\left\{ 1 - \frac{1}{1 + 21/19} \right\} \times 100 \fallingdotseq 50\%$
3. Main Pump			
Submersible pump No.1	φ300 x 12.5 m^3/min x 16 m x 55 kW x 1 unit	φ300 x 12.5 m^3/min x 16 m x 55 kW x 1 unit	φ300 x 12.5 m^3/min x 16 m x 55 kW x 2 units
Submersible pump No.2	φ500 x 25 m^3/min x 16 m x 110 kW x 3 units (reserve 1 unit)	φ500 x 25 m^3/min x 16 m x 110 kW x 3 units (reserve 1 unit)	φ500 x 25 m^3/min x 16 m x 110 kW x 4 units (reserve 1 unit)

II Sewerage Treatment Plant
Calculation of Capacity

	Most Urgent Plan	F/S Plan	Master Plan
1. Design Wastewater Flow			
(1) Design Mean Dry Weather Flow per Day			
Wastewater Groundwater	15,800 m^3/d x 0.8 = 12,640m^3/d 15,800 m^3/d x 0.2 = 3,160m^3/d q_1' = 15,800m^3/d	18,300 m^3/d x 0.8 = 14,640m^3/d 18,300 m^3/d x 0.2 = 3,660m^3/d q_1= 18,300m^3/d	34,500 m^3/d x 0.8 = 27,600m^3/d 34,500 m^3/d x 0.2 = 6,900m^3/d Q_1= 34,500m^3/d (Base Design Flow 35,000m^3/d)
(2) Design Maximum Dry Weather Flow per Day	q_2'= 12,640 x 1.2 + 3,160 ≒ 18,330 m^3/d	q_2= 14,640 x 1.2 + 3,660 ≒ 21,230 m^3/d	Q_2= 27,600 x 1.2 + 6,900 ≒ 40,020 m^3/d
(3) Design Maximum Hourly Wastewater Flow	q_3'=12,640 x 1.2 x 1.4 + 3,160 ≒ 24,400 m^3/d	q_3= 14,640 x 1.2 x 1.4 + 3,660 ≒ 28,260 m^3/d	Q_3= 27,600 x 1.2 x 1.4 + 6,900 ≒ 53,270 m^3/d
(4) Design Wet Weather Maximum Hourly Wastewater Flow	$3q_3'$= 24,400 x 3 = 73,200 m^3/d	$3q_3$= 28,260 x 3 = 84,780 m^3/d	$3Q_3$= 53,270 x 3 = 159,810 m^3/d

2. Design Influent water Quality and removal Efficiency

	Influent quality	Effluent quality	Removal ratio
BOD	120 mg/l	12 mg/l	90 %
SS	100 mg/l	25 mg/l	75 %

	Most Urgent Plan	F/S Plan	Master Plan
3. Loading and Sludge Product Influent BOD SS	$15,800 \times 120 \times 10^{-3} = 1,896$ kl/d $15,800 \times 100 \times 10^{-3} = 1,580$ kl/d	$18,300 \times 120 \times 10^{-3} = 2,196$ kl/d $18,300 \times 100 \times 10^{-3} = 1,830$ kl/d	$35,000 \times 120 \times 10^{-3} = 4,200$ kl/d $35,000 \times 100 \times 10^{-3} = 3,500$ kl/d
Removal BOD SS (SS : OD process reduction ratio 85 %)	$1,896 \times 0.9 \fallingdotseq 1,706$ kg/d $1,580 \times 0.75 \times 0.85 \fallingdotseq 1,007$kg/d	$2,196 \times 0.9 \fallingdotseq 1,976$ kg/d $1,830 \times 0.75 \times 0.85 \fallingdotseq 1,167$kg/d	$4,200 \times 0.9 \fallingdotseq 3,780$ kg/d $3,500 \times 0.75 \times 0.85 \fallingdotseq 2,231$kg/d
excess sludge (moisture conduct 99.3 %)	$1,007 - \frac{100}{100 - 99.3} \times 10^{-3}$ $\fallingdotseq 144$ m³/d	$1,167 - \frac{100}{100 - 99.3} \times 10^{-3}$ $\fallingdotseq 167$ m³/d	$2,231 - \frac{100}{100 - 99.3} \times 10^{-3}$ $\fallingdotseq 319$ m³/d
4. Water Treatment Facility 4.1 Oxidation Ditch Tank			
Design Wastewater Quantity	15,800 m³/d	18,300 m³/d	35,000 m³/d
BOD - SS loading	0.1 kg/SS/kg/d	same as left	same as left
MLSS	2,000 to 3,000 mg/l	same as left	same as left
Required Tank Volume			$\frac{35,000 \times 120}{0.1 - 2,500} = 16,800$ m³
Configuration	W 4.0 m x L 106 m x D 2.5 m 2 tanks x 3 units V = 6,360 m³	W 4.0 m x L 106 m x D 2.5 m 2 tanks x 4 units V = 8,480 m³	W 4.0 m x L 106 m x D 2.5 m 2 tanks x 8 units V = 16,960 m³
Study BOD - SS loading	$\frac{15,800 \times 120}{6,360 \times 2,500} \fallingdotseq 0.12$ kg-BOD/kg-ss/d	$\frac{18,300 \times 120}{8,480 \times 2,500} \fallingdotseq 0.10$ kg-BOD/kg-ss/d	$\frac{35,000 \times 120}{16,960 \times 2,500} \fallingdotseq 0.10$ kg-BOD/kg-ss/d

	Most Urgent Plan	F/S Plan	Master Plan
q_2' or q_2 or Q_2	$\frac{18,300 \times 120}{6,360 \times 2,500} \fallingdotseq 0.14$ kg/ss/kg/d	$\frac{21,230 \times 120}{8,480 \times 2,500} \fallingdotseq 0.12$ kg/ss/kg/d	$\frac{40,020 \times 120}{16,960 \times 2,500} \fallingdotseq 0.11$ kg/ss/kg/d
Areation Time	$\frac{6,360 \times 24}{15,800} \fallingdotseq 9.7$ hr	$\frac{8,480 \times 24}{18,300} \fallingdotseq 11.1$ hr	$\frac{16,960 \times 24}{35,000} \fallingdotseq 11.6$ hr
q_2' or q_2 or Q_2	$\frac{6,360 \times 24}{18,300} \fallingdotseq 8.3$ hr	$\frac{8,480 \times 24}{21,230} \fallingdotseq 9.6$ hr	$\frac{16,960 \times 24}{40,020} \fallingdotseq 10.2$ hr
4.2 Final Sedimation Tank			
Design Wastewater Quality	15,800 m^3/d	18,300 m^3/d	35,000 m^3/d
Surface Loading	15 $m^3/m^2/d$	same as left	same as left
Sedimation Time	3.0 hr	same as left	same as left
Configuration	DIA 19.5 m x D 2.5 m x 3 tanks A = 895 m^2 V = 2,238 m^3	DIA 19.5 m x D 2.5 m x 4 tanks A = 1,194 m^2 V = 2,985 m^3	DIA 19.5 m x D 2.5 m x 8 tanks A = 2,388 m^2 V = 5,970 m^3
Study Surface Loading	$\frac{15,800}{895} \fallingdotseq 17.7$ $m^3/m^2/d$	$\frac{18,300}{1,194} \fallingdotseq 15.3$ $m^3/m^2/d$	$\frac{35,000}{2,388} \fallingdotseq 14.7$ $m^3/m^2/d$
q_2' or q_2 or Q_2	$\frac{18,330}{895} \fallingdotseq 20.5$ $m^3/m^2/d$	$\frac{21,230}{1,194} \fallingdotseq 17.8$ $m^3/m^2/d$	$\frac{40,020}{2,388} \fallingdotseq 16.8$ $m^3/m^2/d$
Sedimation Time	$\frac{2,238 \times 24}{15,800} \fallingdotseq 3.4$ hr	$\frac{2,985 \times 24}{18,300} \fallingdotseq 3.9$ hr	$\frac{5,970 \times 24}{35,000} \fallingdotseq 4.1$ hr
q_2' or q_2 or Q_2	$\frac{2,238 \times 24}{18,330} \fallingdotseq 2.9$ hr	$\frac{2,985 \times 24}{21,230} \fallingdotseq 3.4$ hr	$\frac{5,970 \times 24}{40,020} \fallingdotseq 3.6$ hr

	Most Urgent Plan	F/S Plan	Master Plan
4.3 Chlorination Tank			
Design Westewater Quantity	15,800 m^3/d	18,300 m^3/d	35,000 m^3/d
Contact Time	15 minutes	same as left	same as left
Configuration	W 2.0 m x L 16.0 m x D 1.5 m x 4 channel x 1 unit V = 192 m^3	same as left	same as left
Study Contact Time	$\frac{192 \times 60 \times 24}{15,800} \fallingdotseq 17.5$ min	$\frac{192 \times 60 \times 24}{18,300} \fallingdotseq 15.1$ min	$\frac{384 \times 60 \times 24}{35,000} \fallingdotseq 15.8$ min
q_2' or q_2 or Q_2	$\frac{192 \times 60 \times 24}{18,330} \fallingdotseq 15.1$ min	$\frac{192 \times 60 \times 24}{21,230} \fallingdotseq 13.0$ min	$\frac{384 \times 60 \times 24}{40,020} \fallingdotseq 13.8$ min
Chlorine ratio	2 ~ 4 mg/l	same as left	same as left
Chlorine dosage	$15,800 \times 3 \div 10^{-3} = 47.4$ kg/d	$18,300 \times 3 \div 10^{-3} = 54.9$ kg/d	$35,000 \times 3 \div 10^{-3} = 105$ kg/d
5. Draing Bed			
Design Sludge Product	144 m^3/d (1,007 kg/d)	167 m^3/d (1,167 kg/d)	319 m^3/d (2,231 kg/d)
Drying Days	18 days	same as left	same as left
Solid Loading	4.5 $kg/m^3/d$	same as left	same as left
Required Area	$\frac{1,007 \times 18}{4.5} = 4,028$ m^2	$\frac{1,167 \times 18}{4.5} = 4,668$ m^2	$\frac{2,231 \times 18}{4.5} = 8,928$ m^2
Configration	20 m x 12.6 m x 15 Bed A = 3,780 m^2	20 m x 12.6 m x (18 + 2) Bed A = 3,780 m^2 (18 Bed)	20 m x 12.6 m x (36 + 4) Bed A = 9,072 m^2 (36 Bed)

Table 7.1 Flow Capacity of Bang Yai River

SECTION	Distance from river mouth (km)	River bed (El.m)	Right Bank (El.m)	Left Bank (El.m)	Discharge Bankfull (m3/s)	Freeboard(0.6m) (m3/s)	Name of Bridge
1	0.1	-1.9	Mangrove	1.6	140	140	
2	0.2	-2.1	Mangrove	1.8	140	140	
3	0.4	-2.1	Mangrove	1.8	140	140	
4	0.5	-1.7	Mangrove	1.5	140	10	
5	0.6	-1.7	Mangrove	1.7	140	80	
6	0.7	-1.6	1.8	1.9	140	120	
7	0.8	-1.9	1.8	2.0	140	90	
8	1.0	-1.7	1.8	2.1	140	80	
9	1.1	-1.6	2.0	2.2	140	100	
10	1.2	-1.7	1.8	2.1	140	60	
11	1.3	-1.6	2.4	2.7	140	140	
12	1.4	-1.6	2.2	2.7	140	100	
13	1.6	-2.1	2.3	2.2	140	90	
14	1.7	-1.5	2.3	2.2	140	90	
15	1.8	-1.8	2.3	2.4	140	100	
16	1.9	-1.3	1.8	1.7	90	20	
17	2.0	-1.3	2.0	1.7	80	20	
18	2.2	-1.7	2.3	1.7	40	10	
19	2.3	-1.2	2.1	1.8	40	10	
20	2.4	-1.1	1.9	2.1	40	10	
BR1	2.45	-0.9	2.2	2.2	50	20	Poonphol
21	2.5	-0.2	2.0	2.0	40	20	
22	2.6	-0.9	2.9	2.0	20	10	
23	2.7	-1.0	2.6	1.9	10	20	
24	2.8	-0.8	2.6	1.9	40	20	
BR2	2.85	-0.7	2.8	2.8	40	20	Taling Chan
25	2.9	-0.9	2.5	2.4	20	10	
26	3.0	-0.4	2.5	2.1	20	10	
27	3.1	-0.5	2.6	2.1	20	10	
28	3.2	0.3	2.3	2.3	20	20	
BR3	3.3	0.3	2.4	2.6	20	10	Pra-a-ram
BR4	3.4	-0.1	2.5	2.5	20	10	Phang Nga
BR5	3.5	-0.1	3.2	3.6	30	20	Tuanpradit
32	3.6	0.1	3.8	3.7	40	20	
33	3.7	0.2	3.8	3.8	40	30	
34	3.8	0.2	3.8	3.8	40	20	
BR6	3.85	1.0	3.0	3.0	20	10	Thepkrasattri 3
35	3.9	0.5	4.1	4.1	40	30	
36	4.0	0.5	4.1	4.2	40	20	
37	4.1	1.0	4.7	4.7	50	40	
38	4.2	1.2	4.7	4.6	50	30	
BR7	4.25	1.8	4.8	4.8	50	40	Damrong
39	4.3	1.8	4.6	4.6	40	30	
40	4.4	1.8	5.6	5.6	50	50	
41	4.5	1.3	5.0	4.3	30	10	
42	4.6	1.8	4.5	3.9	20	10	
43	4.7	1.0	4.4	4.4	20	10	
44	4.8	1.4	5.5	5.2	40	30	
45	4.9	2.0	6.1	6.1	60	50	
46	5.0	3.2	5.5	5.5	40	30	
BR8	5.05	3.1	5.5	5.5	40	30	Thepkrasattri 1
47	5.1	3.5	6.3	6.3	60	50	
48	5.2	3.0	6.2	6.2	40	10	
49	5.3	3.4	6.8	6.5	40	20	
50	5.5	3.6	7.2	6.3	30	10	
51	5.6	4.1	7.9	6.9	40	20	
52	5.7	4.8	8.6	8.5	60	40	
53	5.8	3.8	9.0	7.7	40	30	
54	5.9	3.8	9.3	8.5	40	20	
55	6.1	4.7	8.6	8.4	30	20	
56	6.2	4.7	9.3	8.9	30	20	
57	6.4	4.7	9.5	8.7	40	30	
58	6.5	5.2	9.0	9.1	50	40	
59	6.6	5.4	9.2	8.6	40	20	
60	6.8	5.6	10.1	9.9	70	50	
61	6.9	5.8	10.5	10.5	90	60	
62	7.1	6.0	11.0	11.0	80	60	
63	7.2	6.2	10.1	10.6	50	40	
BR9	7.25	6.8	9.9	9.9	50	40	Yaovaraj
64	7.3	6.4	10.2	10.0	40	20	
65	7.5	6.6	9.2	9.0	20	10	
66	7.6	6.8	9.8	9.3	20	10	
67	7.8	7.1	9.8	11.5	30	20	
68	7.9	7.3	10.2	10.5	30	20	
69	8.0	7.5	12.2	12.2	80	60	
70	8.2	7.7	12.2	13.2	80	60	
71	8.3	8.3	11.6	12.1	60	50	
72	8.5	8.6	11.9	12.5	50	30	
73	8.6	8.2	12.2	12.2	50	30	
74	8.8	8.1	12.5	12.4	50	30	
75	9.0	9.4	13.0	13.0	60	40	
76	9.2	9.3	13.8	13.8	70	40	
77	9.4	11.2	14.5	14.7	90	60	
78	9.6	11.6	14.2	15.7	40	20	
79	9.8	11.7	15.2	15.3	60	40	

Table 7.2 Daily Maximum Rainfall

Station name: Phuket

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1968	12	0	0	37	143	85	75	90	82	45	19	54	143
1969	39	16	16	6	61	129	50	53	57	52	48	3	129
1970	11	2	31	53	78	62	71	32	38	40	52	23	78
1971	22	42	44	2	74	95	83	96	110	72	43	21	110
1972	0	2	3	52	53	38	32	32	57	30	24	29	57
1973	2	21	23	29	64	99	85	81	100	37	49	28	100
1974	0	2	12	73	53	76	123	43	61	135	66	20	135
1975	33	10	20	70	71	60	59	15	130	83	30	12	130
1976	0	2	15	46	87	106	104	86	102	53	27	20	106
1977	12	16	0	16	34	70	34	80	87	84	27	4	87
1978	13	0	14	80	38	69	87	67	50	22	35	23	87
1979	2	1	0	34	50	53	80	38	80	36	14	15	80
1980	2	44	54	34	48	69	85	110	41	48	32	29	110
1981	1	0	25	42	53	46	33	53	72	33	124	17	124
1982	1	23	19	28	68	23	135	23	55	44	45	16	135
1983	9	0	28	42	48	43	36	118	88	82	44	11	118
1984	14	1	35	90	42	90	62	29	76	47	28	73	90
1985	34	39	29	47	66	67	50	82	133	68	32	46	133
1986	9	12	3	124	127	44	78	81	173	76	90	10	173
1987	5	0	18	15	80	25	19	95	60	66	126	45	126
1988	8	38	20	41	59	35	57	55	55	42	141	12	141
1989	6	1	112	31	60	31	68	78	90	102	19	7	112
Max.	39	44	112	124	143	129	135	118	173	135	141	73	173

Station name: Bang Wad Dam

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1982												18	
1983	8	0	9	21	50	69	42	101	70	96	36	10	101
1984	10	6	16	65	42	72	107	33	62	61	55	51	107
1985	14	9	68	56	65	57	73	95	96	60	39	18	96
1986	16	4	0	67	146	40	56	167	155	100	219	19	219
1987	4	0	10	19	62	60	16	137	142	63	133	48	142
1988	8	11	22	30	58	50	70	44	76	40	105	20	105
1989	6	0	8	40	66	54	98	115	80	115	30	0	115
Max.	16	11	68	67	146	72	107	167	155	115	219	51	219

Station name: Ban Maireab School

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1989										128	13	21	

Table 7.3 Monthly Rainfall

Station name: Phuket

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1968	14	0	0	135	400	341	343	401	498	188	94	118	2,532
1969	67	17	31	18	305	534	329	283	398	289	255	4	2,530
1970	32	2	130	242	241	184	470	213	354	342	115	79	2,404
1971	22	173	197	3	536	479	203	546	441	499	106	44	3,249
1972	0	2	5	188	235	212	232	136	434	139	108	127	1,818
1973	3	21	73	107	307	371	454	293	482	204	233	81	2,629
1974	0	3	45	156	283	421	423	250	439	507	198	62	2,787
1975	91	15	62	228	384	491	136	100	508	416	191	25	2,647
1976	0	2	56	128	462	268	348	263	416	189	105	23	2,260
1977	15	40	0	25	206	247	157	343	455	376	119	8	1,991
1978	24	0	19	117	226	301	430	213	243	86	82	31	1,772
1979	2	1	0	149	155	266	452	112	248	152	57	42	1,636
1980	2	44	133	63	222	375	349	486	336	294	172	130	2,606
1981	1	1	26	147	289	147	165	149	288	166	279	35	1,693
1982	3	50	30	116	303	87	650	131	184	274	211	36	2,075
1983	15	0	29	43	221	256	294	508	603	366	127	19	2,481
1984	34	1	68	382	203	470	411	86	332	282	69	230	2,568
1985	36	57	103	219	499	196	173	213	430	416	76	80	2,498
1986	29	12	4	248	454	185	308	417	881	330	269	20	3,157
1987	11	0	18	38	321	138	76	656	368	327	501	104	2,558
1988	19	74	44	103	275	114	333	192	546	322	292	31	2,345
1989	16	1	152	67	217	118	220	323	249	480	49	7	1,899
Mean	20	23	56	133	307	282	316	287	415	302	169	61	2,370
Mean ('83-'89)	23	21	60	157	313	211	259	342	487	360	198	70	2,501

Station name: Banq Wad Dam

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1982												42	
1983	14	0	10	22	229	306	304	490	689	374	97	18	2,553
1984	20	6	38	312	260	507	364	87	364	347	108	301	2,714
1985	14	18	126	156	456	203	172	232	367	457	104	72	2,377
1986	31	7	0	148	460	144	290	466	907	420	467	30	3,370
1987	10	0	18	38	363	126	58	776	402	231	506	133	2,661
1988	20	27	35	92	285	142	365	270	694	315	273	46	2,564
1989	11	0	17	95	294	190	240	345	330	502	45	0	2,069
Mean	17	8	35	123	335	231	256	381	536	378	229	86	2,615

Station name: Ban Maireab School

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1989										573	52	21	

Table 7.4 Project Cost for 5-year Flood Control

WORK ITEM	Unit	Quantity	Foreign Currency Unit Price (Baht)	Foreign Currency Amount (B1,000)	Local Currency Unit Price (Baht)	Local Currency Amount (B1,000)
1. Floodway				(56,840)		(20,110)
Excavation Soil	m3	384,000	33	12,670	9	3,460
Levee						
Embankment	m3	0	53	0	13	0
Revetment						
Slope Protection	m2	51,000	520	26,520	195	9,950
Foot&Top Protection	m	6,860	670	4,600	250	1,720
Inlet Concrete	m3	500	1,140	570	290	150
Reinforcement Bar	t	40	3,050	120	4,350	170
Backfill	m3	700	30	20	7	0
Bridge	m2	1,700	7,260	12,340	2,740	4,660
2. River Improvement				(5,890)		(2,250)
Channel Excavation	m3	18,400	33	610	9	170
Levee Embankment	m3	0	53	0	13	0
Retaining Wall						
Excavation	m3	2,000	33	70	9	20
Concrete	m3	600	1,140	680	290	170
Reinforcement Bar	t	48	3,050	150	4,350	210
Backfill	m3	1,400	30	40	7	10
Bridge	m2	480	7,260	3,480	2,740	1,320
Saen Suk Inovation						
Concrete	m3	200	1,140	230	290	60
Reinforcement Bar	t	16	3,050	50	4,350	70
Gate (2 m x 2 m)	no.	2	290,500	580	109,700	220
3. Miscellaneous	10% x (1.+2.)			(6,270)		(2,240)
Access & Service Road						
Yards						
Direct Cost				**69,000**		**24,600**
4. Land Acquisition & Compensation						(17,200)
Land Acquisition	l.s.					10,200
Houses	nos.	20			350,000	7,000
5. Engineering & 10% x (1~3)				6,900		5,230
Administration 2.5% x (1~3,LC4)						
6. Physical Contingency 20% x (1~5)				15,180		9,410
Total				**91,080**		**56,440**
Grand Total	$5,870 (x 1,000)	=		¥842,200 =		B147,520

Exchange rate Baht
US$1 = 25.1
¥1 = 0.175

Table 7.5 Project Cost for 10-year Flood Control

WORK ITEM		Unit	Quantity	Foreign Currency Unit Price (Baht)	Foreign Currency Amount (B1,000)	Local Currency Unit Price (Baht)	Local Currency Amount (B1,000)
1. Floodway					(57,960)		(20,460)
Excavation	Soil	m3	402,000	33	13,270	9	3,620
Levee							
	Embankment	m3	0	53	0	13	0
Revetment							
	Slope Protection	m2	52,000	520	27,040	195	10,140
	Foot&Top Protection	m	6,860	670	4,600	250	1,720
Inlet	Concrete	m3	500	1,140	570	290	150
	Reinforcement Bar	t	40	3,050	120	4,350	170
	Backfill	m3	700	30	20	7	0
Bridge		m2	1,700	7,260	12,340	2,740	4,660
2. River Improvement					(5,950)		(2,260)
Channel	Excavation	m3	18,400	33	610	9	170
Levee	Embankment	m3	1,090	53	60	13	10
Retaining Wall							
	Excavation	m3	2,000	33	70	9	20
	Concrete	m3	600	1,140	680	290	170
	Reinforcement Bar	t	48	3,050	150	4,350	210
	Backfill	m3	1,400	30	40	7	10
Bridge		m2	480	7,260	3,480	2,740	1,320
Saen Suk Inovation							
	Concrete	m3	200	1,140	230	290	60
	Reinforcement Bar	t	16	3,050	50	4,350	70
	Gate (2 m x 2 m)	no.	2	290,500	580	109,700	220
3. Miscellaneous		10% x (1.+2.)			(6,390)		(2,270)
Access & Service Road							
Yards							
Direct Cost					**70,300**		**24,990**
4. Land Acquisition & Compensation							(17,400)
Land Acquisition		l.s.					10,400
Houses		nos.	20			350,000	7,000
5. Engineering & Administration	10% x (1~3) 2.5% x (1~3,LC4)				7,030		5,310
6. Physical Contingency	20% x (1~5)				15,470		9,540
Total					92,800		57,240
Grand Total		$5,970 (x 1,000)		=	¥856,400 =		B150,040

Exchange rate Baht
US$1 = 25.1
Y1 = 0.175

Table 7.6 Project Cost for 20-year Flood Control

WORK ITEM		Unit	Quantity	Foreign Currency Unit Price (Baht)	Foreign Currency Amount (B1,000)	Local Currency Unit Price (Baht)	Local Currency Amount (B1,000)
1. Floodway					(60,390)		(21,300)
Excavation	Soil	m3	422,000	33	13,930	9	3,800
Levee							
	Embankment	m3	0	53	0	13	0
Revetment							
	Slope Protection	m2	54,000	520	28,080	195	10,530
	Foot&Top Protection	m	6,860	670	4,600	250	1,720
Inlet	Concrete	m3	500	1,140	570	290	150
	Reinforcement Bar	t	40	3,050	120	4,350	170
	Backfill	m3	700	30	20	7	0
Bridge		m2	1,800	7,260	13,070	2,740	4,930
2. River Improvement					(6,250)		(2,340)
Channel	Excavation	m3	18,400	33	610	9	170
Levee	Embankment	m3	6,800	53	360	13	90
Retaining Wall							
	Excavation	m3	2,000	33	70	9	20
	Concrete	m3	600	1,140	680	290	170
	Reinforcement Bar	t	48	3,050	150	4,350	210
	Backfill	m3	1,400	30	40	7	10
Bridge		m2	480	7,260	3,480	2,740	1,320
Saen Suk Inovation							
	Concrete	m3	200	1,140	230	290	60
	Reinforcement Bar	t	16	3,050	50	4,350	70
	Gate (2 m x 2 m)	no.	2	290,500	580	109,700	220
3. Miscellaneous		10% x (1.+2.)			(6,660)		(2,360)
Access & Service Road							
Yards							
Direct Cost					**73,300**		**26,000**
4. Land Acquisition & Compensation							(17,600)
Land Acquisition		l.s.					10,600
Houses		nos.	20			350,000	7,000
5. Engineering & Administration	10% x (1~3) 2.5% x (1~3,LC4)				7,330		5,520
6. Physical Contingency	20% x (1~5)				16,130		9,820
Total					**96,760**		**58,940**
Grand Total		**$6,200 (x 1,000)**		=	**¥888,600** =		B155,700

Exchange rate Baht
US$1 = 25.1
¥1 = 0.175

Table 7.7 Project Cost for 30-year Flood Control

WORK ITEM		Unit	Quantity	Foreign Currency Unit Price (Baht)	Foreign Currency Amount (B1,000)	Local Currency Unit Price (Baht)	Local Currency Amount (B1,000)
1. Floodway					(62,290)		(21,960)
Excavation	Soil	m3	442,000	33	14,590	9	3,980
Levee							
	Embankment	m3	0	53	0	13	0
Revetment							
	Slope Protection	m2	55,000	520	28,600	195	10,730
	Foot&Top Protection	m	6,860	670	4,600	250	1,720
Inlet	Concrete	m3	500	1,140	570	290	150
	Reinforcement Bar	t	40	3,050	120	4,350	170
	Backfill	m3	700	30	20	7	0
Bridge		m2	1,900	7,260	13,790	2,740	5,210
2. River Improvement					(6,440)		(2,390)
Channel	Excavation	m3	18,400	33	610	9	170
Levee	Embankment	m3	10,470	53	550	13	140
Retaining Wall							
	Excavation	m3	2,000	33	70	9	20
	Concrete	m3	600	1,140	680	290	170
	Reinforcement Bar	t	48	3,050	150	4,350	210
	Backfill	m3	1,400	30	40	7	10
Bridge		m2	480	7,260	3,480	2,740	1,320
Saen Suk Inovation							
	Concrete	m3	200	1,140	230	290	60
	Reinforcement Bar	t	16	3,050	50	4,350	70
	Gate (2 m x 2 m)	no.	2	290,500	580	109,700	220
3. Miscellaneous		10% x (1.+2.)			(6,870)		(2,440)
Access & Service Road							
Yards							
Direct Cost					**75,600**		**26,790**
4. Land Acquisition & Compensation							(17,900)
Land Acquisition		l.s.					10,900
Houses		nos.	20			350,000	7,000
5. Engineering &	10% x (1~3)				7,560		5,680
Administration	2.5% x (1~3,LC4)						
6. Physical Contingency	20% x (1~5)				16,630		10,070
Total					**99,790**		**60,440**
Grand Total		$6,380\	(x 1,000)	=	¥914,700 =		B160,230

Exchange rate Baht
US$1 = 25.1
¥1 = 0.175

ANNEX : FIGURES

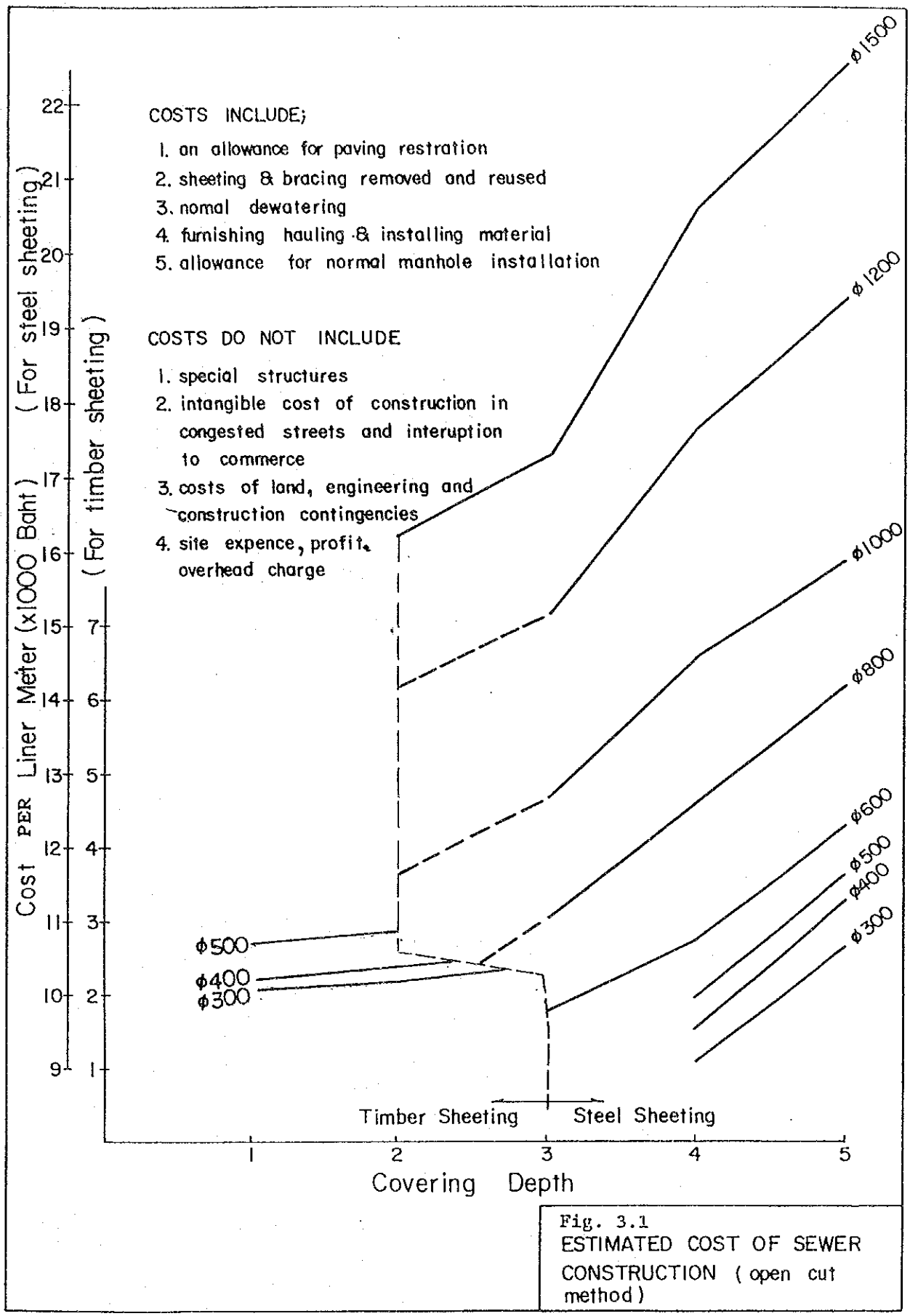


Fig. 3.1
ESTIMATED COST OF SEWER CONSTRUCTION (open cut method)

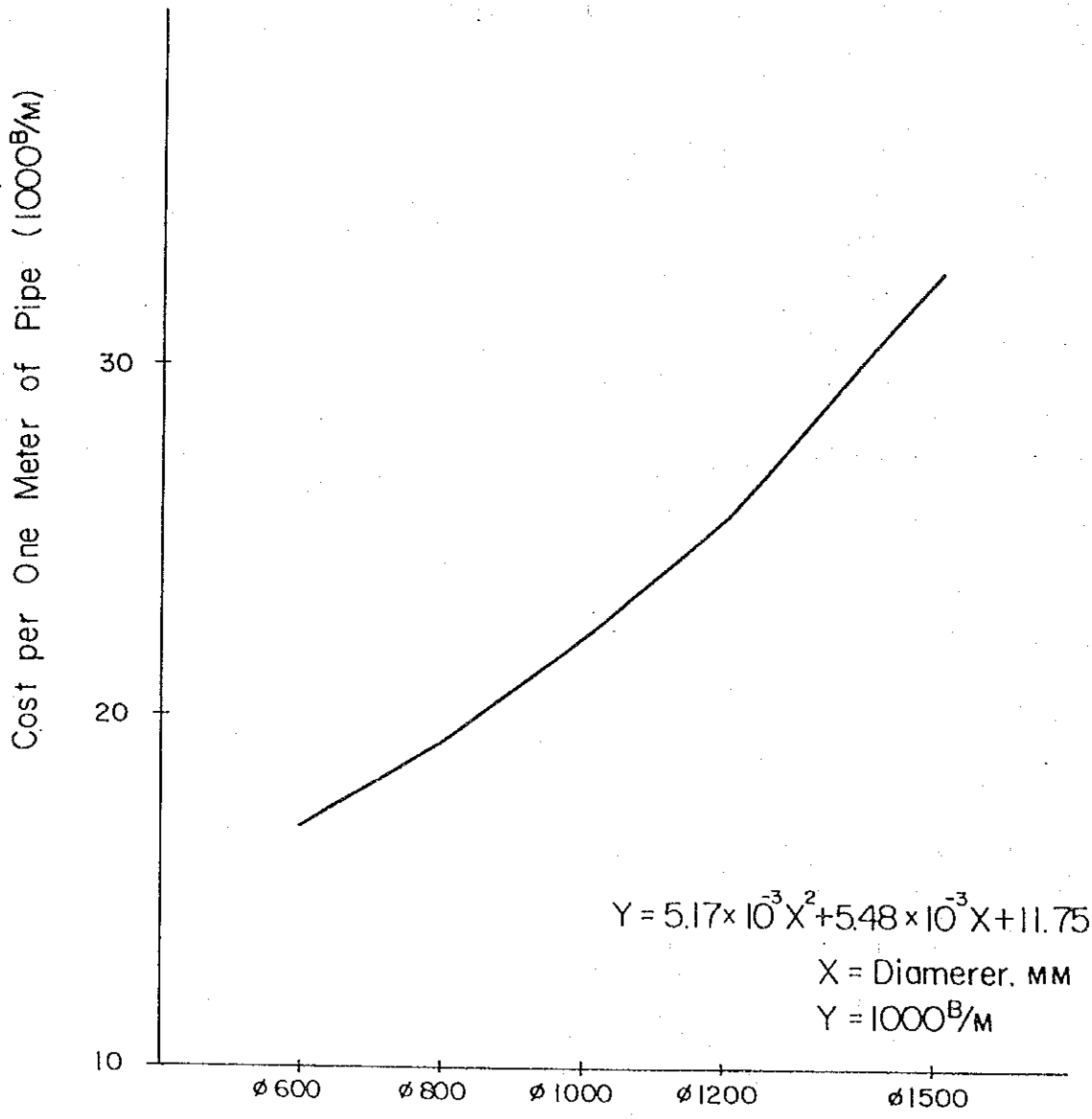


Fig. 3.2
ESTIMATED COST OF SEWER CONSTRUCTION (NORMAL JACKING METHOD)

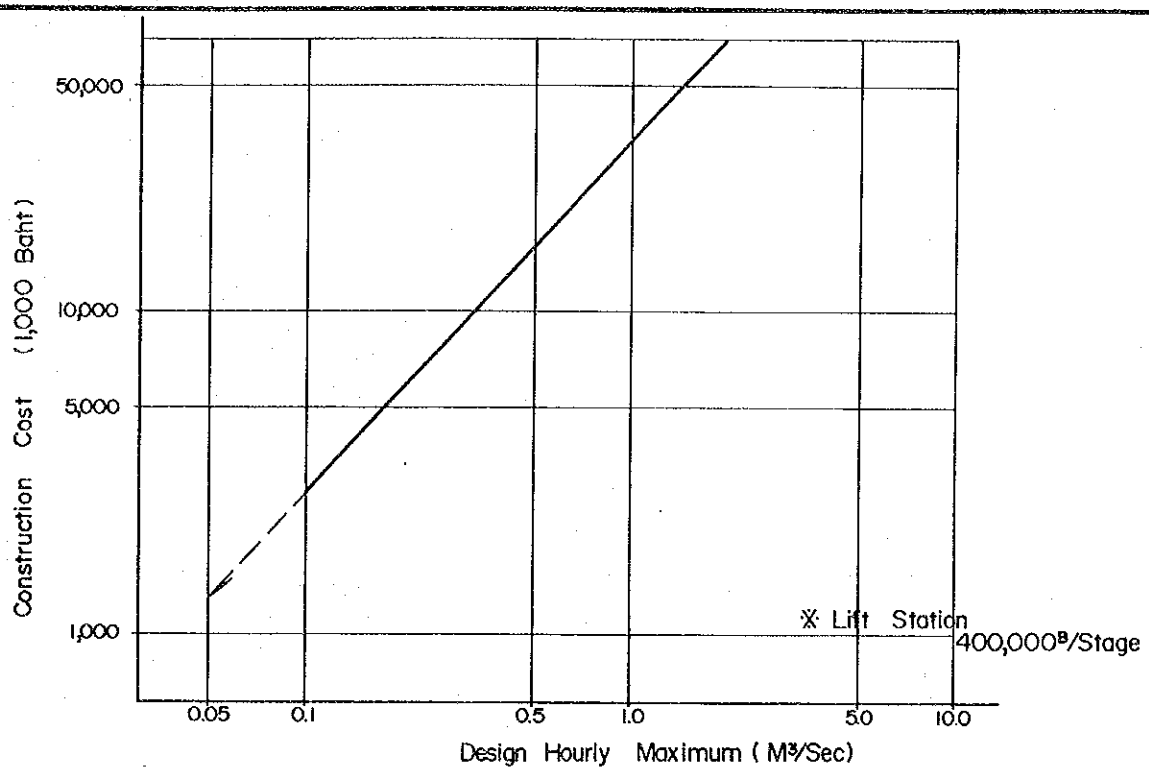


Fig.3.3
CONSTRUCTION COST
FOR PUMPING STATION

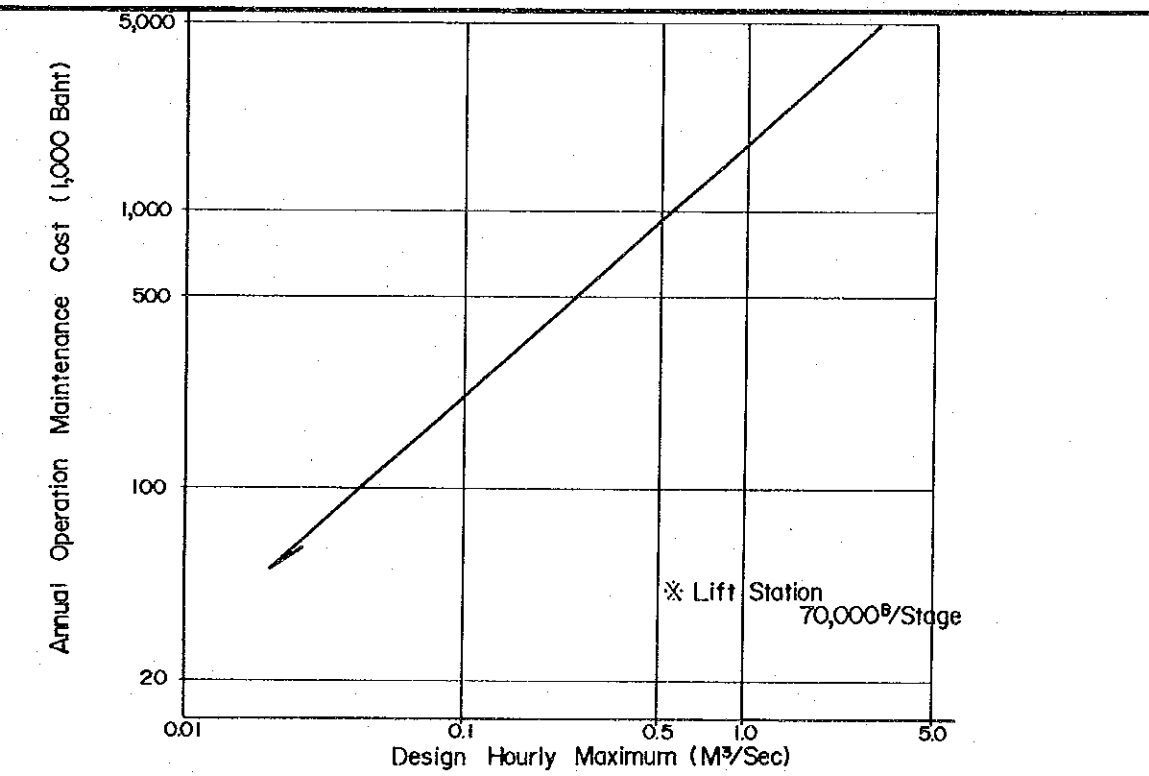
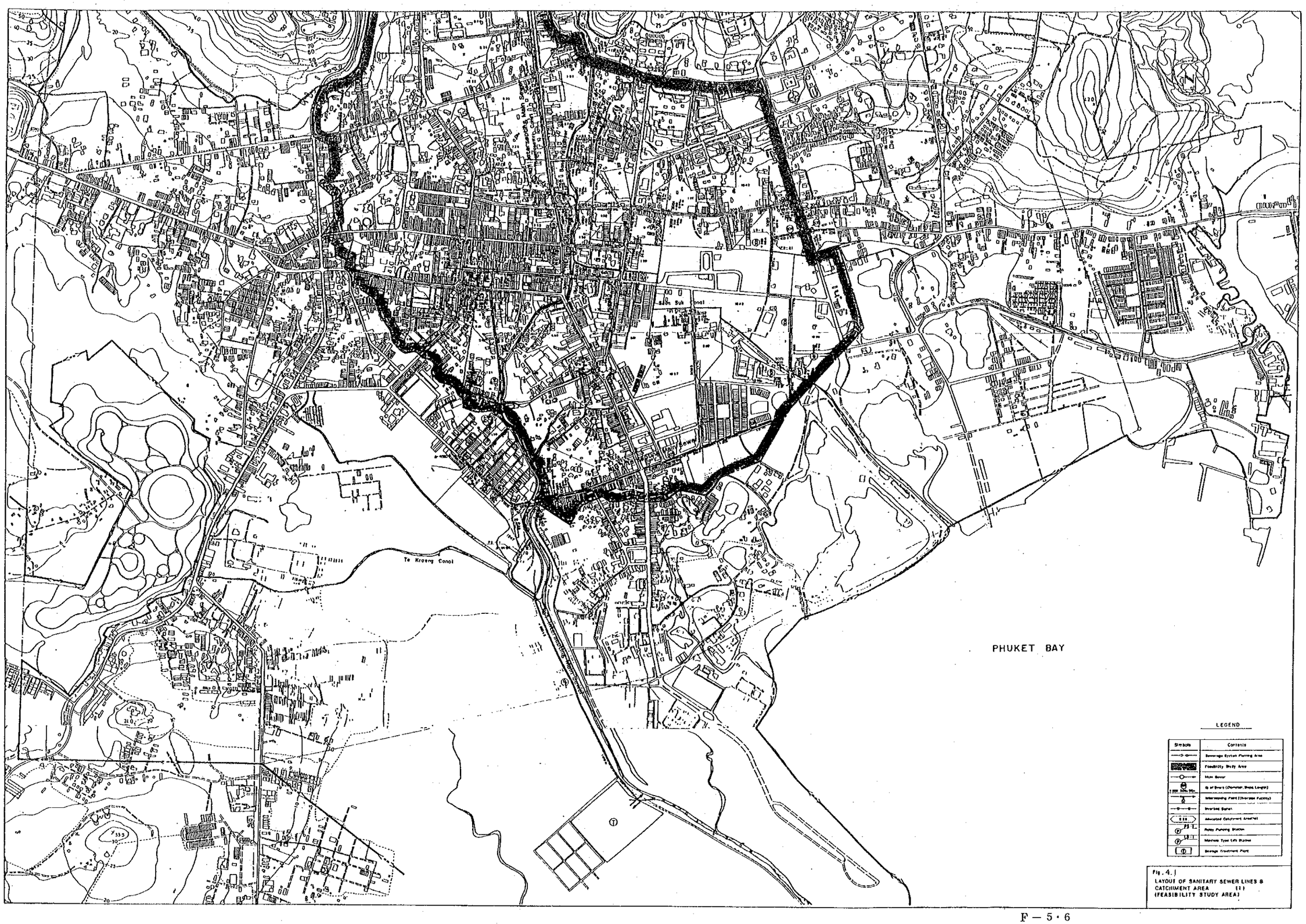


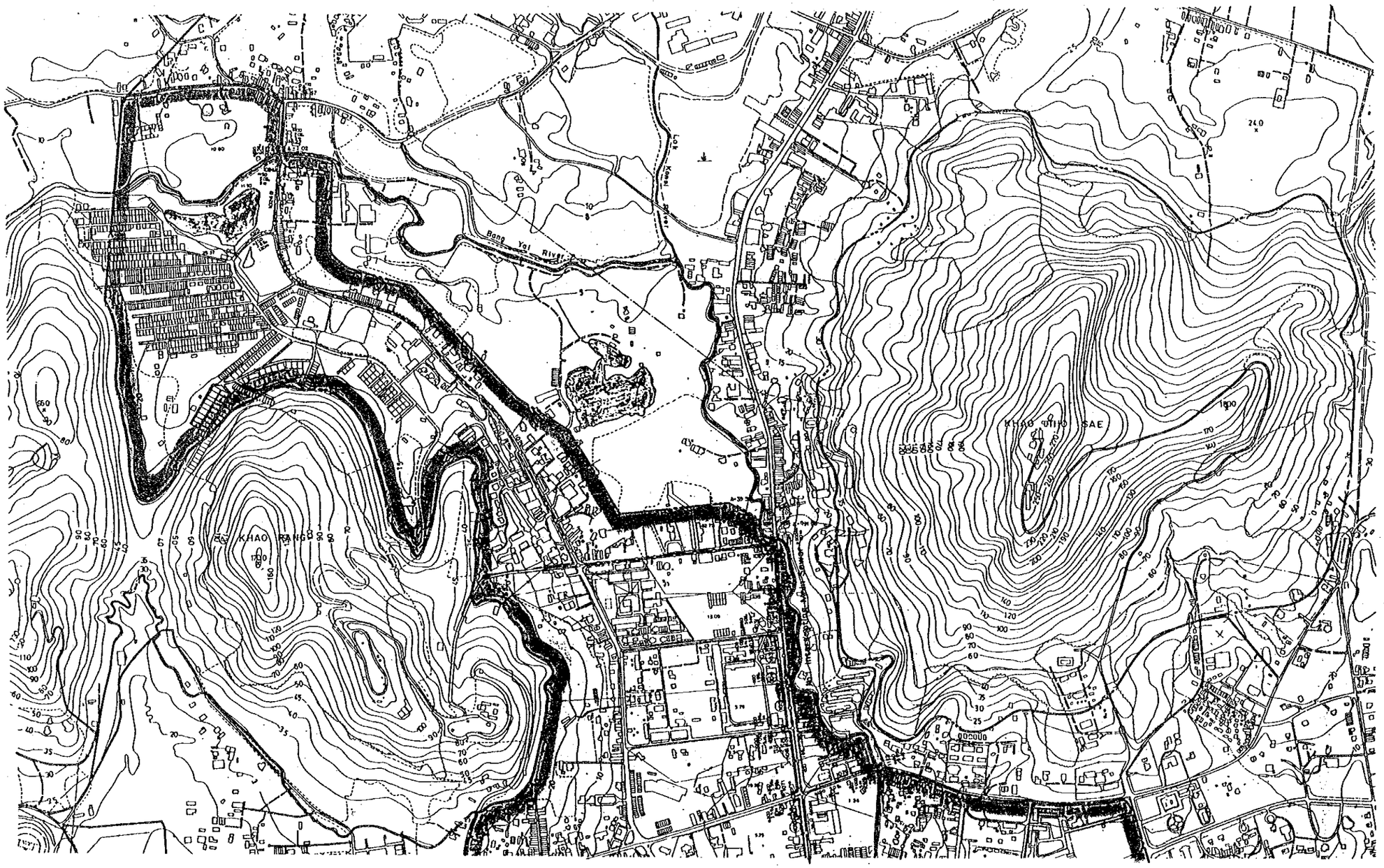
Fig. 3.4
ANNUAL OPERATION AND
MAINTENANCE COST OF
PUMPING STATION

LEGEND

Simbole	Contents
	Sewerage System Planning Area
	Municipality Boundary
③	Population Density Classification Boundary
A1	Population Statistics Zone of DTCP

Fig.3.5
DESIGNED MEAN POPULATION DENSITY DISTRIBUTION MAP


To Khoang Canal
PHUKET BAY
LEGEND
Symbols
Contents
Fig. 4.1
LAYOUT OF SANITARY SEWER LINES & CATCHMENT AREA (1)
(FEASIBILITY STUDY AREA)



LEGEND

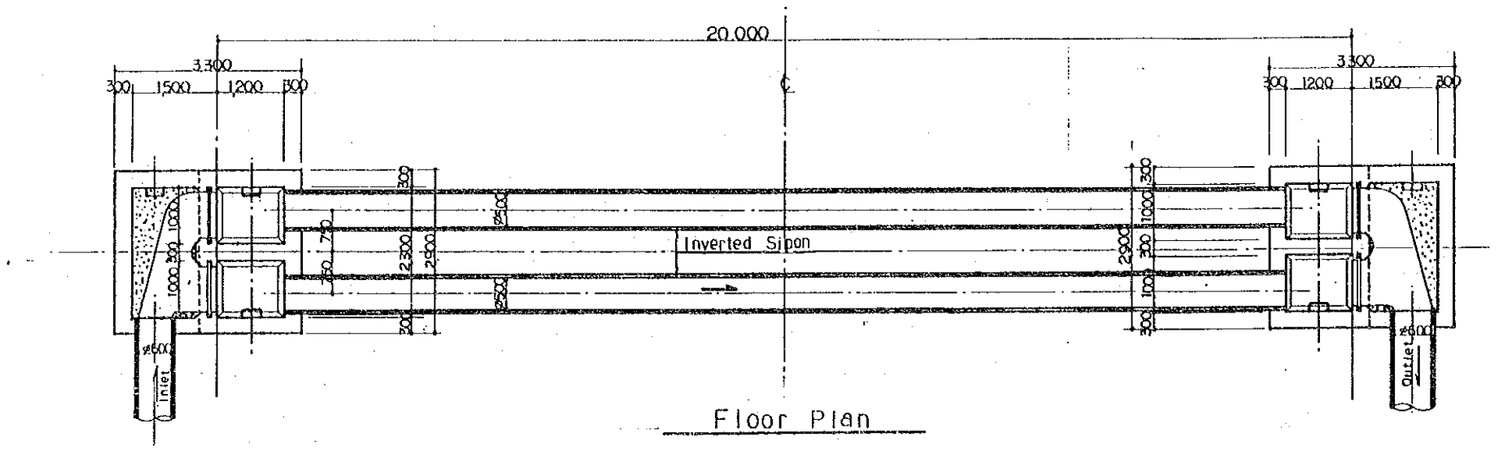
Simbole	Contents
	Sewerage System Planning Area
	Feasibility Study Area
	Main Sewer
	No of Barrs (Diameter, Barrs, Length)
	Intercepting Point (Diversion Facility)
	Inverted Siphon
	Allocated Catchment Area(ha)
	Relay Pumping Station
	Manhole Type Lift Station
	Sewage Treatment Plant

Fig.4.2
LAYOUT OF SANITARY SEWER LINES & CATCHMENT AREA (2)
(FEASIBILITY STUDY AREA)

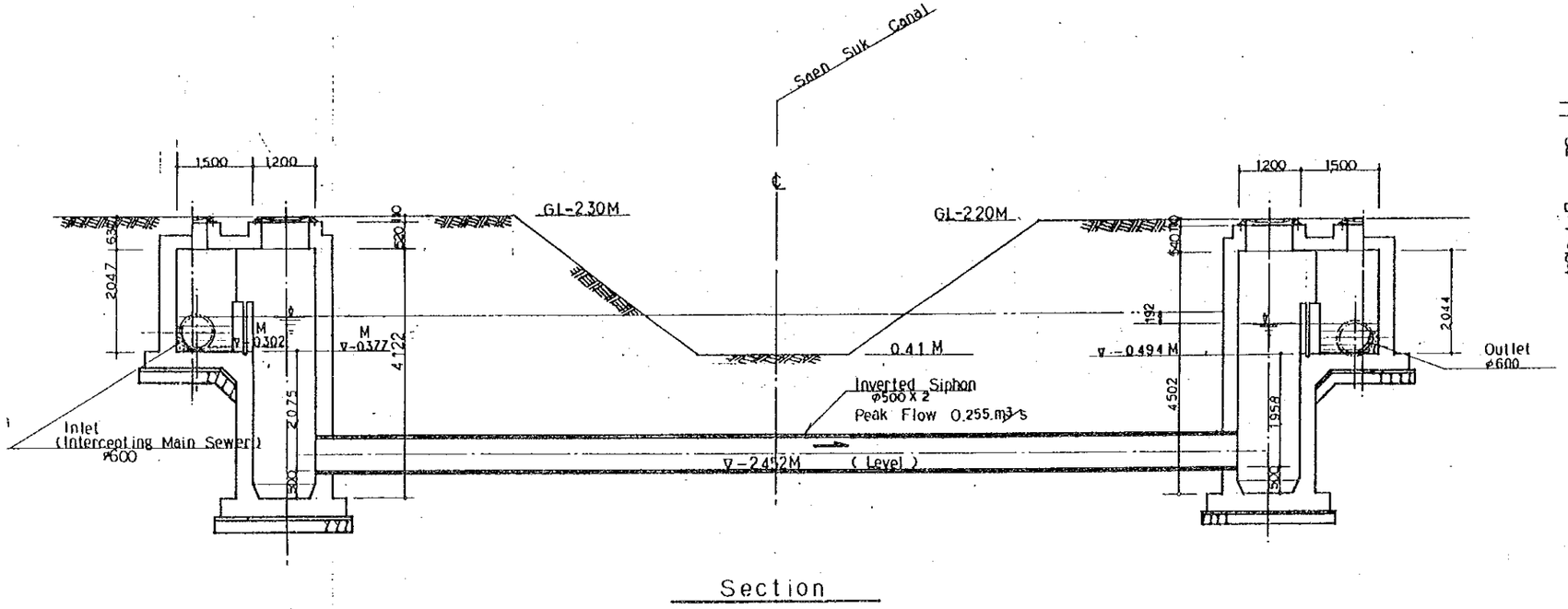
No.3 Intercepting Main Sewer (307)

Inverted Siphon

Scale 1:50



Floor Plan

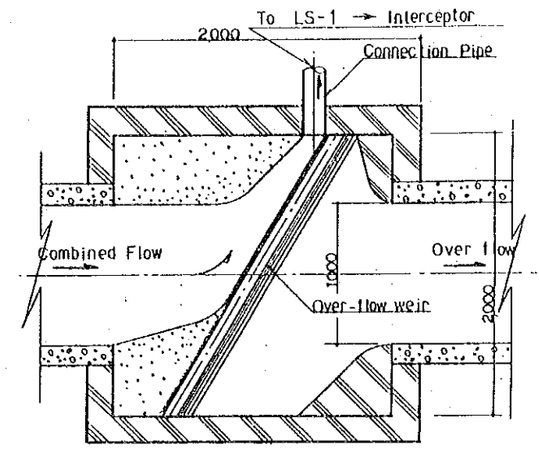


Section

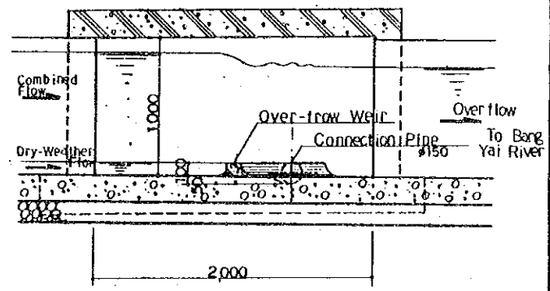
Interceping Sewer (1118)

Intercepting Point (Diversion Facility)

Scale 1:20



Floor Plan

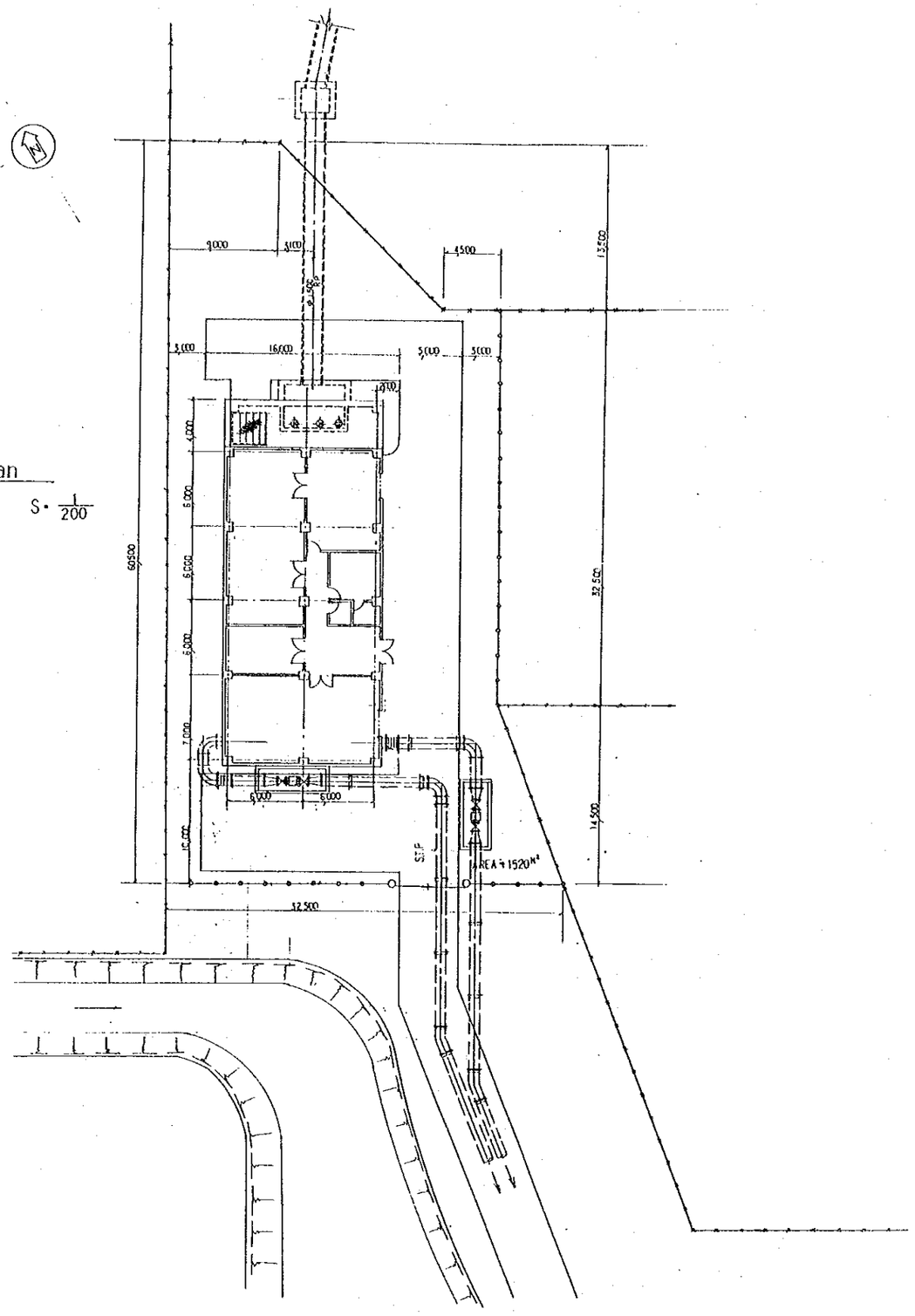


Section

Fig:4.3
LAYOUT OF INVERTED SIPHON & INTERCEPTION POINT

General Plan

S = 1/200



Location Plan

S = 1/3000

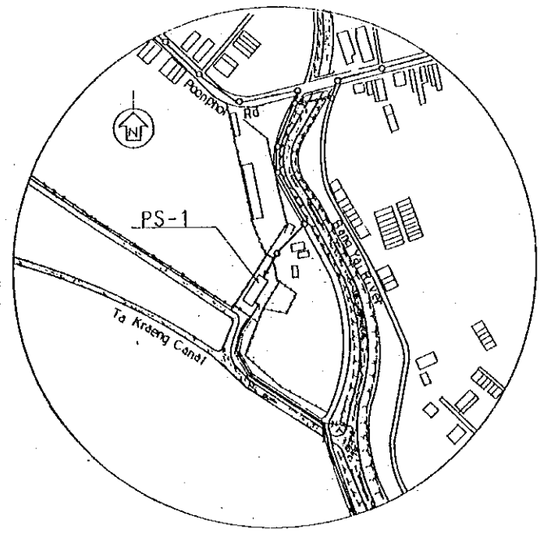
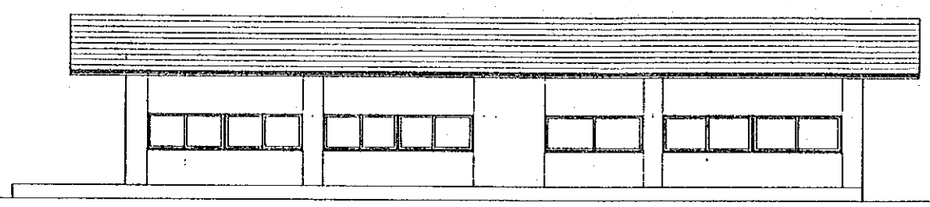
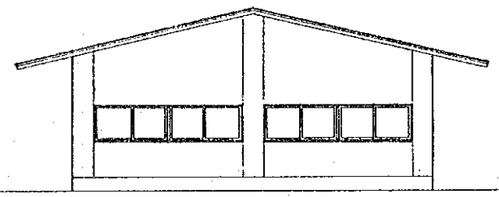


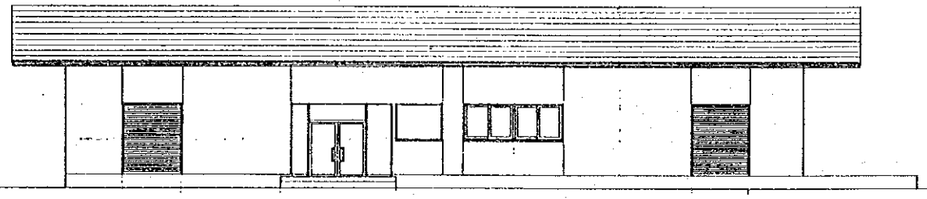
Fig. 4.4
PUMPING STATION (PS-1)
LOCATION & GENERAL PLAN



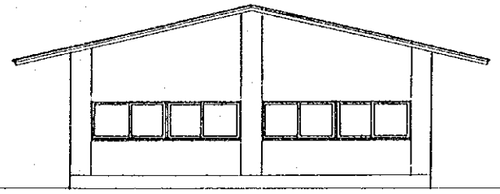
West Elevation 0-1/100



North Elevation 0-1/100



East Elevation 0-1/100



South Elevation 0-1/100

Fig. 4.5
PUMPING STATION (PS-1)
ELEVATION

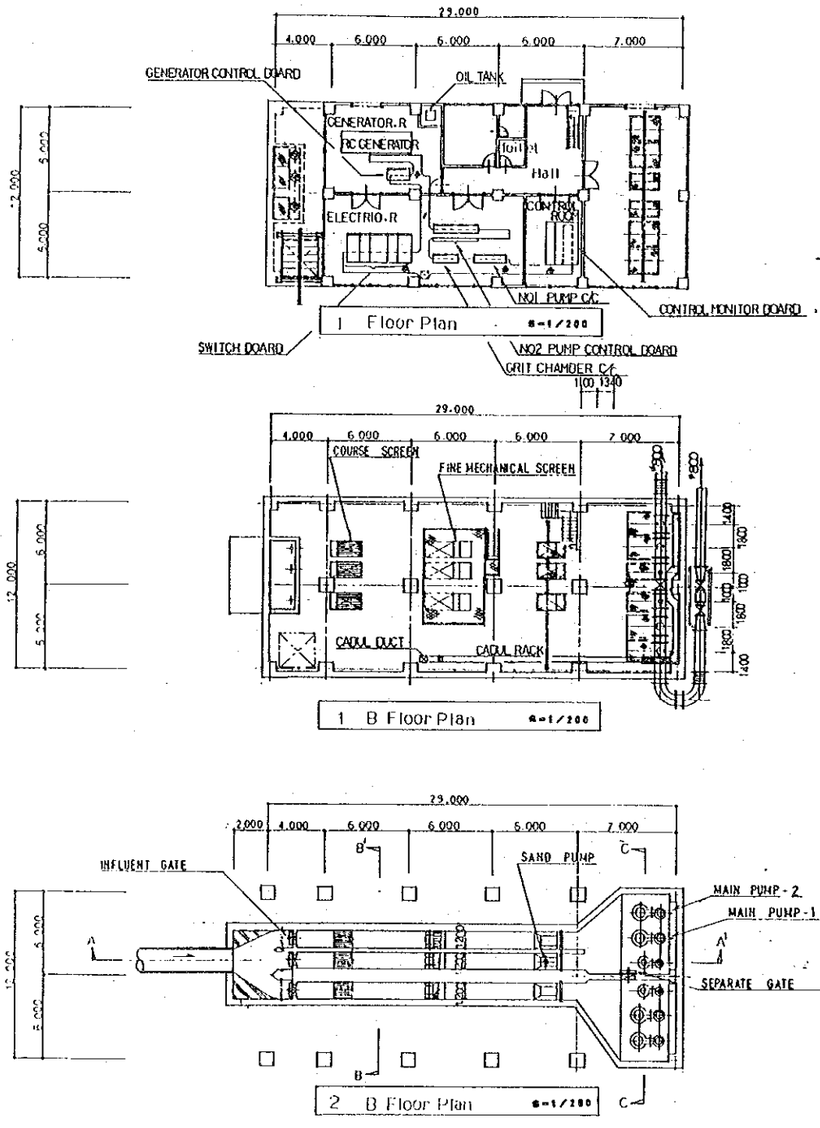
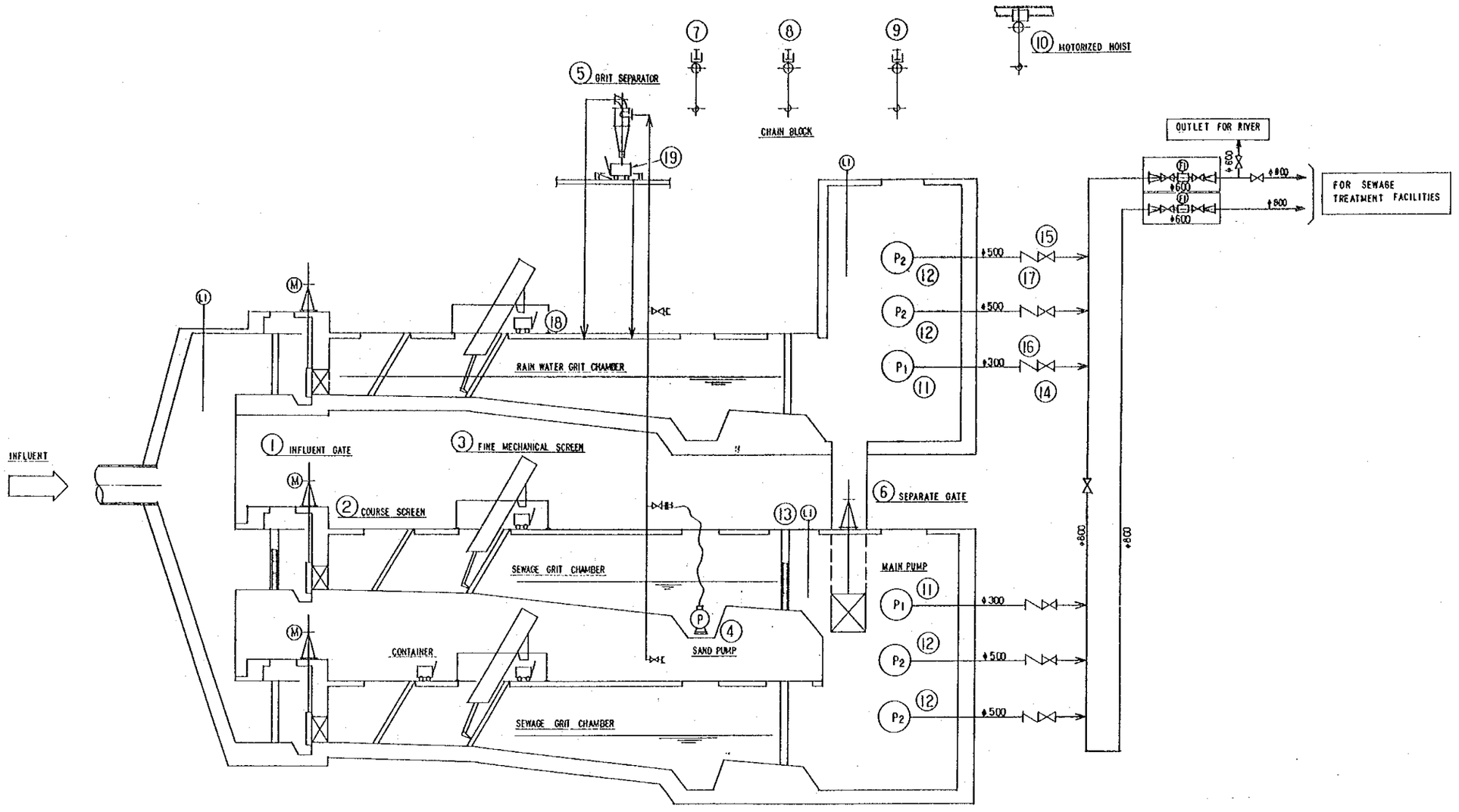


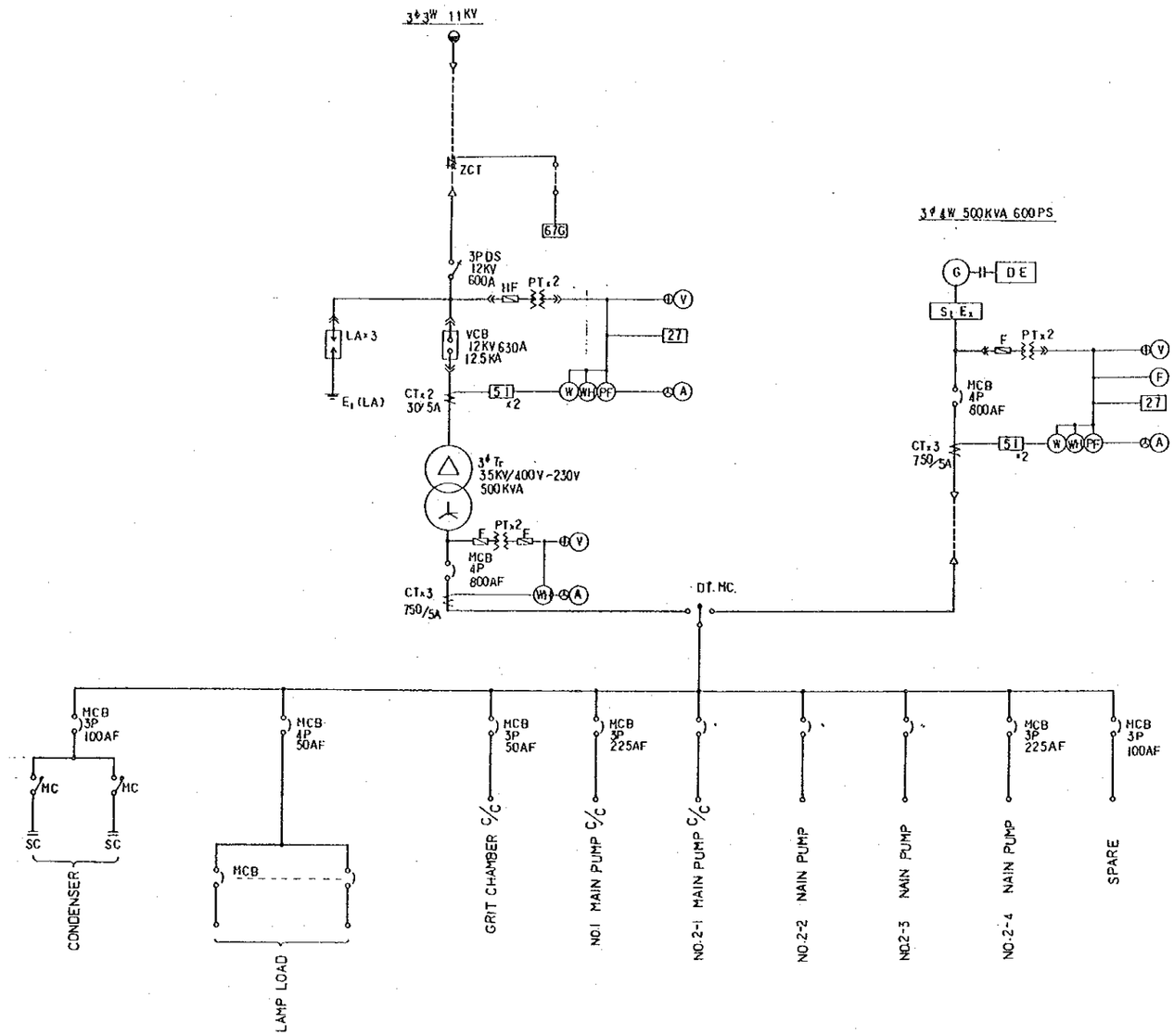
Fig. 4.1
PUMPING STATION (PS-1)
PLAN AND SECTION



	1	2	3	4	5	6	7	8	9	10	11
NAME	INFLUENT GATE	COURSE SCREEN	FINE MECHANICAL SCREEN	SAND PUMP	GRIT SEPARATOR	SEPARATE GATE	CHAIN BLOCK - 1	CHAIN BLOCK - 2	CHAIN BLOCK - 3	MOTORIZED HOIST	MAIN PUMP - 1
TYPE	CAST IRON MOTOR OPERATED GATE	HAND SCREEN	AUTOMATIC CONTINUOUS SCREEN	SUBMERSIBLE VORTEX PUMP	ALUMINUM, CYCLONE	CAST IRON MANUAL GATE	FOR SAND PUMP, TANDEM MOUNTING	FOR STOP LOG	FOR MAIN PUMP, TANDEM MOUNTING	FOR MAINTENANCE	DISCHARGE SUBMERSIBLE SEWAGE PUMP
SPECIFICATION	600W x 1000H	1200W x 2000H	1200W x 2000H, CLEARANCE : 25mm	φ100 x 0.6 m³/s x 16M	φ100 x 0.6 m³/s	800W x 800H	1 TON x 7M	0.5 TON x 7M	3 TON x 5M	2 TON x 6M	φ300 x 125 m³/s x 16M
POWER (KW)	0.75	—	2.2	7.5	—	—	—	—	—	4.0	55
QUANTITY TOTAL	3	3	3	1	1	1	1	1	1	1	2
QUANTITY SPARE	3	2	2	1	1	1	1	1	1	1	1
REMARKS											

	12	13	14	15	16	17	18	19
NAME	MAIN PUMP - 2	OUTLET STOP LOG	OUTLET VALVE FOR MAIN PUMP		CHECK VALVE FOR MAIN PUMP		SCREENING CONTAINER	GRIT CONTAINER
TYPE	DISCHARGE SUBMERSIBLE SEWAGE PUMP	FFU	OUTSIDE SCREW MANUAL VALVE		SWING TYPE CHECK VALVE		SUS TYPE	
SPECIFICATION	φ500 x 25 m³/s x 16M		φ300	φ500	φ300	φ500	CAPACITY; 0.3 m³	— ; 0.3 m³
POWER (KW)	110	—	—	—	—	—	—	
QUANTITY TOTAL	4 (1)	1	2	4	2	4	4	2
QUANTITY SPARE	3 (1)	1	2	4	2	4	2	1
REMARKS								

Fig. 4.7
PUMPING STATION (PS-1)
FLOW SHEET



SKELTON DIAGRAM

EXPLANATORY NOTES

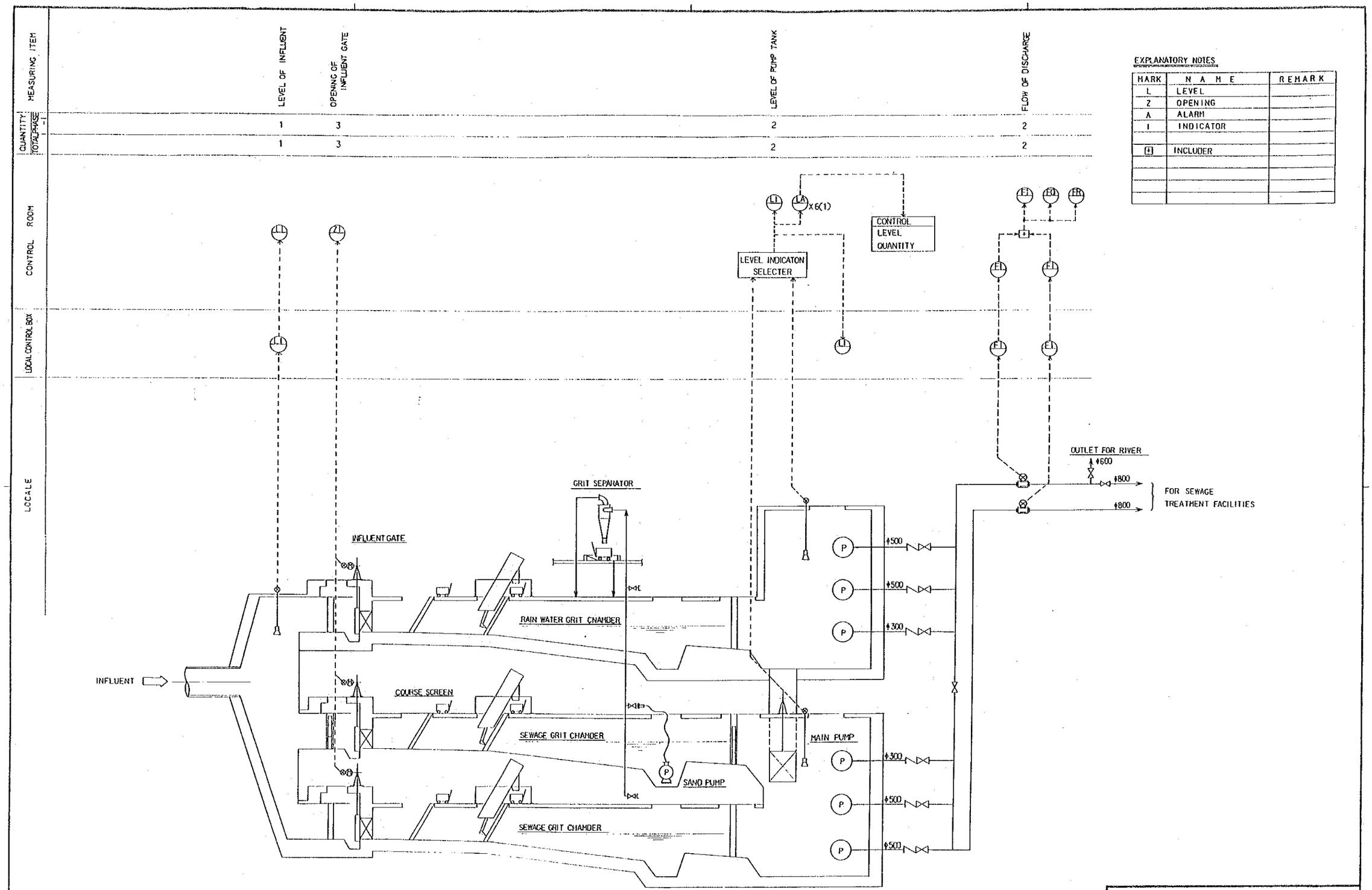
MARK	NAME	REMARK
VCB	VACUM CIRCUIT BREKER	
MCB	MOLDED CASE CIRCUIT BREAKER	
DS	DISCONNECTING SWICH	
LA.	ARRESTER	
Tr	TRANSFOMER	
SC	CONDENSER	
HF	HIGHT VOLTAG FUSE	
F	LOW VOLTAG FUSE	
CT	CURRENT TRANSFOMER	
PT	POTENTIAL TRANSFOMER	
G	AC. GERERATOR	
DE	DIESEL ENGINE	
Ⓐ	A.C. AMMETER	
Ⓐ	AMMETER CHANG-OVER SWICH	
Ⓥ	A.C. VOLTAG	
Ⓥ	VOLTAG CHANG-OVER SWICH	
Ⓦ	WATT METER	
Ⓦ	ELECTRIC ENERGY METER	
Ⓟf	POWER FACTOR INDICATOR	
Ⓕ	FREQUENCY METER	
27	UNDER VOLTAG RELAY	
51	OVER CURRENT RELAY	
67G	GROUND RELAY	

Fig. 4.8
PUMPING STATION
SKELTON DIAGRAM

MEASURING ITEM	LEVEL OF INFLUENT	OPENNING OF INFLUENT GATE	LEVEL OF PUMP TANK	FLOW OF DISCHARGE
QUANTITY TOTAL/PHASE - -	1	3	2	2
	1	3	2	2

EXPLANATORY NOTES

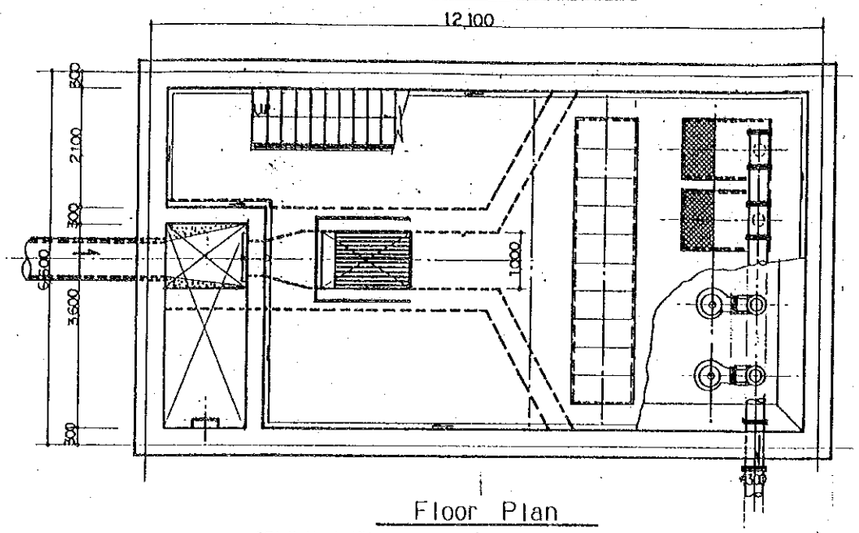
MARK	N A M E	REMARK
L	LEVEL	
Z	OPENING	
A	ALARM	
I	INDICATOR	
[+]	INCLUDER	



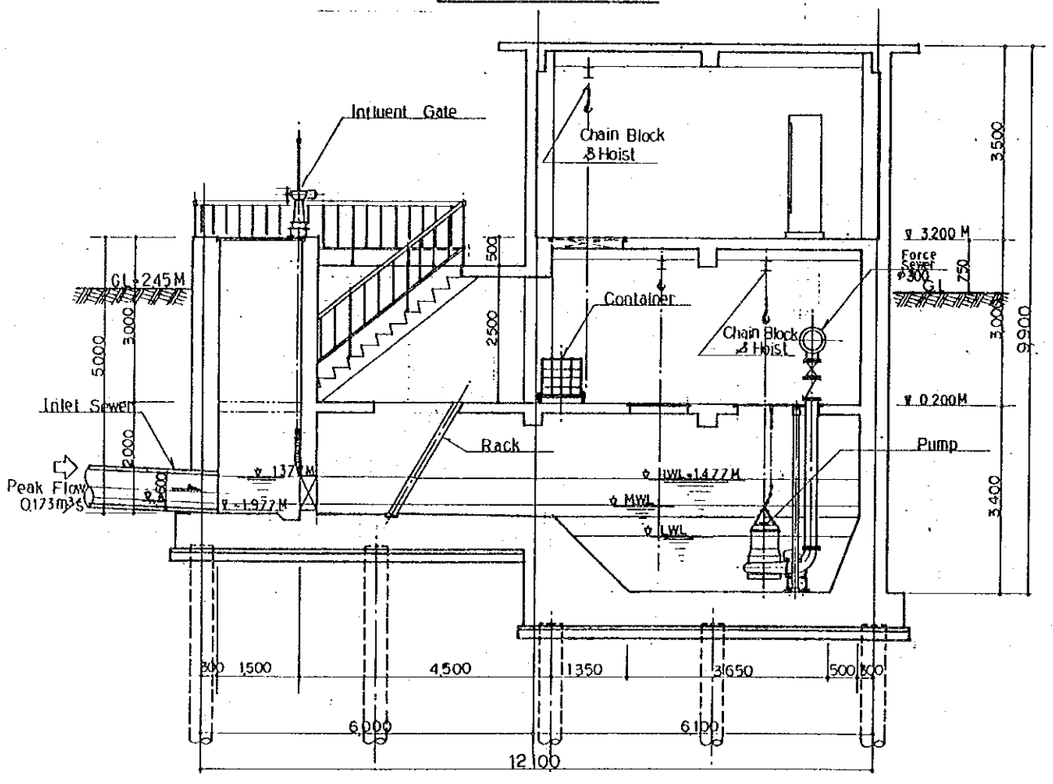
INSTRUMENTATION FLOW SHEET
(GRIT CHAMBER AND PUMPING EQUIPMENT)

Fig. 4.9
PUMPING STATION
INSTRUMENTATION FLOW SHEET

(PS-2) Relay Pumping Station Scale 1:50

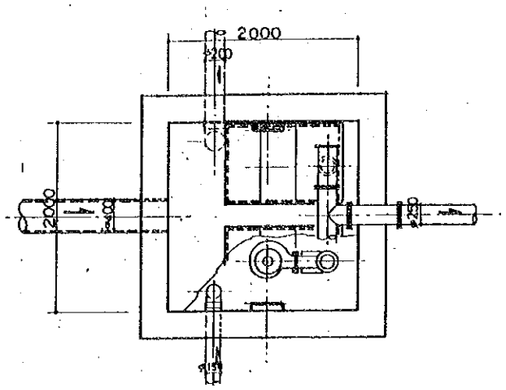


Floor Plan

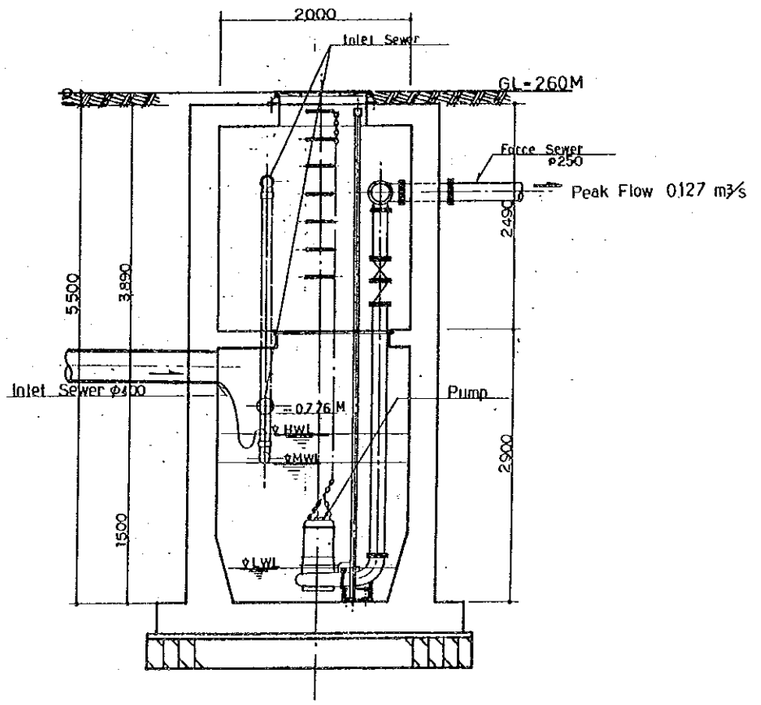


Section

L.S-1 Manhole Type Lift Station Scale 1:30



Floor Plan



Section

Fig. 4.10
LAYOUT OF RELAY PUMPING STATION & MANHOLE TYPE LIFT STATION

GENERAL PLAN

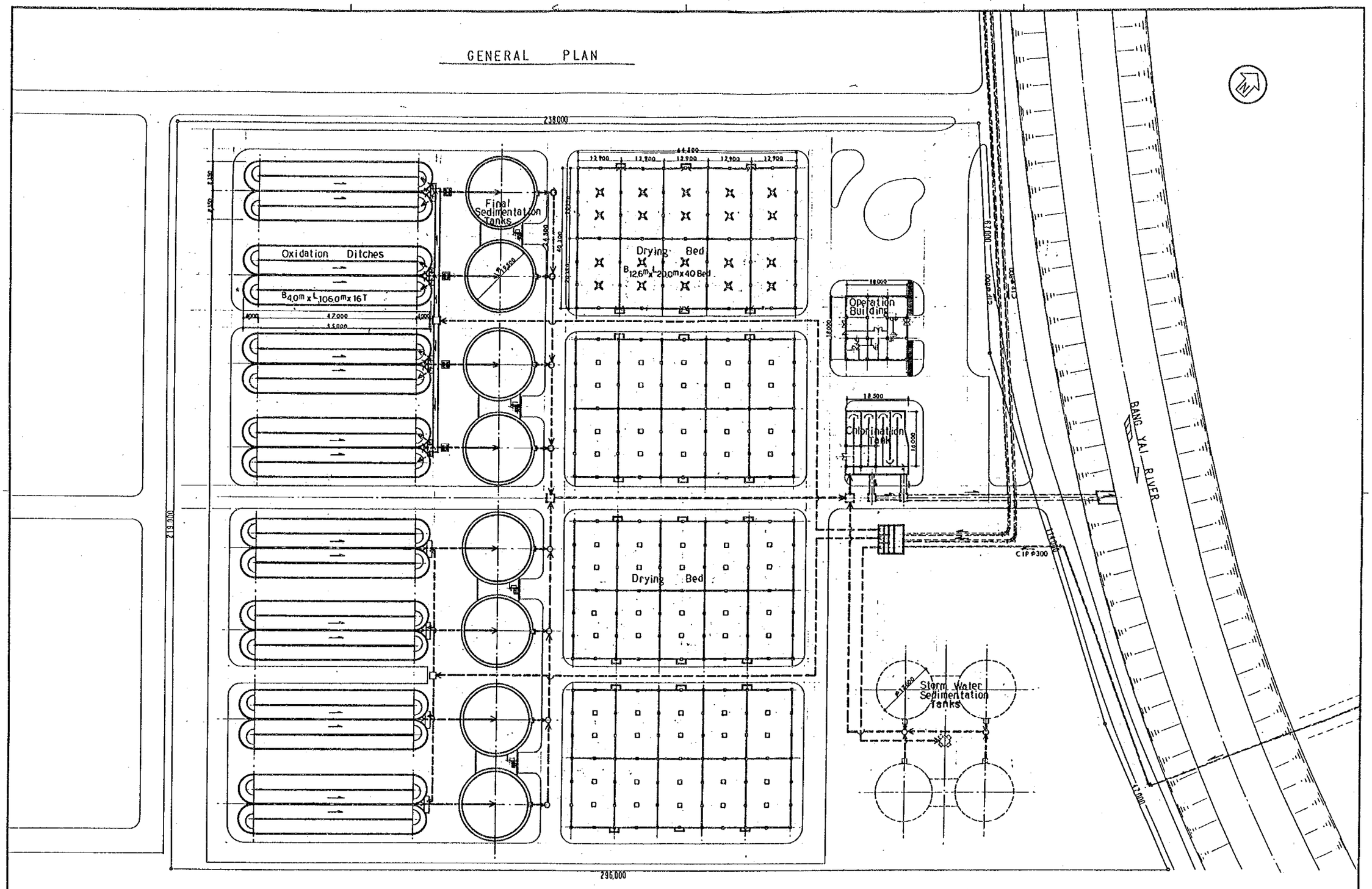


Fig. 4.11
SEWAGE TREATMENT PLANT
GENERAL PLAN

WATER LEVEL PLAN

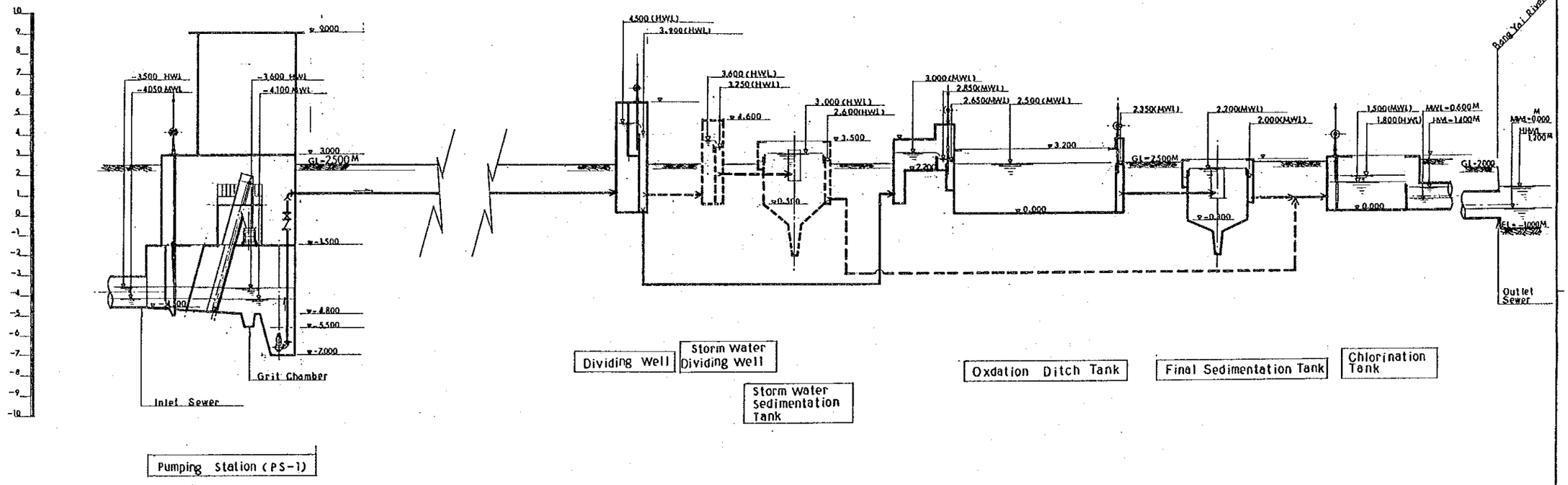
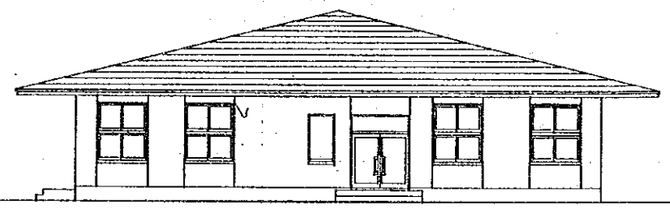
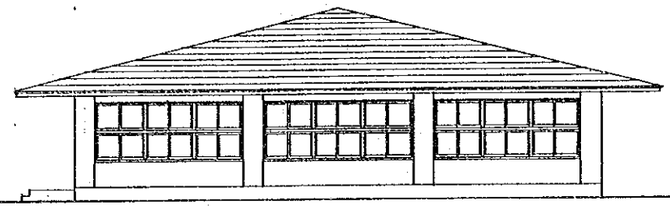


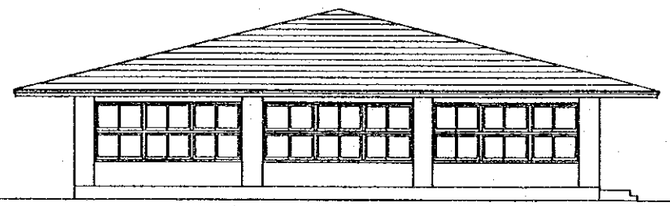
Fig. 4.12
PUMPING STATION & SEWAGE TREATMENT PLANT
WATER LEVEL PLAN



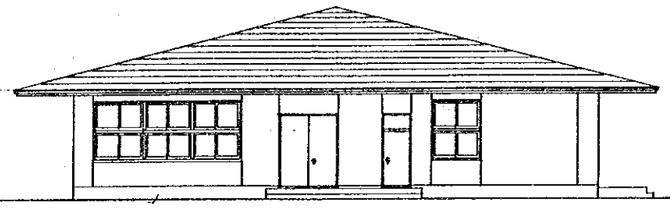
East Elevation S=1/100



North Elevation S=1/100

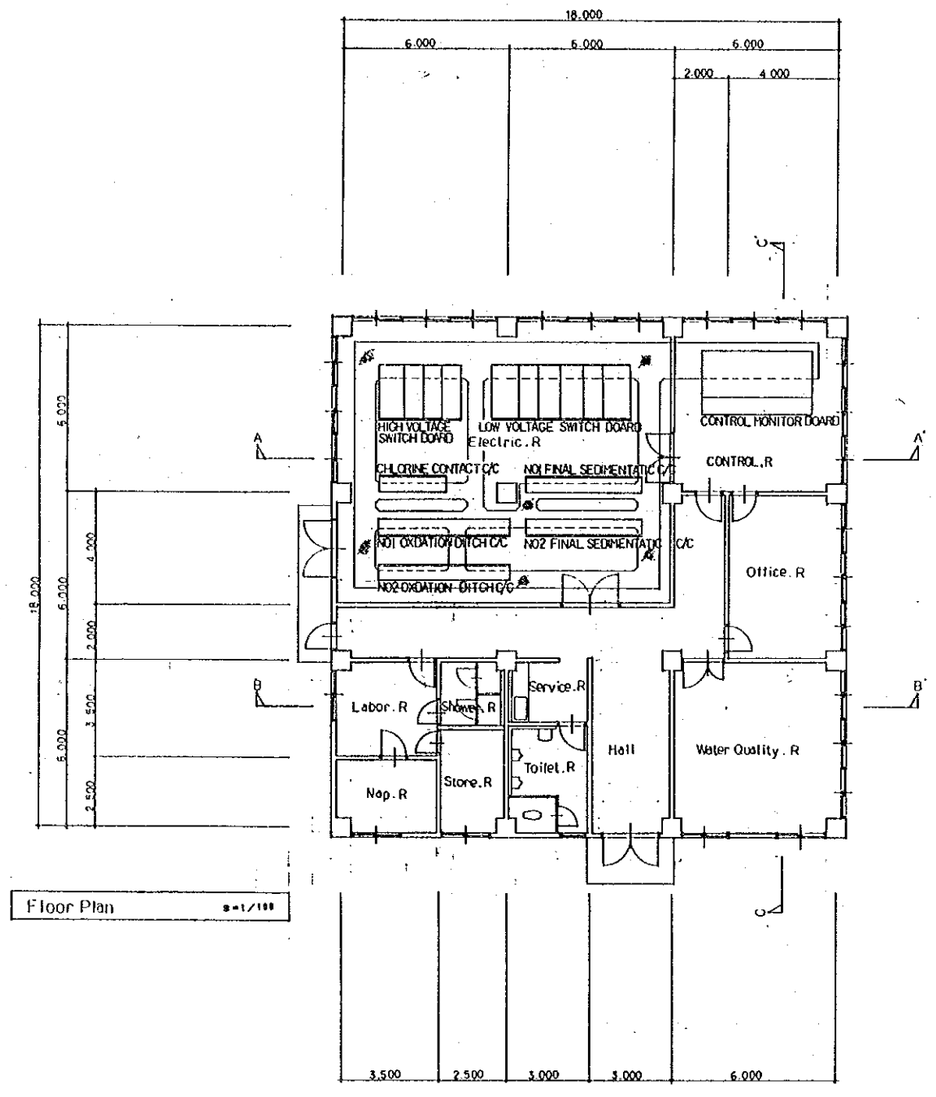


West Elevation S=1/100

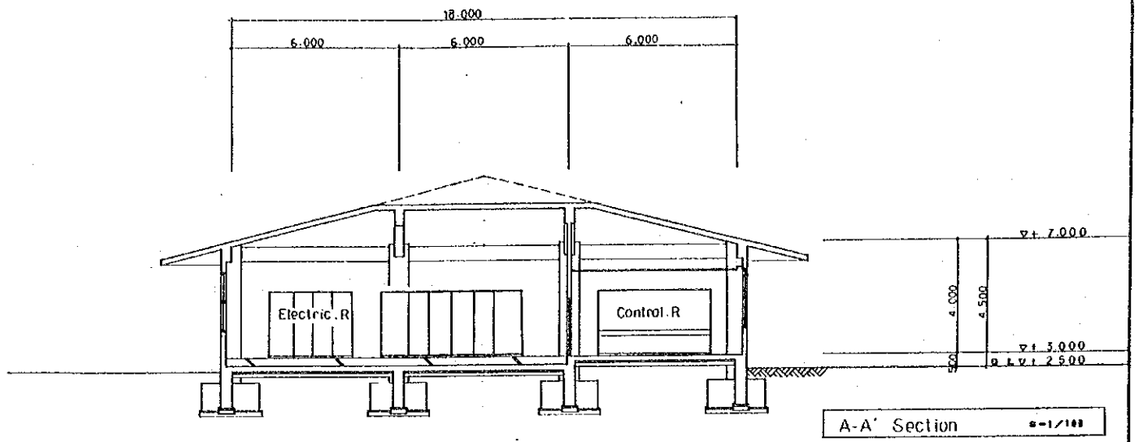


South Elevation S=1/100

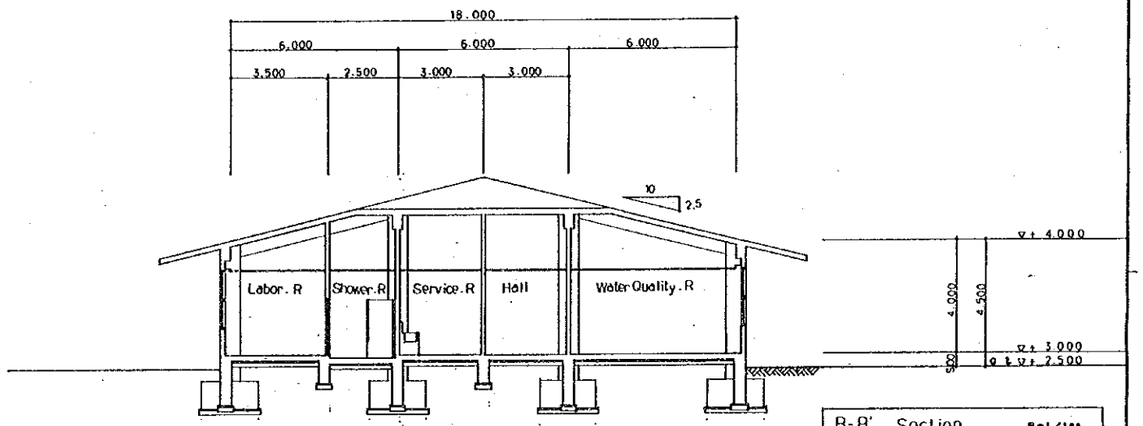
Fig. 4.13
SEWAGE TREATMENT PLANT
OPERATING BUILDING ELEVATION



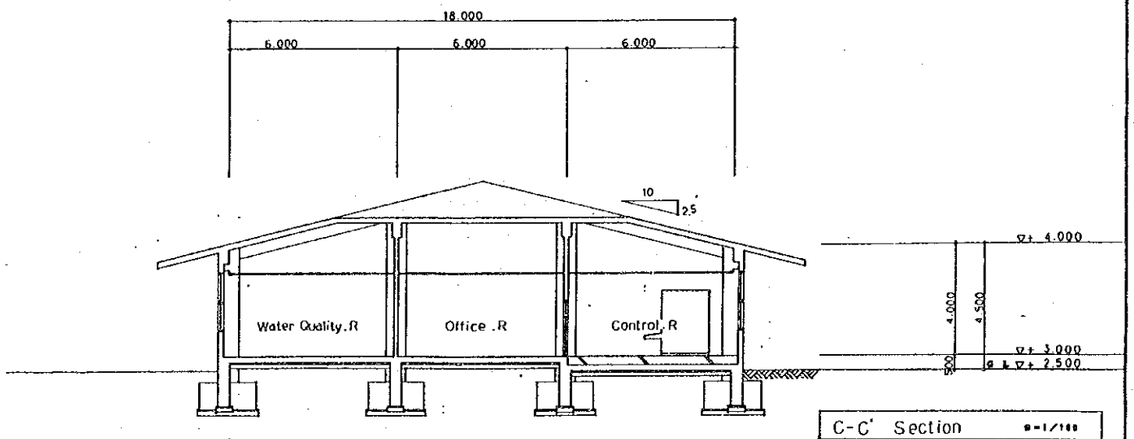
Floor Plan



A-A' Section

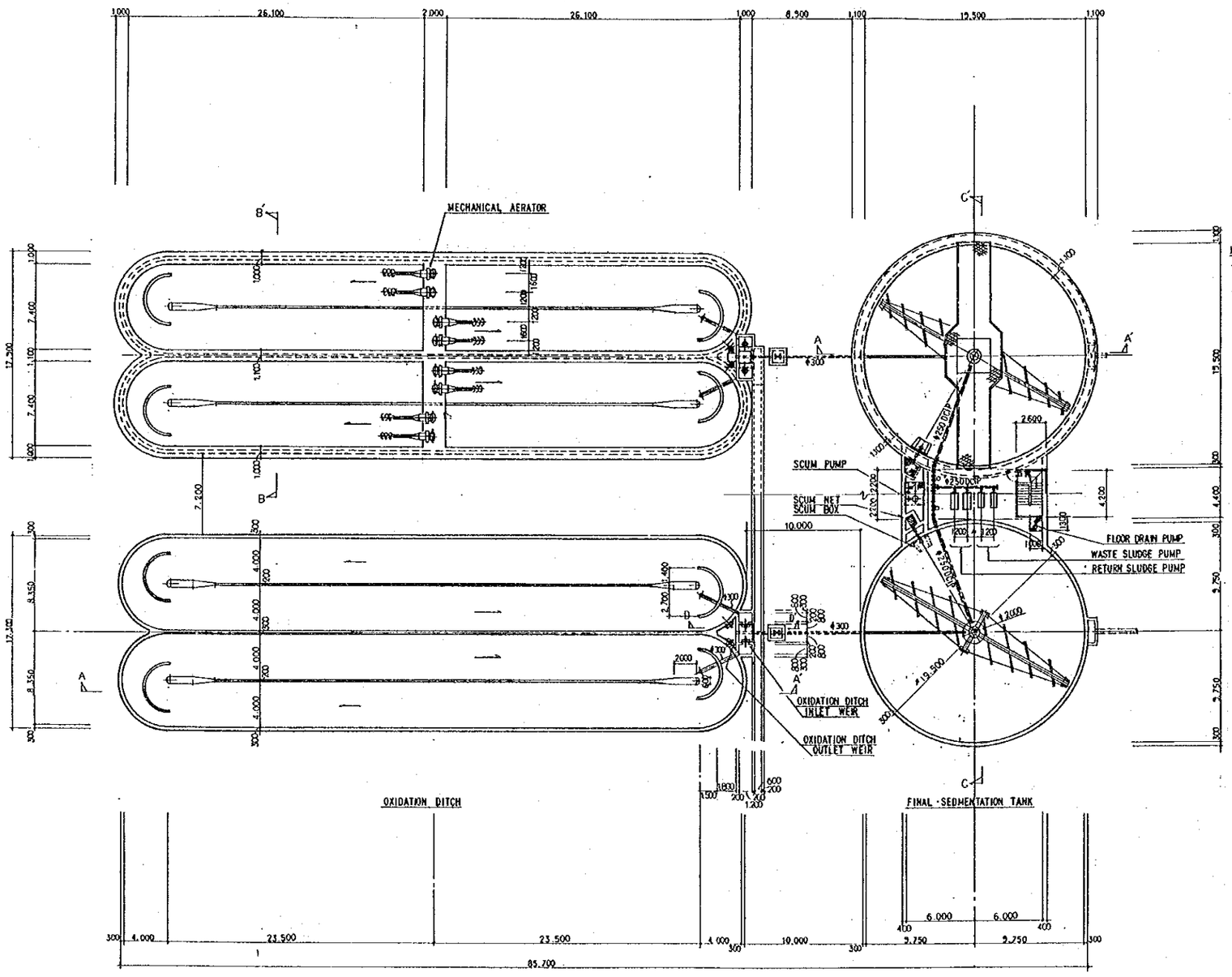


B-B' Section

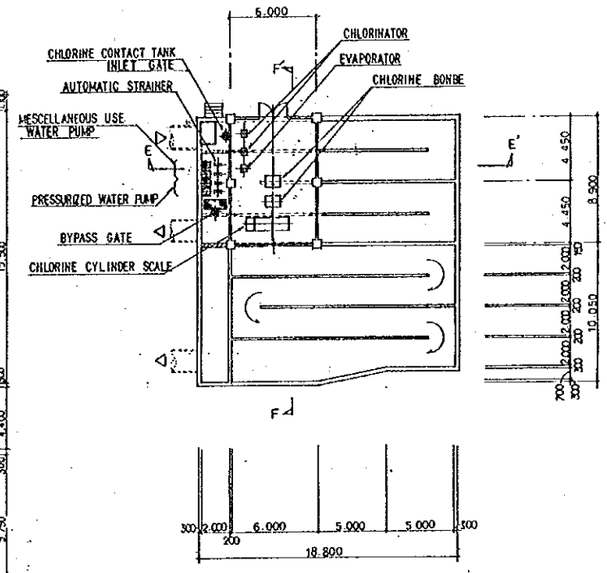


C-C' Section

Fig. 4.14
SEWAGE TREATMENT PLANT
OPERATING BUILDING PLAN AND SECTION



Floor Plan S=1/200

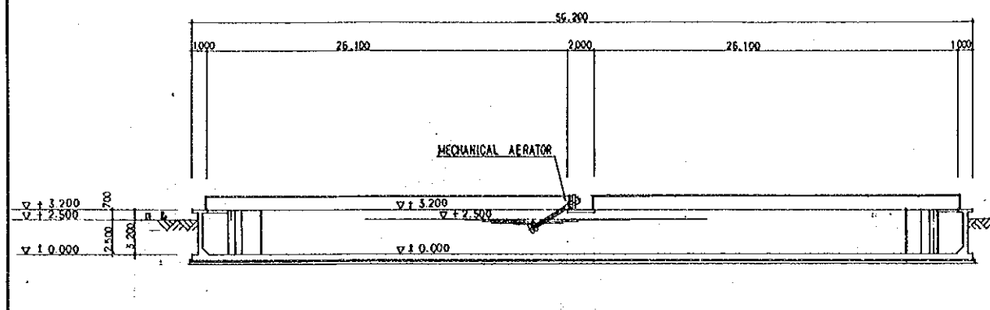


Floor Plan S=1/200

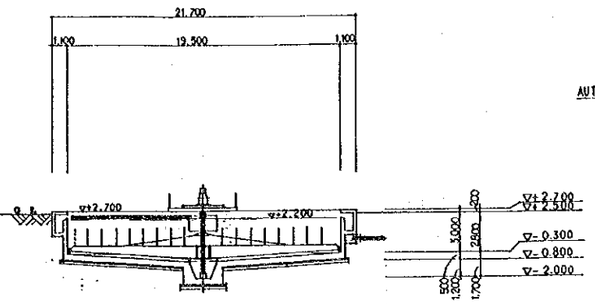
Fig. 4.15

SEWAGE TREATMENT PLANT

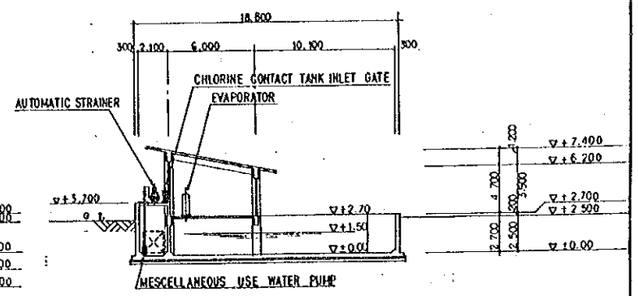
WASTEWATER TREATMENT FACILITY PLAN



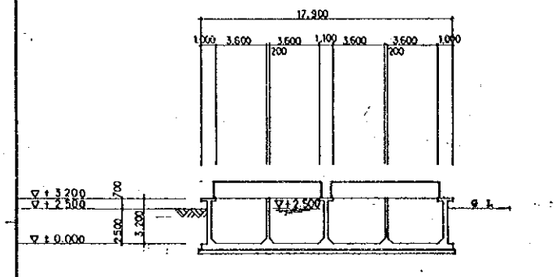
A-A´ Section S=1/200



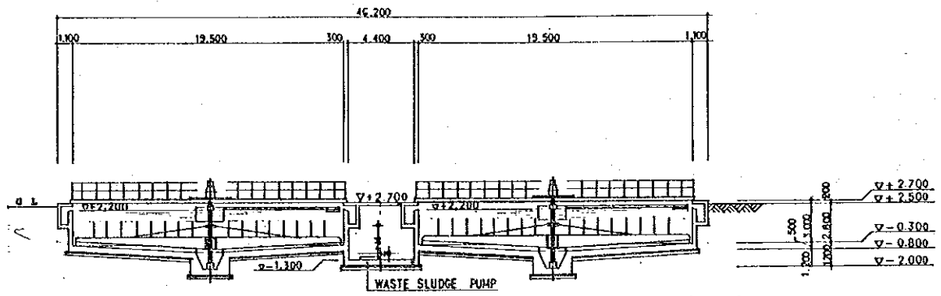
A-A´ Section S=1/200



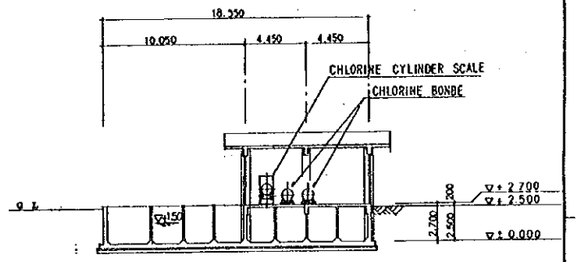
E-E´ Section S=1/200



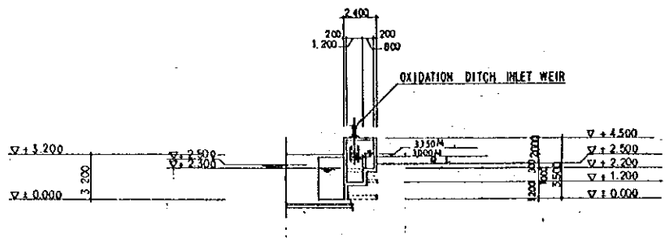
B-B´ Section S=1/200



C-C´ Section S=1/200

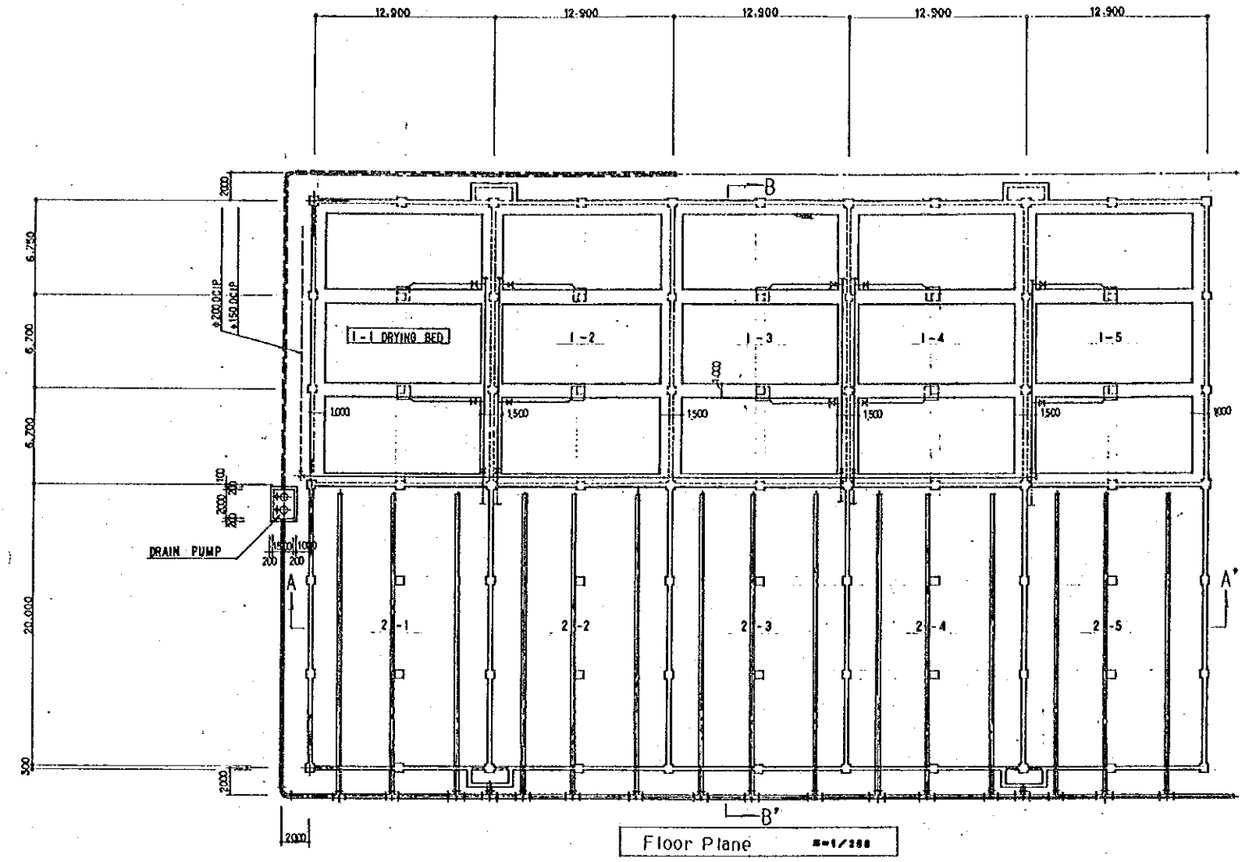


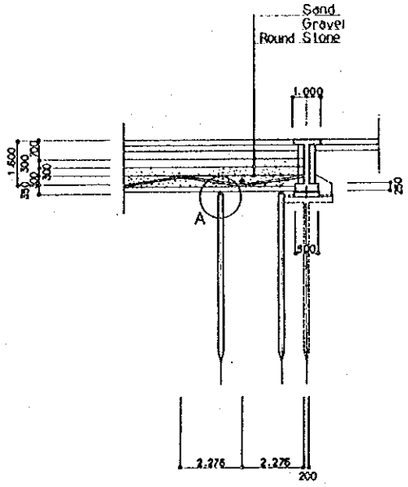
F-F´ Section S=1/200



D-D´ Section S=1/200

Fig. 4.16
SEWAGE TREATMENT PLANT
WASTEWATER TREATMENT FACILITY. SECTION





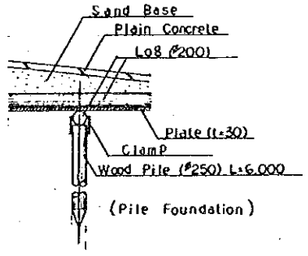
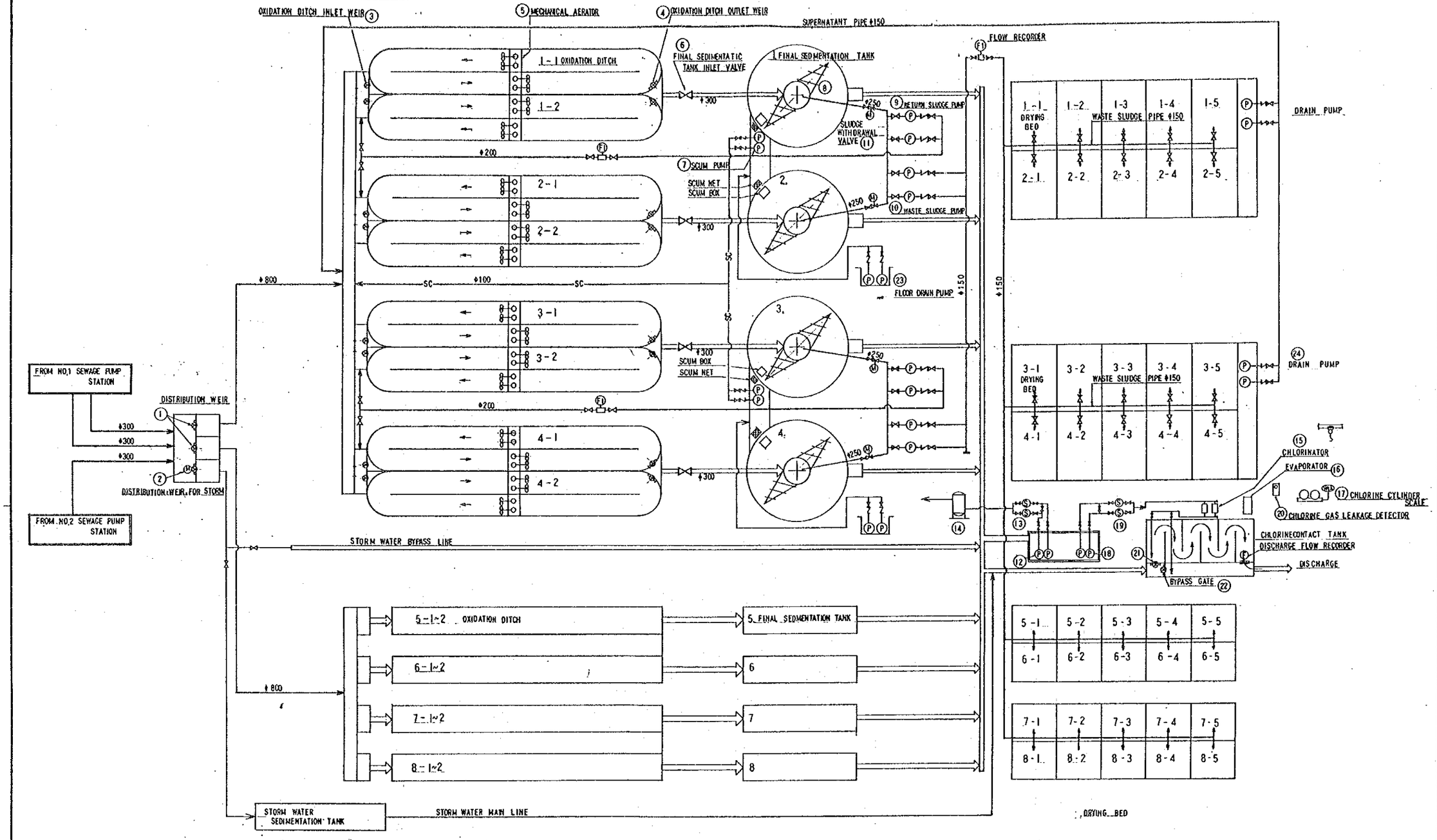


Fig. 4.17
SEWAGE TREATMENT PLANT
DRYING BED PLAN AND SECTION



	1	2	3	4	5	6	7	8	9	10	11	12
NAME	DISTRIBUTION WEIR	DISTRIBUTION WEIR FOR STORM WATER	OXIDATION DITCH INLET WEIR	OXIDATION DITCH OUTLET WEIR	MECHANICAL AERATOR	FINAL SEDIMENTATION TANK OUTSIDE SCREW INLET VALVE MANUAL VALVE	SCUM PUMP	SLUDGE COLLECTOR	RETURN SLUDGE PUMP	WASTE SLUDGE PUMP	SLUDGE WITHDRAWAL VALVE	MISCELLANEOUS USE WATER PUMP
TYPE	CAST IRON MANUAL WEIR	CAST IRON MOTER OPERATED	CAST IRON MANUAL WEIR	CAST IRON MANUAL WEIR	VERTICAL TYPE		SUBMERSIBLE PUMP	SUSPENDED CENTRALLY DRIVEN TYPE	NON-CLOSED SLUDGE PUMP		OUTSIDE SCREW MOTER OPERATED VALVE	SUBMERSIBLE PUMP
SPECIFICATION	1000W X 400H	1500W X 400H	500W X 300H	800W X 200H		φ300	φ80×0.6 M³/M×10M	6M 19500mm X 2500mm	φ125×16 M³/M×5M	φ100×10 M³/M×10M	φ250	φ65×0.3 M³/M×20M
POWER (KW)	—	1.5	—	—	3.7	—	3.7	0.75	5.5	5.5	0.2	2.2
QUANTITY TOTAL	2	1	16	16	64	8	8 (4)	8	6	8 (4)	8	2 (1)
QUANTITY PHASE	2	1	8	8	32	4	4 (2)	4	4	4 (2)	4	2 (1)
REMARKS		PHASE : MANUAL										

	13	14	15	16	17	18	19	20	21	22	23	24
NAME	AUTOMATIC STRAINER	PRESSURIZED WATER TANK	CHLORINATION	EVAPORATOR	CHLORINE CYLINDER SCALE	PRESSURIZED WATER PUMP	AUTOMATIC STRAINER	CHLORINE GAS LEAKAGE DETECTOR	CHLORINE CONTACT TANK INLET GATE	BY-PASS GATE	FLOOR DRAIN PUMP	DRAIN PUMP
TYPE			VACUUM TYPE			SUBMERSIBLE PUMP			CAST IRON MANUAL GATE	CAST IRON MANUAL GATE	SUBMERSIBLE PUMP	DISSORPTION SUBMERSIBLE SEWAGE PUMP
SPECIFICATION	φ65 X 0.3 M³/M	CAPACITY: 2M³	1.0~10 KG/H	50KG/H	1 TON	φ50 X 0.12 M³/M X 40M	φ50 X 0.12 M³/M		1500W X 1500H	1500W X 1500H	φ50 X 0.2 M³/M X 10M	φ100 X 1.5 M³/M X 10M
POWER (KW)	0.2	—	30VA	5.1	—	3.7	0.2	—	—	—	1.5	5.5
QUANTITY TOTAL	2 (1)	1	2 (1)	2 (1)	1	2 (1)	2 (1)	1	1	1	8 (4)	8 (4)
QUANTITY PHASE	2 (1)	1	2 (1)	2 (1)	1	2 (1)	2 (1)	1	1	1	4 (2)	4 (2)
REMARKS												

Fig. 4.18
SEWAGE TREATMENT PLANT
FLOW SHEET