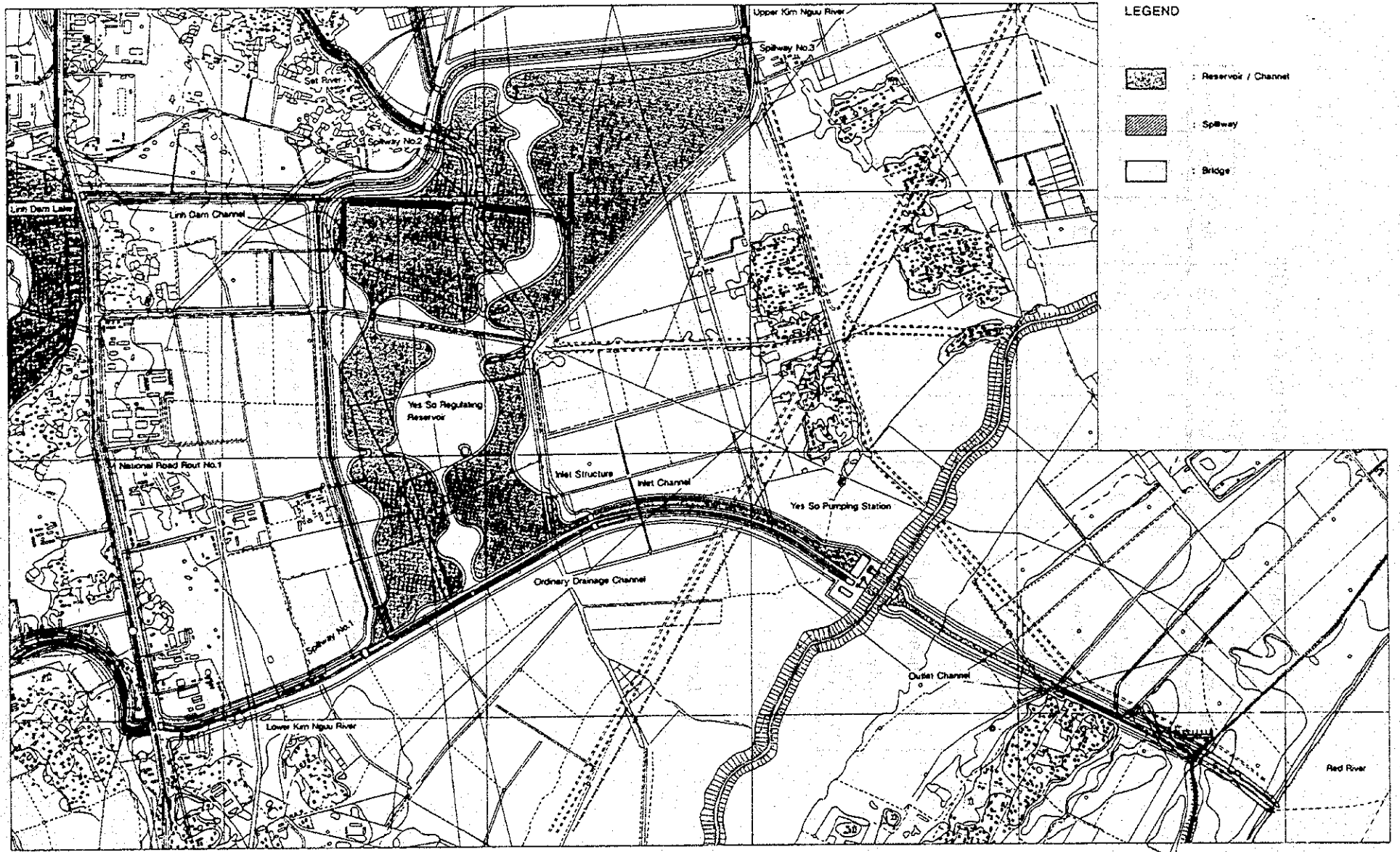

SOCIALIST REPUBLIC OF VIET NAM
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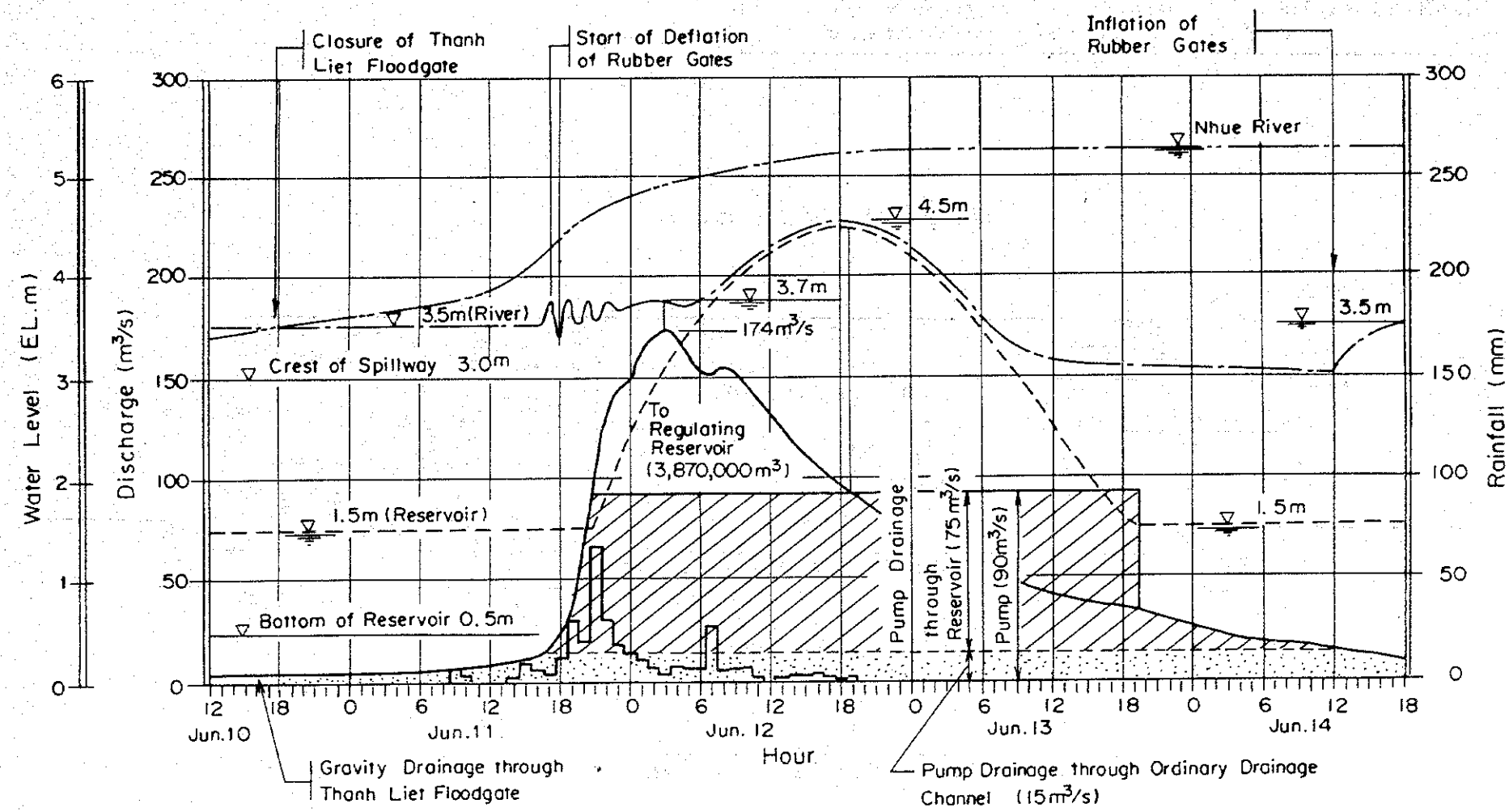
Fig. 3.1
PLAN OF YEN SO SITE



Legend :

Water Level

Discharge

Rainfall

Note :

10-Year return period design flood (1989-Flood Type)

SOCIALIST REPUBLIC OF VIET NAM
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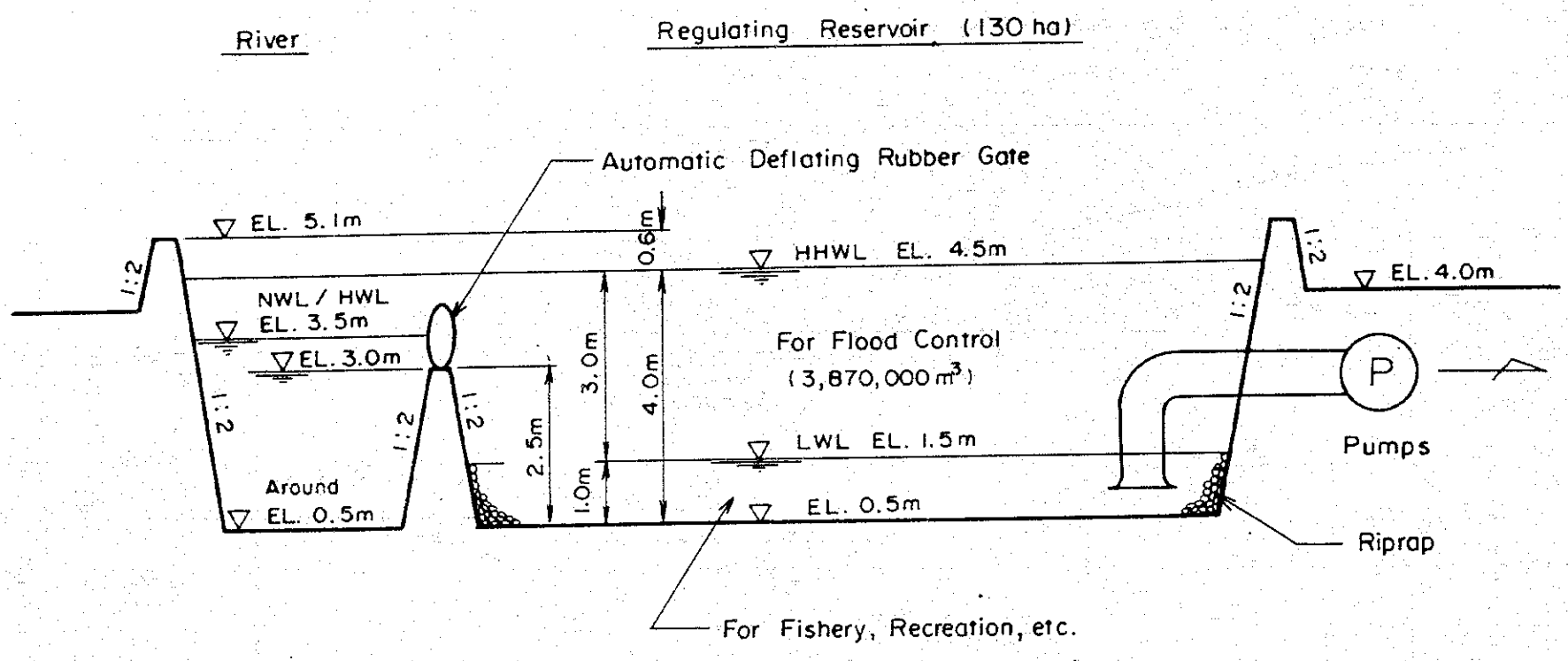
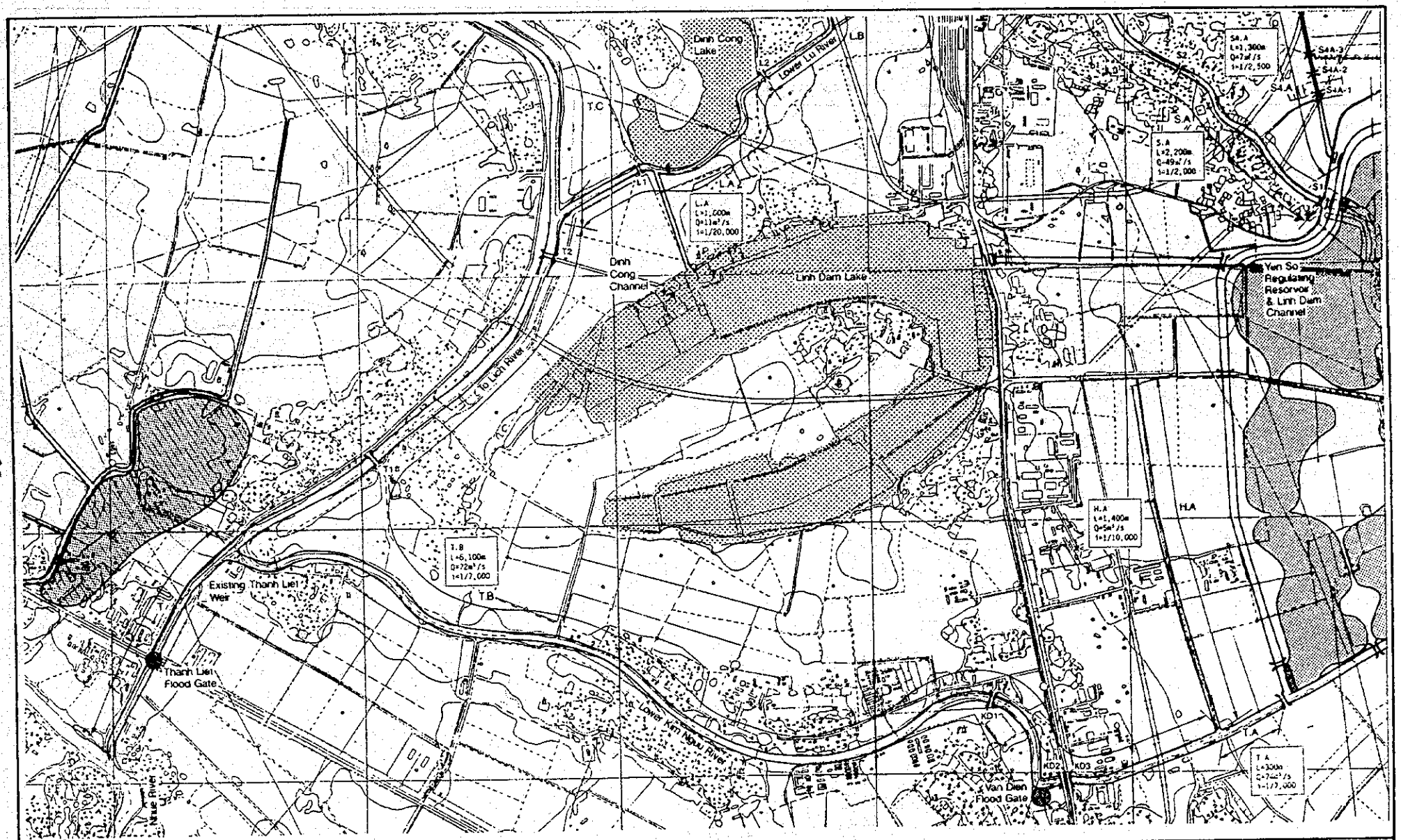
Fig. 3.2
OPERATION OF PUMPS, RESERVOIR AND FLOODGATE FOR DESIGN FLOOD



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.3 SECTION OF YEN SO REGULATING RESERVOIR



SOCIALIST REPUBLIC OF VIET NAM
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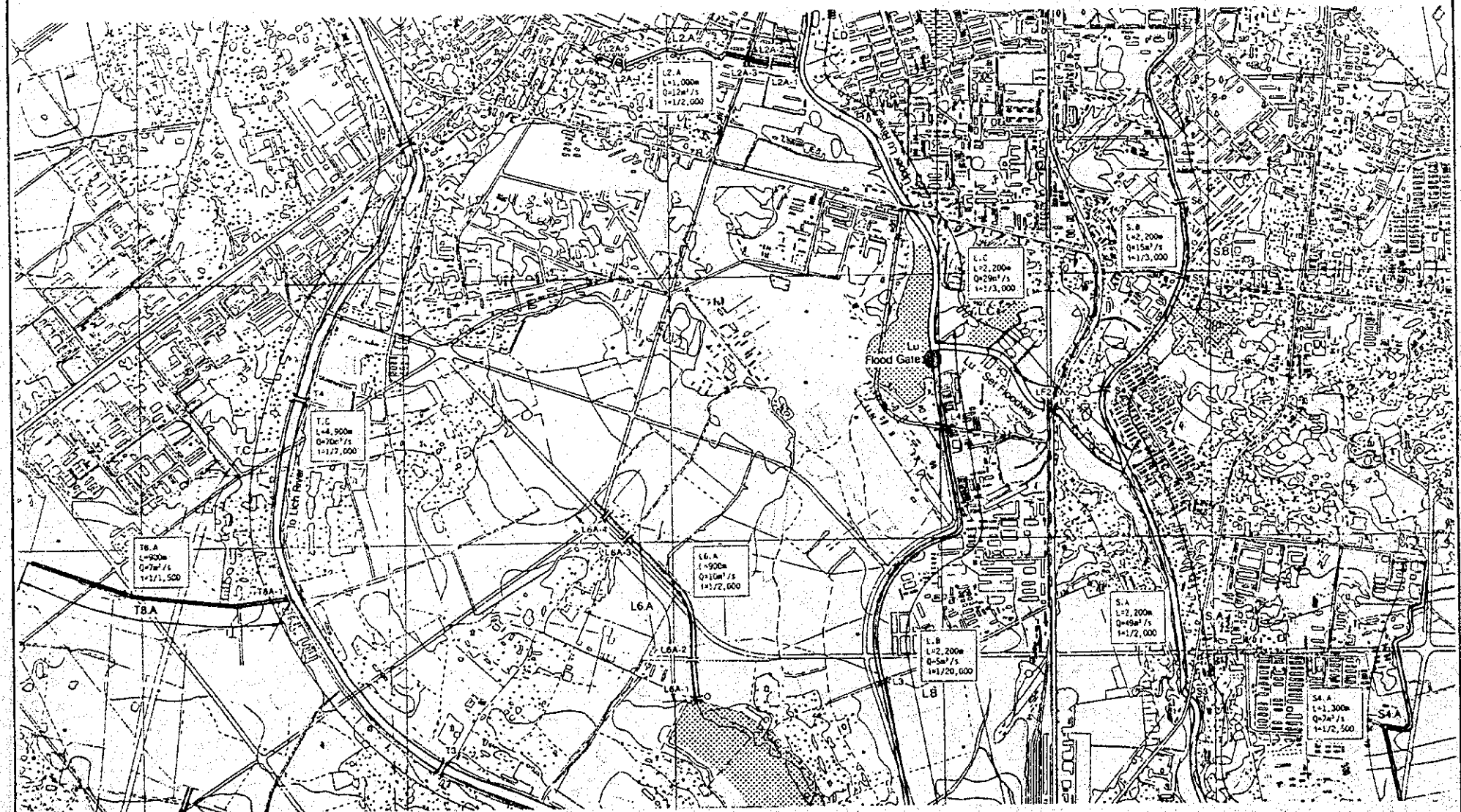
Fig. 3.4 (1)
PLANS OF RIVERS AND DRAINAGE CHANNEL (1/5)



SOCIALIST REPUBLIC OF VIET NAM
THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY
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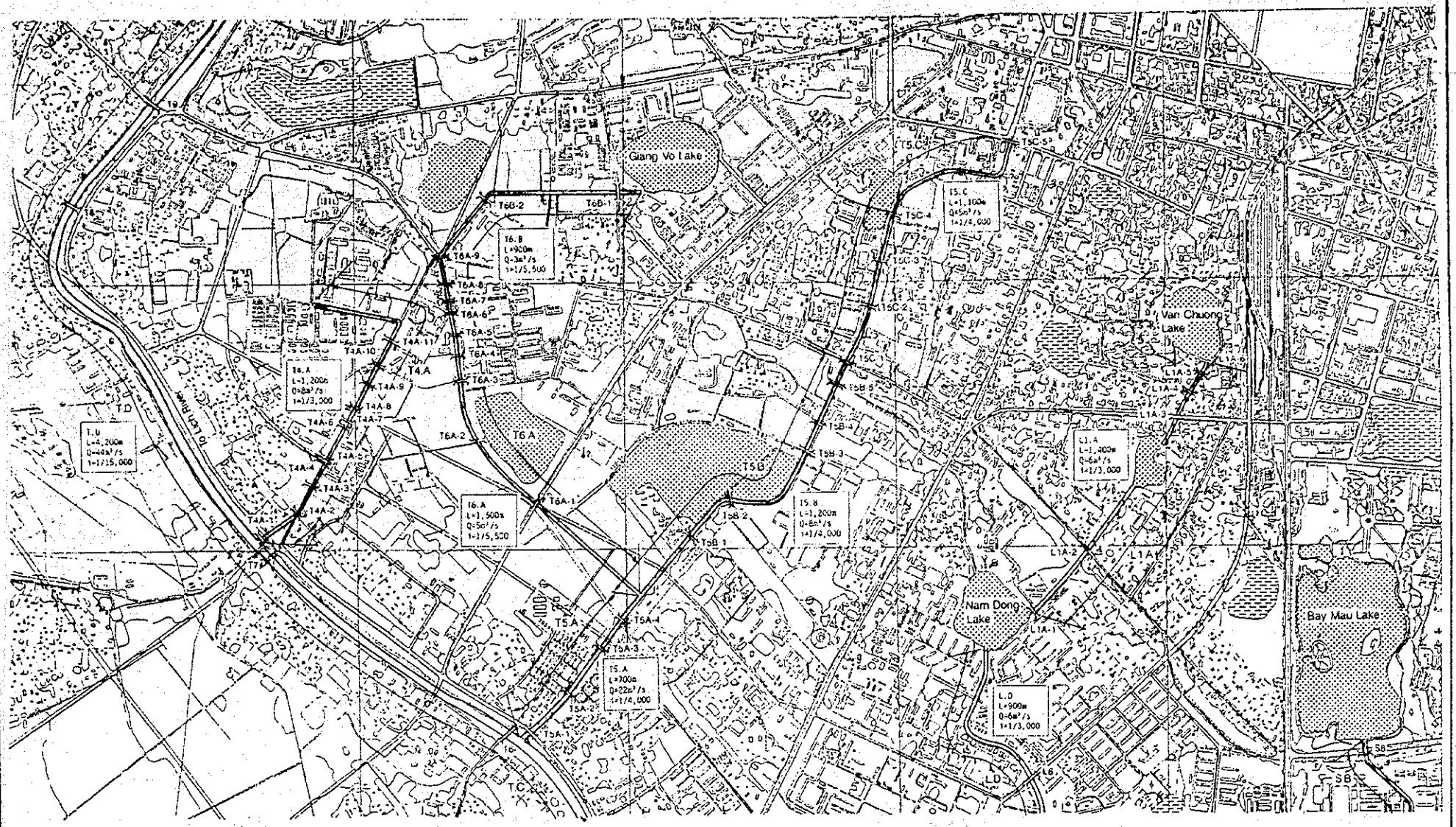
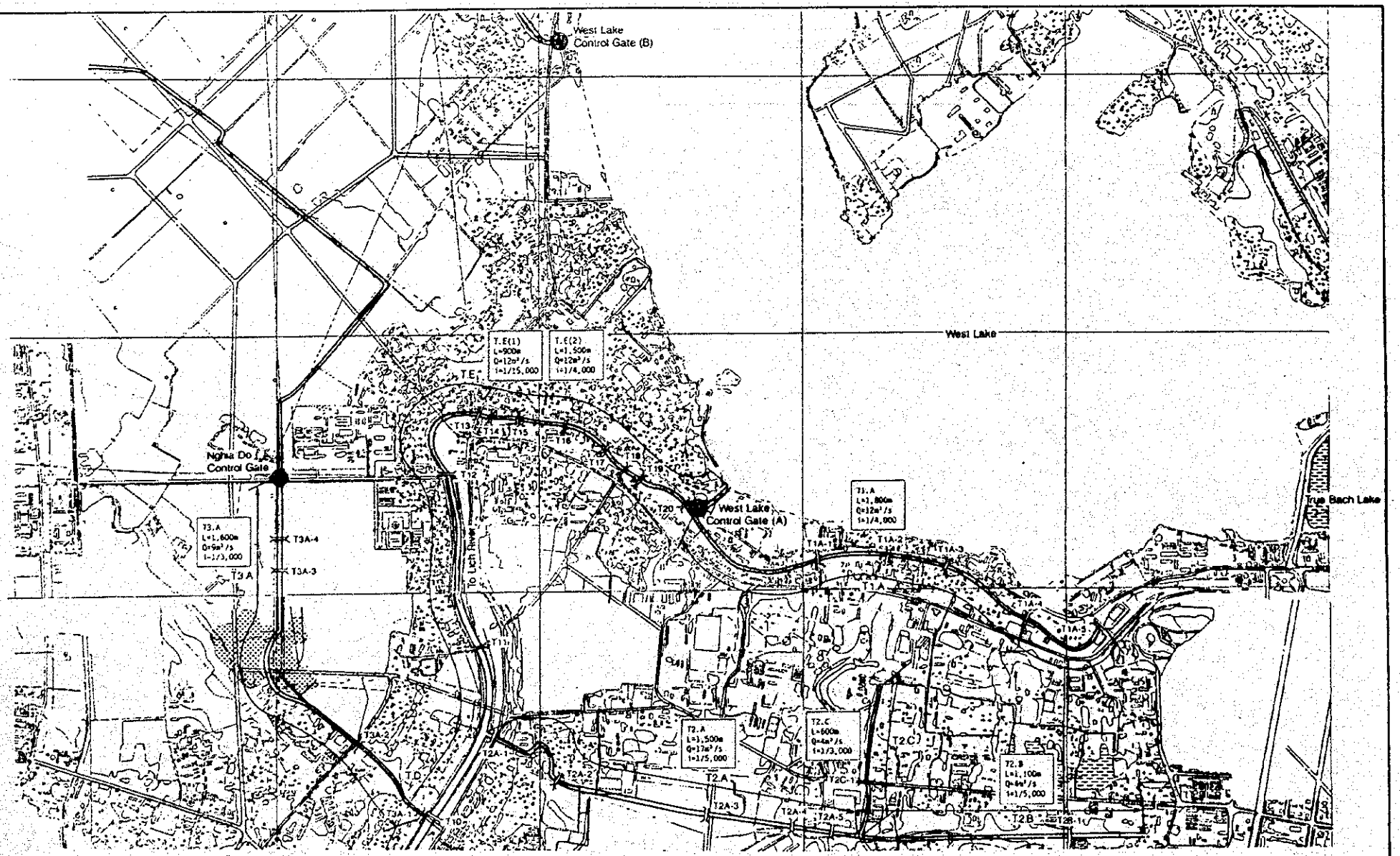
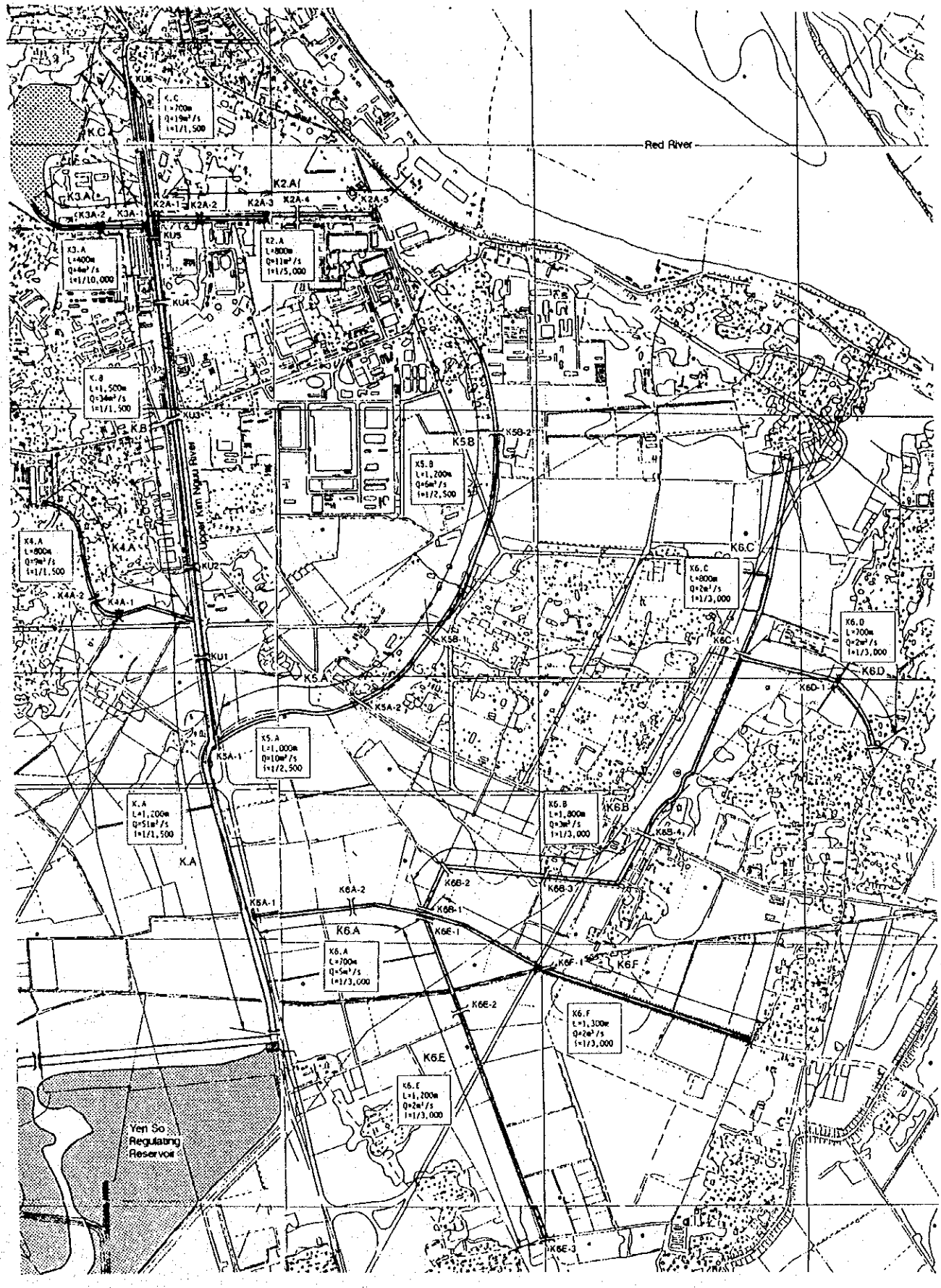
Fig. 3.4 (2)
PLANS OF RIVERS AND DRAINAGE CHANNEL (2/5)



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.4 (3) **PLANS OF RIVERS AND DRAINAGE CHANNEL (3/5)**



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. 3.4 (4)** **PLANS OF RIVERS AND DRAINAGE CHANNEL (4/5)**



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.4 (5) PLANS OF RIVERS AND DRAINAGE CHANNEL (5/5)

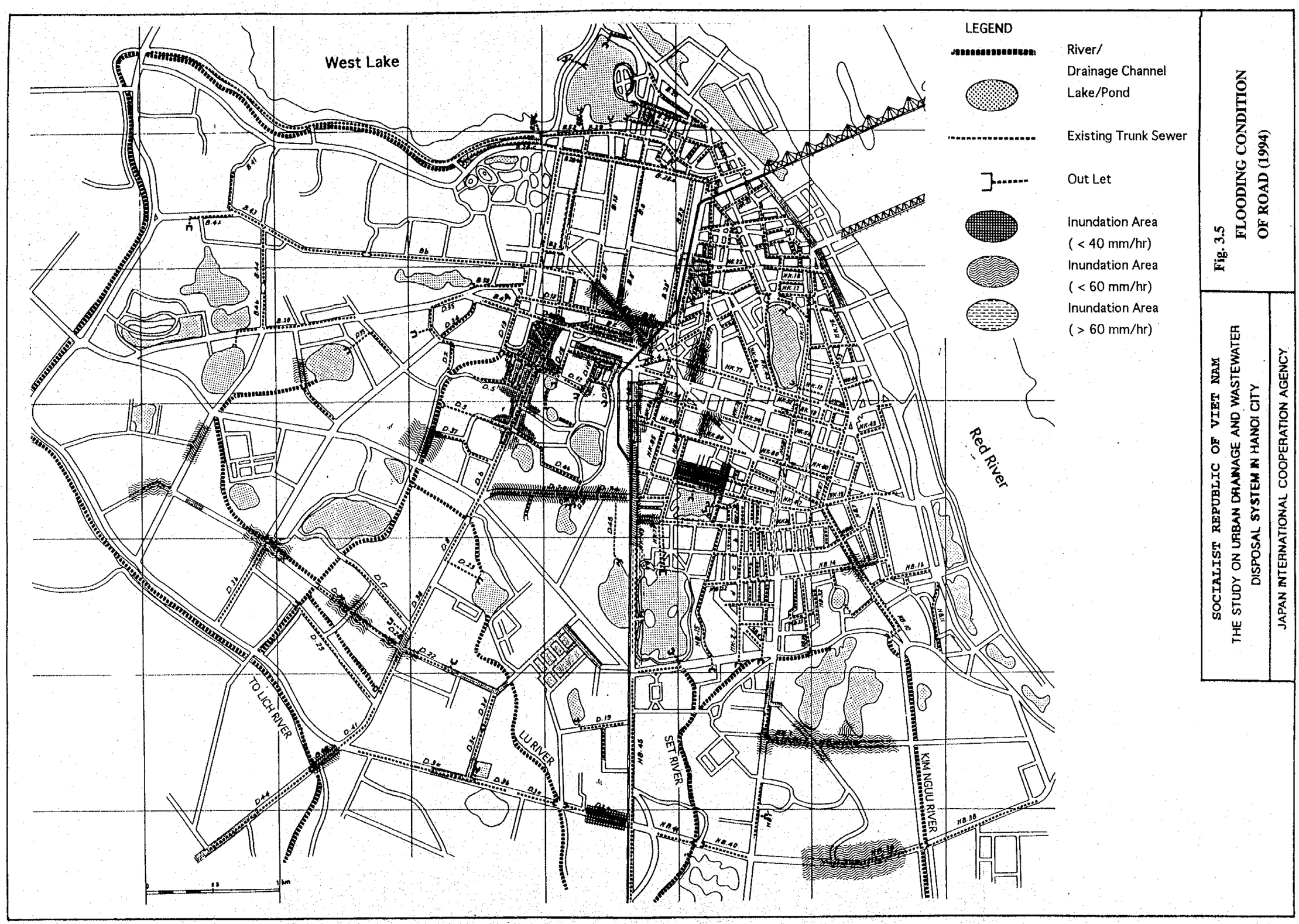


Fig. 3.5
FLOODING CONDITION
OF ROAD (1994)

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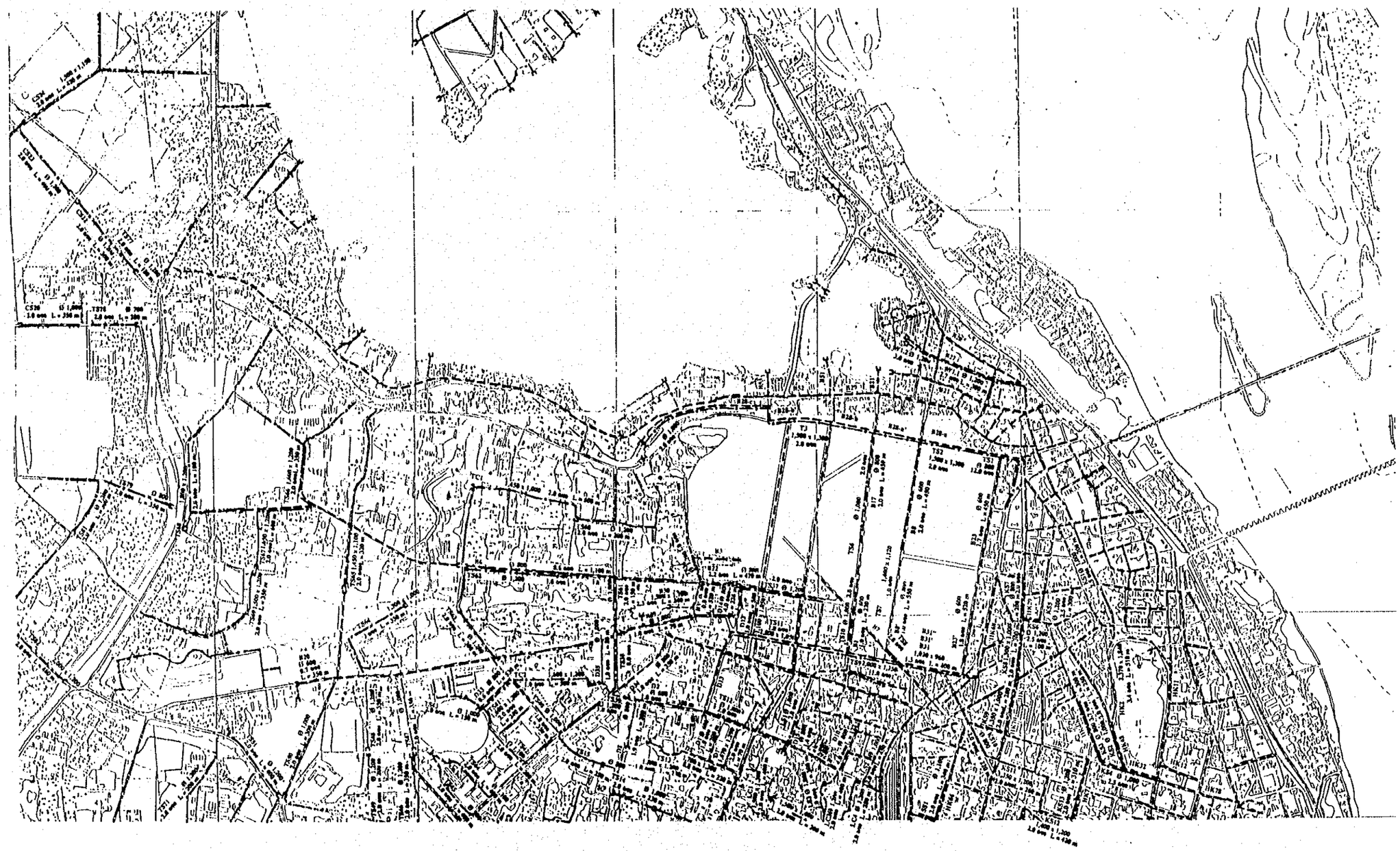
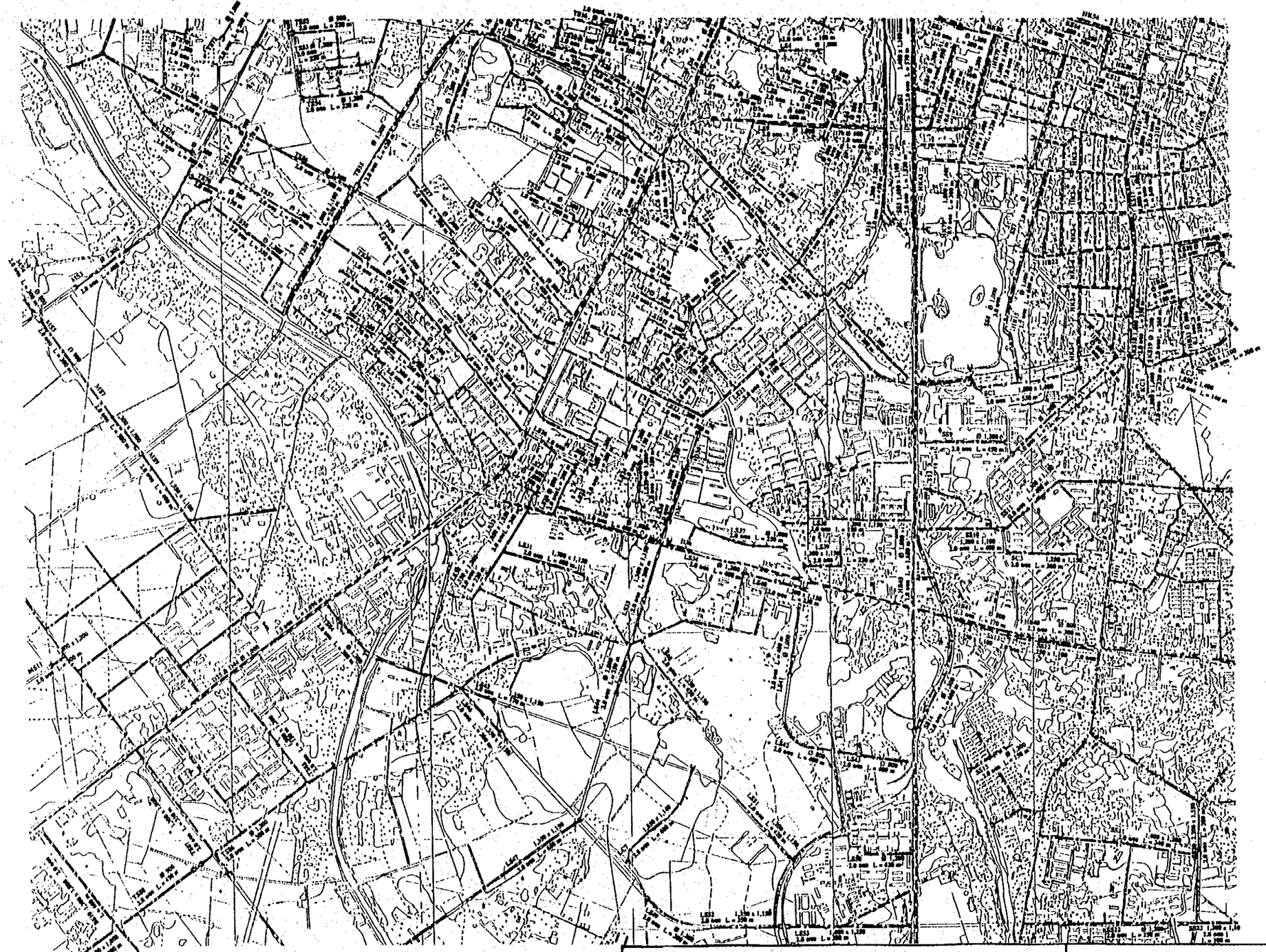
SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.6 (1) LAYOUT PLAN FOR SEWER REHABILITATION AND CONSTRUCTION (1/5)



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.6 (2) LAYOUT PLAN FOR SEWER REHABILITATION AND CONSTRUCTION (2/5)



SOCIALIST REPUBLIC OF VIET NAM

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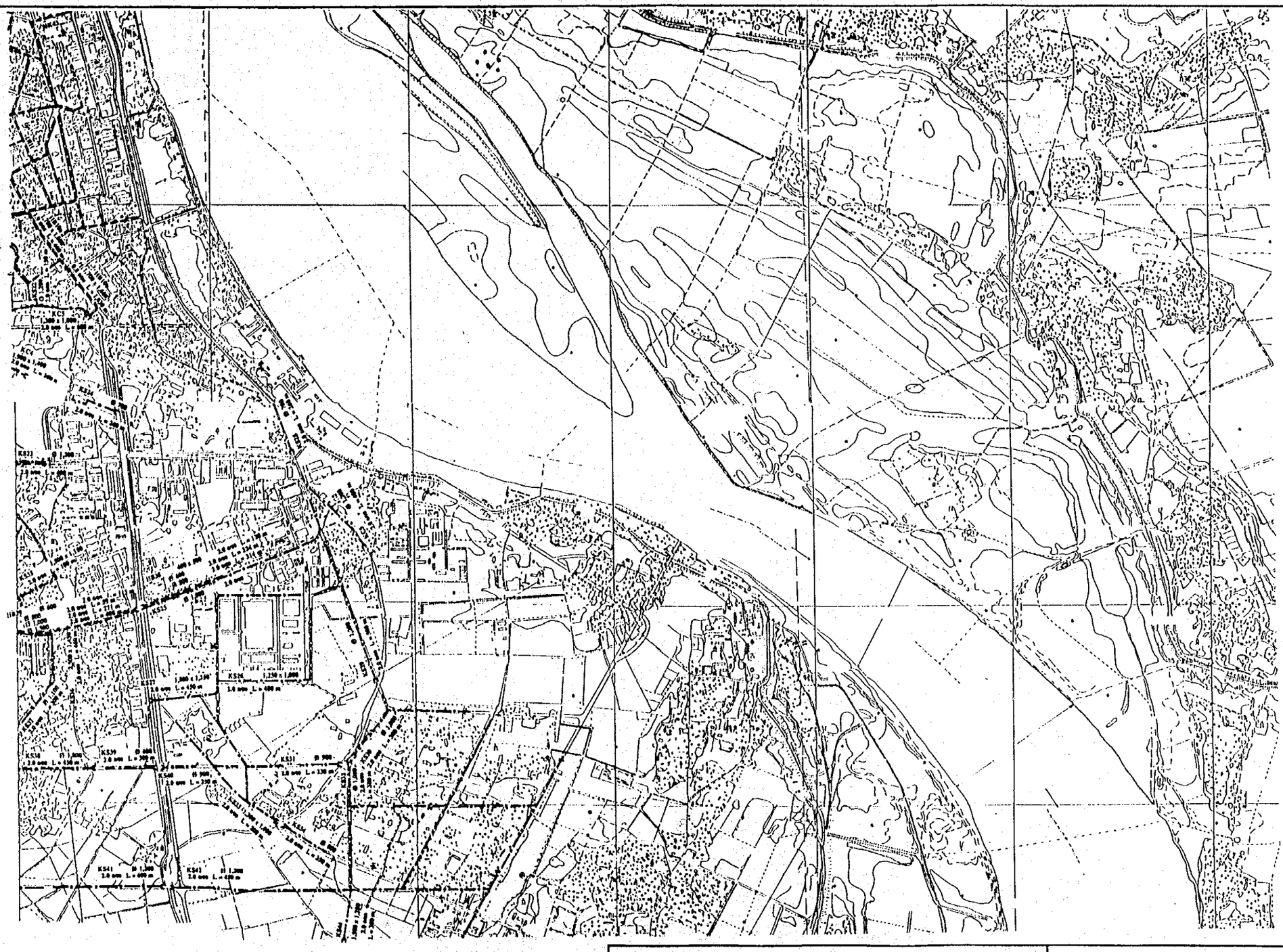
Fig. 3.6 (3)

LAYOUT PLAN FOR SEWER REHABILITATION AND CONSTRUCTION (3/5)



SOCIALIST REPUBLIC OF VIET NAM

THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY

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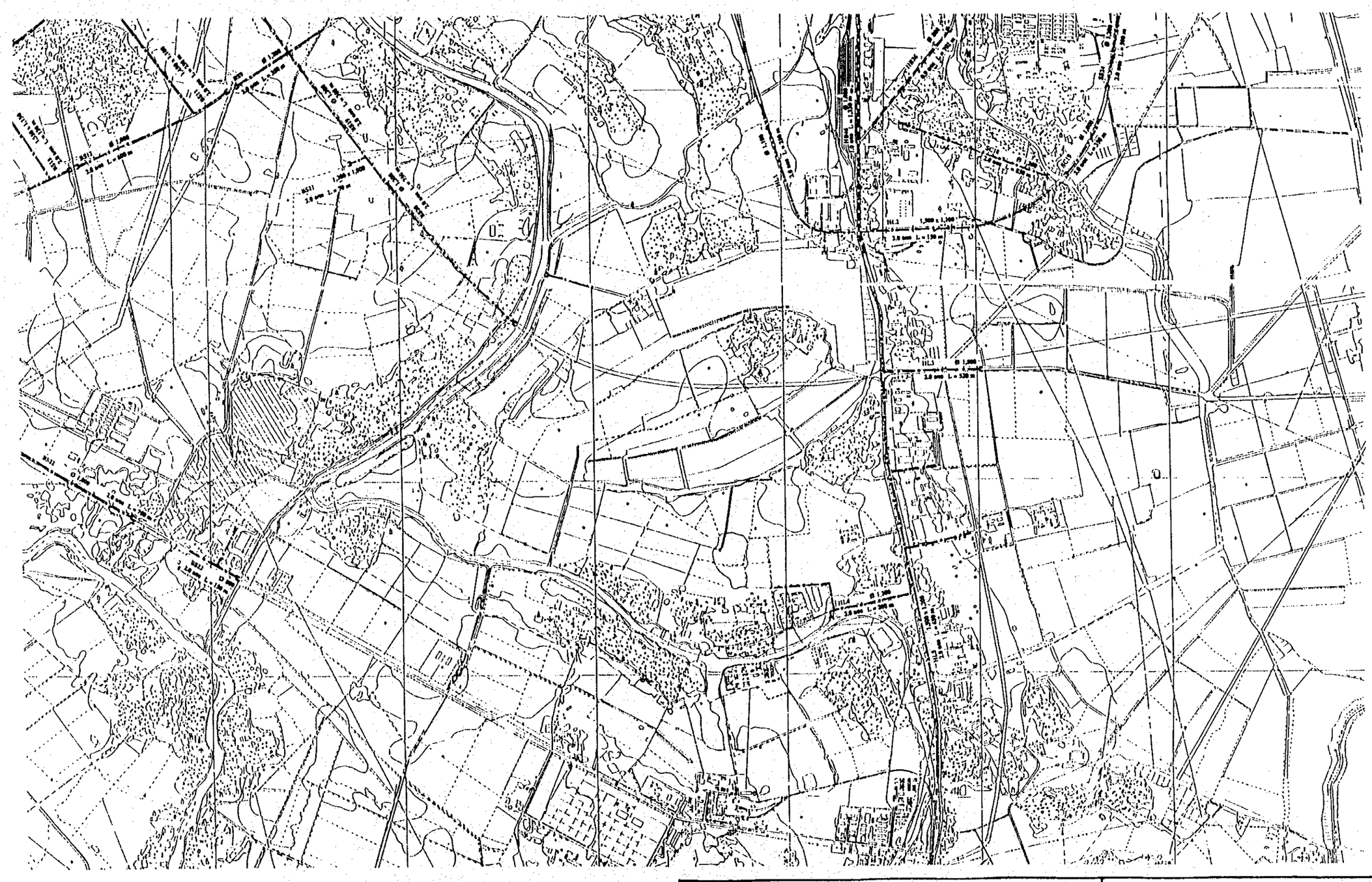
Fig. 3.6 (4)

LAYOUT PLAN FOR SEWER REHABILITATION AND CONSTRUCTION (4/5)



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.6 (5) LAYOUT PLAN FOR SEWER REHABILITATION AND CONSTRUCTION (5/5)

4. IMPLEMENTATION SCHEDULE, COST AND ORGANIZATION

4.1 Implementation Schedule

The Project will require about US $ 377 million in total (refer to Section 4.2), therefore it is expected to be implemented in stages. In view of the cost and the limitation of time, the Project is recommended to be divided into two stages comprising the work items listed in Table 4.1. Completion of the 1st Stage Construction will ensure a protection level of approximately a 2-year return period, while the completion of the 2nd Stage Construction will achieve a 10-year return period.

The Project will take 9 years from the commencement of the detailed design to the completion of the Project. The detailed design will start in March 1995 and the completion of the Project is scheduled to be in April 2004. The overall implementation schedule for the Project is shown in Figure 4.1, which is summarized as follows:

(a) 1st Stage Construction : Year 1995 - 2000
(b) 2nd Stage Construction : Year 2000 - 2004

The main points of the implementation schedule are as follows:

(1) Financial Arrangement

The financial arrangement of engineering services for the detailed design, construction supervision, and construction works is estimated to be 7 months from the appraisal of the Project to the loan agreement for each stage. These are scheduled to be concluded by the end of January 1995 and the end of March 2000.

(2) Engineering Services for Detailed Design and Construction Supervision

The detailed design, including field investigations such as a topographic survey, geological investigation and water quality analysis, detailed design, preparation of tender documents, and construction supervision for each stage, will commence from March 1995 and May 2000 and will be completed by June 1996 and March 2001, respectively.

(3) Procurement of Contractors

All the Project works are executed on a contract basis. The contractors are selected through international and local competitive biddings.

The procurement of equipment for cleaning the drainage canals and sewers for the Urgent Project is scheduled for June 1995 immediately after completion of the detailed design of the equipment.

Following the detailed design, the procurement for the main works of each stage will be May 1996 and November 2000, respectively.

(4) Construction Works

The construction works for each stage will take 43 months from the beginning of December 1995 and 30 months from November 2001, respectively.

(5) Land Acquisition and Compensation

The land required for pumping stations, regulating reservoirs, river and canal improvement, and sewer rehabilitation, will be acquired in stages by the Government. Households located on the land will be compensated for their removal. Fishponds, etc., utilized by the Project but not occupied after completion will also be compensated.

4.2 Project Cost

The financial cost of the Project, comprising the base cost, and physical and price contingencies, at the July 1994 price level, is estimated at US$228 million for the foreign currency portion, and US$149 million for the local currency portion, shown in Table 4.2. The project costs both for the 1st and 2nd Stage projects are summarized as follows:

Unit: US$ million

Stage	1st Stage Project	2nd Stage Project	Total
Base Cost	147.4	143.3	290.7
Import Tax	4.0	3.3	7.3
Price Escalation	13.5	33.3	46.8
Physical Contingency	14.8	17.2	32.0
Total	179.7	197.1	376.8

The Project cost is estimated under the following conditions:

(1) All the direct construction costs are estimated at July 1994 price levels.

The exchange rate applied for the cost estimation is as follows:

US$ 1.00 = JY 100 = VN Dong 10,800

The unit construction costs of the major work items were prepared by referring to the prevailing construction unit prices (price list for construction materials published by the Hanoi Construction Services) for the governmental works in Vietnam and the unit costs (for contractor systems, including cost for quality control, safety control, profit, etc.) employed by similar projects in South-East Asian countries. The project cost is estimated by applying the said unit costs as shown in Table 4.3.

The costs both for the foreign and local currency portions were estimated in terms of US$. The ratio of foreign and local currency components of the major work

items, including costs of construction equipment, materials and labor, are listed in Table 4.3.

(2) The cost for engineering services is estimated on a man/month basis with direct costs according to the implementation schedule.

(3) The cost for the project administration by the Vietnamese Government is estimated at 3 % of the direct construction cost.

(4) Price escalation is estimated by applying the annual inflation rate of 2.5 % both for the foreign and local currency portions.

(5) Physical contingency is estimated at 10 % for the sum of civil works and 5 % for the sum of hydro-mechanical works and the supply of equipment, respectively.

(6) The annual disbursement schedule of both 1st and 2nd Stage Projects was prepared based on the proposed construction schedule as shown in Table 4.4.

4.3 Organizations for Project Implementation and O/M

4.3.1 Executing Agency

The Executing Agency of the proposed Project is the Hanoi People's Committee (HPC), which will have the final responsibilities for direction setting and decision making proceeding the implementation of the Project, with important matters being referred to the Government when necessary.

Within the HPC, the Transport and Public Works Service (TUPWS) is the technical department in charge of the project. As a subordinating organization under the management of TUPWS, the Sewerage and Drainage company (SDC) will be specifically responsible for the management and operation of sewerage/drainage issues of the City.

4.3.2 Project Implementation Organization

For the implementation of the Project, a new implementing organization is to be set up before commencement of the detailed design works. The proposed implementation organization is presented in Figure 4.2.

(1) Firstly, the Project Cooperation Committee (PCC) is to be established by the Hanoi People's Committee (HPC), which will be an executing agency for the proposed drainage and environment improvement project. The main functions of the PCC are: (a) to provide basic policy and guidelines for implementation, (b) to approve fund disbursement, (c) to award contracts for construction and import of equipment, and (d) to provide necessary coordination among the agencies concerned.

(2) Under the PCC, a Project Management Office (PMO) is to be established by the TUPWS for implementing the detailed design work and construction under the guidance of the PCC.

An engineering consultant is to be employed during the detailed design and construction stages. The function of the Consultant will not be limited to the detailed design and construction supervision, but will also include technical and operational assistance to the PCC for the successful completion of the Project.

4.3.3 Operation and Maintenance Organization

After the completion of the project construction works, all the drainage facilities including the Yen So pump station will be transferred to the SDC which is to be designated as the agency responsible for operation and maintenance of the completed project facilities. The PCC (to be re-named the "Drainage Management Committee") will remain an important organization for coordinating other agencies, and making of higher level decisions.

For the operation and maintenance, coordination with the Ministry of Water Resources is important, particularly for the Yen So pumping station and Thanh Liet Floodgate. A telemeter or a radio communication system is proposed to be established to achieve a drainage operation under an integrated operation system. See Figure 4.3 for the proposed organization during operation/maintenance period.

Table 4.1 (1) WORK ITEMS OF 1ST AND 2ND STAGE PROJECT (1/2)

Item	First Stage Project	Second Stage Project
1- Yen So Pumping Station		
(1) Pumping Station	Q = 45 m3/s	Q = 45 m3/s
(2) Inlet Structure	B = 200 m	--
(3) Inlet Channel	L = 1,200 m	--
(4) Ordinary Drainage Channel	L = 1,900 m	--
(5) Outlet Sluiceway	A = 30 m2	A = 30 m2
(6) Outlet Channel	L = 1,600 m	--
2- Yen So Regulating Reservoir		
(1) Regulating Reservoir	A = 203ha (130ha)	--
(2) Yen So Channel	L = 3,400 m	--
(3) Spoil Bank	A = 40 ha	--
3- Linh Dam and Dinh Cong Lakes		
(1) Linh Dam Channel	L = 1,000 m	--
(2) Linh Dam Lake	--	A = 107 ha
(3) Dinh Cong Channel	--	L = 400 m
(4) Dinh Cong Lake	--	A = 25 ha
4- Floodgates and Control Gates	7 places	--
5- River Improvement		
(1) To Lich and Lower Lu River System	L = 22.1 km (Lower Lu = 3.2km)	--
(2) Set and Upper Lu River System	L = 7.5 km (Upper Lu = 3.1km)	--
(3) Kim Nguu River System	L = 3.4 km	--
6- Drainage Channel Improvement		
(1) To Lich and Lower Lu River Basin	Bridges/Box Culverts (21 places)	Channel Works (L = 16.4 km) and Bridge/Box Culverts (24 places)
(2) Set and Upper Lu River Basin	Bridges/Box Culverts (13 places)	Channel Works (L = 3.7 km) and Bridge/Box Culverts (2 places)
(3) Kim Nguu River Basin	Bridges/Box Culverts (20 places)	Channel Works (L = 10.7 km) and Bridge/Box Culverts (1 places)

Table 4.1 (2) WORK ITEMS OF 1ST AND 2ND STAGE PROJECT (2/2)

Item	First Stage Project	Second Stage Project
7- Lake Improvement		
(1) Lake Dredging	4 lakes	14 lakes
(2) Lake Conservation	Aeration in 2 lakes as a pilot project	Overall environmental measures for 11 lakes
8- Sewer Rehabilitation and Construction		
(1) West Lake Basin	Rehabilitation	New construction
(2) To Lich River Basin	Rehabilitation	Rehabilitation/ New construction
(3) Lower Lu River Basin	—	New construction
(4) Hoang Liet Drainage Basin	—	New construction
(5) Set River Basin	Rehabilitation	New construction
(6) Upper Lu River Basin	Rehabilitation/ New construction	New construction
(7) Kim Nguu River Basin	Rehabilitation/ New construction	New construction
(8) Yen So Drainage Basin	—	New construction
9- Equipment Supply for Cleanup of Drainage Channels and Sewers	Grab bucket excavator, water jet cleaner, etc.	— —

Table 4.2 PROJECT COST

Unit: US $ 1,000 equivalent

Item	First Stage Construction			Second Stage Construction			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
1 Construction Works	88,771	24,616	113,387	69,906	31,702	101,608	158,677	56,318	214,995
A. Construction Works	80,021	23,716	103,737	69,906	31,702	101,608	149,927	55,418	205,345
B. Procurement of Equipment & Materials	8,750	900	9,650	0	0	0	8,750	900	9,650
2 Administration Cost	0	3,401	3,401	0	3,048	3,048	0	6,449	6,449
3 Land Acquisition and Compensation Cost	0	15,180	15,180	0	20,050	20,050	0	35,230	35,230
4 Import Tax	0	3,980	3,980	0	3,282	3,282	0	7,262	7,262
5 Engineering Service	10,728	4,660	15,388	12,160	6,547	18,707	22,888	11,207	34,095
6 Price Escalation	9,140	4,356	13,496	18,945	14,273	33,218	28,085	18,629	46,714
7 Physical Contigency	9,296	5,537	14,833	9,290	7,888	17,178	18,586	13,425	32,011
Grand Total	117,935	61,730	179,665	110,301	86,790	197,091	228,236	148,520	376,756

Table 4.3(1) UNIT PRICES FOR COST ESTIMATION (1/2)

Item	Unit	Unit Price (US$)				Total
		F.C		L.C		
A Construction Cost						
1 Earth Work						
(1) Excavation at Yen So/Hoang Liet areas	m3	2.4	(0.80)	0.6	(0.20)	3
(2) Excavation along rivers/drainage channels	m3	3.4	(0.80)	0.9	(0.20)	4.3
(3) Excavation in city area lakes	m3	3.2	(0.80)	0.8	(0.20)	4
(4) Embankment/Backfilling	m3	4	(0.80)	1	(0.20)	5
2 Structural Work						
(1) Reinforced concrete	m3	132	(0.60)	88	(0.40)	220
(2) RC pile	m	55	(0.55)	45	(0.45)	100
(3) PC pile,550 mm diameter	m	90	(0.55)	80	(0.45)	170
(4) Steel pile,600 mm diameter	m	225	(0.90)	25	(0.10)	250
(5) Steel sheet pile	m2	207	(0.90)	23	(0.10)	230
(6) Revetment, 1:0.3	m3	42	(0.45)	52	(0.55)	94
(7) Revetment, 1:2.0	m2	14	(0.45)	17	(0.55)	31
(8) Riprap	m3	8	(0.80)	2	(0.20)	10
(9) Gabions for fall structure	m3	13	(0.90)	2	(0.10)	15
3 Composite Structures						
(1) Bridge	m2	910	(0.70)	390	(0.30)	1300
(2) Bridge protection	pl.	1400	(0.45)	1700	(0.55)	3100
(3) Box culvert	m2	540	(0.60)	360	(0.40)	900
(4) Railway bridge	m	10400	(0.80)	2600	(0.20)	13000
(5) Steel gate structure	m2	20000	(0.80)	5000	(0.20)	25000
(6) Spillway with rubber gates	m	12000	(0.80)	3000	(0.20)	15000
(7) Control structure at outlet of city area lakes	pl.	7000	(0.70)	3000	(0.30)	10000
(8) Pumping station	pl.	(For the Master Plan study,the following curve is used)				
(9) Intake facilities	pl.	8400	(0.70)	3600	(0.30)	12000
(10) Drainage facilities	L.S.	1200	(0.60)	800	(0.40)	2000
4 Others						
(1) Land preparation	m2	2	(0.80)	0.5	(0.20)	2.5
(2) Environmental measures	m2	0.9	(0.30)	2.1	(0.70)	3

Table 4.3 (2) UNIT PRICES FOR COST ESTIMATION (2/2)

Item	Unit	Unit Price (US$)				Total
		F.C		L.C		
B Compensation Cost						
1 Land Acquisition						
(1) Yen So/Hoang Liet areas,inside Red River dike	m2	-	(-)	25	(1.0)	25
(2) Yen So/Hoang Liet areas,outside Red River dike	m2	-	(-)	19	(1.0)	19
(3) Along rivers/drainage channels	m2	-	(-)	190	(1.0)	190
2 House Evacuation	house	-	(-)	1300	(1.0)	1300
3 Fishery Compensation	m2	-	(-)	0.5	(1.0)	0.5

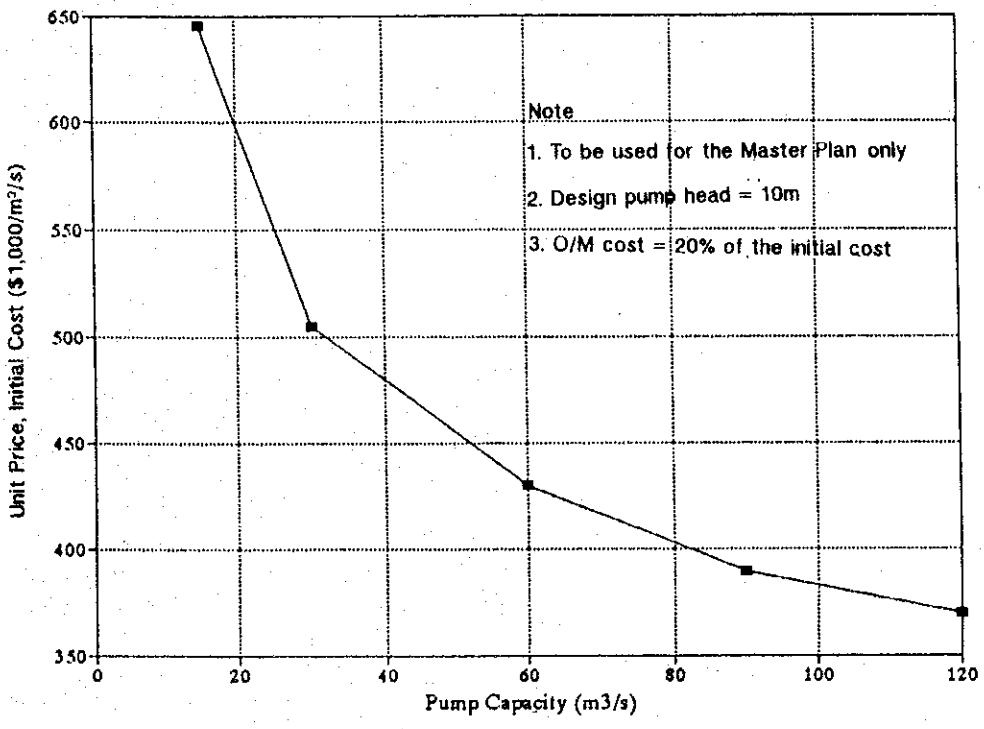


Table 4.4 (1) DISBURSEMENT SCHEDULE FOR FIRST STAGE CONSTRUCTION

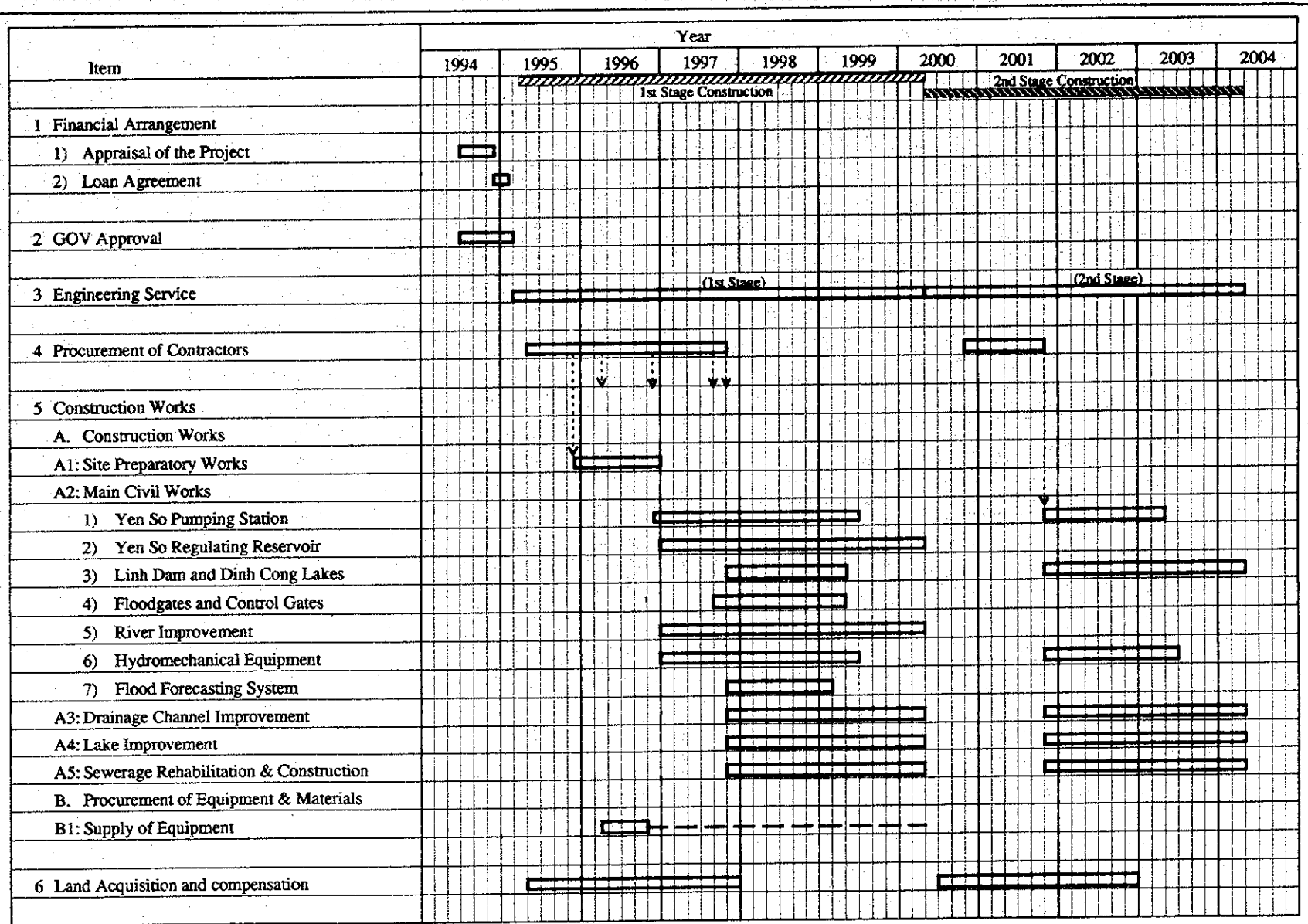
Unit: US $ 1,000 equivalent

ITEM	FIRST STAGE CONSTRUCTION			1995			1996			1997			1998			1999			2000		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C	L.C.	Total
1 Construction Works	88,771	24,616	113,387	52	20	72	15,951	2,144	18,095	23,885	6,844	30,729	30,402	8,624	39,026	16,660	5,917	22,577	1,821	1,067	2,888
A. Construction Works	80,021	23,716	103,737	52	20	72	7,201	1,884	9,085	23,885	6,604	30,489	30,402	8,384	38,786	16,660	5,757	22,417	1,821	1,067	2,888
B. Procurement of Equipment & Materials	8,750	900	9,650	0	0	0	8,750	260	9,010	0	240	240	0	240	240	0	160	160	0	0	0
2 Administration Cost	0	3,401	3,401	0	340	340	0	510	510	0	1,021	1,021	0	850	850	0	510	510	0	170	170
3 Land Acquisition and Compensation Cost	0	15,180	15,180	0	2,396	2,396	0	6,666	6,666	0	4,925	4,925	0	1,193	1,193	0	0	0	0	0	0
4 Import Tax	0	3,979	3,979	0	112	112	0	699	699	0	1,041	1,041	0	1,284	1,284	0	731	731	0	112	112
5 Engineering Service	10,728	4,660	15,388	2,748	1,886	4,634	1,518	644	2,162	2,143	634	2,777	1,705	624	2,329	1,625	608	2,233	989	264	1,253
6 Price Escalation	9,140	4,356	13,496	70	119	189	884	540	1,424	2,001	1,112	3,113	3,333	1,306	4,639	2,403	1,021	3,424	449	258	707
7 Physical Contigency	9,296	5,537	14,833	287	487	774	1,265	1,103	2,368	2,552	1,531	4,083	3,004	1,362	4,366	1,862	867	2,729	326	187	513
Total	117,935	61,729	179,664	3,157	5,360	8,517	19,618	12,306	31,924	30,581	17,108	47,689	38,444	15,243	53,687	22,550	9,654	32,204	3,585	2,058	5,643

Table 4.4 (2) DISBURSEMENT SCHEDULE FOR SECOND STAGE CONSTRUCTION

Unit: US $ 1,000 equivalent

ITEM	SECOND STAGE CONSTRUCTION			2000			2001			2002			2003			2004		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C	L.C.	Total
1 Construction Works	69,906	31,702	101,608	0	0	0	6,875	3,135	10,010	27,708	10,226	37,934	25,726	12,434	38,160	9,597	5,907	15,504
A. Construction Works	69,906	31,702	101,608	0	0	0	6,875	3,135	10,010	27,708	10,226	37,934	25,726	12,434	38,160	9,597	5,907	15,504
B. Procurement of Equipment & Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Administration Cost	0	3,048	3,048	0	305	305	0	610	610	0	914	914	0	914	914	0	305	305
3 Land Acquisition and Compensation Cost	0	20,050	20,050	0	4,010	4,010	0	8,020	8,020	0	8,020	8,020	0	0	0	0	0	0
4 Import Tax	0	3,282	3,282	0	146	146	0	347	347	0	1,263	1,263	0	1,103	1,103	0	423	423
4 Engineering Service	12,160	6,547	18,707	3,648	1,964	5,612	1,216	655	1,871	3,648	1,964	5,612	2,432	1,309	3,741	1,216	655	1,871
5 Price Escalation	18,945	14,273	33,218	583	1,026	1,609	1,637	2,441	4,078	6,898	4,906	11,804	6,862	3,879	10,741	2,965	2,021	4,986
6 Physical Contigency	9,290	7,888	17,178	423	745	1,168	950	1,538	2,488	3,362	2,735	6,097	3,200	1,946	5,146	1,355	924	2,279
Total	110,301	86,790	197,091	4,654	8,196	12,850	10,678	16,746	27,424	41,616	30,028	71,644	38,220	21,585	59,805	15,133	10,235	25,368



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JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 4.1
OVERALL IMPLEMENTATION SCHEDULE FOR THE PROJECT

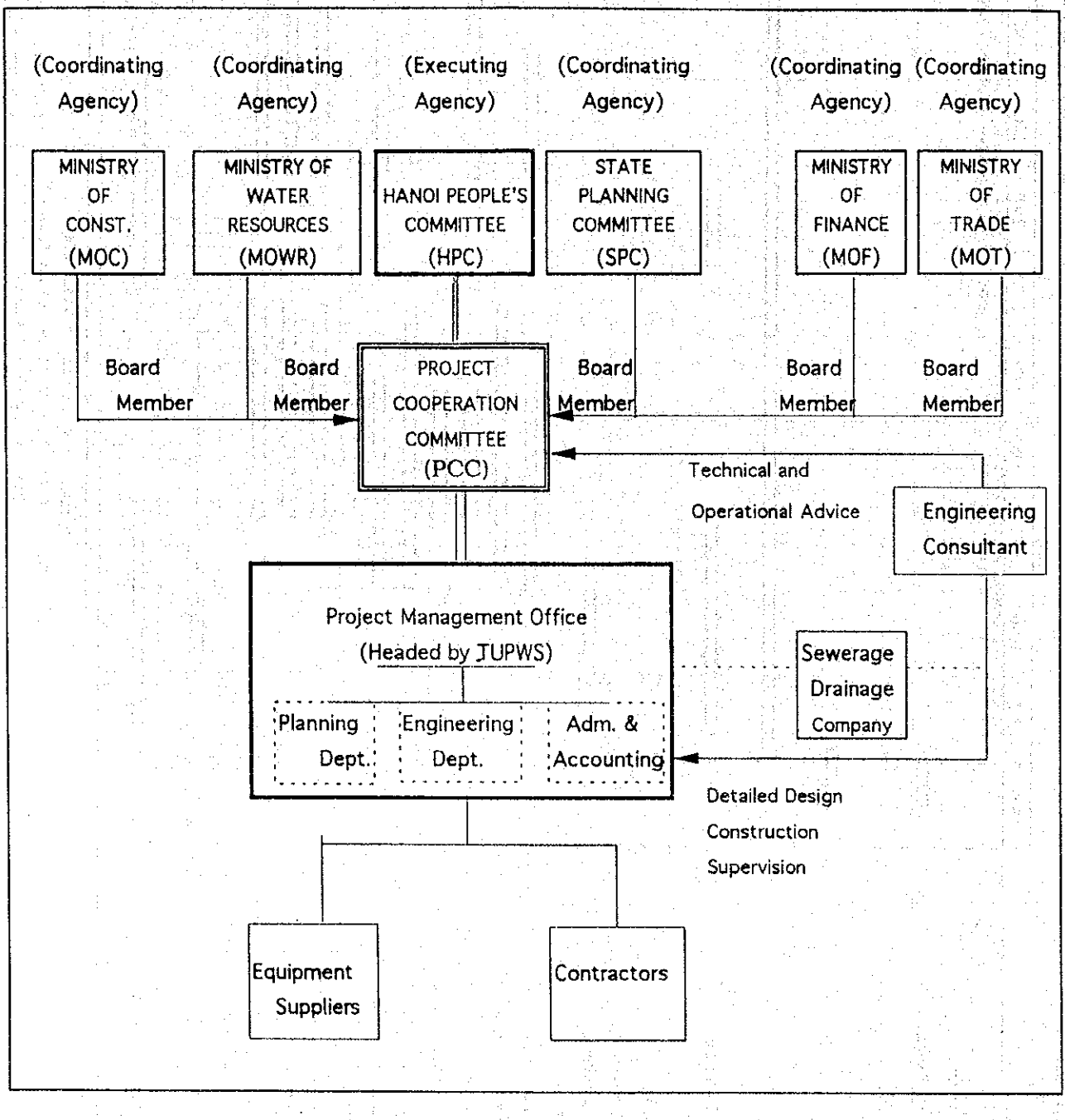

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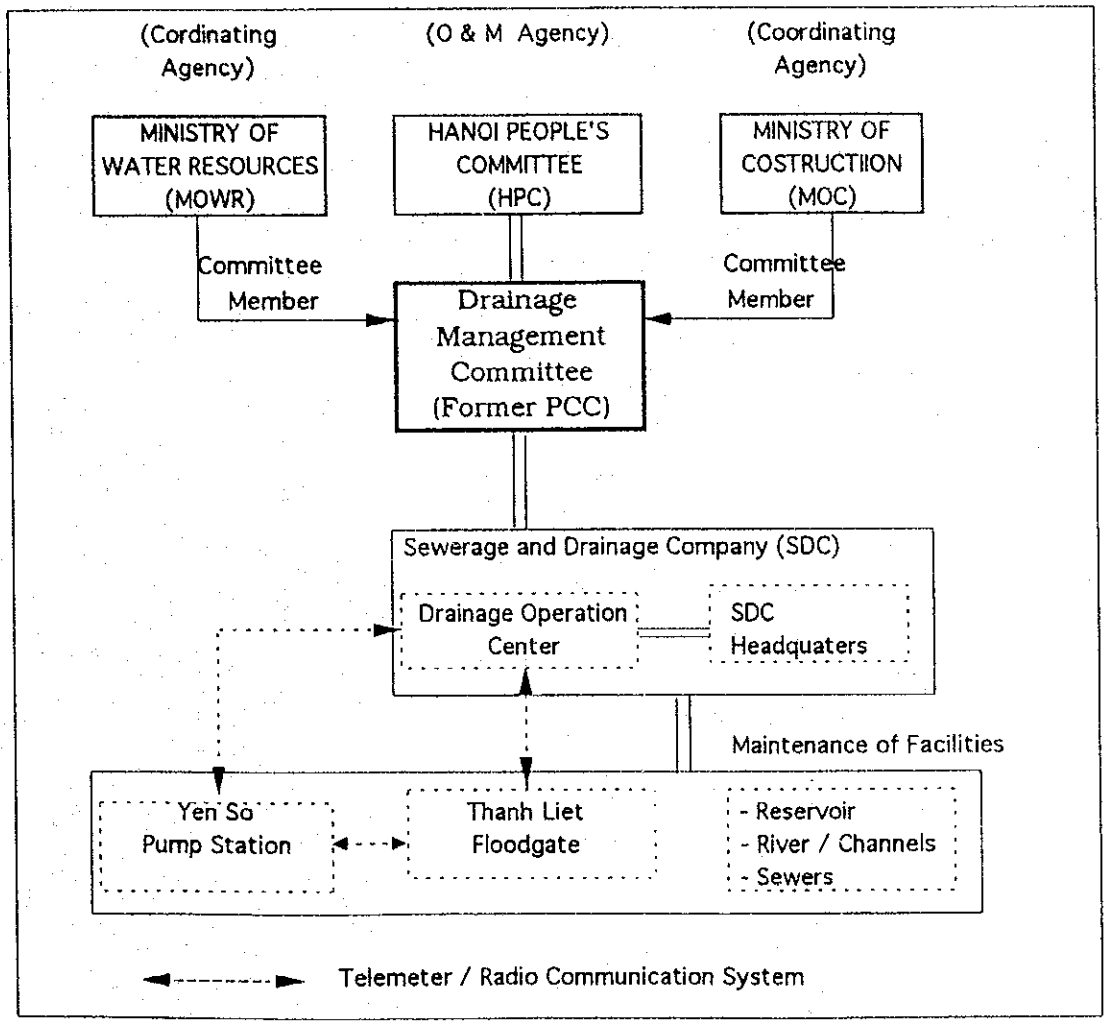
Fig. 4.2
PROJECT IMPLEMENTATION ORGANIZATION



SOCIALIST REPUBLIC OF VIET NAM THE STUDY ON URBAN DRAINAGE AND WASTEWATER DISPOSAL SYSTEM IN HANOI CITY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 4.3 OPERATION AND MAINTENANCE ORGANIZATION

5. PROJECT EVALUATION

5.1 General

The evaluation of the project is conducted from economic, financial, and socio-environmental viewpoints. The economic evaluation is made by calculating the economic rate of return (EIRR) on the basis of the estimated flood control benefit and the economic cost.

For the financial evaluation, a disbursement schedule of the project investment is prepared, then, the government fund requirement, which includes local budget allocation, repayment of loans and interest on the assumed financial conditions is estimated. Financial viability is checked by comparing the required government fund with the Hanoi city budget.

Other socio-economic impacts are also assessed to check the viability of the project implementation.

5.2 Economic Evaluation

5.2.1 Economic Benefit

The economic benefits expected from the Project are the mitigation of flood damage and the contribution to environmental improvement. In this study, only the reduction in flood damage is estimated. To achieve this, the direct damage of residential properties, household goods, shops, merchandise, public/government buildings, factories, and agricultural production is based on the study on damage potential and flood frequency and by applying the damage ratio. Indirect damage is also taken into account, which includes damage to transportation, communication, and loss of income for factory owners and employees.

Based on the results of the inundation analysis and the relationship between the inundation water level and flood damage, flood damage for a different return period was calculated under without-project and with-project conditions. The annual average flood damage was then estimated by applying the average occurrence probability to the corresponding flood damage.

The expected benefit is calculated by estimating the difference between the average annual flood damage without-the-project and with-the-project. After implementation of the project, the Study Area will be free from floods with a return period of 10-year or less. The estimated economic benefit for the project is US$ 12,563 million per year (1994 price). The estimated economic benefit is realized in two stages as presented below.

(US$1,000)

	Economic Benefit
1st Stage	7,537
2nd Stage	5,026
Project Total	12,563

The above estimate is expected to increase at 8 % per annum, which corresponds to the economic growth of the region.

5.2.2 Economic Cost

The economic cost of the project is calculated by applying the adjustment (land acquisition and compensation) to the financial cost presented in Chapter 4. The estimated economic cost of the Project is as follows:

(US$1,000)

	Construction Cost	O & M Cost
1st Stage	146,809	1,143
2nd Stage	138,894	579
Total	285,703	1,722

5.2.3 Economic Evaluation

On the basis of the estimated construction cost, operation and maintenance cost (OM cost), and estimated economic benefit, EIRRs are calculated for the whole project and in development plan stages (Table 5.1 to 5.3). The calculated EIRRs are presented below:

	EIRR (%)
1st Stage	11.7
2nd Stage	11.4
Project Total	11.6

As indicated above, the Project is economically justified, with the first stage proving to have a slightly higher economic return.

To check the sensitivity of the economic feasibility, EIRRs are calculated on the following assumptions:

Case 1 Construction costs increase by 15 %
Case 2 Economic benefits decrease by 15 %
Case 3 Case 1 plus case 2

The results of the sensitivity analysis are as follows:

	EIRR (%)
Case 1	10.5
Case 2	10.3
Case 3	9.2

The economy of the project is more sensitive to the benefit reduction than to the cost increase. The project is proved to have a reasonable return even under the situation of 15 % cost increases plus 15 % benefit reductions. (Cost benefit streams of the above three cases are presented in Table 5.4 to Table 5.6.)

5.3 Financial Evaluation

Generally, the drainage project will not produce a direct cash income. Construction costs and operation costs are, therefore, to be borne by the Government. In this study, the annual fund requirement for the project implementation is estimated, then, the government fund requirement including interest costs and loan repayments is estimated on the following financial assumptions.

(1) 85 % of the total investment cost will be financed by an international financial source with the following conditions:

Interest : 2.5 %

Repayment : 30 years with 10 years grace period

(2) The remaining 15 % will be financed by budget allocation

As indicated in Table 5.7, the government fund requirement is US$ 1.2 – 12.7 million per year during the construction stage and US$ 13.8 – 20.2 million during the repayment stage.

(In 1993, Hanoi city raised US$ 185 million as revenue and contributed US$ 139 million to the Central Government. The estimated fund requirement proves to be 10 to 14.5 % of this contribution even during the repayment period, and seems to be within the repayable range of the Hanoi city budget.)

5.4 Environmental Impact Assessment

5.4.1 Environmental Impact

In general, most of the improvements in the drainage system and flood control will have a positive impact on the environment of Hanoi, where floods frequently cause serious problems and disturb normal life. During floods, surface runoff washes solid waste into lakes, rivers and channels, and pollutes water bodies and wells. Lake dredging, bank-cleaning, and conservation will increase the possibilities of recreational use of lakes and also improve the living environment.

This Project, however, can create a negative environmental impact during the construction of regulation reservoirs and connecting channels, and during the dredging of lakes, if work is done carelessly. Problems must be overcome, not relocated. Eventually, changes of water level in regulation reservoirs can disturb lake ecosystems.

(1) Yen So Pumping Station and Connecting Channels

The pumping station causes minimal environmental impact, and requires minimal land. At least according to present information, buildings do not disturb or alter the landscape very much.

Instead, the channel connecting the reservoir to the pumping station (Inlet Channel) and the pumping station to the Red River (Outlet Channel) are totally new structures, cutting the natural connection from area to area. Also, the outlet channel will be constructed outside the Red River levee, and should be provided with embankments on both side.

(2) Yen So Regulating Reservoir

The total area of the reservoir is 250 ha, of which the lake area is 130 ha consisting of three different reservoirs. Reservoirs are partly located in the same area as the present fishponds. The reservoirs besides being used for drainage will be used for fish farming and recreation. The surrounding areas will be parks and/or green areas. The lakes will be naturally shapes, and will include islands.

The difference between the maximum and the minimum water level in the reservoir is 3.0 meters, which creates a large impact on vegetation and fauna, and causes erosion on the banks, if the changes of water level happen very quickly and often. The degree and the duration of the disturbance caused by storm water discharge depends on the type of receiving water. In isolated stagnant waters such as ponds, the effect is severe due to its long exposure to pollution. To prevent erosion, banks have to be covered with grass or other materials.

Construction work of the reservoir will last about three years, and during that time about 3,500,000 m^3 soil will be excavated. To minimize transportation and other extra work the soil should be utilized in the construction area, e.g. as a material for dikes.

Storm waters can have an impact on the water quality of reservoirs. It is very probable that the amount of suspended solids, nutrients and bacteria will increase after storm water discharge. Water pumped from the reservoir to the Red River may also decrease the water quality in the Red River. This can be prevented if the retardation in reservoir is long enough to cause sedimentation. Bottom sediment has to be dredged frequently to keep the water level in its planned elevation.

In the Yen So area, the present lakes are used for fish farming. The lakes are emptied and dredged every year. The needs of fish farming and flood controlling, especially concerning water level, conflict. The water level will be higher, and the reservoir larger than present. This will cause changes in fish farming methods, and in maintenance of the reservoir.

The water level demands for flood regulation and fish farming differ, so a combination of these uses of the reservoir must occur.

The reservoir's impact on soil subsidence, groundwater level and possible pollution of the Phap Van wellfield must be prevented.

(3) Linh Dam and Dinh Cong Lakes and Channels

The Linh Dam (Hoang Liet) and Dinh Cong lakes are to be excavated to complete the regulation function of the Yen So reservoir. The capacity of the lakes is small compared to Yen So. In the beginning there will be minimum impact to lakes because excavation will be done during the second stage. According to the City Master Plan, Linh Dam lake will be used for recreation, demanding high-quality water.

The impact of channels depends on their width, the severing of important connections between different areas and the disturbance of normal life.

(4) River Improvement and Drainage Channel Improvement

The planned improvements concern mostly the re-construction of bridges to increase the flow of the channels. Small culverts collect floating garbage and clogged culverts prevent flow. Improvement is obvious if the flow increases and especially if the channels are cleaned. The water quality will not improve if untreated wastewater is discharged into the rivers and channels.

(5) Lake Improvement

A total of 18 lakes are planned to be dredged, four lakes being dredged during the first stage. There is a lack of reliable data concerning water quality and sediment from most of the lakes, but visual analyzing clearly shows these lakes need restoration.

Many lake bottoms seems to be devoid of life, so dredging will not cause harm to the lake ecosystem. One of the biggest environmental problems is storage of the sludge without harming any other lakes or rivers.

However, the water quality, amount and type of sediment, and possible bottom fauna and vegetation has to be studied before and after dredging to find out the real impact. Mitigation of the wastewater load to the lakes has to occur at the same time as dredging, otherwise restoration will only have a very short influence.

At the same time, attention should also be paid to the banks and surrounding areas to improve the whole area and use of the lakes. Recreational lakes should especially be conserved for that purpose. Well-maintained lakeside parks increase living environment and welfare.

(6) Sewer Construction and Equipment Supply

If there is no wastewater treatment and if only a few open channels are covered and piped, there will not be adequate environmental improvement. Cleaning of the sewers has a very positive environmental impact and is highly recommended as clogged sewers cause serious environmental problems.

5.4.2 Socio-economic Impact

The improvement of the drainage system, mitigation of floods, and sewer rehabilitation in the inner city area will create an impact on the people's life and environment of the whole project area. Construction of regulation reservoirs and channels will have more of a local effect. Lake dredging and conservation, combined with clearing of the banks, will increase the recreational use of the lakes and improve the living environment. Resettlement along the channels might cause the only negative impact.

(1) Intensive Land Use and Future Urban Development

Upon completion of the drainage facilities, the annual inundated area will be free from flood, creating a more productive land use. Urban development is also facilitated in the flood prone area under the framework of the City Development Master Plan 2010.

(2) Infrastructure and Transportation

Improvement of the infrastructure of the city will create a more secure operation of water supply network, sewer network and transportation network, and will mitigate the damage after floods. The overflow from sewers during floods will be reduced after the rehabilitation and cleaning of the sewers.

The decrease of floods, especially in the main streets, creates ease of mobility and mitigates the damage to cars and motorbikes.

(3) Improvement of the Environment

Sanitation in the Project area will be improved substantially by controlling floods. Health conditions for the residents, particularly through the reduction of waterborne diseases, are also expected to be improved.

The improvement of the rivers, drainage channels, lakes and ponds will provide amenities and recreation areas for the residents. All these effects are not limited to environmental improvement, but are expected to considerably contribute to the rise of living standards of the residents.

(4) Improvement of Welfare and Social Security

Based on the above effects, the welfare of residents, including incomes, assets, and amenities will improve. Social security in the Project area is expected to be strengthened, contributing to the socio-economic stability of the entire country.

(5) Resettlement

The resettlement of the reservoir area and along the rivers is not a serious problem, as there are few houses to be moved. The problem is in the resettlement of people who live along the channels.

It is difficult to relocate people to similar areas with similar conditions. People who live in the inner city are not willing to move to the countryside, because of the non-availability of schools, shops, entertainment, and transportation. Social

networks are also very tight and it takes some time to settle in the new areas. Shopkeepers and people who own businesses are especially not willing to move because they also lose their income.

This problem is to be carefully studied before starting the project and a compensation and resettlement plan is to be prepared to keep the negative impact to a minimum.

5.4.3 Proposed Studies and Conclusions

(1) Proposed Studies

There is very little reliable data and studies available concerning the general environment, the water quality, and especially the bottom fauna. Long-term sampling and analyzing have not been done. Therefore, it is necessary to start an environmental monitoring program, which includes visual checks of the condition of different water bodies and surrounding areas.

A monitoring program should be started as soon as possible for the lakes which are proposed to be dredged or where there will be some other restoration or conservation. There will be a separate project for the restoration of West Lake.

The monitoring program should consist of studies concerning physical and chemical water quality, algae, bottom fauna, vegetation, amount and quality of sediment, and the general condition of surroundings. It should also be continuous enabling control of the impact of dredging and other restoration methods.

An environmental Monitoring Program has been separately planned for different sub-projects with bigger environmental impacts, which need long-term monitoring.

Currently, the Wastewater Monitoring Program is being conducted by the HSDC. There are sampling points in the main rivers, channels and factories. To plan the sewer network and wastewater treatment plants, it is essential to support this monitoring program to obtain long-term background information about wastewater quality, and collect more data about waste water quantity and pollutants.

(2) Conclusions

The main objectives of the Project are to improve the drainage system of the city, to reduce disadvantages and damage caused by floods, and to improve the living environment of the city, particularly health and hygene aspects.

Implementing this Project will improve all socio-economic areas. Only the resettlement of the channels will create a negative impact. Most of the construction work of the drainage and flood control system will have a positive long-term impact on the environment (Table 5.8). During the construction works there will be temporary problems, which can be minimized utilizing proper working methods.

The discharge of storm waters into the reservoirs can temporarily decrease the water quality. Planned river and channel improvements will only have a small effect on the water quality.

The dredging of lakes will have a positive impact on water quality, but a possible negative impact on fauna.

Unfortunately during the first stage construction, there is minimum sewer construction to improve water quality in the inner city area.