

- (e) Centralized wastewater treatment plants will have flexibility for the future improvement of facilities in order to re-use of treated wastewater, such as maintenance flow of rivers, amenity of water at parks and fire prevention water.
- (5) Upgrading/Increase of Public Latrines in order to decrease the overflow of untreated escreta.
- (6) Upgrading/Increase of Individual Latrines in order to decrease the overflow of untreated escreta.
- (7) Improvement to the Solid Waste Collection system

6.7.2 Non-Structural Measures

(1) Institutional Support

The following support by the government is recommended :

- (a) Financial back-up of soft loan with a revolving fund system to encourage installation of adequate septic tanks, individual wastewater treatment plants and pre-treatment plants for industries.
 - (b) Adoption of a free or low-price charge system for the collection of excess sludge from septic tanks.
 - (c) Intensification of regulations for supporting the operation / maintenance of the above-mentioned structural measures.
- ##### (2) Relocation of Industries

Specific water-consumptive industries yielding heavy-polluted effluent are relocated outside the urban area .

(3) Enforcement of "Care for Drainage/Sewerage "Campaign and Sewerage Levy-Based System

"Care for Drainage/Sewerage "campaign shall be enforced in order to educate people on the need for public health and the necessity of sanitary facilities. A sewerage levy-based system shall be established partially in order to secure the O& M cost of the proposed wastewater disposal system.

Table E1.1 SERVICE COVERAGE

NAME OF DISTRICT	AREA (ha)	POPULATION (persons)	POPULATION DENSITY(p/ha)	LENGTH OF SEWER (m)	LENGTH OF OPEN CHANNEL (m)	COVERAGE PER CAPITA(m/p)	COVERAGE PER AREA(m/ha)	LENGTH OF ROAD (m)	COVERAGE PER AREA (m/ha)
BA DINH	1,095.7	188,437	172.0	24,191	9,140	0.18	30.4	54,860	50.1
HOAN KIEM	351.0	147,266	419.6	39,403		0.27	112.3	58,220	165.9
HAI BA TRUNG	1,035.0	286,212	276.5	34,838	10,650	0.16	43.9	44,280	42.8
DONG DA	1,484.6	334,356	225.2	21,575	12,710	0.10	23.1	29,530	19.9
SUB TOTAL	3,966.3	956,271	241.1	120,007	32,500	0.16	38.5	186,890	47.1
TU LIEM	5,523.5	172,355	31.2					65000	11.8
THAN TRI	3,719.5	84,632	22.8					40000	10.8
HA TAY	322.0	5,400	16.8					5600	17.4
TOTAL	13,531.3	1,218,638	90.1	120,007	32,500	0.13	11.3	297,490	22.0

TABLE E1.2 SEWERAGE LEDGER (RECORD OF PUMPING STATION) (1/3)

Name	Location	Site Area	Operation Date	Catchment Area		Designed population	Capacity of Lift Pump		Name of Receiving water	Facility for landscape	Remark		
				Wastewater	Stormwater		Wastewater at fine weather	Wastewater at rainy weather				Storm water	
Kim Lien	Kim lien Living quarter	670 m ²	1965	ha	ha	6,000 person	4.1667 m ³ /min	8.0 m ³ /min	m ³ /min	m ²			
Location Map of Pump Station (S= 1/10000)													
						Item	Unit	Quantity	Type	Size	Capacity	Construction Date	Remarks
						Inlet Sewer	m	12	Circle	ø 400	m ³ /sec	1965	
						Gate Chamber	room	1	Semi-circle	30m ²		1965	
						Gate	p.c.s	1	Rectangle paralle	LxBxH 1.5x1.2x5 m		1965	
						Grit Chamber	unit				m ³		
						Screen	p.c.s	1	Rectangle	LxB 2.5x1.2m		1965	
						Pump for waste water	p.c.s	3	China	4PW	m ³ /min	1965	
						Pump for storm water	p.c.s				16.667 m ³ /min		
						Outlet Sewer	m	300	Circle	ø 200	m ³ /sec	1965	
						Outlet Gate	p.c.s	1	Double crust tank			1965	
						Control office	No.s	1		18m ²	m ²	1965	

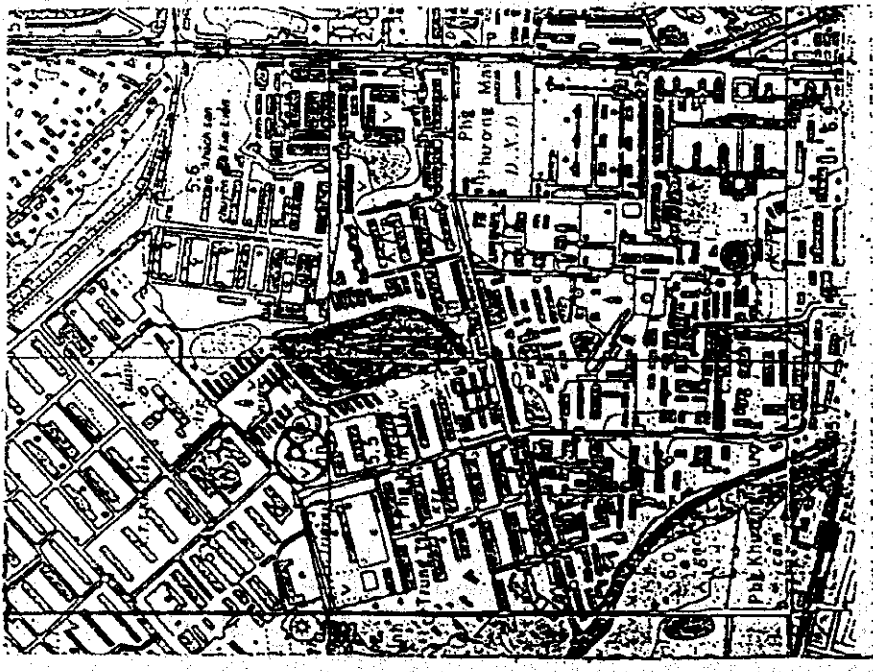


TABLE E1.2 SEWERAGE LEDGER (RECORD OF PUMPING STATION) (2/3)

Name	Location	Site Area	Operation Date	Catchment Area		Designed population	Capacity of Lift Pump			Name of Receiving water	Facility for landscape	Remark
				Wastewater	Stormwater		Wastewater at fine weather	Wastewater at rainy weather	Storm water			
Kim Lien	Kim Lien Living quarter	200 m ²	1965	ha	3.5 ha	person	m ³ /min	33.33 m ³ /min	m ³ /min		m ²	
Location Map of Pump Station (S= 1/10000)												
						Item	Unit	Quantity	Type	Size	Capacity	Construc tion Date
						Inlet Sewer	m	6	Circle	ø 200	m ³ /sec	1965
						Gate Chamber	room	1	Rectangle parallel-piped	LxBxH 12x3x5m		1965
						Gate	p.c.s					
						Grit Chamber	unit				m ³	
						Screen	p.c.s	4	Rectangle	LxB 2.5x1.5m	m ³ /min	1965
						Pump for waste water	p.c.s					
						Pump for storm water	p.c.s	2	Vietnam	DK 82-6	16.667 m ³ /min	1965
						Outlet Sewer	m				m ³ /sec	
						Outlet Gate	p.c.s	1	Rectangle parallel piped	LxBxH 40x6x2.5 m		1965
						Control office	No.s	1		30m ²	m ²	1965

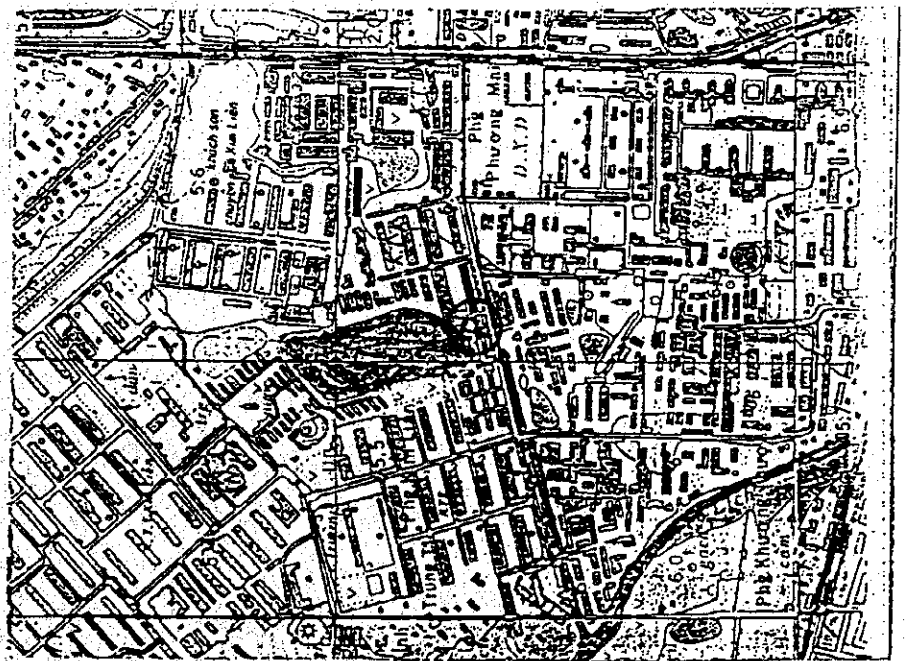


TABLE E1.2 SEWERAGE LEDGER (RECORD OF PUMPING STATION) (3/3)

Name	Location	Site Area	Operation Date	Catchment Area		Designed population	Capacity of Lift Pump			Name of Receiving water	Facility for landscape	Remark
				Wastewater	Stomwater		Wastewater at fine weather	Wastewater at rainy weather	Storm water			
Tan Mai	Tan Mai Living quarter	30 m ²	1965	ha	0.03 ha	person	m ³ /min	m ³ /min	m ³ /min		m ²	
<p>Location Map of Pump Station (S= 1/10000)</p>												
	Inlet Sewer						m				m ³ /sec	
	Gate Chamber						room					
	Gate						p.e.s					
	Grit Chamber						unit				m ³	
	Screen						p.e.s					
	Pump for waste water						p.e.s	3	Vietnam	30KW	16.0 m ³ /min	1987
	Pump for storm water						p.e.s				m ³ /min	
	Outlet Sewer						m				m ³ /sec	
	Outlet Gate						p.e.s					
	Control office						No.s				m ²	

TABLE E1.3 NUMBER OF EXISTING TOILET UNDER URENCO

District	Public Toilet with Septic tank		Public Toilet with Double-vault		Individual Toilet		Total
	Commercial area	Residential area	Commercial area	Residential area	Septic	Double-Vault Others(Bucket, etc)	
Dong Da	4	16		74	No detail information		
Ba Dinh	4	21		49			
Hoan Kiem	8	9		20			
Hai Ba Trung	2	26		76			
Total	18	72	0	219	84501	30779	19208
				309			134488
							134797

Table E2.1 WATER AND ELECTRICITY CONSUMPTION (1/6)
in Minh Khai - Vinh Tuy Industrial area

Branches - Enterprises	Water m3/24h	Electricity 1000kwh	Value of Yield (million VND) in 1989 price	Unit Water Consumption m3/million D	Use Efficiency kwh/1000 D Value of Yield
TOTAL	4,627	71,530	156,125.81	0.03	0.46
I. Mechanical Engineering Industry Branch	437	2,930	8,395.13	0.05	0.35
1. HN Commercial Equipment Factory	55	300			
2. Minh Khai Lock Manufacture	60	550			
3. HN Works Mechanical Engineering Factory	50	250			
4. Mai Dong Mechanical Engineering Factory	50	450			
5. Hanoi Ship Yard Enterprise	50	350			
6. HN Industrial Production & Installation Co.	40	300			
7. Ngo Gia Tu Automobile Repairing Factory	25	150			
8. Civil Engineering Design Enterprise	22	100			
9. Sea Routine Works Engineering Enterprise	15	50			
10. Union of Water Pumping Construction Engineering Enterprise	15	50			
	20	100			
12. Motobike Repairing Enterprise	20	200			
13. Irrigation Vehicle Enterprise	15	80			
II. Construction Material Industry Branch	350	1,070	7,453.30	0.05	0.14
14. Hanoi - Vinh Tuy Concrete Factory	80	200			
15. Nam Thang Brick Enterprise	120	450			
16. Dai Thanh Brick Enterprise	60	100			
17. Linh Nam Silicate Sand Enterprise	10	80			
18. Thinh Liet Concrete Factory	60	150			
19. Interior Decoration Enterprise	10	50			
20. Housing repairing Enterprise	10	40			
III. Food Processing Industry Branch	460	2,900	11,695.63	0.04	0.25
21. Hanoi Foodstuff Enterprise	250	1,150			
22. Hanoi - Hai Chau Candy Factory	200	1,650			
23. Huu Nghi Sweet & Cake Factory	10	100			
IV. Textile Industry Branch	2,490	60,840	124,803.35	0.02	0.48
24. Union of Hanoi Knitware	600	33,900			
25. Union of Mar. 8 Textile	800	20,800			
26. Industrial Cloth Textile	250	500			
27. Hanoi Thread	80	400			
28. Hanoi Jute Textile	100	100			
29. Minh Khai Textile	400	3,000			
30. Cotton Enterprise	10	40			
31. Dong Xuan Textile Factory	100	600			
32. Oct. 10 Textile	150	1,500			
V. Garment Industry Branch	500	2,400	3,295.50	0.15	0.73
33. Thang Long Garment Factory	400	1,900			
34. Domestic Trade Garment Enterprise	100	500			
VI. Leather Shoes Industry	150	1000	212.13	0.71	4.7
35. Thang Long Shoes Enterprise	150	1000			
VII. Printing Industry Branch	40	140	636	0.06	0.22
36. Printing Workshop of Ministry of Social Labour, Invalid and Social Affair	30	100			
37. Hanoi People Printing House No. 2	10	40			
VIII. Others	200	250	270.77	0.74	0.9
38. Cuu Long Stationary Factory	200	250			

Table E2.1 WATER AND ELECTRICITY CONSUMPTION (2/6)
In Truong Dinh - Duoi Ca Industrial area

Branches - Enterprises	Water m ³ /24h	Electricity 1000kwh	Value of Yield (Million VND) in 1989 price	Unit Water Consumption m ³ /million D	Use Efficiency kwh/1000D Value of Yield
Total	890	7,930	41,378.35	0.02	0.19
<i>I. Mechanical Engineering Branch</i>	130	4,150	10,747	0.01	0.38
1. Automobile Repairing Factory No. 1	20	250			
2. Hanoi Engineering Factory No. 120	50	1,800			
3. Hanoi-Thong Nhat Mechanical Electric Ent.	60	2,100			
<i>II. Food Processing Industry Branch</i>	690	3,380	30,050.35	0.02	0.11
4. Hanoi Tuong Mai Mushroom Factory	60	400			
5. Hanoi VIFON noodle Enterprise	80	300			
6. Hanoi Hoang Mai Noodle Enterprise	90	330			
7. HN Microbiological Food Processing Factory	70	250			
8. HN Export Tinnery Factory	240	800			
9. Hanoi - Halha Export Candy Factory	150	1,300			
<i>III. Glass Industry Branch</i>	20	30	300	0.07	0.1
10. Thanh Duc Glass Enterprise	20	30			
<i>IV. Forestry Wood Processing Industry</i>	10	30			
11. Glap Bat Carpentry Enterprise	10	30			
<i>V. Garment Industry Branch</i>	10	40	57	0.18	0.7
12. Garment Enterprise No. 120 (Glap Bat Living Quater)	10	40			
<i>VI. Textile Industry Branch</i>	30	300	667	0.04	0.45
13. Dying - Textile Enterprise (Glap Bat)	20	300			

Table E2.1 WATER AND ELECTRICITY CONSUMPTION (3/6)
in Van Dien - Phap Van Industrial Area

Branches - Enterprises	Water m3/24h	Electricity 1000kwh	Value of Yield (million VND) in 1989 price	Unit Water Consumption m3/million D	Use Efficiency kwh/1000D Value of Yield
Total	645	5,820	52,241.50	0.01	0.11
<i>I. Mechanical Engineering Industry Branch</i>	270	2,600	19,944	0.01	0.13
1. Transformer Manufacturing Factory	60	500			
2. Food Equipment Manufacture No.1	50	350			
3. Ngu Hiep Metal Ware Factory	45	400			
4. Forestry Machinery Manufacture	30	350			
5. Irrigation Engineering Factory	25	300			
6. Transportation Engineering Factory No. 2	20	200			
7. Tam Hiep Engineering Factory	20	250			
8. Lien Minh Civil Engineering Factory	20	250			
<i>II. Chemical Industry Branch</i>	220	270	29,391.20	0.01	0.09
9. Van Dien Phosphorus Factory	120	1,500			
10. Union of Battery Enterprises	100	1,200			
<i>III. Construction Material Industry</i>	60	120	529	0.11	0.23
11. Van Dien Brick Factory	40	80			
12. Thanh Tri Brick Factory	20	40			
<i>IV. Pottery - Glass Industry Branch</i>	45	100			
<i>V. Forestry Wood Processing Industry</i>	50	300	2,000.90	0.02	0.15
14. Wooden Package Enterprise	50	300			

Table E2.1 WATER AND ELECTRICITY CONSUMPTION (4/6)
in Thuong Dinh Industrial Area

Branches - Enterprises	Water m ³ /24h	Electricity 1000kwh	Value of Yield (Million VND) in 1989 price	Unit Water Consumption m ³ /million D	Use Efficiency kwh/1000D Value of Yield
Total	1,200	18,610	167,603	0.007	0.11
I. Engineering Industry	510	5,490	24,465	0.021	0.22
1. Electronic Engineering Enterprise	20	300			
2. Sewing Machine Enterprise	30	250			
3. Thuong Dinh Bicycle Accessories Enterprise	50	350			
4. Bus Manufacture	40	250			
5. Hanoi Automobile Repairing Enterprise	35	250			
6. Automobile Repairing Factory - MOWR	30	300			
7. Tool Manufacture No. 1	60	800			
8. Agricultural Machine Tool Manufacture No.	30	300			
9. Dong Da Bicycle Accessories Factory	25	250			
10. Precision Engineering factory No. 1	100	1,500			
11. Hoa Binh Automobile Factory	20	250			
12. Cinematographic & Video Equipment Ent	20	150			
13. Cigarette Branch Engineering Enterprise	20	240			
14. Thong Nhat Bicycle Enterprise	20	300			
II. Chemical Industry Branch	370	2,750	30,928	0.012	0.09
15. Sao Vang Rubber Factory	150	1,800			
16. Hanoi Soap Factory	220	950			
III. Food Processing Industry Branch	120	1,300	76,703	0.002	0.02
17. Cigarette Factory	120	1,300			
IV. Textile Industry Branch	220	2,550	10,061	0.022	0.25
18. Mua Dong Woolen Knitting Enterprise	60	1,300			
19. Hanoi Cotton Enterprise	10	250			
20. May 19 Textile Factory	150	1000			
V. Garment Industry Branch	150	900	1,910	0.079	0.47
21. Garment Enterprise No. 40	150	900			
VI. Pottery - Glass Industry	320	1,840	7,157	0.045	0.26
22. Rang Dong Bulb Factory	300	1,800			
23. Hanoi Glass Enterprise	20	40			
VII. Paper Industry Branch	80	250	430	0.186	0.58
24. Binh Minh Experimental paper Manufacture	80	250			
VIII. Leather Foot Wear Industry	330	3,000	14,164	0.023	0.21
25. Hanoi Foot Wear for Export Enterprise	150	1,300			
26. Thuong Dinh Foot Wear Factory	100	900			
27. Hanoi Leather Foot Wear Enterprise	80	800			
IX. Other Branches	100	530	1,790	0.056	0.33
28. Cultural Works Enterprise	140	200			
29. Dai Kim Plastic Enterprise	30	150			
30. Goods Production for Export Enterprise	30	150			

Table E2.1 WATER AND ELECTRICITY CONSUMPTION (5/6)
In Cau Dien - Nghia Do Industrial Area

Branches - Enterprise	Water m3/24h	Electricity 1000kwh	Value of Yield (million VND) in 1989 price	Unit Water Consumption m3/million D	Use Efficiency kwh/1000D Value of Yield
Total	600	3,680	16,797.10	0.04	0.22
I. Mechanical Engineering Industry	40	250	944	0.042	0.26
1. Electricity-Isolating Material Manufacture	40	250			
II. Chemical Industry Branch	60	500	3,135	0.019	0.16
2. Hanoi Paint Enterprise	60	500			
III. Construction Material Branch	70	130	786	0.089	0.16
3. Tu Liem Tile Enterprise	30	60			
4. Tu Liem Brick Enterprise	40	70			
IV. Food Processing Industry Branch	410	2,600	11,352.11	0.036	0.23
5. Thang Long Mill Enterprise	30	200			
6. Hanoi Candy Factory	180	1,600			
7. Thang Long Distillery Enterprise	200	800			
V. Forestry Wood Processing Industry	20	200	580	0.034	0.34
8. Hanoi Forestry Products Processing Enter.	20	200			

In Chem Industry Area

Branches - Enterprise	Water m3/24h	Electricity 1000kwh	Value of Yield (million VND) In 1989 price	Unit Water Consumption m3/million D	Use Efficiency kwh/1000D Value of Yield
Total	390	1,320	14,810.56	0.026	0.09
I. Construction Material Industry	200	220	10,648.56	0.019	0.03
1. Construction Concrete Casting Factory	100	150			
2. Construction Material Factory	89	120			
3. Sand - Gravel Enterprise No. 1	20	50			
II. Textile Industry Branch	150	900	1,933	0.078	0.47
4. Hanoi Knitware Enterprise	150	900			
III. Others	40	100	2,229	0.018	0.04
5. Union of Package Production & Export Enter	40	100			

Table E2.1 WATER AND ELECTRICITY CONSUMPTION (6/6)
In Cau Bleu Industrial Area

Branches - Enterprises	Water m ³ /24h	Electricity 1000kwh	Value of Yield (million VND) in 1989 price	Unit Water Consumption m ³ /million D	Use Efficiency kwh/1000D Value of Yield
Total	195	1,950	5,690	0.034	0.34
I. Mechanical Engineering Industry	125	1,500	2,068	0.060	0.73
1. Hanoi Needle Enterprise	45	550			
2. Gial Phong Engineering Factory	50	600			
3. 75 Engineering Factory	30	350			
II. Construction Material Industry	30	40	350	0.086	0.11
4. Thanh Tri Brick Factory	30	40			
III. Chemical Industry	40	400	3,272	0.012	0.12
5. Synthetic Paint Factory	40	400			

Table E2.2 Daily Average Water

Country	Year		Population	
Argentina	1968	Buenos Aires	6,500,000	575
Argentina	1960	Resistencia	58,000	143
Branzil	1968	Sao Paulo	5,165,000	294
Branzil	1968	Porto Alegre	720,000	250
Branzil	1968	Joao Pessoa	220,000	220
Branzil	1968	Valinhos	20,000	187
Burma		Rangoon		170
Chile	1970	Santiago	2,500,000	300
Colombia	1960	Bogot	1,000,000	234
Colombia	1960	Cartagena	135,000	132
Colombia	1970	Urban area	-	113 ~ 275
Costa Rica	1960			445
Ethiopia	1970	Urban area	-	20 ~ 100
Greece		Athens		144
India	1970	Urban area	-	50 ~ 270
Italy		Provinces		200
Pakistan	1970	Urban area	-	70 ~ 180
Philippines		Urban area	-	110 ~ 590
Puerto Rico	1960	Villages		240
Serria Leone	1968	Villages	2,200 ~ 16,000	23 ~ 157
Surinam	1969	Paramaribo	130,000	100
Thailand	-	-	5,000	60 ~ 100
	-	-	5,000 ~ 10,000	100 ~ 150
	-	-	10,000 ~ 25,000	150 ~ 250
	-	-	25,000 ~ 50,000	200 ~ 250
Turkey	1975	Istanbul		134
Uganda	1968	Kampala	129,000	254
Uganda	1970	Urban area	-	50 ~ 500
Uganda	1968	Jinja	65,000	223
Venezuela	1960	13 cities	395 ~ 4,333	187
Venezuela	1970	Urban area		200 ~ 300

Source: D. A. Okun & G. Ponghis, "Community Wastewater Collection and Disposal", pp. 92-95, WHO Geneva (1975)

TABLE E2.3 ESTIMATE OF WASTEWATER YIELD BY ADMINISTRATIVE UNIT FOR THE YEAR 1992

(1/3)

	Phuong/ Xa	Study Area	1992		Wastewater Yield in 1992			Total (m3/d)
			Population	Density (person/ha)	Domestic (m3/d)	Commercial (m3/d)	Industrial (m3/d)	
URBAN AREA								
	Dong Da							
1	Van Mieu	23.0	11,288	490.8	1,016	485		1,501
2	Van Chuong	43.0	12,787	297.4	1,151	550	211	1,912
3	Cat Linh	46.2	13,126	284.1	1,181	564	63	1,809
4	Quoc Tu Giam	22.7	7,726	340.4	695	332		1,028
5	Hang Bot	27.8	14,313	514.9	1,288	615	258	2,162
6	O Cho Dua	84.5	17,356	205.4	1,562	746		2,308
7	Nam Dong	40.2	14,209	353.5	1,279	611	714	2,604
8	Quang Trung	50.2	9,475	188.7	853	407		1,260
9	Trung Liet	91.1	13,216	145.1	1,189	568		1,758
10	Tho Quan	24.2	12,338	509.8	1,110	531	374	2,015
11	Kham Tien	16.0	9,292	580.8	836	400		1,236
12	Trung Phung	24.1	11,104	460.7	999	477		1,477
13	Phuong Lien	34.3	11,636	339.2	1,047	500		1,548
14	Phuon Mai	43.9	12,478	284.2	1,123	537		1,660
15	Phuong Liet	65.0	11,256	173.2	1,013	484	168	1,665
16	Kim Lien	33.9	11,790	347.8	1,061	507	85	1,653
17	Trung Tu	74.3	13,056	175.7	1,175	561	101	1,837
18	Khuong Thuong	35.1	10,080	287.2	907	433	103	1,444
19	Nguyen Trai	42.5	21,082	496.0	1,897	907	209	3,013
20	Thinh Quang	38.3	14,321	373.9	1,289	616		1,905
21	Lang Ha	80.7	13,113	162.5	1,180	564		1,744
22	Lang Thuong	123.0	11,851	96.3	1,067	510		1,576
23	Thuong Dinh	35.8	10,195	284.9	918	438	269	1,625
24	Thang Xuan	72.0	8,982	124.8	808	386	1,429	2,624
25	Kim Giang	44.0	6,978	158.6	628	300		928
26	Thang Xuan Bac Officials*2	146.0 122.8	20,987 10,321	143.7 84.0	1,889 929	902 444	211	3,002 1,373
	Quan Total	1,484.6	334,356	225.2	30,092	14,377	4,195	48,664
	Ba Dinh							
27	Trung Truc	18.9	9,951	526.5	896	428		1,323
28	Dien Bien	134.2	10,868	81.0	978	467	48	1,493
29	Cau Giay	99.0	14,574	147.2	1,312	627		1,938
30	Ngoc Ha	99.2	13,741	138.5	1,237	591	83	1,911
31	Truc Bach	38.7	12,358	319.3	1,112	531	239	1,883
32	Yen Phu	56.1	8,166	145.7	735	351		1,086
33	Phuc Xa	3.2	788	246.3	71	34		105
34	Quan Thanh	56.0	10,670	190.5	960	459		1,419
35	Thuy Khe	51.5	12,195	236.8	1,098	524	195	1,817
36	Buoi	106.0	14,047	132.5	1,264	604	83	1,951
37	Giang Vo	53.5	14,349	268.2	1,291	617	138	2,046
38	Thanh Cong	63.6	16,332	256.8	1,470	702	211	2,383
39	Kim Ma	76.0	13,308	175.1	1,198	572	250	2,020
40	Doi Can	38.0	12,907	339.7	1,162	555		1,717
41	Cong Vi Officials*3 Officials*4	136.7 39.0 13.0	18,474 3,728 0	135.1 95.6 0	1,663 336 0	794 160 0		2,457 496 0
	Quan Total	1082.6	186,456	172.2	16,781	8,018	1,247	26,046

Phuong/ Xa	Study Area	1992		Wastewater Yield in 1992				
		Population	Density (person/ha)	Domestic (m3/d)	Commercial (m3/d)	Industrial (m3/d)	Total (m3/d)	
Hoan Kiem								
42	Cua Nam	34.2	11,971	350.0	1,077	515	369	1,961
43	Tran Hung Dao	36.0	10,511	292.0	946	452		1,398
44	Hang Bai	29.4	9,348	318.0	841	402		1,243
45	Phan Chu Trinh	53.5	7,861	146.9	707	338		1,046
46	Ly Thai To	27.8	8,176	294.1	736	352		1,087
47	Trang Tien	7.4	6,612	893.5	595	284		879
48	Hang Bac	22.0	8,082	367.4	727	348		1,075
49	Hang Buom	13.2	11,186	847.4	1,007	481		1,488
50	Dong Xuan	12.6	11,936	947.3	1,074	513		1,587
51	Hang Dao	8.0	7,466	933.3	672	321		993
52	Hang Ma	21.7	8,520	392.6	767	366		1,133
53	Hang Bo	7.3	9,222	1263.3	830	397		1,227
54	Cua Dong	13.5	8,406	622.7	757	361		1,118
55	Hang Bong	14.8	8,278	559.3	745	356		1,101
56	Hang Gai	12.0	10,220	851.7	920	439		1,359
57	Hang Trong	37.6	9,471	251.9	852	407		1,260
58	Phuc Tan	0.0	0		0	0		0
59	Chuong Duong Do Officials	0.0 0.0	0 0		0 0	0 0		0 0
Quan Total		351.0	147,266	419.6	13,254	6,332	369	19,955
Hai Ba Trung								
60	Le Dai Hang	83.6	13,807	165.2	1,243	594		1,836
61	Nguyen Du	29.3	9,438	322.1	849	406		1,255
62	Dong Nhan	21.7	10,262	472.9	924	441	676	2,041
63	Ngo Thi Nham	18.1	11,347	626.9	1,021	488	91	1,600
64	Pham Dinh Ho	23.5	8,128	345.9	732	350		1,081
65	Thanh Nhan	58.5	15,477	264.6	1,393	666		2,058
66	Quynh Loi	29.0	10,900	375.9	981	469	430	1,880
67	Bach Khoa	29.0	10,460	360.7	941	450		1,391
68	Dong Mac	17.0	8,658	509.3	779	372		1,152
69	Thanh Luong	40.3	5,844	145.0	526	251		777
70	Bach Dang	19.1	4,989	260.5	449	215		664
71	Giap Bat	64.5	9,367	145.2	843	403	211	1,457
72	Minh Khai	51.0	12,797	250.9	1,152	550	750	2,452
73	Bui Thi Xuan	16.5	10,463	634.1	942	450	769	2,161
74	Vinh Tuy	109.0	17,406	159.7	1,567	748	646	2,961
75	Quynh Mai	37.6	11,319	301.0	1,019	487		1,505
76	Tuong Mai	45.5	15,427	339.1	1,388	663	593	2,645
77	Dong Tam	18.8	12,076	642.3	1,087	519		1,606
78	Mai Dong	82.5	10,993	133.2	989	473	365	1,827
79	Cau Den	24.0	8,872	369.7	798	381		1,180
80	Bach Mai	29.5	14,505	491.7	1,305	624		1,929
81	Tan Mai	63.7	15,259	239.5	1,373	656	211	2,240
82	Truong Dinh	30.0	14,882	496.1	1,339	640	722	2,701
83	Pho Hue	20.1	13,578	675.5	1,222	584		1,806
84	Hoang Van Thu Officials	60.0 0.0 0.0	7,557 0 0	126.0	680 0 0	325 0 0	66	1,071 0 0
Quan Total		1,021.9	283,811	277.7	25,543	12,204	5,530	43,277
Urban Total		3,940.0	956,271	242.7	85,670	40,931	11,341	137,942

	Phuong/ Xa	Study Area	1992		Wastewater Yield in 1992			Total (m3/d)
			Population	Density (person/ha)	Domestic (m3/d)	Commercial (m3/d)	Industrial (m3/d)	
SUBURBAN AREA								
Thanh Tri								
1	Tran Van Dien	68.6	9,744	142.0	487	419		906
2	Khuong Dinh	240.4	7,103	29.5	639	305	960	1,905
3	Dinh Cong	239.4	5,723	23.9	515	246	48	809
4	Vinh Tuy	180.6	5,922	32.8	533	255		788
5	Thanh Tri	120.8	3,554	29.4	178	153		331
6	Tran Phu	141.0	1,809	12.8	163	78		241
7	Yen So	292.8	3,444	11.8	310	148		458
8	Tu Hiep	38.8	606	15.6	55	26		81
9	Thinh Liet	301.8	8,670	28.7	780	373	114	1,267
10	Thanh Liet	172.1	3,102	18.0	279	133	114	527
11	Dai Kim	250.4	5,894	23.5	530	253		784
12	Linh Nam	150.2	2,713	18.1	244	117		361
13	Tam Hiep	33.3	757	22.7	68	33		101
14	Tan Trieu	313.2	10,072	32.2	906	433	114	1,454
15	Hoang Liet	467.2	8,227	17.6	740	354	114	1,208
16	Yen Mai	498.4	3,748	7.5	337	161		498
Huyen Total		3,509.0	81,088	23.1	6,766	3,487	1,464	11,717
Tu Liem								
17	Tran Ngia Do	132.7	10,319	77.8	929	444		1,372
18	Tran Cau Giay	94.4	13,635	144.4	1,227	586	114	1,927
19	Tran Cau Dien	129.1	4,484	34.7	404	193		596
20	Tu Lien	141.7	2,097	14.8	189	90	42	321
21	Quang An	123.6	3,056	24.7	275	131		406
22	Nhat Tan	111.2	2,356	21.2	212	101		313
23	Mai Dich	187.9	12,025	64.0	1,082	517		1,599
24	Dich Vong	349.1	9,450	27.1	851	406	114	1,371
25	My Dinh	460.6	7,505	16.3	675	323		998
26	Dong Nhac	243.3	9,664	39.7	870	416		1,285
27	Xuan La	213.5	6,089	28.5	548	262		810
28	Xuan Dinh	557.5	12,570	22.5	1,131	541		1,672
29	Co Nhue	283.7	7,639	26.9	688	328	114	1,130
30	Yen Hoa	186.0	8,440	45.4	760	363	114	1,237
31	Trung Hoa	234.1	7,454	31.8	671	321	114	1,105
32	Trung Van	289.2	6,761	23.4	608	291		899
33	Nhan Chinh	254.3	7,900	31.1	711	340	116	1,167
34	Me Tri	706.6	12,632	17.9	1,137	543		1,680
35	Phu Thuong	399.8	5,620	14.1	506	242		747
36	Thuy Phuong	49.8	1,290	25.9	116	55		172
37	Ngai Tan	53.6	13,318	248.5	1,199	573		1,771
Huyen Total		5,201.8	164,304	31.6	14,787	7,065	728	22,580
Ha Tay								
1	Van Yen	322.0	5,400	16.8	486	232	900	1,618
Suburban Total		9,032.8	250,792	27.8	22,039	10,784	3,092	35,915
TOTAL		12,972.8	1,207,063	93.0	107,709	51,715	14,433	173,858

*1 : Percentage of the area inside the Study Area

*2 : Bach Mai airbase

*3 : Government & military area

*4 : Ho Chi Minh square

TABLE E2.4 ESTIMATE OF WASTEWATER YIELD BY ADMINISTRATIVE UNIT FOR THE YEAR 2010

(1/3)

	Phuong/ Xa	Study Area	2,010		Wastewater Yield in 2010			Total (m3/d)
			Population	Density (person/ha)	Domestic (m3/d)	Commercial (m3/d)	Industrial (m3/d)	
URBAN AREA								
Dong Da								
1	Van Mieu	23.0	11,842	514.9	2,132	651		2,783
2	Van Chuong	43.0	13,415	312.0	2,415	738		3,152
3	Cat Linh	46.2	17,470	378.1	3,145	961		4,105
4	Quoc Tu Glam	22.7	10,283	453.0	1,851	566		2,416
5	Hang Bot	27.8	19,050	685.2	3,429	1,048		4,477
6	O Cho Dua	84.5	21,596	255.6	3,887	1,188		5,075
7	Nam Dong	40.2	18,283	454.8	3,291	1,006		4,297
8	Quang Trung	50.2	12,192	242.9	2,195	671		2,865
9	Trung Liet	91.1	18,308	201.0	3,295	1,007		4,302
10	Tho Quan	24.2	12,944	534.9	2,330	712		3,042
11	Kham Tien	16.0	9,748	609.3	1,755	536		2,291
12	Trung Phung	24.1	11,649	483.4	2,097	641		2,738
13	Phuong Lien	34.3	12,207	355.9	2,197	671		2,869
14	Phuong Mai	43.9	16,612	378.4	2,990	914		3,904
15	Phuong Liet	65.0	33,381	513.5	6,009	1,836	980	8,824
16	Kim Lien	33.9	15,696	463.0	2,825	863		3,689
17	Trung Tu	74.3	16,800	226.1	3,024	924		3,948
18	Khuong Thuong	35.1	13,420	382.3	2,416	738		3,154
19	Nguyen Trai	42.5	39,580	931.3	7,124	2,177		9,301
20	Thinh Quang	38.3	22,601	590.1	4,068	1,243		5,311
21	Lang Ha	80.7	18,299	226.7	3,294	1,006		4,300
22	Lang Thuong	123.0	17,461	142.0	3,143	960		4,103
23	Thuong Dinh	35.8	11,839	330.7	2,131	651		2,782
24	Thang Xuan	72.0	15,380	213.6	2,768	846	1,540	5,154
25	Kim Giang	44.0	13,101	297.7	2,358	721		3,079
26	Thang Xuan Bac	146.0	54,953	376.4	9,891	3,022	980	13,894
	Officials*2	122.8	10,321	84.0	1,858	568		2,425
	Quan Total	1,484.6	488,429	329.0	87,917	26,864	3,500	118,281
Ba Dinh								
27	Trung Truc	18.9	7,683	406.5	1,383	423		1,805
28	Dien Bien	134.2	12,085	90.0	2,175	665		2,840
29	Cau Giay	99.0	15,751	159.1	2,835	866		3,701
30	Ngoc Ha	99.2	18,665	188.2	3,360	1,027		4,386
31	Truc Bach	38.7	9,541	246.5	1,717	525		2,242
32	Yen Phu	56.1	8,470	151.1	1,525	466		1,990
33	Phuc Xa	3.2	818	255.6	147	45		192
34	Quan Thanh	56.0	9,799	175.0	1,764	539		2,303
35	Thuy Khe	51.5	2,052	39.8	369	113		482
36	Buoi	106.0	13,283	125.3	2,391	731		3,121
37	Giang Vo	53.5	14,608	273.0	2,629	803		3,433
38	Thanh Cong	63.6	22,791	358.3	4,102	1,253		5,356
39	Kim Ma	76.0	13,548	178.3	2,439	745		3,184
40	Doi Can	38.0	16,275	428.3	2,930	895		3,825
41	Cong Vi	136.7	25,548	186.9	4,599	1,405		6,004
	Officials*3	39.0	3,728	95.6	671	205		876
	Officials*4	13.0	0	0	0	0		0
	Quan Total	1082.6	194,643	179.8	35,036	10,705	0	45,741

	Phuong/ Xa	Study Area	2,010		Wastewater Yield in 2010			Total (m3/d)
			Population	Density (person/ha)	Domestic (m3/d)	Commercial (m3/d)	Industrial (m3/d)	
Hoan Kiem								
42	Cua Nam	34.2	10,997	321.6	1,980	605		2,584
43	Tran Hung Dao	36.0	9,488	263.5	1,708	522		2,230
44	Hang Bai	29.4	8,438	287.0	1,519	464		1,983
45	Phan Chu Trinh	53.5	6,764	126.4	1,217	372		1,590
46	Ly Thai To	27.8	7,631	274.5	1,374	420		1,793
47	Trang Tien	7.4	5,968	806.5	1,074	328		1,403
48	Hang Bac	22.0	7,544	342.9	1,358	415		1,773
49	Hang Buom	13.2	9,912	750.9	1,784	545		2,329
50	Dong Xuan	12.6	11,046	876.7	1,988	608		2,596
51	Hang Dao	8.0	6,926	865.8	1,247	381		1,628
52	Hang Ma	21.7	7,904	364.2	1,423	435		1,857
53	Hang Bo	7.3	8,555	1171.9	1,540	471		2,010
54	Cua Dong	13.5	7,798	577.6	1,404	429		1,833
55	Hang Bong	14.8	7,727	522.1	1,391	425		1,816
56	Hang Gai	12.0	9,481	790.1	1,707	521		2,228
57	Hang Trong	37.6	8,840	235.1	1,591	486		2,077
58	Phuc Tan	0.0	0		0	0		0
59	Chuong Duong Do Officials	0.0	0		0	0		0
Quan Total		351.0	135,019	384.7	24,303	7,426	0	31,730
Hai Ba Trung								
60	Le Dai Hang	83.6	11,622	139.0	2,092	639		2,731
61	Nguyen Du	29.3	8,519	290.8	1,533	469		2,002
62	Dong Nhan	21.7	8,830	406.9	1,589	486		2,075
63	Ngo Thi Nham	18.1	9,763	539.4	1,757	537		2,294
64	Pham Dinh Ho	23.5	6,994	297.6	1,259	385		1,643
65	Thanh Nhan	58.5	12,876	220.1	2,318	708		3,026
66	Quynh Loi	29.0	9,068	312.7	1,632	499		2,131
67	Bach Khoa	29.0	9,350	322.4	1,683	514		2,197
68	Dong Mac	17.0	7,450	438.2	1,341	410		1,751
69	Thanh Luong	40.3	6,403	158.8	1,153	352		1,505
70	Bach Dang	19.1	4,292	224.1	773	236		1,009
71	Giap Bat	64.5	14,768	229.0	2,658	812	840	4,311
72	Minh Khai	51.0	10,646	208.8	1,916	586		2,502
73	Bui Thi Xuan	16.5	8,807	533.8	1,585	484		2,070
74	Vinh Tuy	109.0	18,063	165.7	3,251	993	4,032	8,277
75	Quynh Mai	37.6	9,417	250.4	1,695	518		2,213
76	Tuong Mai	45.5	25,035	550.2	4,506	1,377		5,883
77	Dong Tam	18.8	10,795	574.2	1,943	594		2,537
78	Mai Dong	82.5	11,168	135.4	2,010	614	1,988	4,612
79	Cau Den	24.0	7,931	330.4	1,428	436		1,864
80	Bach Mai	29.5	16,229	550.1	2,921	893		3,814
81	Tan Mai	63.7	23,172	363.8	4,171	1,274		5,445
82	Truong Dinh	30.0	24,023	800.8	4,324	1,321		5,645
83	Pho Hue	20.1	11,683	581.2	2,103	643		2,745
84	Hoang Van Thu Officials	60.0	7,677	128.0	1,382	422		1,804
		0.0	0		0	0		0
		0.0	0		0	0		0
Quan Total		1,021.9	294,580	288.3	53,024	16,202	6,860	76,086
Urban Total		3,940.0	1,112,671	282.4	200,281	61,197	10,360	271,838

	Phuong/ Xa	Study Area	2,010		Wastewater Yield in 2010			Total (m3/d)
			Population	Density (person/ha)	Domestic (m3/d)	Commercial (m3/d)	Industrial (m3/d)	
SUBURBAN AREA								
Thanh Tri								
1	Tran Van Dien	68.6	17,148	250.0	1,715			1,715
2	Khuong Dinh	240.4	12,029	50.0	2,165	662	560	3,387
3	Dinh Cong	239.4	11,960	50.0	2,153	658	1,624	4,435
4	Vinh Tuy	180.6	6,668	36.9	1,200	367		1,567
5	Thanh Tri	120.8	4,578	37.9	458		2,016	2,474
6	Tran Phu	141.0	2,253	16.0	406	124		529
7	Yen So	292.8	4,987	17.0	898	274		1,172
8	Tu Hiep	38.8	834	21.5	83			83
9	Thinh Liet	301.8	15,099	50.0	2,718	830	168	3,716
10	Thanh Liet	172.1	4,418	25.7	442			442
11	Dai Kim	250.4	7,592	30.3	759		448	1,207
12	Linh Nam	150.2	3,614	24.1	361			361
13	Tam Hiep	33.3	672	20.2	67			67
14	Tan Trieu	313.2	15,572	49.7	2,803	856		3,659
15	Hoang Liet	467.2	10,777	23.1	1,940	593		2,533
16	Yen Mai	498.4	4,286	8.6	429			429
Huyen Total		3,509.0	122,487	34.9	18,596	4,364	4,816	27,776
Tu Liem								
17	Tran Ngia Do	132.7	31,174	234.9	5,611	1,715		7,326
18	Tran Cau Giay	94.4	41,192	436.4	7,415	2,266		9,680
19	Tran Cau Dien	129.1	19,346	149.8	3,482	1,064		4,546
20	Tu Lien	141.7	2,175	15.3	218			218
21	Quang An	123.6	4,902	39.6	490			490
22	Nhat Tan	111.2	1,946	17.5	195			195
23	Mai Dich	187.9	12,223	65.0	2,200	672		2,872
24	Dich Vong	349.1	21,493	61.6	3,869	1,182	560	5,611
25	My Dinh	460.6	10,925	23.7	1,093		1,680	2,773
26	Dong Nhac	243.3	23,420	96.3	2,342		1,120	3,462
27	Xuan La	213.5	15,773	73.9	2,839	868		3,707
28	Xuan Dinh	557.5	26,018	46.7	4,683	1,431		6,114
29	Co Nhue	283.7	17,113	60.3	3,080	941		4,022
30	Yen Hoa	186.0	37,211	200.1	6,698	2,047		8,745
31	Trung Hoa	234.1	16,045	68.5	2,888	882		3,770
32	Trung Van	289.2	11,936	41.3	2,148	656		2,805
33	Nhan Chinh	254.3	8,604	33.8	1,549	473		2,022
34	Me Tri	706.6	20,256	28.7	2,026			2,026
35	Phu Thuong	399.8	8,868	22.2	887			887
36	Thuy Phuong	49.8	2,545	51.1	255		560	815
37	Ngai Tan	53.6	20,298	378.7	3,654	1,116		4,770
Huyen Total		5,201.8	353,463	67.9	57,620	15,313	3,920	76,854
Ha Tay								
1	Van Yen	322.0	8,251	25.6	1,485	454		1,939
Suburban Total		9,032.8	484,200	53.6	77,702	20,131	8,736	106,569
TOTAL		12,972.8	1,596,871	123.1	277,982	81,328	19,096	378,406

*2 : Bach Mai airbase

*3 : Government & military area

*4 : Ho Chi Minh square

Table E2.5 POLLUTANT LOAD PER CAPITA IN OTHER COUNTRIES

(UNIT: g/c/d)

Name of Area	BOD	SS
Indonesia (Jarkata)	30	
India	30 - 45	67
S.E. Asia	43	
Kenya	23	
Zambia	36	
JAPAN	50 - 60	40
UK	50 - 59	62
USA	45 - 78	
UAS :Met.California (Combined System)	48	41
Developing Countries (WHO)	40	

Table E2.6 Industrial Waste Water Quality & Typical Treatment

Industry	BOD PPM	COD PPM	SS PPM	PH	Typical Treatment
1. Food					
Processing	1,000 - 2,700	430 - 2,700	450 - 800	1 - 14	A.S
Dairy Products	250	170	200	65 - 11	A.S
Seasoning	340 - 2,300	109 - 11,900	76 - 4,250	6 - 8	A.S
Milling	1,900	1,600	2,400	6 - 8	OF + A.S
Soft Drink	340	330	370	9 - 12	A.S
Alcoholic Drink	490 - 1,700	127 - 1,400	88 - 776	8 - 11	A.S
Frozen	410	170	200	-	A.S
Confectionery	860	780	610	6 - 8	OF + A.S
Feed/Fertilizer	1,200	480	25	-	A.S
Cooking Oil	4,400	3,100	2,600	1 - 7	OF + A.S
Others	450 - 2,400	450 - 1,200	450 - 1,200	6 - 8	A.S
2. Spinning					
Tex tile	20 - 300	30 - 610	15 - 630	3, 5 - 9	A.S
Tex tile	60	30	100	6 - 8	A.S
Garment	10	10	30	6 - 8	A.S
Dyeing	200 - 300	160 - 450	80 - 200	3 - 11	C.D
3. Chemical					
Organic Chemical	300 - 600	460 - 870	100 - 150	1 - 13	N.T + A.S/C.S
Plastic/Rubber	10	20	50	-	N.T + A.S
Petro - Chemical	20 - 200	20 - 200	20 - 100	1 - 13	OF + A.S / G.S
Others	500	500	30	-	A.S / C.D
4. Wood/Furniture					
Wood/Furniture	10	10	30 - 40	-	A.S
5. Glass/Ceramic					
Glass/Ceramic	3 - 10	1 - 13	30 - 20,000	7 - 9	C.S / F.M
6. Cement/Concrete					
Cement/Concrete	8 - 30	7 - 17	200 - 1,400	9 - 14	N.T
7. Metal product					
Metal product	20 - 360	20 - 360	20 - 560	2 - 8	N.T / C.S
8. Plate					
Plate	-	-	30 - 150	1 - 6	N.T / C.D
9. Pulp/Paper					
Pulp/Paper	300	250	180	7 - 9	A.S / C.S
10. Machinery					
Machinery	10	30	100	-	OF + A.S / C.D
11. Automobile					
Automobile	50	90	100	-	OF + A.S / C.D
12. Electronics					
Electronics	10	30	100	-	OF + A.S / C.D
13. Miscellaneous					
Miscellaneous	5	10	40	6 - 8	A.S

A.S : Activated Sludge Method
 C.S : Coagulated Sedimentation
 O.F : Oil Floating

F.M : Filter Method
 N.T : Neutralization Treat
 C.D : Chemical Treat

TABLE E2.7 CHARACTERS OF SEWAGE

(Unit: mg/l)

	Kenya (Nairobi)	Kenya (Nakuru)	India (Kodungaiyur)	Peru (Lima)	Israel (Herzliya)	USA (Allentown)	UK (Yeovil)
BOD ₅	448	940	282	175	285	213	324
SS	550	662	402	196	427	186	321
TDS	503	611	1,060	1,187	1,094	502	-
Chloride	50	62	205	163	163	96	315
NH ₄ -N	67	72	30	76	76	12	29

TABLE E2.8 EXISTING & FUTURE POLLUTANT LOAD

(1/3)

Phuong/ Xa	Study Area	1992		2010	
		POLLUTANTLOAD GENERATION(kg/d)	SPECIFICPOLLUTANT LOAD(kg/d/ha)	POLLUTANTLOAD GENERATION(kg/d)	SPECIFICPOLLUTANT LOAD(kg/d/ha)
URBAN AREA					
Dong Da					
1	Van Mieu	23.0	549	23.9	841
2	Van Chuong	43.0	706	16.4	952
3	Cat Linh	46.2	663	14.4	1,240
4	Quoc Tu Giam	22.7	375	16.5	730
5	Hang Bot	27.8	799	28.7	1,353
6	O Cho Dua	84.5	844	10.0	1,533
7	Nam Dong	40.2	976	24.3	1,298
8	Quang Trung	50.2	460	9.2	866
9	Trung Liet	91.1	642	7.1	1,300
10	Tho Quan	24.2	749	31.0	919
11	Kham Tien	16.0	452	28.2	692
12	Trung Phung	24.1	540	22.4	827
13	Phuong Lien	34.3	566	16.5	867
14	Phuong Mai	43.9	606	13.8	1,179
15	Phuong Liet	65.0	614	9.4	2,762
16	Kim Lien	33.9	607	17.9	1,114
17	Trung Tu	74.3	675	9.1	1,193
18	Khuong Thuong	35.1	531	15.1	953
19	Nguyen Trai	42.5	1,108	26.1	2,810
20	Thinh Quang	38.3	696	18.2	1,605
21	Lang Ha	80.7	637	7.9	1,299
22	Lang Thuong	123.0	576	4.7	1,240
23	Thuong Dinh	35.8	603	16.8	841
24	Thang Xuan	72.0	1,008	14.0	1,708
25	Kim Giang	44.0	339	7.7	930
26	Thang Xuan Bac	146.0	1,104	7.6	4,294
	Officials*2	122.8	502	4.1	733
Quan Total		1,484.6	17,928	12.1	36,078
Ba Dinh					
27	Trung Truc	18.9	484	25.6	545
28	Dien Bien	134.2	547	4.1	858
29	Cau Giay	99.0	708	7.2	1,118
30	Ngoc Ha	99.2	701	7.1	1,325
31	Truc Bach	38.7	696	18.0	677
32	Yen Phu	56.1	397	7.1	601
33	Phuc Xa	3.2	38	12.0	58
34	Quan Thanh	56.0	519	9.3	696
35	Thuy Khe	51.5	671	13.0	146
36	Buoi	106.0	716	6.8	943
37	Giang Vo	53.5	753	14.1	1,037
38	Thanh Cong	63.6	878	13.8	1,618
39	Kim Ma	76.0	747	9.8	962
40	Doi Can	38.0	627	16.5	1,156
41	Cong Vi	136.7	898	6.6	1,814
	Officials*3	39.0	181	4.6	265
	Officials*4	13.0	0	0.0	0
Quan Total		1082.6	9,561	8.8	13,820

Phuong/ Xa	Study Area	1992		2010		
		POLLUTANTLOAD GENERATION(kg/d)	SPECIFICPOLLUTANT LOAD(kg/d/ha)	POLLUTANTLOAD GENERATION(kg/d)	SPECIFICPOLLUTANT LOAD(kg/d/ha)	
Hoan Kiem						
42	Cua Nam	34.2	729	21.3	781	22.8
43	Tran Hung Dao	36.0	511	14.2	674	18.7
44	Hang Bai	29.4	454	15.5	599	20.4
45	Phan Chu Trinh	53.5	382	7.1	480	9.0
46	Ly Thai To	27.8	397	14.3	542	19.5
47	Trang Tien	7.4	321	43.4	424	57.3
48	Hang Bac	22.0	393	17.9	536	24.3
49	Hang Buom	13.2	544	41.2	704	53.3
50	Dong Xuan	12.6	580	46.0	784	62.2
51	Hang Dao	8.0	363	45.4	492	61.5
52	Hang Ma	21.7	414	19.1	561	25.9
53	Hang Bo	7.3	448	61.4	607	83.2
54	Cua Dong	13.5	409	30.3	554	41.0
55	Hang Bong	14.8	402	27.2	549	37.1
56	Hang Gai	12.0	497	41.4	673	56.1
57	Hang Trong	37.6	460	12.2	628	16.7
58	Phuc Tan	0.0	0	#DIV/0!	0	#DIV/0!
59	Chuong Duong Do Officials	0.0	0	#DIV/0!	0	#DIV/0!
		0.0	0	#DIV/0!	0	#DIV/0!
Quan Total		351.0	7,305	20.8	9,586	27.3
Hai Ba Trung						
60	Le Dai Hang	83.6	671	8.0	825	9.9
61	Nguyen Du	29.3	459	15.7	605	20.6
62	Dong Nhan	21.7	769	35.4	627	28.9
63	Ngo Thi Nham	18.1	588	32.5	693	38.3
64	Pham Dinh Ho	23.5	395	16.8	497	21.1
65	Thanh Nhan	58.5	752	12.9	914	15.6
66	Quynh Loi	29.0	702	24.2	644	22.2
67	Bach Khoa	29.0	508	17.5	664	22.9
68	Dong Mac	17.0	421	24.8	529	31.1
69	Thanh Luong	40.3	284	7.0	455	11.3
70	Bach Dang	19.1	242	12.7	305	15.9
71	Giap Bat	64.5	540	8.4	1,385	21.5
72	Minh Khai	51.0	922	18.1	756	14.8
73	Bui Thi Xuan	16.5	816	49.5	625	37.9
74	Vinh Tuy	109.0	1,104	10.1	2,895	26.6
75	Quynh Mai	37.6	550	14.6	669	17.8
76	Tuong Mai	45.5	987	21.7	1,777	39.1
77	Dong Tam	18.8	587	31.2	766	40.8
78	Mai Dong	82.5	680	8.2	1,588	19.2
79	Cau Den	24.0	431	18.0	563	23.5
80	Bach Mai	29.5	705	23.9	1,152	39.1
81	Tan Mai	63.7	826	13.0	1,645	25.8
82	Truong Dinh	30.0	1,012	33.7	1,706	56.9
83	Pho Hue	20.1	660	32.8	829	41.3
84	Hoang Van Thu Officials	60.0	394	6.6	545	9.1
		0.0	0	#DIV/0!	0	#DIV/0!
		0.0	0	#DIV/0!	0	#DIV/0!
Quan Total		1,021.9	16,005	15.7	23,659	23.2
Urban Total		3,940.0	50,798	12.9	83,144	21.1

Phuong/ Xa	Study Area	1992		2010		
		POLLUTANTLOAD GENERATION(kg/d)	SPECIFICPOLLUTANT LOAD(kg/d/ha)	POLLUTANTLOAD GENERATION(kg/d)	SPECIFICPOLLUTANT LOAD(kg/d/ha)	
SUBURBAN AREA						
Thanh Tri						
1	Tran Van Dien	68.6	474	6.9	1,029	15.0
2	Khuong Dinh	240.4	729	3.0	1,078	4.5
3	Dinh Cong	239.4	297	1.2	1,499	6.3
4	Vinh Tuy	180.6	288	1.6	473	2.6
5	Thanh Tri	120.8	173	1.4	1,081	8.9
6	Tran Phu	141.0	88	0.6	160	1.1
7	Yen So	292.8	167	0.6	354	1.2
8	Tu Hiep	38.8	29	0.8	50	1.3
9	Thinh Liet	301.8	467	1.5	1,139	3.8
10	Thanh Liet	172.1	196	1.1	265	1.5
11	Dai Kim	250.4	286	1.1	635	2.5
12	Linh Nam	150.2	132	0.9	217	1.4
13	Tam Hiep	33.3	37	1.1	40	1.2
14	Tan Trieu	313.2	535	1.7	1,106	3.5
15	Hoang Liet	467.2	445	1.0	765	1.6
16	Yen Mai	498.4	182	0.4	257	0.5
Huyen Total		3,509.0	4,526	1.3	10,148	2.9
Tu Liem						
17	Tran Ngia Do	132.7	502	3.8	2,213	16.7
18	Tran Cau Giay	94.4	708	7.5	2,925	31.0
19	Tran Cau Dien	129.1	218	1.7	1,374	10.6
20	Tu Lien	141.7	119	0.8	131	0.9
21	Quang An	123.6	149	1.2	294	2.4
22	Nhat Tan	111.2	115	1.0	117	1.1
23	Mai Dich	187.9	584	3.1	868	4.6
24	Dich Vong	349.1	505	1.4	1,750	5.0
25	My Dinh	460.6	365	0.8	1,328	2.9
26	Dong Nhac	243.3	470	1.9	1,853	7.6
27	Xuan La	213.5	296	1.4	1,120	5.2
28	Xuan Dinh	557.5	611	1.1	1,847	3.3
29	Co Nhue	283.7	417	1.5	1,215	4.3
30	Yen Hoa	186.0	456	2.5	2,642	14.2
31	Trung Hoa	234.1	408	1.7	1,139	4.9
32	Trung Van	289.2	329	1.1	847	2.9
33	Nhan Chinh	254.3	430	1.7	611	2.4
34	Me Tri	706.6	614	0.9	1,215	1.7
35	Phu Thuong	399.8	273	0.7	532	1.3
36	Thuy Phuong	49.8	63	1.3	377	7.6
37	Ngai Tan	53.6	647	12.1	1,441	26.9
Huyen Total		5,201.8	8,276	1.6	25,838	5.0
Ha Tay						
1	Van Yen	322.0	622	1.9	586	1.8
Suburban Total		9,032.8	13,425	1.5	36,573	4.0
TOTAL		12,972.8	64,223	5.0	119,716	9.2

*1: Percentage of the area inside the Study Area

*2: Bach Mai airbase

*3: Government & military area

*4: Ho Chi Minh square

TABLE E3.1 WASTEWATER DISCHARGE AND POLLUTANT LOAD RUN-OFF

Name of Drainage Basins	Name of Drainage Sub-Basins	Area (km ²)	1992					2010				
			Wastewater Discharge (m ³ /day)	Pollutant Load (kg/day)	Specific Discharge (m ³ /day/ha)	Specific Load Runoff (kg/day/ha)	Wastewater Quality:BOD (mg/l)	Wastewater Discharge (m ³ /day)	Pollutant Load (kg/day)	Specific Discharge (m ³ /day/ha)	Specific Load Runoff (kg/day/ha)	Wastewater Quality:BOD (mg/l)
1. To Lich	a. West Lake	9.3	10,933	3,596	1,178	387	328	18,920	5,627	2,034	605	297
	b. To Lich	20	47,985	16,441	2,399	822	343	101,034	29,809	5,052	1,490	295
	c. Lu	10.2	28,687	10,147	2,812	995	354	73,032	20,831	7,160	2,042	285
	d. Kim Nguu	17.3	27,991	9,633	1,618	557	344	50,706	14,486	2,931	837	286
	e. Set	7.1	32,164	11,432	4,530	1,610	355	51,085	14,965	7,195	2,108	293
	f. Hoan Liet	8.1	3,129	1,734	386	214	554	6,054	2,394	747	296	395
	g. Yen So	5.5	348	321	63	58	923	1,892	718	344	131	380
Total		77.5	151,256	53,305	1,952	688	352	302,725	88,829	3,906	1,146	293
2. Nhuue	a. Co Nhuue	19.7	2,782	2,762	141	140	993	17,028	9,338	864	474	548
	b. My Dinh	13.6	5,737	2,440	422	179	425	21,191	8,620	1,558	634	407
	c. Me Tri	14.7	12,170	4,688	828	319	385	33,300	11,134	2,265	757	334
	d. Ba Xa	9.9	1,912	1,028	193	104	537	4,162	1,796	420	181	431
Total		57.9	22,602	10,918	390	189	483	75,681	30,887	1,307	533	408
Grand Total		135.4	173,858	64,223	1,284	474	369	378,406	119,716	2,795	884	316

Table E3.2 EXISTING AND FUTURE RIVER WATER QUALITY

No. of Input River Station	Area of Sub-basin (ha)	Low Flow (m ³ /sec)	Inflow BOD at Station (mg/l)	Pollutant Load Runoff of BOD (ton/day)		Pollution Load of BOD (mg/l)		
				1992	2010	1992	2010	
(1)	1,690	1.02	50	13.86	25.18	50	91	
(2)	2,960	1.57	46	26.43	51.08	46	89	
(3)	6,820	5.83	31	103.68	209.86	31	63	
(4)	460	0.67	62	2.37	7.50	62	130	
(5)	1,960	0.40	52	9.73	14.79	52	79	
(6)	2,850	1.47	41	75.13	155.79	41	85	
Average River Water Quality of Bod in the To Lch river basin (mg/l)							31	63

Table E3.3 REQUIRED REMOVAL EFFICIENCY & PREDICTED RIVER WATER QUALITY

Name of Input River Sub-Basin	Pollutant Load Runoff of BOD (ton/day)		Pollution Load of BOD Without Treatment (mg/l)		Pollution Load of BOD With Treatment (mg/l)					
	1992	2010	1992	2010	Removal Efficiency: 85 %		Removal Efficiency: 80 %		Removal Efficiency: 75 %	
					1992	2010	1992	2010	1992	2010
To Lich (up)	13.86	25.18	50	91	8	14	10	18	13	23
To Lich/Lu	26.43	51.08	46	89	7	13	9	18	12	22
To Lich (down)	39.95	69.07	31	54	5	8	6	11	8	13
Lu*	2.37	7.50	62	130	9	19	12	26	16	32
Kime Nguu	9.73	14.79	52	79	8	12	10	16	13	20
Set*	11.40	15.00	41	54	6	8	8	11	10	13
Old To Lich*	23.18	32.89	38	54	6	8	8	11	10	13
Average River Water Quality of BOD in To Lich River Basin (mg/l)			31	54	5	8	6	11	8	13

*: In flow BOD at river is presumed.

TABLE E3.4 CORRELATION BETWEEN RIVER WATER QUALITY AND POPULATION DENSITY

No. of point	BOD		POPULATION DENSITY
02.4.01	64.4	68.7	236.8
04.4.01	62.2	73.2	175.1
00.2.05	50.0	59.2	162.5
06.1.02	75.5	70.1	490.8
00.2.06	62.0	60.0	284.2
00.2.02	46.1	49.7	23.9
05.1.02	23.7	34.4	165.2
05.4.01	82.8	86.4	369.7
03.1.02	39.8	28.7	251.9
03.4.01	69.4	74.0	260.5
00.2.04	51.5	56.5	11.8
00.2.03	41.0	45.3	28.7
00.2.01	37.9	42.6	18.0
00.2.07	5.3	5.8	14.6
00.2.08	30.3	29.8	14.6

LAKE/POND

	BOD	COD	DO	POPULATION DENSITY
WEST	14.3		7.2	190.5
BAY MAU	6.5	354.8	3.8	165.2
THU LE	8.5	442.5	5.8	147.2
GIANG VO	4.8	425.0	2.1	175.1
THIEN QUANG	6.0	552.5	1.5	322.1
HOAN KIEM	1.5	430.0	6.3	251.9

Note : BOD/COD/DO data are based on water quality analysis data and population density estimated based on population density map prepared by the Study.

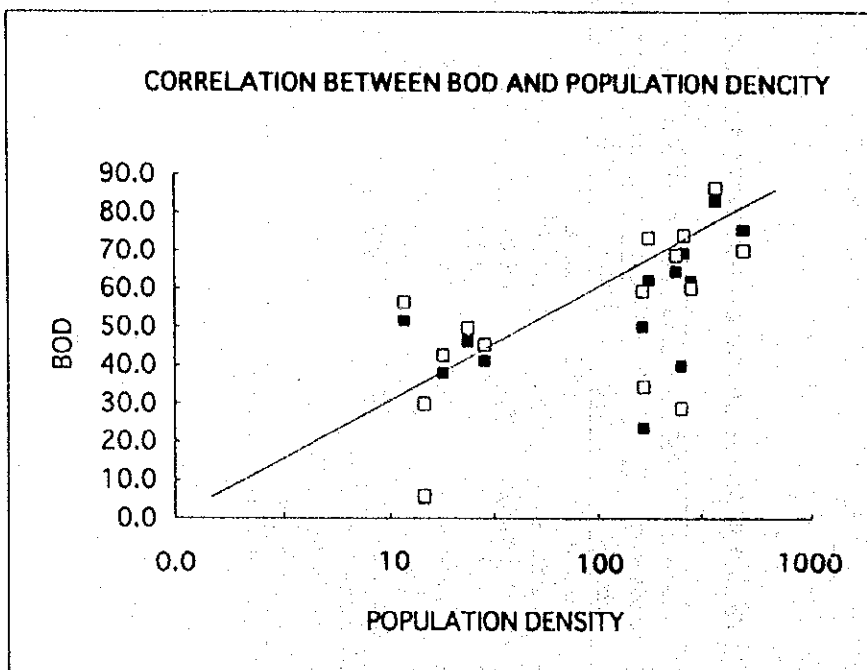


Table E3.5 Overall Runoff Coefficient

Individual Surface Characteristics	Area : Ai(ha)		Runoff Coefficient Ci	Ai · Ci	
	1992	2010		1992	2010
Residential area	2,298	3,679	0.80	1,838.40	2,943.20
Industrial area	447	832	0.65	290.55	540.80
Commercial area	833	1,226	0.80	666.40	980.80
Green & Park	322	622	0.35	112.70	217.70
Lake & Pond	1,880	1,930	1.00	1,880.00	1,930.00
Utilities(Road & Squares)	379	967	0.90	341.10	870.30
Other area(Farmland,etc.)	7,381	4,284	0.35	2,583.35	1,499.40
Toatl	13,540	13,540		7,713	8,982
Overall Runoff Coefficient				0.57	0.66

**Table E3.6 EFFICIENT STANDARDS IN VIET NAM AND JAPAN
(ALLOWABLE POLLUTION LOAD)**

Parameter	Type	Unit	VIETNAM			JAPAN
			Class 1	Class 2	Class 3	
(Toxic/Hazardous)						
Total Mercury		mg/l	0.005	0.01	0.5	0.005
Cyanide		"	0.05	0.1	0.2	1.0
Alkyl Mercury		"	-	-	-	Not detectable
Cadmium		"	0.01	0.2	0.5	0.1
Total Chromium		"	0.2	1.0	2.0	2.0
Hexavalent Chromium		"	0.05	0.05	0.5	0.5
Arsenic		"	0.05	0.1	0.5	0.5
Lead		"	0.1	0.5	1.0	1.0
Nickel		"	0.2	1.0	2.0	-
PCB		"	-	-	-	0.003
Trichloro Ethylene		"	-	-	-	0.3
Tetrachloro Ethylene		"	-	-	-	0.1
(General)		°C				
Temperature		mg/l	40	40	45	-
Dissolved Solids		"	1000	1500	2000	-
PH		"	6 - 9	5.5 - 9	5 - 9	5.5 - 8.6
SS		"	50	100	200	200
BOD		"	20	50	100	160, (Daily average: 120)
COD		"	50	100	400	160, (Daily average: 120)
Meneral Oil		"	-	-	-	5
Oil & Grease		"	Not detectable	0.1	10	-
Chlorine		"	400	500	1000	-
Phenol		"	0.001	0.05	1.0	5
Sulphide		"	0.2	0.5	1.0	-
Nitrogen		"	-	-	-	121, (Daily average: 60)
Fluorine		"	1.0	2.0	5.0	15
Phosphorus		"	-	-	-	17, (Daily average: 8)
Anionic Surtactant		"	0.1	1.0	10	-
Cupper		"	0.2	1.0	5.0	3.0
Zinc		"	1.0	2.0	5.0	5.0
Manganese		"	0.2	1.0	5.0	10.0
Organophosphorus		"	-	-	-	1.0
Iron		"	1.0	5.0	10	10.0
Coliform Group Count		/cm3	20000	50000	-	3000
Tin		mg/l	0.2	1	5	-

Class 1: River used for water supply & bathing

Class 2: River used for fisheries, irrigation, transportation and tourism

Class 3: River used for other purpose

**Table E3.7 Environmental Quality Standards for River's Water
(Maximum Acceptable Level)**

Parameter	Type	VIETNAM		JAPAN		
		Class 1 (Water Supply /Bathing)	Class 2 (Others)	Class 1 (Water Supply /Environmental Protection)	Class 2 (Water Supply /Bathing)	Class 3 (Water Supply /Fisheries)
(related to life environment)						
PH		6.5 - 8.5	5.5 - 9.0	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5
BOD (mg/l)		4	25	1	2	3
SS		20	80	25	25	25
DO (mg/l)		> 6	> 2	> 7.5	> 7.5	> 5
COD (mg/l)		10	35	-	-	-
Coliform Group Count (MPN/100 ml)		10,000	20,000	50	1,000	5,000
Normal-Hexane Extracts (Oil)		-	-	Not Detectable	Not Detectable	-
(related to the protection of human health) (mg/l)						
Alkyl Mercury		-	-		Not Detectable	
Organophosphorus		-	-		Not Detectable	
Hexavalent Chromium		0.005	0.05		0.05	
Total Mercury		0.005	0.005		0.0005	
Cadmium		0.01	0.02		0.01	
Lead		1.0	2.0		0.1	
Total Chromium (Trivalent)		0.1	1.0		-	
Arsenic		0.05	0.10		0.05	
Copper		0.1	1.0		-	
Zinc		0.01	5.0		-	
Oil & Grease		Not Detectable	0.3		-	
Cyanide		0.01	0.05		Not Detectable	
Phenol		0.005	0.02		-	
Chlorinated Organics		-	-		Not Detectable	
Nickel		0.1	1.0		-	
Manganese		0.1	0.8		-	
Barium		1	4		-	
Pb		0.05	0.10		-	
Iron		1	2		-	
Amoniac (calculated as N)		0.05	1		-	
Florua		1	1.5		-	
Nitrat (calculated as N)		10	15		-	
Nitrit (calculated as N)		0.01	0.05		-	
Detergent		0.5	0.5		-	
Tin		1	2		-	
Pesticide (except DDT)		0.15	0.15		-	
DDT		0.012	0.012		-	
Total alpha unit of activity (A)		0.1	0.1		-	
Total beta unit of activity (B)		1.0	1.0		-	

TABLE E3.8 HYDRAULIC DESIGN OF SEWER

No.	Area (ha)	Accumulated Area (ha)	Q (m ³ /s)	Diameter (m)	Gradient	Velocity (m/s)	Q (m ³ /s)	Q/Q ₁ (%)	Pipe Length (m)
ZONE 2									
1	151.25	151.25	0.09	0.5	0.0030	1.05	0.21	242	1700
2	366.25	366.25	0.21	0.6	0.0030	1.19	0.34	163	3100
3	230.00	747.50	0.42	0.8	0.0025	1.32	0.66	157	1900
To CWT									
4	436.25	436.25	0.25	0.6	0.0030	1.19	0.34	137	1450
5	291.25	727.50	0.41	0.8	0.0025	1.32	0.66	161	2200
6	652.08	652.08	0.37	0.7	0.0030	1.32	0.51	138	1500
7	281.25	933.33	0.53	0.8	0.0025	1.32	0.66	125	1700
8	196.25	1129.58	0.64	0.9	0.0025	1.42	0.91	142	2000
9	108.75	836.25	0.47	1.0	0.0020	1.37	1.07	227	1300
To CWT									
10	232.50	232.50	0.13	0.6	0.0030	1.19	0.34	256	1600
11	75.00	307.50	0.17	0.6	0.0025	1.09	0.31	177	1600
12	213.75	521.25	0.29	0.7	0.0025	1.20	0.46	157	2100
13	85.00	606.25	0.34	0.8	0.0020	1.18	0.59	173	2900
To CWT									
ZONE 3									
1	192.50	192.50	0.13	0.5	0.0020	0.86	0.17	121	850
2	372.50	565.00	0.38	0.8	0.0020	1.18	0.59	156	1800
3	455.00	1020.00	0.68	0.9	0.0020	1.27	0.81	118	1800
4	105.00	1125.00	0.76	1.0	0.0020	1.37	1.07	142	900
5	208.75	208.75	0.14	0.6	0.0020	0.97	0.27	196	1200
6	145.00	1478.75	0.99	1.2	0.0020	1.54	1.74	176	500
To CWT									
7	412.50	412.50	0.28	0.7	0.0020	1.08	0.41	150	1000
8	115.00	115.00	0.08	0.5	0.0020	0.86	0.17	219	1100
9	97.50	212.50	0.14	0.6	0.0020	0.97	0.27	192	1200
10	86.88	711.88	0.48	0.8	0.0020	1.18	0.59	124	600
11	70.00	70.00	0.05	0.35	0.0030	0.83	0.08	170	1200
12	0.00	781.88	0.52	0.9	0.0020	1.27	0.81	154	300
To CWT									
ZONE 4									
1	292.50	292.50	0.33	0.8	0.0020	1.18	0.59	177	1400
2	118.33	118.33	0.14	0.6	0.0030	1.19	0.34	249	700
3	144.58	555.42	0.63	0.9	0.0020	1.27	0.81	128	1000
4	68.75	68.75	0.08	0.5	0.0030	1.05	0.21	263	1750
5	83.13	707.29	0.81	1.0	0.0020	1.37	1.07	133	600
6	79.58	79.58	0.09	0.6	0.0015	0.84	0.24	261	1400
7	0.00	786.88	0.90	1.0	0.0020	1.37	1.07	119	300
8	116.25	116.25	0.13	0.6	0.0020	0.97	0.27	207	2200
9	0.00	903.13	1.03	1.2	0.0020	1.54	1.74	169	300
To CWT									
ZONE 5									
1	196.25	196.25	0.05	0.4	0.0040	1.05	0.13	287	2100
2	242.50	438.75	0.10	0.5	0.0030	1.05	0.21	202	1800
3	235.00	673.75	0.16	0.6	0.0020	0.97	0.27	175	1500
4	191.25	191.25	0.04	0.4	0.0040	0.96	0.09	207	1500
5	303.75	303.75	0.07	0.4	0.0040	1.05	0.13	186	1800
6	198.75	693.75	0.16	0.6	0.0030	1.19	0.34	208	1200
7	382.08	1075.83	0.25	0.8	0.0020	1.18	0.59	235	2500
8	37.50	711.25	0.17	0.6	0.0020	0.97	0.27	165	500
9	50.83	1837.92	0.43	0.8	0.0020	1.18	0.59	138	1000
10	411.25	411.25	0.10	0.5	0.0030	1.05	0.21	215	2200
11	191.25	602.50	0.14	0.6	0.0030	1.19	0.34	239	1000
12	186.25	186.25	0.04	0.4	0.0040	0.96	0.09	212	1000
13	37.50	826.25	0.19	0.7	0.0020	1.08	0.41	215	600
14	192.50	192.50	0.04	0.4	0.0040	0.96	0.09	205	1200
15	620.83	1639.58	0.38	0.8	0.0015	1.02	0.51	134	1500
16	570.00	4047.50	0.94	1.2	0.0015	1.34	1.51	160	2300
To CWT									
ZONE 6									
1	237.50	237.50	0.06	0.4	0.0020	0.74	0.09	149	2700
2	113.75	113.75	0.03	0.3	0.0030	0.75	0.05	177	1800
3	331.25	682.50	0.18	0.6	0.0015	0.84	0.24	132	1700
4	165.63	848.13	0.22	0.6	0.0030	1.19	0.34	151	1900
5	346.25	346.25	0.09	0.5	0.0030	1.05	0.21	227	1200
6	333.33	679.58	0.18	0.6	0.0030	1.19	0.34	188	1000
7	247.50	1775.21	0.47	0.8	0.0030	1.44	0.72	155	1000
8	345.00	2120.21	0.56	0.9	0.0020	1.27	0.81	145	1600
9	115.00	2235.21	0.59	1.0	0.0020	1.37	1.07	182	700
10	535.00	535.00	0.14	0.5	0.0030	1.05	0.21	147	1900
11	73.75	608.75	0.16	0.6	0.0030	1.19	0.34	210	1000
12	386.25	386.25	0.10	0.5	0.0030	1.05	0.21	203	2000
13	110.00	1105.00	0.29	0.7	0.0020	1.08	0.41	142	1400
14	207.50	1312.50	0.35	0.7	0.0020	1.08	0.41	120	700
15	172.50	172.50	0.05	0.4	0.0020	0.74	0.09	205	2000
16	65.00	1550.00	0.41	0.8	0.0020	1.18	0.59	145	600
17	437.50	437.50	0.12	0.5	0.0030	1.05	0.21	180	2700
18	45.00	2032.50	0.53	0.9	0.0015	1.10	0.70	131	800
19	165.00	4432.71	1.17	1.2	0.0015	1.34	1.51	129	1200
To CWT									

TABLE E4.1 CIVIL AREA FOR DIFFERENT LAND USES AT ZONE IN 2010

Area (ha)	ZONE 1-1	ZONE 1-2	ZONE 2-1	ZONE 2-2	ZONE 3	ZONE 4	ZONE 5	ZONE 6-1	ZONE 6-2	ZONE 7	Total
1)Office & Public	43	79	127	53	219	102	413	74	80	36	1226
2)Residence	157	300	505	298	715	284	512	275	554	79	3679
-Urban	92	0	505	97	715	284	153	83	166	0	2095
-Village	65	300	0	201	0	0	359	192	388	79	1584
3)Industry	3	150	56	150	47	20	97	49	160	100	832
-Small Industry	3		56		47	20	7	49			182
-Large Industry		150		150			90		160	100	650
4)Road & Square	18	75	138	58	173	43	176	40	114	132	967
5)Green & Park	20	23	89	44	136	24	135	59	14	78	622
6)Lake & pond	593	13	54	237	60	27	110	131	89	934	2248
7)Village,etc.	96	420	21	170	0	0	1,357	242	1,279	381	3966
Total	930	1,060	990	1,010	1,350	500	2,800	870	2,290	1,740	9,180

TABLE E4.2 CHARACTERISTICS OF ZONES

Item	ZONE 1			ZONE 2			ZONE 3	ZONE 4	ZONE 5	ZONE 6		ZONE 7	Total/Average
	ZONE 1-1	ZONE 1-2	ZONE 2-1	ZONE 2-2	ZONE 6-1	ZONE 6-2							
	Area (ha)	930	1,060	990	1,010	870				2,290	500		
Future Population	40,300	46,500	303,800	129,200	190,300	243,900	190,300	243,900	180,100	180,100	49,100	1,596,800	
Future Population Density (person/ha)	43.3	43.9	306.9	127.9	380.6	87.1	380.6	87.1	78.6	78.6	28.2	117.9	
Future Wastewater Yield (m ³ /d)	8,260	7,910	73,370	36,000	44,720	56,450	44,720	56,450	43,220	43,220	8,290	378,410	
- Domestic	6,539	5,585	54,660	23,026	34,254	42,063	34,254	42,063	31,151	31,151	6,330	277,980	
- Commercial	1,722	642	16,689	6,951	10,467	12,147	10,467	12,147	9,035	9,035	977	81,327	
- Industrial	0	1,680	2,016	6,020	0	2,240	0	2,240	3,035	3,035	984	19,096	
Future Pollutant Load (kg/d)	2,765	3,591	22,455	11,507	13,511	17,962	13,511	17,962	13,827	13,827	3,463	119,716	
Specific Yield (m ³ /d/ha)	8.88	7.46	74.11	35.64	89.44	20.16	89.44	20.16	18.87	18.87	4.76	27.95	
Specific Load (kg/d/ha)	2.97	3.39	22.68	11.39	27.02	6.42	27.02	6.42	6.04	6.04	1.99	8.84	
Raw wastewater Quality (BOD & SS :mg/l)	335	454	306	320	302	318	302	318	320	320	418	316	
Name of Receiving Water	West Lake	Nhue	Kim Nguu	Kim Nguu	Lu	Nhue	Lu	Nhue	Nhue	Nhue	To Lich	To Lich	
Proposed Removal Efficiency of BOD & SS(%)	80	80	85	85	85	75	85	75	75	75	75	75	
Treated Wastewater Quality (BOD:mg/l)	60	50	80	80	80	80	80	80	80	80	80	80	
- Domestic	50	50	50	50	50	80	50	80	80	80	90	90	
- Commercial/Industrial	50	50	50	50	50	80	50	80	80	80	50	50	
Proposed Wastewater Disposal System	On-site/Community	Community	Large Scale Centralized	Large Scale Centralized	Medium Scale Centralized	Medium Scale Centralized	Medium Scale Centralized	Medium Scale Centralized	Medium Scale Centralized	Medium Scale Centralized	None-Treatment	None-Treatment	
Alternative Wastewater Disposal System	Small Scale Centralized	Small Scale Centralized	Medium Scale Centralized	Medium Scale Centralized	Large Scale Centralized	Large Scale Centralized	Large Scale Centralized	Large Scale Centralized	Large Scale Centralized	Large Scale Centralized	On-site/Community	On-site/Community	

TABLE E4.3 COMPARISON OF TYPICAL WASTEWATER TREATMENT METHOD

Item	AS	EA	MA	OD	SP	AL	TF	RB
Flexibility	Shock Load	1	2	1	2	3	3	2
	Over Load	1	2	1	2	3	3	2
Workability	Toxic/Hazardous	2	2	1	2	2	2	2
	Workability of O&M	1	2	1	3	3	3	2
	Reliability of O&M System	3	3	3	3	3	2	1
	Complication	2	2	1	3	3	3	2
Characteristics	Necessity of High Technology	2	2	2	2	3	3	1
	Excess Sludge	1	3	1	3	3	2	1
	Stability of temperature	2	2	2	3	1	2	2
	Nitrification	2	3	1	3	2	3	3
Required Land	Actual Results	3	3	1	3	3	1	1
	Side effect against the circumference	2	2	2	2	1	1	2
Removal Efficiency	(OD : 100%)	3	(50)	(75)	(100)	(730)	(270)	(55)
	(BOD) (%)	90	90	70	85	70	70	90
Required Cost	(SS) (%)	85	85	70	80	70	70	85
	Construction	1	1	2	2	3	3	1
Evaluation	O & M	1	1	2	2	3	3	2
		30	35	25	39	38	39	37

Remarks: 3 : Excellent 2 : Moderate 1 : Inferior

AS : Conventional Activated Sludge Process SP : Stabilization Pond Process
 EA : Extended Aeration Process AL : Aerated Lagoon Process
 MA : Modified Aeration Process TF : High Rate Trickling Filter Process
 OD : Oxidation Ditch Process RB : Rotating Biological Contactor Process

TABLE E5.1 EXAMINATION OF ALTERNATIVE DISPOSAL SYSTEMS

Alternative Disposal System	Particulars	Construction Cost (US\$/m ³)					Annual O&M Cost (US\$/m ³)
		Treatment Plant		Sub-total	Sewerage	Total	
		Civil works	Machinery				
On-site/Community	<ul style="list-style-type: none"> - Q < 1000 m³ (Average: 100 m³/d) - Septic tank with high level - Sewer for wastewater is not necessary - Pollutant Pay Principle - Excess sludge shall be frequently collected 	600	1,500	0.02 ha	2,101	2,101	137
Small scale disposal	<ul style="list-style-type: none"> - Q < 30000 m³ (Average = 10000 m³) - Number of plants is 38 - served area at each plant is about 360 ha with conveyance sewer of 1100 m - Minimum number of Relay pumping station : 0 - Excess sludge shall be properly collected 	368	470	2.0 ha	839	274	25
Medium scale disposal	<ul style="list-style-type: none"> - Q < 100000 m³ (Average = 50000 m³/d) - number of plants is 7 - served area at each plant is about 1500 ha with conveyance sewer of 8000 m - Minimum number of Relay pumping station : 1 - Storage yard/disposal facilities for excess sludge will be established at each plant 	190	382	10 ha	574	332	17
Large scale disposal	<ul style="list-style-type: none"> - Q > 100000 m³ (Average = 120000 m³/d) - Number of plants is 3 - served area at each plant is about 3500 ha with conveyance sewer of 100000 m - Minimum number of Relay pumping station : 3 - Storage yard/disposal facilities for excess sludge will be established at each plant - Some counter measures are necessary in order to supply water into lakes or rivers during dry season 	133	342	24 ha	476	451	14
						318	1
						14	18
						423	1
						28	16

TABLE E5.2 COMPARATIVE CONSTRUCTION & OM COST OF ZONE 1-1

ITEM	On-site/community Disposal System		Community Disposal System (Medium Scale)		Community Disposal System (Large Scale)		Small Scale Centralized Disposal System	
	UNIT COST (US\$)	QUANTITY	UNIT COST (US\$)	QUANTITY	UNIT COST (US\$)	QUANTITY	UNIT COST (US\$)	QUANTITY
1. Treatment Plant (Unit)								
1.1 Machinery & equipment	150,000	17	2,583,000	46	648,307	8	1,186,531	4
-Community Plant	2,000	7,498	14,995,349					
-Septic Tank	60,000	17	1,033,200	46	964,894	8	1,452,404	4
1.2 Civil works			18,611,549					
Sub-total								
2. Separate Sewer (m)								
2.1 Secondary & Tertiary (d:200-400 mm)					48	25,410	1,219,680	48
2.2 Trunk Sewer (d :500-1000 mm)					95	7,260	689,700	95
2.3 Conveyance (d: > 1000 mm)					250	3,630	907,500	250
Sub-total							2,816,880	
3. Combined Sewer								
3.1 Secondary & Tertiary (d:200-400 mm)								
3.2 Trunk Sewer (d :500-1000 mm)								
3.3 Conveyance (d: > 1000 mm)								
3.4 Interceptor & Diversion Chamber (Unit)					9,500	5	47,500	5
Sub-total							47,500	
4. Relay Pumping Station (Manhole Type) (Unit)								
Sub-total							183,959	3
Direct Cost(1+2+3+4)			18,611,549				15,769,989	
5. Land Acquisition (m ²)	190,000	16,520	3,138,800	15,694	190,000	14,868	2,824,920	13,216
5.1 Treatment Plant							0	195
5.2 Relay Pumping Station			3,138,800				2,824,920	300
Sub-total								2,511,235
Total			21,750,349				18,594,909	
Annual O&M Cost			1,131,620				395,761	
								19,300,109
								335,372

TABLE E5.3 COMPARATIVE CONSTRUCTION & O&M COST OF ZONE 1-2

ITEM	On-site/community Disposal System		Community Disposal System (Medium Scale)		Community Disposal System (Large Scale)		Small Scale Centralized Disposal System	
	UNIT COST (US\$)	QUANTITY	UNIT COST (US\$)	QUANTITY	UNIT COST (US\$)	QUANTITY	UNIT COST (US\$)	QUANTITY
1. Treatment Plant (Unit)								
1.1 Machinery & equipment	150,000	23	3,483,000	79	2,091,127	2	3,974,434	1
-Community Plant	2,000	8,651	17,302,326					
-Septic Tank	60,000	23	1,393,200	79	2,131,086	2	3,290,809	1
1.2 Civil works			22,178,526					
Sub-total								
2. Separate Sewer (m)								
2.1 Secondary & Tertiary (d:200-400 mm)					48	74,200 (m)	3,561,600	48
2.2 Trunk Sewer (d :500-1000 mm)					95	21,200	2,014,000	95
2.3 Conveyance (d: >1000 mm)					250	10,600	2,650,000	250
Sub-total							8,225,600	
3.3 Conveyance (d: > 1000 mm)								
3.4 Interceptor & Diversion Chamber (Unit)					9,500	0	9,500	0
Sub-total								0
4. Relay Pumping Station (Manhole Type) (Unit)								
Sub-total					183,959	2	367,918	3
Sub-total							17,037,943	
5. Land Acquisition (m2)								
5.1 Treatment Plant	25,000	16,520 (m2)	413,000	15,694 (m2)	25,000	14,238 (m2)	355,950	12,656 (m2)
5.2 Relay Pumping Station			413,000		25,000	200	5,000	300
Sub-total							360,950	
Annual O&M Cost			22,591,526	24,122,350			17,398,893	
Total			1,083,670	711,900			279,113	
Sub-total								24,268,320
Sub-total								316,400
Sub-total								7,500
Sub-total								323,900
Sub-total								24,592,220
Sub-total								268,967

TABLE ES.4 COMPARATIVE CONSTRUCTION & O&M COST OF ZONE 2

ITEM	Small Scale Centralized Disposal System		Medium Scale Centralized Disposal System		Large Scale Centralized Disposal System	
	UNIT COST (US\$)	QUANTITY	UNIT COST (US\$)	AMOUNT (US\$)	UNIT COST (US\$)	AMOUNT (US\$)
1. Treatment Plant (Unit)						
1.1 Machinery & equipment	5,565,299	9	50,087,687	450,792,183	37,808,368	37,808,368
1.2 Civil works	4,132,676	9	37,194,081	334,771,127	15,108,954	15,108,954
Sub-total			87,281,768	815,563,310	52,917,322	52,917,322
2. Separate Sewer (m)						
2.1 Secondary & Tertiary (d:200-400 mm)	48	244,821	11,751,404	2,871,404	48	11,751,404
2.2 Trunk Sewer (d:500-1000 mm)	95	36,026	3,422,484	124,248	95	3,422,484
2.3 Conveyance (d: >1000 mm)	250	31,205	7,801,308	243,660	250	7,801,308
Sub-total			22,975,196	327,696	35,225,196	35,225,196
3. Combined Sewer						
3.1 Secondary & Tertiary (d:200-400 mm)						
3.2 Trunk Sewer (d:500-1000 mm)						
3.3 Conveyance (d: >1000 mm)	11,875	4	47,500	47,500	11,875	47,500
3.4 Interceptor & Diversion Chamber (Unit)						
Sub-total			47,500	47,500	47,500	47,500
4. Relay Pumping Station (Manhole Type) (Unit)						
Sub-total			0	0	100,656	100,656
Direct Cost(1+2+3+4)			110,304,464	94,409,704	88,693,296	88,693,296
5. Land Acquisition (m2)						
5.1 Treatment Plant	25.00	196,704	4,917,600	4,389,930	25.00	3,750,000
5.2 Relay Pumping Station	25.00	0	0	5,000	25.00	7,500
Sub-total			4,917,600	4,394,930	3,757,500	3,757,500
Total			115,222,064	98,804,634	92,450,796	92,450,796
Annual O&M Cost			2,687,521	1,940,791	1,694,848	1,694,848

TABLE E5.5 COMPARATIVE CONSTRUCTION & OM COST OF ZONE 3

ITEM	Small Scale Centralized Disposal System		Medium Scale Centralized Disposal System	
	UNIT COST (US\$)	QUANTITY	AMOUNT (US\$)	QUANTITY
1. Treatment Plant (Unit)				
1.1 Machinery & equipment	4,197,999	8	33,583,993	1
1.2 Civil works	3,414,944	8	27,319,553	1
Sub-total			60,903,547	
2. Separate Sewer (m)				
2.1 Secondary & Tertiary (d:200-400 mm)	48	177,645	8,526,938	48
2.2 Trunk Sewer (d :500-1000 mm)	95	39,806	3,781,540	95
2.3 Conveyance (d: > 1000 mm)	250	15,645	3,911,136	250
Sub-total			16,219,614	
3. Combined Sewer				
3.1 Secondary & Tertiary (d:200-400 mm)				
3.2 Trunk Sewer (d :500-1000 mm)				
3.3 Conveyance (d: > 1000 mm)				
3.4 Interceptor & Diversion Chamber (Unit)	5,400	7	38,000	7
Sub-total			38,000	
4. Relay Pumping Station (Manhole Type) (Unit)				
Sub-total	0	0	0	3
Direct Cost (1-2-3-4)			77,161,160	
5. Land Acquisition (m2)				
5.1 Treatment Plant	190,000	112,576	21,389,440	80,000
5.2 Relay Pumping Station	190,000	0	0	0
Sub-total			21,389,440	
Annual O&M Cost			98,550,600	
Total			1,875,879	
				76,268,063
				1,197,533

TABLE ES.6 COMPARATIVE CONSTRUCTION & OM COST OF ZONE 4

ITEM	Small Scale Centralized Disposal System			Medium-Scale Centralized Disposal System		
	UNIT COST (US\$)	QUANTITY	AMOUNT (US\$)	UNIT COST (US\$)	QUANTITY	AMOUNT (US\$)
1.1 Treatment Plant (Unit)						
1.1.1 Machinery & equipment	3,790,868	5	18,954,339	15,425,544	1	15,425,544
1.1.2 Civil works	3,187,186	5	15,935,932	8,237,583	1	8,237,583
Sub-total			34,890,272			23,663,126
1.2 Pilot Treatment Plant (Kim Lien)						
1.2.1 Machinery & equipment	2,831,970	1	2,831,970	2,831,970	1	2,831,970
1.2.2 Civil Works	2,616,468	1	2,616,468	2,616,468	1	2,616,468
Sub-total			5,448,438			5,448,438
Sub-total of 1			40,338,709			29,111,564
2. Separate Sewer (m)						
2.1 Secondary & Tertiary (d:200-400 mm)	48	64,960	3,118,080	48	64,960	3,118,080
2.2 Trunk Sewer (d :500-1000 mm)	95	4,700	446,500	95	13,700	1,301,500
2.3 Conveyance (d: >1000 mm)	250	740	185,000	250	8,740	2,185,000
Sub-total			3,749,580			6,604,580
3. Combined Sewer						
3.1 Secondary & Tertiary (d:200-400 mm)						
3.2 Trunk Sewer (d :500-1000 mm)						
3.3 Conveyance (d: >1000 mm)	2,375	8	19,000	2,375	8	19,000
3.4 Interceptor & Diversion Chamber (Unit)						
Sub-total			19,000			19,000
4. Relay Pumping Station (Manhole Type) (Unit)	0	0	0	61,320	3	183,959
Sub-total			0			183,959
Direct Cost(1+2+3+4)			44,107,289			35,919,103
5. Land Acquisition (m2)						
5.1 Treatment Plant	190,000	62,592	11,892,480	190,000	50,000	9,500,000
5.2 Relay Pumping Station	190,000	0	0	190,000	100	19,000
5.3 Pilot Treatment Plant	190,000	10,000	1,900,000	190,000	10,000	1,900,000
Sub-total			13,792,480			11,419,000
Total			57,899,769			47,338,103
Annual O&M Cost			1,221,467			893,770

TABLE E5.7 COMPARATIVE CONSTRUCTION & OM COST OF ZONE 5

ITEM	Small Scale Centralized Disposal System		Medium Scale Centralized Disposal System		Large Scale Centralized Disposal System	
	UNIT COST (US\$)	QUANTITY	AMOUNT (US\$)	UNIT COST (US\$)	QUANTITY	AMOUNT (US\$)
1. Treatment Plant (Unit)						
1.1 Machinery & equipment	4,452,170	6	26,713,021	21,238,295	1	21,238,295
1.2 Civil works	3,553,505	6	21,321,031	10,227,422	1	10,227,422
Sub-total			48,034,052			31,465,717
2. Separate Sewer (m)						
2.1 Secondary & Tertiary (d:200-400 mm)	48	294,700	14,145,600	48	294,700	14,145,600
2.2 Trunk Sewer (d :500-1000 mm)	95	115,775	10,998,625	95	136,825	12,998,375
2.3 Conveyance (d: >1000 mm)	250	42,100	10,525,000	250	73,675	18,418,750
Sub-total			35,669,225			45,562,725
3. Combined Sewer						
3.1 Secondary & Tertiary (d:200-400 mm)						
3.2 Trunk Sewer (d :500-1000 mm)						
3.3 Conveyance (d: >1000 mm)						
3.4 Interceptor & Diversion Chamber (Unit)		0	0		0	0
Sub-total						0
4. Relay Pumping Station (Manhole Type) (Unit)						
Sub-total	234,435	1	234,435	183,959	2	367,918
Direct Cost(1+2+3+4)			83,937,712			77,396,360
5. Land Acquisition (m ²)						
5.1 Treatment Plant	25,000	124,190	3,104,750	25,000	110,000	2,750,000
5.2 Relay Pumping Station	25,000	100	2,500	25,000	200	5,000
Sub-total			3,107,250			2,755,000
Total			87,044,962			80,151,360
Annual O&M Cost			1,548,733			1,081,763

TABLE E5.8 COMPARATIVE CONSTRUCTION & OM COST OF ZONE 6

ITEM	Small Scale Centralized Disposal System		Medium Scale Centralized Disposal System		Large Scale Centralized Disposal System	
	UNIT COST (US\$)	QUANTITY	AMOUNT (US\$)	UNIT COST (US\$)	QUANTITY	AMOUNT (US\$)
1. Treatment Plant (Unit)	4,873,265	7	34,112,855	26,591,664	1	26,591,664
1.1 Machinery & equipment	3,777,570	7	26,442,992	11,907,495	1	11,907,495
1.2 Civil works			60,555,847			38,499,159
Sub-total						
2. Separate Sewer (m)	48	343,364	16,481,472	48	343,364	16,481,472
2.1 Secondary & Tertiary (d:200-400 mm)						
2.2 Trunk Sewer (d :500-1000 mm)	95	98,104	9,319,880	95	159,419	15,144,805
2.3 Conveyance (d: >1000 mm)	250	49,052	12,263,000	250	85,841	21,460,250
Sub-total			38,064,352			53,086,527
3. Combined Sewer						
3.1 Secondary & Tertiary (d:200-400 mm)						
3.2 Trunk Sewer (d :500-1000 mm)						
3.3 Conveyance (d: >1000 mm)						
3.4 Interceptor & Diversion Chamber (Unit)	9,500	0	0	9,500	0	0
Sub-total						0
4. Relay Pumping Station (Manhole Type) (Unit)	234,435	1	234,435	183,959	3	551,876
Sub-total			234,435			551,876
Direct Cost(1+2+3+4)			98,854,634			92,137,562
5. Land Acquisition (m ²)						
5.1 Treatment Plant	25,000	116,880	2,922,000	25,000	70,000	1,750,000
5.2 Relay Pumping Station	25,000	100	2,500	25,000	300	7,500
Sub-total			2,924,500			1,757,500
Total			101,779,134			93,895,062
Annual O&M Cost			1,931,572			1,315,890

TABLE E5.9 COMPARATIVE CONSTRUCTION & OM COST OF ZONE 7

ITEM	On-site/Community Disposal System		Small Scale Centralized Disposal System	
	UNIT COST (US\$)	QUANTITY	AMOUNT (US\$)	QUANTITY
1. Treatment Plant (Unit)				
1.1 Machinery & equipment -Community Plant	150,000	20	2,941,500	1
-Septic Tank	1,000	9,135	9,134,884	
1.2 Civil works	60,000	20	1,176,600	1
Sub-total			13,252,984	
2. Separate Sewer (m)				
2.1 Secondary & Tertiary (d:200-400 mm)				215,600
2.2 Trunk Sewer (d :500-1000 mm)				84,700
2.3 Conveyance (d: > 1000 mm)				46,200
Sub-total				29,945,300
3. Combined Sewer				
3.1 Secondary & Tertiary (d:200-400 mm)				
3.2 Trunk Sewer (d :500-1000 mm)				
3.3 Conveyance (d: > 1000 mm)				
3.4 Interceptor & Diversion Chamber (Unit)				0
Sub-total				0
4. Relay Pumping Station (Manhole Type) (Unit)				
Sub-total				183,959
Sub-total			13,252,984	
5. Land Acquisition (m2)	25.00	16,580	414,500	13,264
5.1 Treatment Plant				300
5.2 Relay Pumping Station			414,500	7,500
Sub-total				339,100
Total			13,667,484	38,121,151
Annual O&M Cost			1,135,730	310,038

**TABLE E5.10 SUMMARY ON PROPOSED FACILITIES OF WASTEWATER TREATMENT PLANT
(OXIDATION DITCH PROCESS)**

Item	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 3&4	Pilot Plant	ZONE 5	ZONE 6	ZONE 7	TOTAL
1. Grit Chamber										
1.1 Number (Unit)		2	2	2	2	2	2	2		
1.2 Size (m)										
Necessary Surface Area		54	43	24	68	3	31	40		
Depth		1.0	1.0	1.0	1.0	1.0	1.0	1.0		
Width		3.8	3.0	1.7	4.7	0.2	2.2	2.8		
Length		14.4	14.4	14.4	14.4	14.4	14.4	14.4		
2. Oxidation Ditch		97,553	78,294	43,776	122,070	5,600	56,468	71,859		
2.1 Number (Unit)		10	12	10	14	4	10	12		
2.2 Size (m)										
Depth		3	3	2.5	3	2	2.7	3		
Width		12	8	7	11	6	8	8		
Length		270	270	250	270	120	250	250		
3. Settling Tank										
3.1 Number (Unit)		5	4	5	7	2	5	4		
3.2 Size (m)										
Depth		2.6	2.6	2.4	2.4	2.6	2.4	2.4		
Diameter		32.0	32.0	22.0	30.0	12.0	25.0	32.0		
4. Designed Sludge (m ³ /d)	639	1,873	1,460	816	2,276	104	962	1,239	308	7,401
5. Chlorination Tank										
5.1 Number (Unit)		2	2	2	6	2	2	2		
5.2 Size (m)										
Depth		4.0	4.0	4.0	4.0	2.0	4.0	4.0		
Width		10.0	10.0	5.0	5.0	3.0	5.0	7.0		
Length		12.0	10.0	10.0	10.0	5.0	12.0	12.0		
6. Thickener										
6.1 Number (Unit)		5	4	5	14	2	5	4		
6.2 Size (m)										
Depth		5.0	4.0	4.0	4.0	4.0	4.0	5.0		
Diameter		40.0	43.0	30.0	30.0	16.0	35.0	37.0		
7. Thickened Sludge (m ³ /d)	223	656	511	286	797	37	337	434	108	2,590
8. Sludge Digestion Tank										
8.1 Number (Unit)		4	4	2	5	2	4	2		
8.2 Size (m)										
Depth		6.0	5.0	5.0	5.0	4.0	5.0	10.0		
Diameter		40	38	40	40	16	38	30		
9. Excess Sludge (m ³ /d)	67	197	153	86	239	11	101	130	32	777
10. Area of Facilities (m ²)		48,248	40,031	25,300	62,413	3,882	32,456	33,576		
11. Dry Bed (15 days)										
11.1 Number (Unit)		15					15			
11.2 Size (m)										
11.3 Required Area (m ²)		40,000					30,000			70,000
11.4 Size (m)										
Depth		0.15					0.15			
Width		50.0					40.0			
Length		55.0					50.0			
12. Dried Sludge (m ³ /d)		89					66			155
13. Proposed Land (m ²)		140,000	80,000	50,000	120,000	10,000	100,000	70,000		450,000

**TABLE E5.11 SUMMARY ON PROPOSED FACILITIES OF WASTEWATER TREATMENT PLANT
(CONVENTIONAL ACTIVATED SLUDGE PROCESS)**

Item	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 3&4	Pilot Plant	ZONE 5	ZONE 6	ZONE 7	TOTAL
1.Grit Chamber										
1.1 Number (Unit)		2	2	2	2	2	2	2		
1.2 Size (m)										
Depth		1.0	1.0	1.0	1.0	1.0	1.0	1.0		
Width		3.8	3.0	1.7	4.7	0.2	2.2	2.8		
Length		14.4	14.4	14.4	14.4	14.4	14.4	14.4		
2.Primary Settling Tank										
2.1 Number (Unit)		4	4	2	4	2	2	4		
2.2 Size (m)										
Depth		2.5	2.5	2.5	2.5	2.5	2.5	2.5		
Diameter		28.0	25.0	28.0	30.0	10.0	28.0	25.0		
3.Aeration Tank										
3.1 Number (Unit)		12	10	6	12	4	8	10		
3.2 Size (m)										
Depth		5	5	5	5	5	5	5		
Width		8	8	8	10	3	8	8		
Length		60	60	50	60	25	50	50		
4.Settling Tank										
4.1 Number (Unit)		6	5	6	6	2	4	5		
4.2 Size (m)										
Depth		3.0	2.5	2.5	3.0	2.5	3.0	2.5		
Diameter		30.0	28.0	20.0	32.0	12.0	28.0	28.0		
5. Designed Sludge (m3/d)	639	3,122	2,433	1,360	3,793	174	1,603	2,065	308	11,703
6. Chlorination Tank										
6.1 Number (Unit)		2	2	2	2	2	2	2		
6.2 Size (m)										
Depth		4.0	4.0	4.0	4.0	2.0	4.0	4.0		
Width		10.0	10.0	5.0	10.0	3.0	5.0	7.0		
Length		12.0	10.0	10.0	15.0	5.0	12.0	12.0		
7.Thickener										
7.1 Number (Unit)		6	4	6	6	2	4	5		
7.2 Size (m)										
Depth		5.0	4.0	4.0	5.0	4.0	4.0	4.0		
Diameter		38.0	43.0	28.0	43.0	16.0	38.0	38.0		
8.Thickened Sludge (m3/d)	179	874	681	381	1,062	49	449	578	86	3,277
9.Sludge Digestion Tank										
9.1 Number (Unit)		6	4	2	6	2	4	4		
9.2 Size (m)										
Depth		5.0	6.0	6.0	6.0	4.0	5.0	6.0		
Diameter		40	40	40	40	20	40	38		
10. Excess Sludge (m3/d)	67	328	255	143	398	18	168	217	32	1,229
11.Area of Facilities (m2)		24,382	19,198	10,734	27,898	1,555	15,645	17,296		
12.Dry Bed (15 days)										
12.1 Number (Unit)		15					15			
12.2 Size (m)										
12.3 Required Area (m2)		70,000					50,000			120,000
12.4 Size (m)										
Depth		0.15					0.15			
Width		70.00					58.0			
Length		70.00					60.0			
13.Dried Sludge (m3/d)		149					97			246
14.Proposed Land (m2)		150,000	40,000	30,000	60,000	4,000	110,000	40,000		374,000

TABLE E5.12 PRELIMINARY DIRECT CONSTRUCTION COST ESTIMATION

(Unit : US\$)

	On-site/community Disposal System	Small Scale Centralized Disposal System	Medium Scale Centralized Disposal System	Large Scale Centralized Disposal System	Proposed system
ZONE 1-1 Plant Sewerage Total	13,800,000 47,500 13,847,500	10,555,737 6,233,137 16,788,874			Community Disposal* 13,847,500
ZONE 1-2 Plant Sewerage Total	8,444,425 8,593,518 17,037,943	7,265,243 17,003,077 24,268,320			Community (Large Scale) Disposal* 17,037,943
ZONE 2 Plant Sewerage Total		87,281,768 23,022,696 110,304,464	61,391,196 33,185,114 94,576,310	52,917,322 35,775,974 88,693,296	Large Scale Disposal 88,693,296
ZONE 3 Plant Sewerage Total		60,903,547 16,257,613 77,161,160	37,382,551 23,685,512 61,068,063		Medium Scale Disposal 61,068,063
ZONE 4 Plant Sewerage Total		40,338,709 3,768,580 44,107,289	29,111,564 6,807,539 35,919,103		Medium Scale Disposal 35,919,103
ZONE 5 Plant Sewerage Total		48,034,052 35,903,660 83,937,712	31,465,717 45,930,643 77,396,360		Medium Scale Disposal 77,396,360
ZONE 6 Plant Sewerage Total		60,555,847 38,298,787 98,854,634	38,499,159 53,638,403 92,137,562		Medium Scale Disposal 92,137,562
ZONE 7 Plant Sewerage Total	13,252,984 0 13,252,984	7,284,874 30,497,177 37,782,051			On-site/Community Disposal* 13,252,984
Grand Total					355,214,384

Remarks:

- 1) Cost of community disposal plant is estimated by wastewater flow of 100 m³/day at each plant.
- 2) Grand total does not included direct construction cost of On-site/Community disposal system.

TABLE EG.1 CIVIL AREA AND POPULATION OF EACH ZONE IN 2010

Zone	Total Area (ha)	Civil Area of Land Use								Population (person)	Population Density (person/ha)
		Residential		Commercial/Institutional		Industrial		Others			
		(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)		
Zone 1	1,990	457	23	122	6	153	8	1258	63	86,800	44
Zone 1-1	930	157	17	43	5	3	0	727	78	40,300	43
Zone 1-2	1,060	300	28	79	7	150	14	531	50	46,500	44
Zone 2	2,000	803	40	180	9	206	10	811	41	433,000	217
Zone 2-1	990	505	51	127	13	56	6	302	31	303,800	307
Zone 2-2	1,010	298	30	53	5	150	15	509	50	129,200	128
Zone 3	1,350	715	53	219	16	47	3	369	27	299,400	222
Zone 4	500	284	57	102	20	20	4	94	19	190,300	381
Zone 5	2,800	512	18	413	15	97	3	1,778	64	243,900	87
Zone 6	3,160	829	26	154	5	209	7	1,968	62	294,300	93
Zone 6-1	870	275	32	74	9	49	6	472	54	114,200	131
Zone 6-2	2,290	554	24	80	3	160	7	1,496	65	180,100	79
Zone 7	1,740	79	5	36	2	100	6	1,525	88	49,100	28
Total	13,540	3,679	27	1,226	9	832	6	7,803	58	1,596,800	118

TABLE E6.2 WASTEWATER YIELD OF EACH ZONE IN 2010

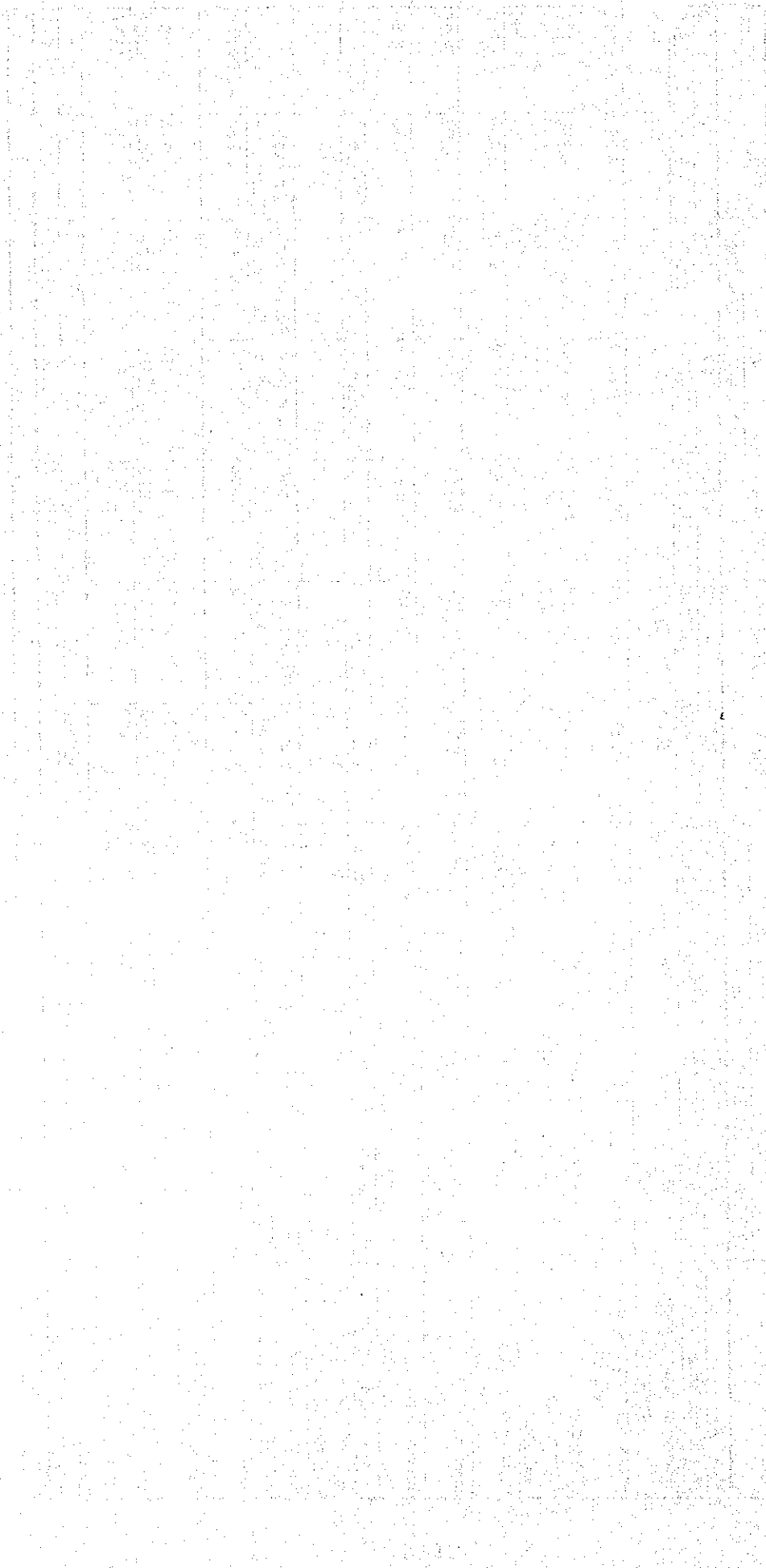
Zone	Wastewater Yield in 2010							Specific Yield (m3/d/ha)
	Domestic		Commercial		Industrial		Total (m3/d)	
	(m3/d)	(%)	(m3/d)	(%)	(m3/d)	(%)		
Zone 1	12,124	75	2,364	15	1,680	10	16,170	8.13
Zone 1-1	6,539	79	1,722	21	0	0	8,260	8.88
Zone 1-2	5,585	71	642	8	1,680	21	7,910	7.46
Zone 2	77,686	71	23,640	22	8,036	7	109,370	54.69
Zone 2-1	54,660	74	16,689	23	2,016	3	73,370	74.11
Zone 2-2	23,026	64	6,951	19	6,020	17	36,000	35.64
Zone 3	53,892	77	16,467	23	0	0	70,360	52.12
Zone 4	34,254	77	10,467	23	0	0	44,720	89.44
Zone 5	42,063	75	12,147	22	2,240	4	56,450	20.16
Zone 6	51,631	71	15,265	21	6,156	8	73,050	23.12
Zone 6-1	20,480	69	6,230	21	3,121	10	29,830	34.29
Zone 6-2	31,151	72	9,035	21	3,035	7	43,220	18.87
Zone 7	6,330	76	977	12	984	12	8,290	4.76
Total	277,980	73	81,327	21	19,096	5	378,410	27.95

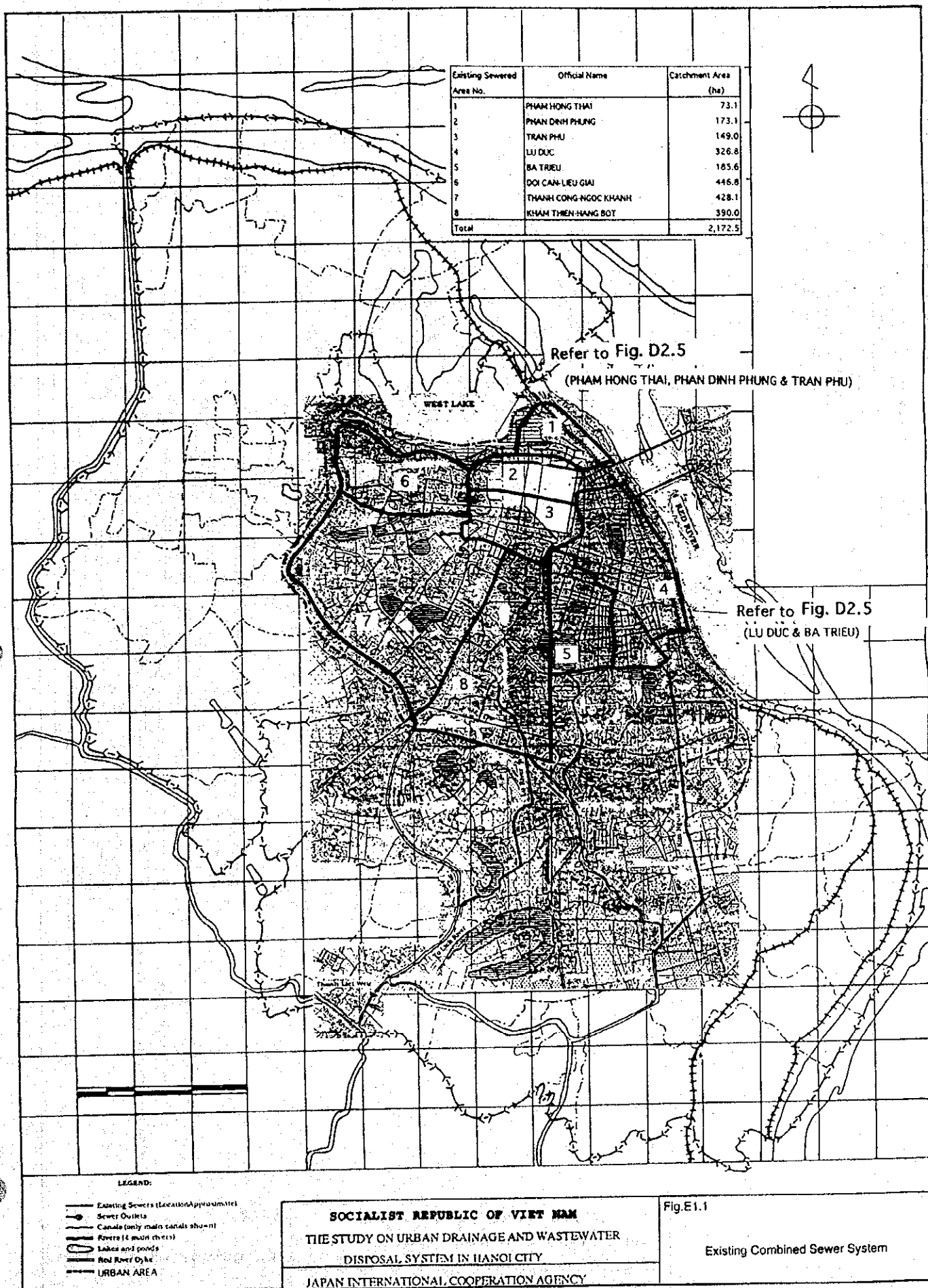
TABLE E6.3 PROPOSED PROJECT COST AND ANNUAL O&M COST

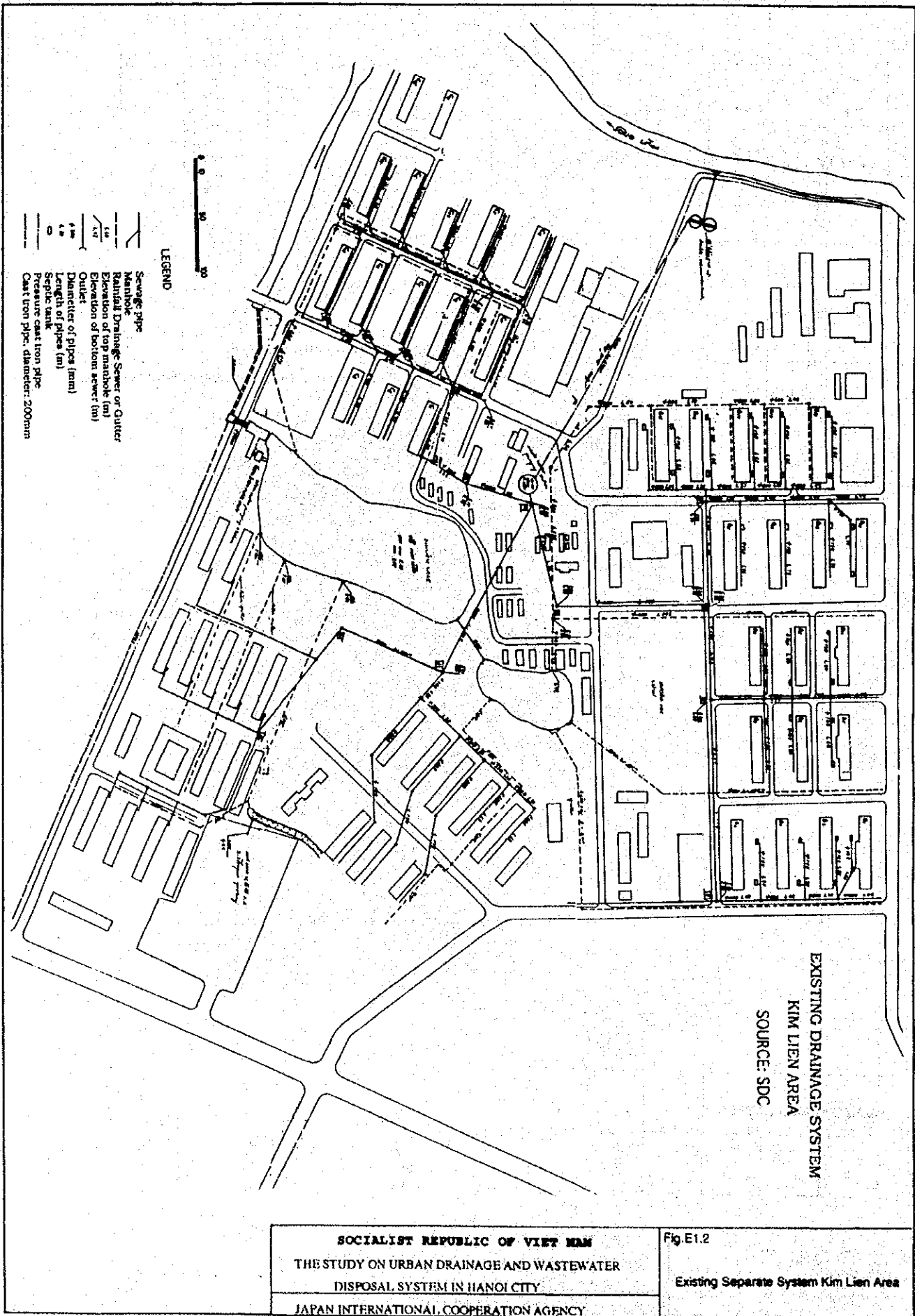
(Project Cost)		(Unit: US\$)										Total
Sewerage Zone	Cost Item	ZONE 1-1	ZONE 1-2	ZONE 2-1	ZONE 2-2	ZONE 3	ZONE 4	ZONE 5	ZONE 6-1	ZONE 6-2	ZONE 7	
A.	Direct Cost	15,608,000	17,038,000	57,198,000	55,375,000	62,904,000	38,275,000	77,397,000	30,705,000	61,433,000	13,253,000	295,340,000
1.	Treatment Plant	13,800,000	8,444,000	35,499,000	17,418,000	37,383,000	23,663,000	31,466,000	15,721,000	22,778,000	13,253,000	170,785,000
2.	Sewer	48,000	8,226,000	17,436,000	17,789,000	23,464,000	6,605,000	45,563,000	14,616,000	38,471,000		107,684,000
3.	Diversion Chamber			48,000		38,000	19,000					153,000
4.	Relay Pumping Station		368,000	336,000	168,000	184,000	184,000	368,000	368,000	184,000		1,440,000
5.	Pilot treatment plant (Kim Lien)						5,448,000					5,448,000
6.	Lake water Quality Improvement Works	1,760,000		3,879,000		1,835,000	2,356,000					9,830,000
	(West lake is not included)											
B.	Land Acquisition Cost	2,982,000	361,000	2,505,000	1,253,000	15,200,000	11,419,000	2,755,000	718,000	1,040,000	415,000	35,994,000
C.	Engineering Services Cost (15 % of A)	2,341,000	2,556,000	8,580,000	5,306,000	9,436,000	5,741,000	11,610,000	4,606,000	9,215,000	1,988,000	44,302,000
D.	Administration Cost (5 % of A+B)	930,000	870,000	2,985,000	1,831,000	3,905,000	2,485,000	4,008,000	1,571,000	3,124,000	683,000	16,567,000
E.	Physical Contingency (20 % of A to D)	4,372,000	4,165,000	14,254,000	8,753,000	18,289,000	11,584,000	19,154,000	7,520,000	14,962,000	3,268,000	78,441,000
	Sub-Total	26,233,000	24,990,000	85,522,000	52,518,000	109,734,000	69,504,000	114,924,000	45,120,000	89,774,000	19,607,000	637,926,000
(Annual O&M Cost)												Total
Sewerage Zone	Cost Item	ZONE 1-1	ZONE 1-2	ZONE 2-1	ZONE 2-2	ZONE 3	ZONE 4	ZONE 5	ZONE 6-1	ZONE 6-2	ZONE 7	
A.	Treatment Plant (US\$/year)	414,000	253,000	1,065,000	523,000	1,121,000	873,000	944,000	472,000	683,000	1,136,000	7,484,000
B.	Collection Sewer System	5,000	26,000	65,000	54,000	77,000	27,000	138,000	45,000	116,000		553,000
	Total	419,000	279,000	1,130,000	577,000	1,198,000	900,000	1,082,000	517,000	799,000	1,136,000	8,037,000
(Replacement cost)												Total
	25 years after Construction (US\$)	9,200,000	4,550,000	25,699,000	12,613,000	25,736,000	18,441,000	21,606,000	11,227,000	15,917,000	12,076,384	157,065,384

TABLE E6.4 PRIORITY OF SEWERAGE DEVELOPMENT ZONES

Item	ZONE 1		ZONE 2		ZONE 3	ZONE 4	ZONE 5	ZONE 6		ZONE 7	Total/Average
	ZONE 1-1	ZONE 1-2	ZONE 2-1	ZONE 2-2				ZONE 6-1	ZONE 6-2		
Area (ha)	930	1,060	990	1,010	1,350	500	2,800	870	2,290	1,740	13,540
Served Population	40,300	46,500	303,800	129,200	299,400	190,300	243,900	114,200	180,100	49,100	1,596,800
Served Population Density (person/ha)	43.3 (111.0)	43.9	306.9	127.9	221.8	380.6	87.1	131.3	78.6	28.2	117.9
Future Wastewater Yield (m ³ /d)	8,260	7,910	73,370	36,000	70,360	44,720	56,450	29,830	43,220	8,290	378,410
- Domestic	6,539	5,585	54,660	23,026	53,892	34,254	42,063	20,480	31,151	6,330	277,980
- Commercial	1,722	642	16,689	6,951	16,467	10,467	12,147	6,230	9,035	977	81,327
- Industrial	0	1,680	2,016	6,020	0	0	2,240	3,121	3,035	984	19,096
Future Pollutant Load (kg/d)	2,765	3,591	22,455	11,507	21,257	13,511	17,962	9,378	13,827	3,463	119,716
Specific Yield (m ³ /d/ha)	8.88 (22.75)	7.46	74.11	35.64	52.12	89.44	20.16	34.29	18.87	4.76	27.95
Specific Load (kg/d/ha)	2.97 (7.62)	3.39	22.68	11.39	15.75	27.02	6.42	10.78	6.04	1.99	8.84
Name of Receiving Water	West Lake	Nhue	Kim Nguu	Kim Nguu	To Lich	Lu	Nhue	To Lich	Nhue	To Lich	
Index of influence to Receiving water Quality	4	7	1	5	1	1	8	6	9	10	
Proposed Wastewater Disposal System	On-site/Community	Community	Large Scale Centralized	Large Scale Centralized	Medium Scale Centralized	Medium Scale Centralized	Medium Scale Centralized	Medium Scale Centralized	Medium Scale Centralized	On-site/Community	
Direct cost (Million US\$)	13.848	17.038	53.319	35.375	61.068	35.919	77.396	30.705	61.433	13.253	399.354
Specific Direct Cost (US\$/person)	344	366	176	274	204	189	317	269	341	270	250
(Million US\$/ha)	0.015	0.016	0.054	0.035	0.045	0.072	0.028	0.035	0.027	0.008	0.029
Pollutant Load Runoff after Treatment (kg/d)	415	539	3,368	1,726	3,189	2,027	2,694	1,407	2,074	519	17,957
IRR (%)	4.4	-	5.7	-	8.2	6.7	1.9	2.1	1.7	-	
Benefit per cost index	169.72	179.15	357.97	276.49	295.87	319.73	197.27	259.61	191.31	222.10	254.81
Priority of Developed Zone	4	9	1	5	3	2	7	6	8	10	












Planned Treated Area No.	Design Area (ha)	Design Wastewater Flow (m ³ /day)	
		DFW	WWF
1*	1,200.4		
2	2,819.6	99,000	297,000
3	4,505.0	84,000	252,000
4	3,281.6	46,300	139,000
5	1,313.8		
Total	13,120.4	229,300	688,000

*: Area 446 ha of west lake is not included.

DFW: Dry weather flow

WWF: Wet weather flow

LEGEND

-  Existing combined sewer
-  Planned Treated Area
-  Planned Relay Pumping Station
-  Planned Centralized Wastewater Treatment Plant
-  Planned separate sewer (trunk)

- 42 Cua Nam
- 43 Tran Hung Dao
- 44 Hang Bai
- 45 Phan Chu Trinh
- 46 Ly Thai To
- 47 Trang Tien
- 48 Hang Bac
- 49 Hang Buom
- 50 Dong Xuan
- 51 Hang Dao
- 52 Hang Ma
- 53 Hang Bo
- 54 Cua Dong
- 55 Hang Bong
- 56 Hang Gai
- 57 Hang Trong
- 58 Phuc Tan
- 59 Chuong Duong Do
- 62 Dong Nhan
- 63 Ngo Thi Nham
- 68 Dong Mac
- 73 Bui Thi Xuan



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Fig.E1.3

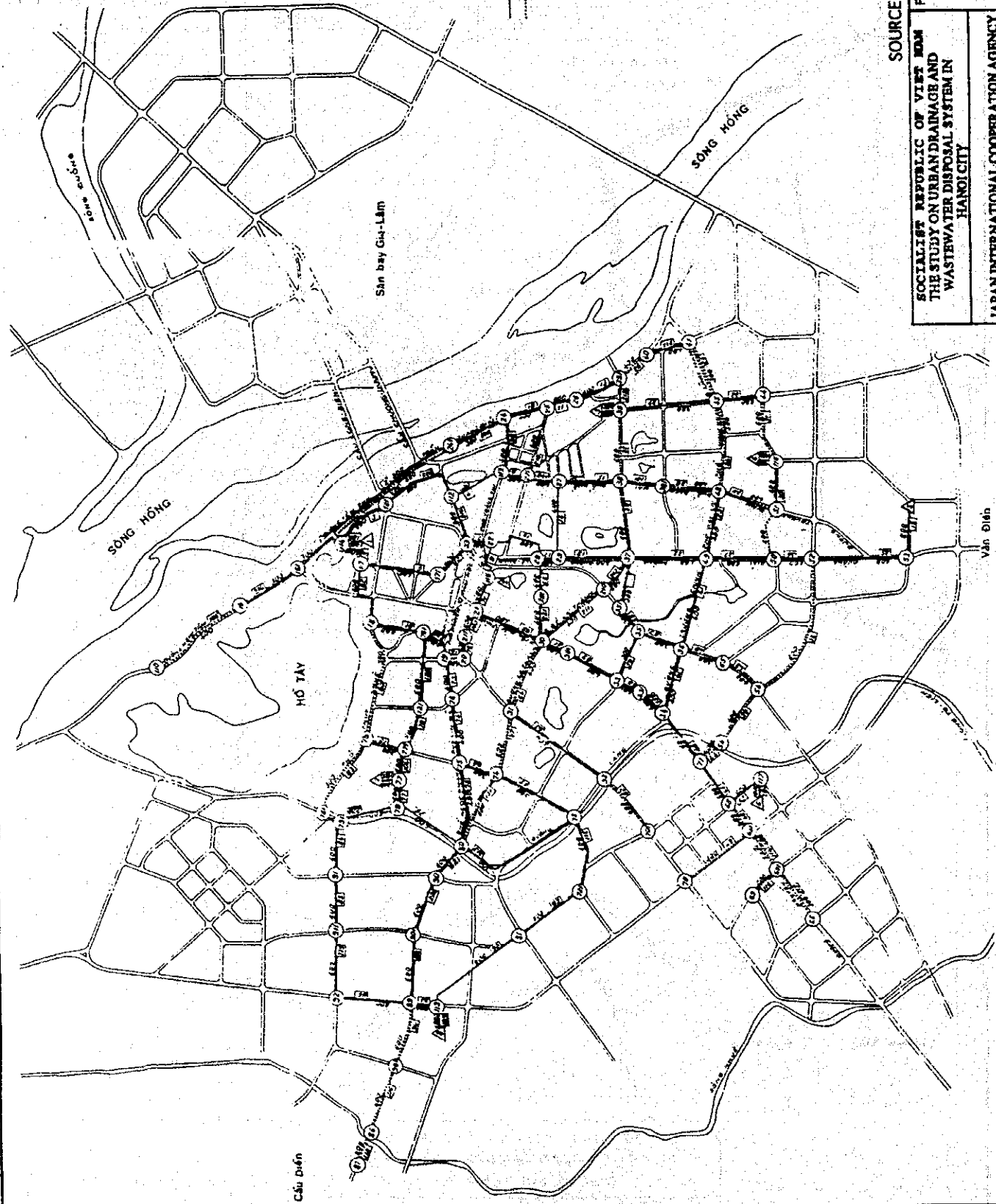
Sewerage Master Plan in 2010 (UPI, HPC)



1:75,000

LEGEND

- Existing population
- Population in development 1971-1980
- Water sewerage
- Existing plant
- New plant
- Ngô Đình Luyện
- Long Bien
- Trang An
- Pháp Liên
- Mỹ Đình
- Ngọc Li
- Mỹ Đình



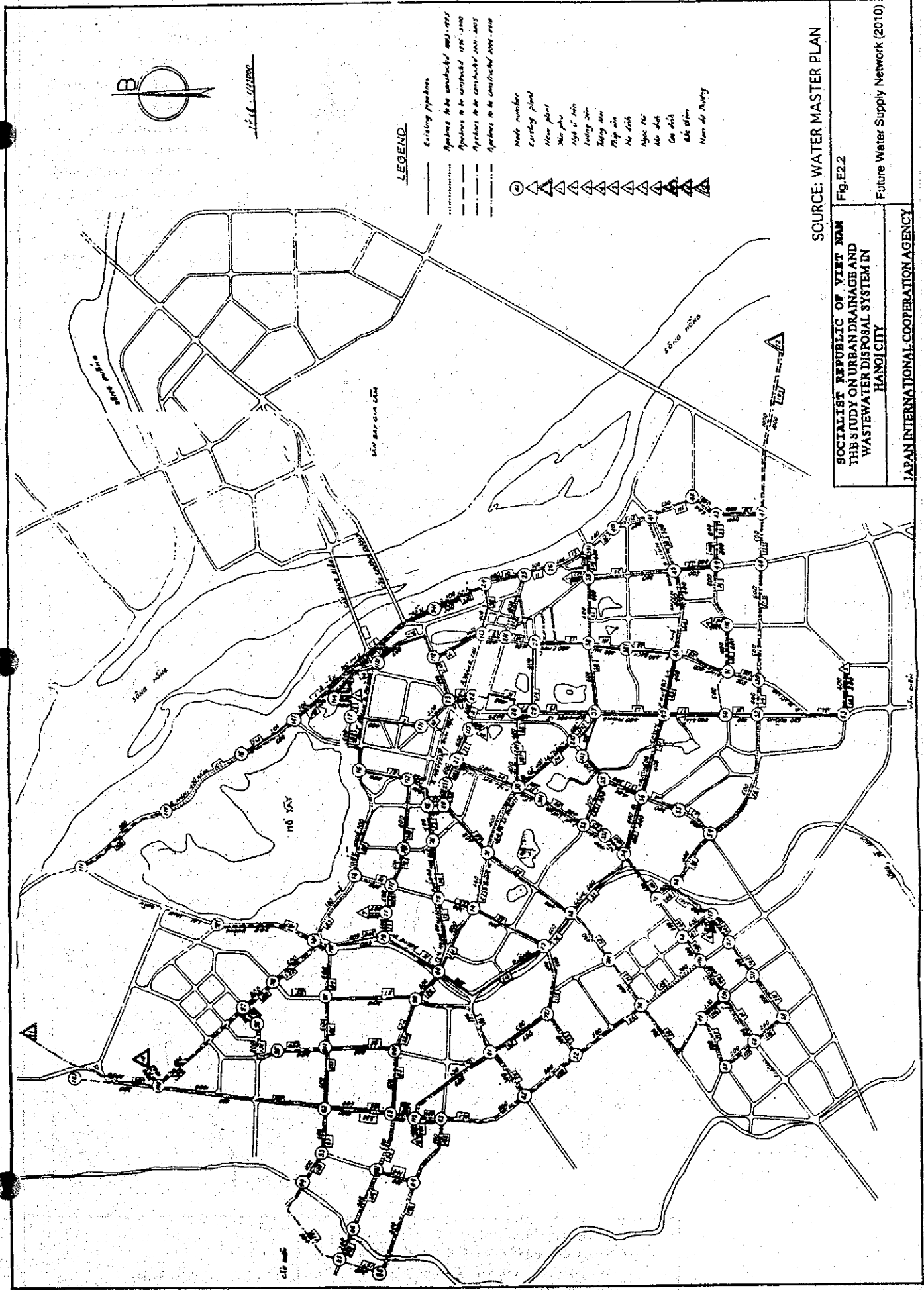
SOURCE: WATER MASTER PLAN

Fig.E2.1

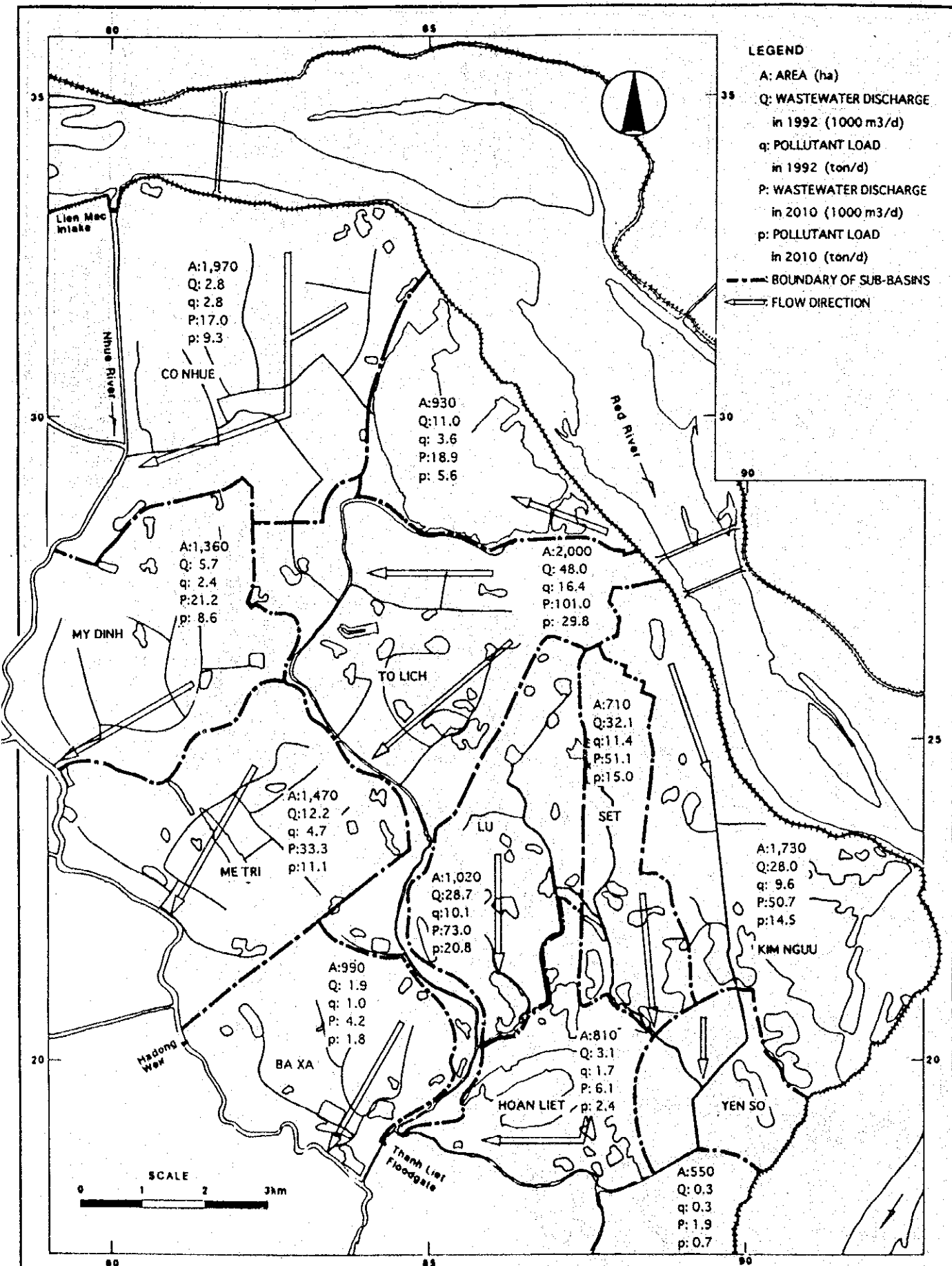
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Existing Water Supply Network

JAPAN INTERNATIONAL COOPERATION AGENCY

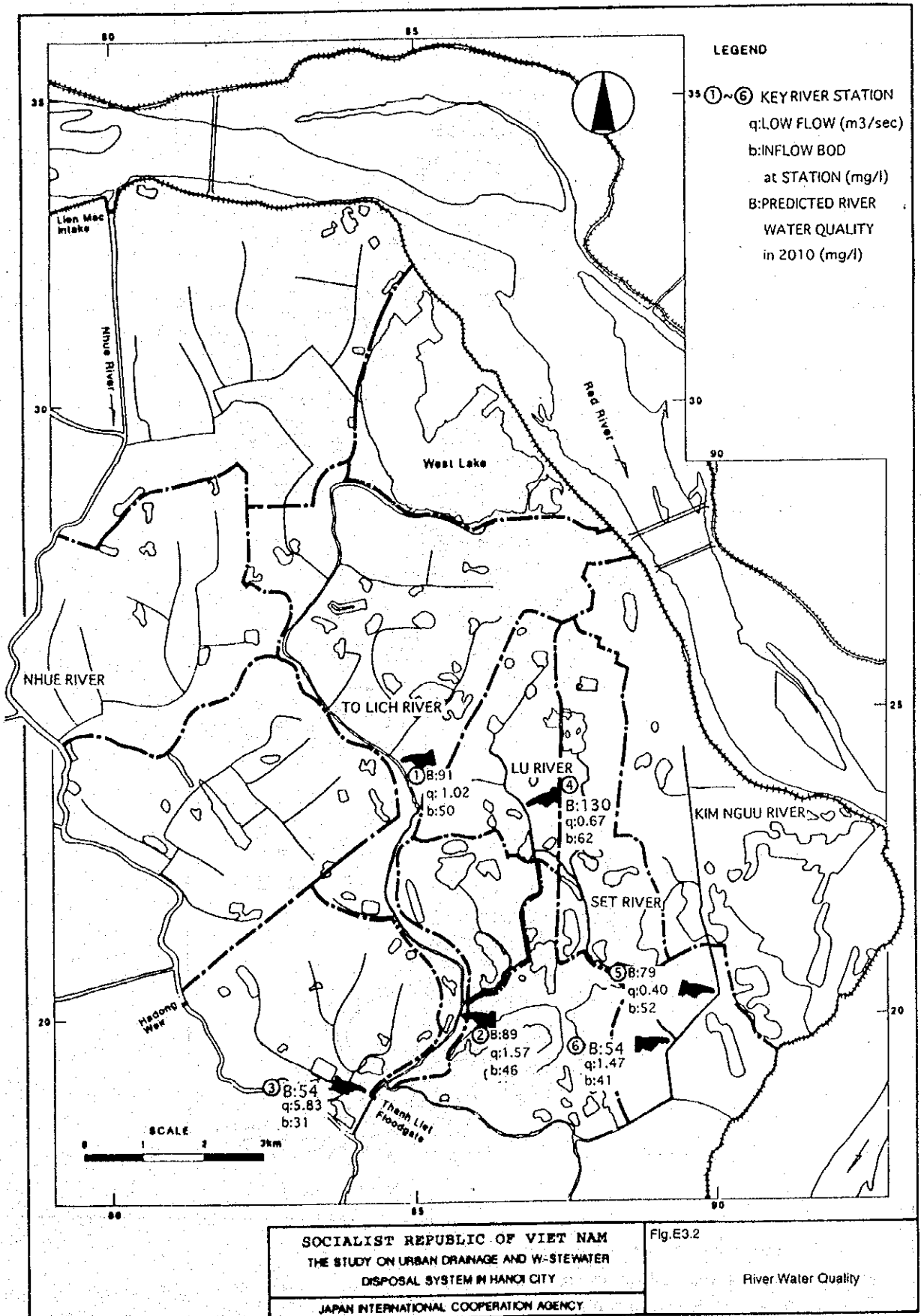


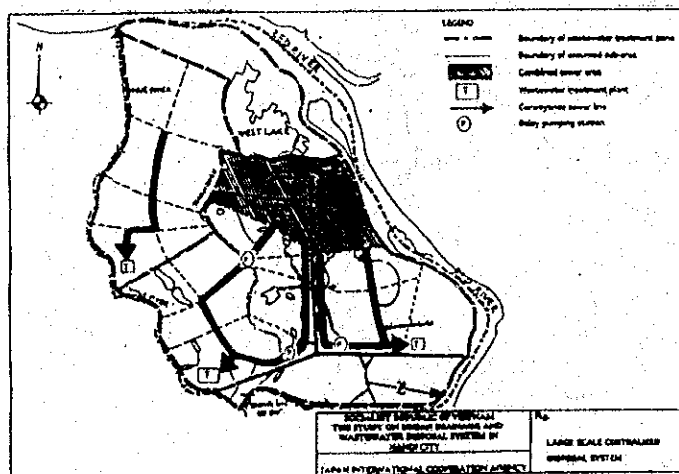
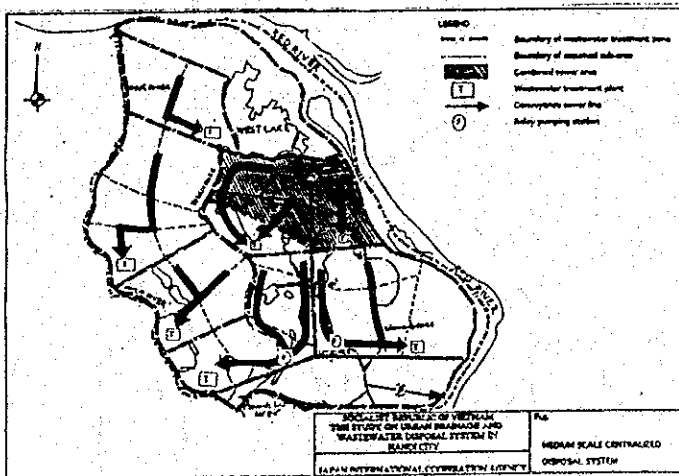
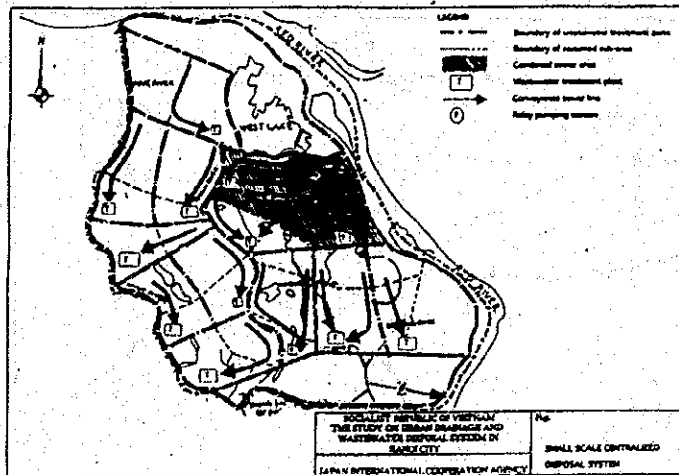
SOURCE: WATER MASTER PLAN
 Fig.E2.2
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 WASTEWATER DISPOSAL SYSTEM IN
 HANOI CITY
 JAPAN INTERNATIONAL COOPERATION AGENCY
 Future Water Supply Network (2010)



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 DISPOSAL SYSTEM IN HANOI CITY
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Fig.E3.1
 River Basins



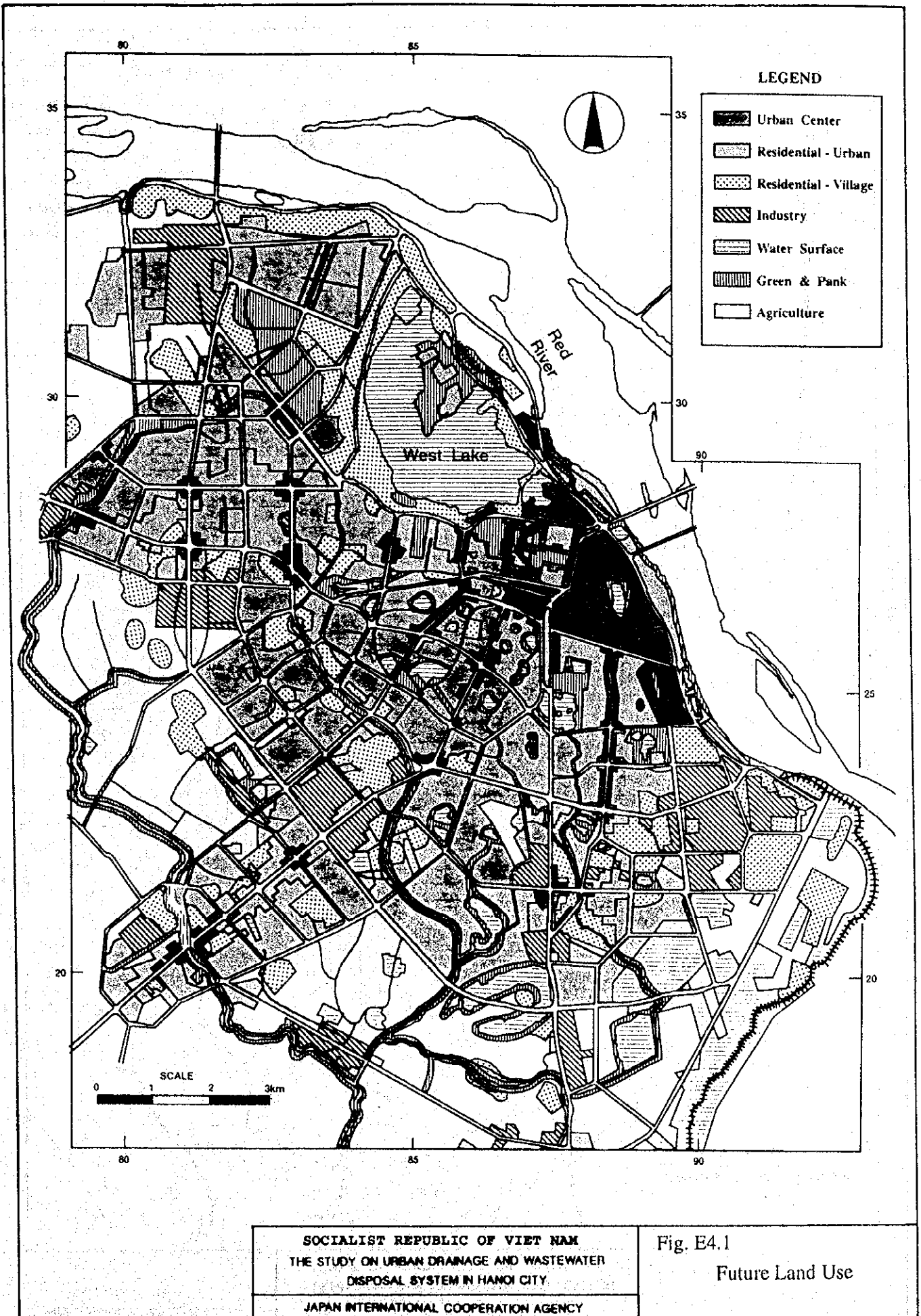


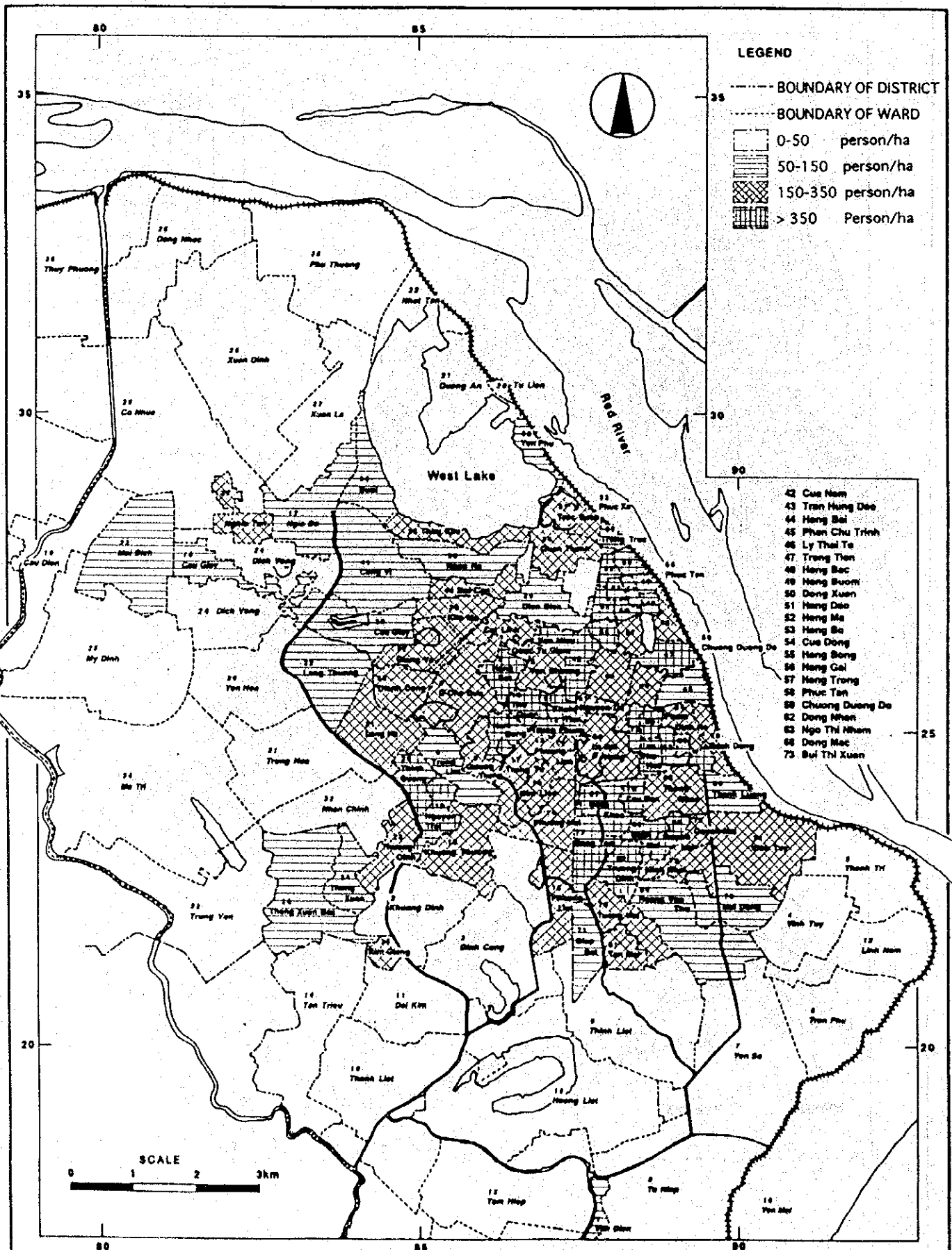
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DISPOSAL SYSTEM IN HANOI CITY

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Fig.E3.3

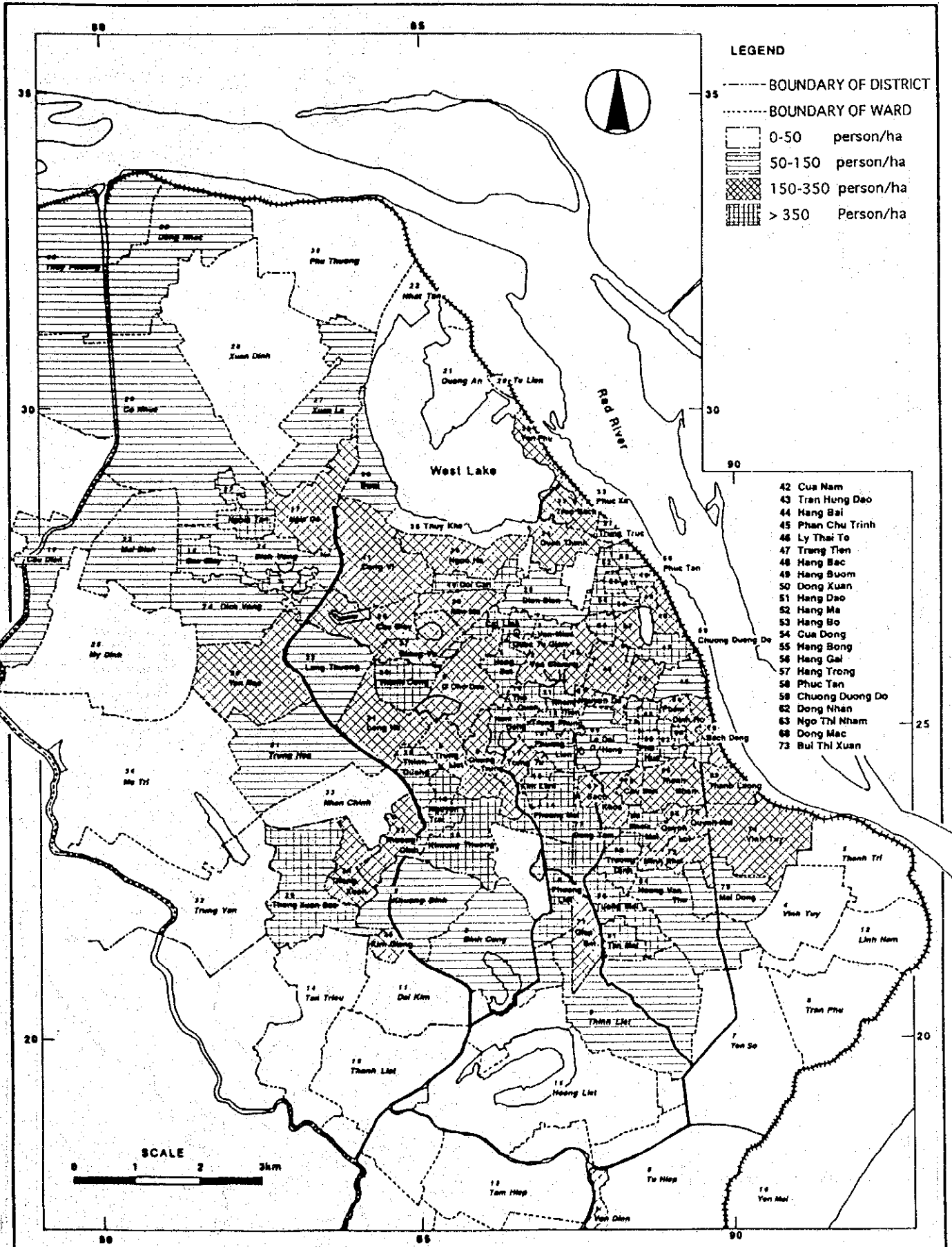
Schematic Wastewater Disposal System at Each Scale





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Fig.E4.2
 Existing Population Density in 1992



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Fig.E4.3
 Future Population Density in 2010

