社会開発調査部報告書

No. 32

Japan International Cooperation Agency (JICA)

Hanoi People's Committee

Socialist Republic of Vietnam

The Study on Environmental Improvement for Hanoi City in The Socialist Republic of Vietnam

Final Report

Data Book

July 2004

Nippon Koei Co., Ltd.

EX Corporation

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ESTIMATE OF PROJECT COST

Estimate of Base Cost : As of March 1999 Price Level
Currency Exchange Rate : USD1.0 = VND13,900 = Yen 122

THE STUDY
ON
ENVIRONMENTAL IMPROVEMENT FOR HANOI CITY
IN
THE SOCIALIST REPUBLIC OF VIETNAM

FINAL REPORT

DATA BOOK

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SURVEY DATA (1st STUDY PERIOD)

A. Water Quality Survey

Water Quality Survey conducted in 1998

Water Quality Surveys were conducted in September and October, 1998 by sub-contractor, "INSTITUTE OF CHEMISTRY, Vietnam National Center for Natural Science and Technology". Water Quality Surveys were carried out in six fields as below;

1) Urban water areas (UW) — Water Bodies in Urban District Area and surround area (The Area between right bank of Red River and Left Bank of Nhue River)

2) Suburban water areas (SW) — Water Bodies in the Study Area except for Urban Area and major big Rivers.

3) Rivers (RW) — Major big rivers in the Study Area (Cau River, Red River, Calo River, Red River, Dung River, Nhue River)

4) Wastewater treatment plants (TW) — Influent and effluent of five Wastewater treatment plants. Total 10 samples

5) Industrial wastewater (IW) — 15 samples of effluent of selected industrial factories

6) Underground water (GW) — Selected 15 points of groundwater wells.

Sampling points and analytical items on each fields are summarized as below

Sampling Points and Analysis Items

	Category I	Category II	Sampling Points
1) Surface Water			
Urban water areas (UW)	10	20	Figure A.1 and Table A.2
Suburban water areas (SW)	5	15	Figure A.2 and Table A.3
Rivers (RW)	10	-	Figure A.3 and Table A.4
2) Pollution Source			
Industrial wastewater (IW)	10	-	Figure A.4 and Table A.5
Wastewater treatment plants (TW)	15	-	Figure A.4 and Table A.6
3) Underground water (GW).	5	10	Figure A.5 and Table A.7

Category I: Analysis 24 Items for Present Condition of Environmental Pollution (refer to Table A.1)

Category II: Analysis 6 Items for Indicator of Environmental Pollution

Water Quality Analytical Methods are shown in Table A.8. The results of Water Quality Analysis are shown in Table A.9 to Table A.16.

Table A.1 Analytical Parameter and Number

(Unit: No. of analyses)

	Parameter	Urban Water Areas		Suburban Water Areas		Rivers	Treatment Plants (In/out flow)	Industrial wastewater	Under-ground water	
	Name of Group	I-UW	II-UW	I-SW	II-SW	I-RW	I-TW	I-IW	I-GW	II-GW
	Number of Samples	10	20	5	15	10	10	15	5	10
1	Number of Analyses ph	10	-	5	-	10	10	15	5	-
2	Turbidity	10	-	5	-	10	10	15	5	-
3	Eldctrical Conductivity	10	-	5	-	10	10	15	5	-
4	DO	10	20	5	15	10	10	15	5	10
5	BOD	10	20	5	15	10	10	15	5	10
6	COD	10	20	5	15	10	10	15	5	10
7	SS	10	20	5	15	10	10	15	5	10
8	Total Nitrogen	10	20	5	15	10	10	15	5	10
9	Ammonia Nitrogen	10	-	5	-	10	10	15	5	-
10	Total Phosphorus	10	20	5	15	10	10	15	5	10
11	Iron	10	-	5	-	10	10	15	5	-
12	Manganese	10	-	5	-	10	10	15	5	-
13	Arsenic	10	-	5	-	10	10	15	5	-
14	Cadmium	10	-	5	-	10	10	15	-	-
15	Chrome	10	-	5	-	10	10	15	-	-
16	Hexavalent Chromium	10	-	5	-	10	10	15	-	-
17	Copper	10	-	5	-	10	10	15	-	-
18	Cyanide	10	-	5	-	10	10	15	-	-
19	Lead	10	-	5	-	10	10	15	-	-
20	Total Mercury	10	-	5	-	10	10	15	-	-
21	Fluoride	10	-	5	-	10	-	15	5	-
22	Chloride	10	-	5	-	10	-	15	5	-
23	Fecal Coliform Count	10	-	5	-	10	10	15	5	-
24	Total Coliform Count	10	-	5	-	10	10	15	-	-

Table A.2 List of Sampling Point in Urban Area

No	Name / Location of the points
1-UW-1	Truc Bach Lake
1-UW-2	Ho Tay (West Lake)
1-UW-3	New bridge (To Lich river)
1-UW-4	To bridge
1-UW-5	Set bridge (after Truong Dinh market)
1-UW-6	Concrete bridge (Nguyen Tam Trinh Str.)
1-UW-7	Hoan Kiem Lake
1-UW-8	Bay Mau Lake
1-UW-9	Giang Vo Lake
1-UW-10	Ho Van Chuong
2-UW-1	Sewerage in Buoi market
2-UW-2	To Lich river (Buoi slope)
2-UW-3	Co Nhue dam
2-UW-4	Co Nhue channel
2-UW-5	Cong Vi channel (To Lich river)
2-UW-6	Cau Giay bridge (To Lich river)
2-UW-8	Moc sewerage (To Lich river)
2-UW-9	New bridge (Nga Tu So junction)
2-UW-10	Kim Nguu river (O Dong Mac, city entrance)
2-UW-11	Set river (Hanoi University of Tech.)
2-UW-12	Xa Dan lake
2-UW-13	Kim Nguu bridge
2-UW-14	Van Dien bridge
2-UW-15	Buou bridge
2-UW-15	Dau bridge
2-UW-16	Lu bridge
2-UW-17	Channel (on the South Thang Long road)
2-UW-18	Trung Van channel
2-UW-19	Thu Le Lake
2-UW-20	Nhue river, My Dinh

Table A.3 List of Sampling Point in Sub-urban Area

No	Name / Location of the points
1-SW-1	Luong Chau, Da Phuc distr.
	Da Phuc bridge
1-SW-2	Lai Son bridge (Nam Son distr.)
1-SW-3	Dong Anh railway station
1-SW-4	Sai Dong railway bridge
1-SW-5	Cau Nga pumping station (Tay Mo distr)
2-SW-1	Channel (People Committee of Soc Son distr.)
2-SW-2	Kim Anh bridge
2-SW-3	Xuan Non channel (nearby Viet Tiep factory)
2-SW-4	Van Ha pumping station (Thiet Ung commune)
2-SW-5	Van Tri pond
2-SW-6	Phuong Trach bridge
2-SW-7	Loc Ha bridge
2-SW-8	Dinh Xuyen dam (Ninh Hiep post office)
2-SW-9	Lake nearby Gia Lam railway Station
2-SW-10	Nhu Quynh bridge
2-SW-11	River junction (Tan Quang commune)
2-SW-12	Bat Trang bridge
2-SW-13	Phu Dien sewerage
2-SW-14	Channel, opposite 24 (other side of Nhue river)
2-SW-15	Dong Quan lake (Soc Son distr.)

Table A.4 List of Sampling Point in Major Rivers

No	Name / Location of the points
1-RW-1	Da Phuc bridge
1-RW-2	Xuan Phuong bridge
1-RW-3	Phu Lo bridge
1-RW-4	Trung Mau
1-RW-5	Thuong Cat hydrometedological station
1-RW-6	Ca Lo river (junction with Cau river)
1-RW-7	Lien Mac dam (sampling on Red river)
1-RW-8	Lien Mac dam (sampling on Nhue river)
1-RW-9	Khuyen Luong river port
1-RW-10	Nearby To bridge

Table A.5 List of Factories for Water Sampling

Reference No.	Name of Factories	Type of Industry	Address
1-IW-1	Hanoi Beer	Food Processing	Ba Dinh
1-IW-2	Sai Dong Industrial Zone *2		Sai Dong, Gia Lam
1-IW-3	8th-March Textile Factory	Textile	Hai Ba Trung
1-IW-4	Minh Khai Lock Factory *1	Mechanical	Hai Ba Trung
1-IW-5	Van Dien phospho fertilizer factory	Chemical	Thanh Tri
1-IW-6	General Paint Factory	Chemical	Thanh Tri
1-IW-7	Cao Sa La Industrial Area (Rubber, Detergent & Cigarette)	Chemical & Food Processing	Thanh Xuan
1-IW-8	Hanoi Food Factory	Food Processing	
1-IW-9	Viet Tiep Lock Factory	Mechanical	Dong ANh
1-IW-10	Duc Giang Chemicals Factory	Chemical	Tu Liem
1-IW-11	Cau Dien Paint Factory	Chemical	Tu Liem
1-IW-12	Vietnam Milk Company	Food Processing	Gia Lam
1-IW-13	Bac Song Hong Wine-Beer Company	Food Processing	Gia Lam
1-IW-14	X-Army Factory	Mechanical	Dong ANh
1-IW-15	Dong Anh Amian Cover Board Factory	Construction Material	Soc Son

*1: Wastewater treatment plant may be operated.
*2: Factories in the Zone have individual wastewater treatment plants.

Table A.6 List of Wastewater Treatment Plant for Water Sampling

Reference No.	Name of Wastewater Treatment Plant	Capacity	Address
1-TW-1	Hospital of tuberculosis		Ba Dinh
1-TW-2	Bach Mai Hospital	60 m^3/d	Bach Mai
1-TW-3	Export Engineering Tools Factory (Mechanical)		Dong Da
1-TW-4	Tay Mo Leachate Treatment Plant		Tay Mo
1-TW-5	Hyun Dai Steel Corporation	30 m^3/d	Dong Anh

(Remarks) Samples shall be collected from inlet and outlet at a plant.

Table A.7 List of Wells for Water Sampling

Reference No.	Location of Wells
1-GW-1	Nam Son
1-GW-2	Tay Mo / Cau Dien
1-GW-3	Me Tri
1-GW-4	Tam Hiep
1-GW-5	Lam Du
2-GW-1	Nam Son
2-GW-2	Da Phuc
2-GW-3	Xuan Non
2-GW-4	Dong Anh
2-GW-5	Thuong Thanh
2-GW-6	Phu Dien
2-GW-7	Dong Da
2-GW-8	Hai Ba Trung
2-GW-9	Yen So
2-GW-10	Thanh Xuan

(Remarks) Category I: Analysis for Present Condition of Environmental Pollution
Category II: Analysis for Indicator of Environmental Pollution

Table A.8 Water Quality Analytical Method

No	Parameter	Unit	Anal. method	Determ. limits
1	pH	-	sensor pH meter	0.05
2	Turbidity	NTU	sensor meter	0.5
3	Elec. conductivity	µS/cm	sensor cond. meter	1
4	DO	mg/l	sensor	0.01
5	BOD_5	mg/l	sensor	0.01
6	COD	mg/l	Titration TCVN 4565-1988	0.01
7	SS	mg/l		0.01
8	Total Nitrogen	mg/l	TCVN 5987-1995 ISO 5663-1984	0.005
9	Ammonia nitrogen	mg/l	TCVN 5988-1995 ISO 5664-1984	0.005
10	NH_3-N	mg/l	Spectrophotometer	0.015
11	PO_4^{3-}-P	mg/l	AAS - visible spectr.	0.005
12	Iron	mg/l	AAS- visible spectr.	0.010
13	Manganese	mg/l	AAS-visible spectr. TCVN 4578-1988	0.005
14	Arsenic	mg/l	AAS / Polarographic TCVN 4571-88	0.001
15	Cadmium	mg/l	AAS / Polarographic TCVN 4574-88	0.001
16	Chrome	mg/l		0.001
17	Hexavalent chromium	mg/l		0.001
18	Copper	mg/l	AAS / Polarographic TCVN 4572-88	0.001
19	Lead	mg/l	AAS / Polarographic TCVN 1978-88	0.001
20	Cyanide	mg/l	TCVN 2660-78	0.001
21	Total mercury	mg/l	AAS / Polarographic TCVN 5989-1995 ISO 5666-1:1983	0.001
22	Fluoride	mg/l	TCVN 4568-88	0.001
23	Chloride	mg/l	TCVN 2656-78	0.001
24	Fecal coliform count	MNP/ 100ml	Membrane filter	3
25	Total coliform count	MNP/ 100ml	Membrane filter	3

Table A.9 Results of Water Quality Analysis in Urban Area (Category I)

No	Parameters	Unit	1UW.1	1UW.2	1UW.3	1UW.4	1UW.5	1UW.6	1UW.7	1UW.8	1UW.9	1UW.10	Vietnamese Standard B
	Sampling Date	--	13/9/98	13/9/98	13/9/98	10/9/98	10/9/98	10/9/98	13/9/98	13/9/98	13/9/98	13/9/98	--
	Sampling Time	--	18h30	18h50	11h30	18h35	10h00	17h15	14h15	14g35	16h30	14h55	--
	Temperature	°C	29.5	29.1	30	28	30.5	30	29	28.1	29.8	29.1	--
1	pH	--	7.6	8.3	7.3	7.3	7.5	7.7	9.0	7.8	7.8	7.5	5.5 - 9.0
2	Turbidity	NTU	38.2	51	32.2	32.6	29.9	50.0	92.0	14.75	20.7	26.4	--
3	Electrical Conductivity	$\mu S.cm^{-1}$	289	299	443	695	7.51	592	134	529	426	483	--
4	DO	mg/l	1.85	3.44	0.41	0.41	1.11	5.96	10.5	1.95	4.15	0.57	2
5	BOD_5	mg/l	54.0	25.0	44.5	18.0	32.0	35.5	39.0	20.75	46.5	33.2	25
6	COD	mg/l	84.0	40.0	80.0	62.4	88.4	67.6	120	52.0	88.0	58.0	35
7	SS	mg/l	30	53	26	13.0	11	17	123	20	19.0	25.0	80
8	Total Nitrogen	mg/l	3.0	5.5	17.0	14.25	20.5	5.7	1.70	8.65	11.0	11.2	--
9	Amonia Nitrogen	mg/l	2.5	<0.01	13.5	0.25	17.5	<0.01	0.11	7.75	5.5	5.6	1
10	Total Phosphorus	mg/l	0.28	0.15	1.24	0.43	0.37	0.52	0.22	0.82	0.89	0.54	--
11	Iron	mg/l	1.08	0.80	0.86	0.72	0.16	1.18	0.64	0.28	0.20	1.2	2
12	Manganese	mg/l	0.03	0.03	0.20	0.18	0.12	0.11	0.04	0.05	0.06	0.82	0.8
13	Arsenic	mg/l	0.0009	0.0017	0.0008	0.0016	0.0008	0.00090	0.0009	0.0009	0.0015	0.0014	0.1
14	Cadimium	mg/l	0.00026	<0.0001	0.0010	0.0023	0.00063	0.0014	0.0004	<0.0001	0.00025	0.0003	0.02
15	Chromium	mg/l	0.0022	0.0019	0.0024	0.0040	0.0060	0.0030	0.0098	0.0021	0.0020	0.0090	--
16	Hexavalent Chromium	mg/l	0.0020	0.0018	0.0023	0.0040	0.0060	0.0030	0.0078	0.0021	0.0020	0.0090	0.05
17	Copper	mg/l	0.0257	0.0138	0.019	0.0620	0.0436	0.0390	0.0256	0.0242	0.0282	0.0119	1
18	Lead	mg/l	0.015	0.002	0.008	0.0045	0.010	0.007	0.006	0.004	0.007	0.016	0.1
19	Cyanide	mg/l	0.0076	0.0025	0.0048	0.0045	0.009	0.0085	0.012	0.0061	0.0057	0.0176	--
20	Total Mercury	mg/l	$2.1x10^{-4}$	$2.4x10^{-4}$	$2.8x10^{-4}$	$3.3x10^{-4}$	$7.4x10^{-4}$	$2.6x10^{-4}$	$1.6x10^{-4}$	$3.3x10^{-4}$	$2.5x10^{-4}$	$7.1x10^{-4}$	0.001
21	Fluoride	mg/l	0.92	1.57	1.95	1.77	1.65	1.23	0.85	1.40	1.59	1.70	1
22	Chloride	mg/l	30.2	32.0	46.2	63.90	63.90	55.0	12.4	71.0	39.10	58.5	--
23	Fecal Coliform	MPN/100ml	440	600	700	200	240	120	20	152	40	400	5000
24	Total Coliform	MPN/100ml	940	1400	1600	440	775	360	50	242	180	1666	--
	Characteristics		Sewarage junction to West Lake durty	No. 262 Thuy Khue Str.	River junction to Tô Lich from Ngh a Tân lake	--	--	--	Green color water Hoàn Kiê'm	--	Some dead fishes	Blackish water	--

Table A.10 Results of Water Quality Analysis in Urban Areas (Category II)

N°	Parameters	Unit	2UW1	2UW2	2UW3	2UW4	2UW5	2UW6	2UW7	2UW8	2UW9	2UW10
	Sampling Date	–	25/9/98	25/9/98	23/9/98	13/9/98	–	13/9/98	13/9/98	13/9/98	10/9/98	10/9/98
	Sampling Time	–	10h30	10h30	10h00	18h00	11h45	10h50	10h35	10h20	8-9am	8-9am
	Temperature	°C	30.8	31	28.1	29.3	–	30.2	30.2	30.2	30	30
1	DO	mg/l	0.84	0.90	4.34	10.43	2.42	2.10	4.15	4.25	0.49	2.7
2	BOD_5	mg/l	29.7	35.5	22.5	45.25	19.0	30.3	30.25	31.8	29	29.5
3	COD	mg/l	48.0	66.0	42.0	72.0	72.0	68.0	52.00	74.0	72.8	52.0
4	SS	mg/l	35.0	58.0	31.0	52.0	11.0	9.00	18.0	17.0	100.0	15.0
5	Total Nitrogen	mg/l	0.75	1.75	1.60	1.45	13.20	10.50	20.75	14.10	8.80	5.20
6	Total Phosphorus	mg/l	0.60	0.75	0.37	0.22	1.48	1.06	1.53	1.41	2.73	1.01
	Characteristics		Buoi market sewarage	Buoi slopway sewarage	Co Nhue dam	Co Nhue channel	Cong Vi sewarage	Dirty dark color	–	Lots of solid waste	–	–

N°	Parameters	Unit	2UW11	2UW12	2UW13	2UW14	2UW15	2UW16	2UW17	2UW18	2UW19	2UW20
	Sampling Date	–	10/9/98	10/9/98	10/9/98	10/9/98	13/9/98	13/9/98	13/9/98	13/9/98	13/9/98	12/9/98
	Sampling Time	–	9h40	16h55	1050	18h45	9h30	10h00	8h15	8h40	16h45	–
	Temperature	°C	30.2	30	31	30	29.5	29.9	29.8	29.5	29.3	29.5
1	DO	mg/l	0.68	4.66	1.30	5.99	3.15	2.02	3.70	2.20	8.55	5.47
2	BOD_5	mg/l	20	24.5	32.5	26.2	51.5	67.5	52.5	38.5	28.5	10.25
3	COD	mg/l	46.8	52.7	52	46.8	76	144	86	60	44	44
4	SS	mg/l	41	14	20	305	64	30	31	34	14	496
5	Total Nitrogen	mg/l	16.25	1.80	5.0	2.30	17.50	20.50	8.9	3.25	1.35	1.75
6	Total Phosphorus	mg/l	2.01	0.69	0.41	0.24	1.86	1.53	0.64	0.23	0.31	0.18
	Characteristics		–	–	–	–	–	Blackish color	South of Th.Long channel	Trung Van channel	Thu Le Park lake	My Dinh, Sông NhuÖe

Table A.11 Results of Water Quality Analysis in Sub-urban Areas (Category I)

N°	Parameters	Unit	1SW.1	1SW.2	1SW.3	1SW.4	1SW.5	Vietnamese Standard B
	Sampling Date	–	21/9/98	21/9/98	–	11/9/98	17/9/98	–
	Sampling Time	–	11h50	10h50	9h30	17h25	11h00	–
	Temperature	°C	31.0	31.2	31.1	314	31.7	–
1	pH	–	7.12	7.07	8.0	7.7	7.6	5.5 - 9.0
2	Turbidity	NTU	39.8	88.0	275.0	738.0	175.0	–
3	Electrical Conductivity	$\mu S.cm^{-1}$	178.1	98.8	228.0	427.0	196.0	–
4	DO	mg/l	4.23	4.32	7.72	5.82	3.45	2
5	BOD_5	mg/l	12.9	9.7	16.5	21.5	48.0	25
6	COD	mg/l	22.6	20	44.0	40.0	72.0	35
7	SS	mg/l	33	70	207	417	108	80
8	Total Nitrogen	mg/l	1.75	1.40	8.20	1.80	1.75	–
9	Amonia Nitrogen	mg/l	0.67	0.38	2.37	0.18	0.25	1
10	Total Phosphorus	mg/l	0.32	0.08	0.15	0.41	0.23	–
11	Iron	mg/l	3.30	2.00	2.96	14.00	3.40	2
12	Manganese	mg/l	0.20	0.18	0.06	0.10	0.17	0.8
13	Arsenic	mg/l	0.0009	0.0012	0.0024	0.0014	0.0007	0.1
14	Cadimium	mg/l	<0.0001	0.00062	0.0003	0.0004	<0.0001	0.02
15	Chromium	mg/l	0.0060	0.0060	0.0040	0.0018	0.0070	–
16	Hexavalent Chromium	mg/l	0.0060	0.0060	0.0023	0.0018	0.0070	0.05
17	Copper	mg/l	0.0804	0.0190	0.0215	0.0260	0.0264	1
18	Cyanide	mg/l	0.003	0.005	0.005	0.005	0.003	0.1
19	Lead	mg/l	0.0205	0.0056	0.0078	0.0112	0.0039	–
20	Total Mercury	mg/l	$1.7x10^{-4}$	$4.7x10^{-4}$	$2.4x10^{-4}$	$4.3x10^{-4}$	$6.3x10^{-4}$	0.001
21	Fluoride	mg/l	0.82	0.95	1.21	0.67	1.15	1
22	Chloride	mg/l	26.6	23.10	16.00	28.50	17.80	–
23	Fecal Coliform	MPN/100ml	420	80	800	830	640	5000
24	Total Coliform	MPN/100ml	680	160	2000	1400	1000	–
	Characteristics		Luong Châu, Da Phóc	Lai Sơn bridge	–	Sampling in railway bridge, in pumping outlet	Ngà bridge channel, behind waste area	–

Table A.12 Results of Water Quality Analysis Sub-urban Areas (Category II)

N°	Parameters	Unit	2SW1	2SW2	2SW3	2SW4	2SW5	2SW6	2SW7
	Sampling Date	–	21/9/98	21/9/98	11/9/98	11/9/98	11/9/98	11/9/98	11/9/98
	Sampling Time	–	15h45	17h20	10h40	10h30	8h45	8h30	13h30
	Temperature	°C	28.6	32.5	29.4	28.2	31.2	28.7	30.4
1	DO	mg/l	7.67	6.45	1.86	6.76	4.20	2.64	9.2
2	BOD_5	mg/l	10.0	16.5	27.5	31.75	10.75	11.25	43.75
3	COD	mg/l	21.0	36.0	56.0	58.0	24.0	28.0	72.0
4	SS	mg/l	80	41	14	128	80	328	389
5	Total Nitrogen	mg/l	0.50	0.70	3.0	0.75	2.70	0.52	0.60
6	Total Phosphorus	mg/l	0.13	0.06	0.37	0.29	0.22	0.27	0.27
	Characteristics		–	Kim Anh bridge	–	Van Hà pumping station	–	–	Loc hà

N°	Parameters	Unit	2SW8	2SW9	2SW10	2SW11	2SW12	2SW13	2SW14	2SW15
	Sampling Date	–	11/9/98	11/9/98	11/9/98	16/9/98	16/9/98	16/9/98	16/9/98	21/9/98
	Sampling Time	–	14h5	17h05	17h45	16h30	14h20	–	–	12h30
	Temperature	°C	34.7	33.7	28	27.8	28	26.9	27.1	322
1	DO	mg/l	7.55	14.30	6.71	5.00	6.95	5.15	3.01	6.56
2	BOD_5	mg/l	12.5	20.0	17.0	16.2	19.0	21.4	16.0	13.2
3	COD	mg/l	36.0	40.0	40.0	28.0	34.0	34.0	28.0	32.0
4	SS	mg/l	35	11	180	139	181	14	58	45.0
5	Total Nitrogen	mg/l	1.45	1.30	0.70	1.90	2.0	1.35	0.85	1.50
6	Total Phosphorus	mg/l	0.23	0.47	0.18	0.15	0.30	0.215	0.34	0.10
	Characteristics		Channel closed, still water	Lake nearby Gia Lâm railway station	Bac Hung Hai irrigation channel - Nhu Quynh	Tân Quang commun-Bac-Sông Hai river	Bát Tràng bridge	Phú Dien village	Phú Dien (opposite of Phú Dien)	Dông Quan

Table A.13. Results of Water Quality Analysis in Major Rivers

N°	Parameters	Unit	1RW1	1RW2	1RW3	1RW4	1RW5	1RW6	1RW7	1RW8	1RW9	1RW10	Vietnamese Standard B
	Sampling Date	–	21/9/98	21/9/98	21/9/98	11/9/98	11/9/98	21/9/98	13/9/98	13/9/98	10/9/98	10/9/98	–
	Sampling Time	–	10h15	17h50	16h50	14h50	16h30	16h00	17h30	17h15	17h30	18h20	–
	Temperature	°C	31.2	31.8	31.6	30.5	28.9	32.0	27.6	31.5	29.5	29.5	–
1	pH	–	7.6	7.4	7.3	7.6	6.9	7.8	7.8	7.8	7.7	7.4	5.5 - 9.0
2	Turbidity	NTU	30.1	85.0	81.0	751.0	607.0	52.0	312.0	289.0	588.0	421.0	–
3	Electrical Conductivity	$\mu S.cm^{-1}$	54.1	153.5	157.3	187.5	185.0	157.2	147.0	135.0	136.6	183.0	–
4	DO	mg/l	6.60	5.30	5.80	8.77	8.89	7.15	10.91	9.06	5.60	6.11	2
5	BOD_5	mg/l	3.90	8.20	8.00	17.75	12.40	18.30	7.50	18.20	24.50	26.50	25
6	COD	mg/l	16.0	16.0	20.8	52.0	32.0	30.6	24.0	44.0	44.0	46.8	35
7	SS	mg/l	30	90	90	681	390	62	375	298	298	239	80
8	Total Nitrogen	mg/l	0.50	0.80	0.51	1.70	1.0	0.70	2.60	2.60	2.80	5.10	–
9	Amonia Nitrogen	mg/l	0.20	0.62	0.47	0.20	0.28	0.30	0.32	0.24	<0.01	<0.01	1
10	Total Phosphorus	mg/l	0.14	0.54	0.14	0.18	0.18	0.34	0.21	0.27	0.14	0.21	–
11	Iron	mg/l	1.02	1.70	2.10	11.30	11.00	1.50	7.60	3.0	14.00	12.50	2
12	Manganese	mg/l	0.05	0.11	0.06	0.05	0.04	0.11	0.11	0.05	0.13	0.18	0.8
13	Arsenic	mg/l	0.0015	0.0009	0.0011	0.0017	0.0011	0.0014	0.0013	0.0018	0.0007	0.0012	0.1
14	Cadimium	mg/l	0.0006	0.00039	0.0005	0.0010	<0.0001	0.0005	0.0006	0.00017	<0.0001	0.00028	0.02
15	Chromium	mg/l	0.0080	0.0070	0.0050	0.0088	0.0056	0.0040	0.0098	0.0099	0.0050	0.0098	–
16	Hexavalent Chromium	mg/l	0.0040	0.0070	0.0050	0.0078	0.0030	0.0040	0.0096	0.0099	0.0040	0.0065	0.05
17	Copper	mg/l	0.0159	0.037	0.032	0.018	0.052	0.0202	0.0146	0.027	0.0160	0.0140	1
18	Cyanide	mg/l	0.008	0.007	0.008	0.006	0.008	0.01	0.006	0.006	0.005	0.003	0.1
19	Lead	mg/l	0.0109	0.045	0.012	0.034	0.0027	0.0120	0.0048	0.0028	0.010	0.0082	–
20	Total Mercury	mg/l	$1.5x10^{-4}$	$4.7 x10^{-4}$	$1.1 x10^{-4}$	$7.5 x10^{-4}$	$1.2 x10^{-4}$	$1.5 x10^{-4}$	$4.4 x10^{-4}$	$3.7 x10^{-4}$	$2.5 x10^{-4}$	$1.4 x10^{-4}$	0.001
21	Fluoride	mg/l	1.35	1.38	1.20	1.35	0.35	1.30	0.30	0.60	0.45	0.87	1
22	Chloride	mg/l	12.10	14.20	15.50	5.5	9.01	15.92	9.04	9.04	14.20	9.0	–
23	Fecal Coliform	MPN/100ml	400	130	120	244	210	180	400	360	160	100	5000
24	Total Coliform	MPN/100ml	700	340	280	744	550	400	3500	600	180	870	–
	Characteristics		River water, Da phúc bridge	Xuân Phuong bridge	River water, Phu Lo bridge	Duong river down-stream	Thuong Cat meterio. station	River junction	Red river, Liên Mac dam	Liên Mac dam, red color	In stream, redish brown color	Reddish dark brown	–

Table A.14 Results of Water Quality Analysis of Groundwater

N°	Parameters	Unit	1GW1	1GW2	1GW3	1GW4	1GW5	2GW1	2GW2	2GW3	2GW4	2GW5	2GW6	2GW7	2GW8	2GW9	2GW10
	Sampling Date	–	21/9/98	17/9/98	13/9/98	10/9/98	16/9/98	21/9/98	21/9/98	11/9/98	–	11/9/98	16/9/98	10/9/98	10/9/98	10/9/98	21/9/98
	Sampling Time	–	11h03	–	8h50	18h15	14h30	11h15	11h55	10h40	10h00	16h50	–	9h30	9h30	18h00	17h37
	Temperature	°C	27.7	31.7	29.0	30	–	28.7	27.3	–	33.2	30.5	–	30	30	29.5	26.0
1	pH	–	5.7	7.6	7.1	7.2	7.2	–	–	–	–	–	–	–	–	–	–
2	Turbidity	NTU	29.1	35.8	4.2	2.5	0.7	–	–	–	–	–	–	–	–	–	–
3	Electrical Conductivity	$\mu S.cm^{-1}$	84.0	742	402	1007	559	–	–	–	–	–	–	–	–	–	–
4	DO	mg/l	2.62	1.17	4.20	3.86	1.3	5.0	2.0	7.79	4.33	5.11	1.95	2.02	3.33	2.27	0.46
5	BOD_5	mg/l	2.6	8.2	14.5	5.2	1.9	1.8	2.5	1.5	1.2	2.0	3.7	4.0	6.8	8.2	1.0
6	COD	mg/l	8.0	15.2	18.0	24.0	4.8	5.6	9.6	5.6	4.0	4.8	6.4	18	14	16	4
7	SS	mg/l	26	9.0	203	2.0	7.0	0	0	8.0	4.0	1.0	38	21	55	101	0
8	Total Nitrogen	mg/l	1.6	2.4	1.40	1.7	0.60	0.40	0.40	0.50	0.55	3.40	5.20	8.70	2.10	8.10	0.60
9	Amonia Nitrogen	mg/l	0.40	1.8	1.35	1.1	0.137	–	–	–	–	–	–	–	–	–	–
10	Total Phosphorus	mg/l	0.11	0.37	1.41	0.41	0.46	0.36	0.50	0.45	0.37	0.47	0.43	0.54	0.41	0.27	0.42
11	Iron	mg/l	0.57	0.82	30	0.25	0.95	–	–	–	–	–	–	–	–	–	–
12	Manganese	mg/l	0.15	1.15	0.34	0.30	0.82	–	–	–	–	–	–	–	–	–	–
13	Arsenic	mg/l	0.0016	0.0009	0.0021	0.0044	0.0006	–	–	–	–	–	–	–	–	–	–
14	Cadimium	mg/l	0.0003	0.00025	0.00032	<0.0001	<0.0001	–	–	–	–	–	–	–	–	–	–
15	Chromium	mg/l	0.0030	0.0038	0.0022	0.0018	0.0050	–	–	–	–	–	–	–	–	–	–
16	Hexavalent Chromium	mg/l	0.0030	0.0038	0.0018	0.0010	0.0050	–	–	–	–	–	–	–	–	–	–
17	Copper	mg/l	0.074	0.0334	0.0077	0.0122	0.138	–	–	–	–	–	–	–	–	–	–
18	Cyanide	mg/l	0.001	0.001	0.0010	<0.001	0.010	–	–	–	–	–	–	–	–	–	–
19	Lead	mg/l	0.0045	0.0043	0.0018	0.0043	0.0016	–	–	–	–	–	–	–	–	–	–
20	Total Mercury	mg/l	$4.0x10^{-4}$	$1.0x10^{-4}$	$7.2x10^{-4}$	$9.7x10^{-4}$	$1.3x10^{-4}$	–	–	–	–	–	–	–	–	–	–
21	Fluoride	mg/l	1.07	1.20	0.70	1.25	1.30	–	–	–	–	–	–	–	–	–	–
22	Chloride	mg/l	23.0	55.00	17.80	81.50	30.0	–	–	–	–	–	–	–	–	–	–
23	Fecal Coliform	MPN/100ml	4	0	10	0	0	–	–	–	–	–	–	–	–	–	–
24	Total Coliform	MPN/100ml	8	10	60	2	4	–	–	–	–	–	–	–	–	–	–
	Characteristics		Surface water, Lai Son bridge, upstream	Mrs. Tran Thá Ty's - Nhuê Giang, Tây Mo	Public well	–	15-m-depth well (Lâm Du construction waste area)	Lai Son bridge, downstream	Luong Châu, Da Phúc (private well)	Xuân Noi, Dông Anh	Dông Anh, Red Cross office	Thu'ong Cát Meterio. station	Mr. Pham Viet Hùng's, group 1 of town	–	–	–	Highway column 6km to Phúc Yên

Table A.15 Results of Water Quality Analysis of Treatment Plant

N°	Parameters	Unit	1TW1		1TW2		1TW3		1TW4		1TW5		Industrial Effluent Standard B
			inlet	outlet	inlet	outlet	inlet	outlet	inlet	outlet	inlet	outlet	
	Sampling Date	–	19/10/98	19/10/98	12/9/98	12/9/98	22/9/98	22/9/98	17/9/98	17/9/98	11h30	11h30	–
	Sampling Time	–	14h00	14h00	11h00	11h00	11h30	11h30	10h00	10h00	11/9/98	11/9/98	–
	Temperature	°C	–	–	35	35	27.1	27.0	31	30.5	32	32.6	–
1	pH	–	8.6	8.3	7.7	7.7	6.7	7.0	7.7	7.9	2.2	4.2	5 - 9
2	Turbidity	NTU	327	27	30.02	8.31	318	5.76	425	435	11.42	5.79	–
3	Electrical Conductivity	$\mu S.cm^{-1}$	785	321	863	820	679	915	10600	10800	5300	10920	–
4	DO	mg/l	2.84	3.95	3.00	1.77	5.84	6.04	0.12	0.42	2.18	4.38	–
5	BOD_5	mg/l	159	18.2	20.4	11	14.5	7.5	700	650	5.0	5.2	50
6	COD	mg/l	276	42.8	64	48	44	28	2800	2600	144	50	100
7	SS	mg/l	97	4	20.0	7.0	225	1	1160	820	7.0	0.0	100
8	Total Nitrogen	mg/l	48.56	6.57	74.5	24.0	14.5	0.75	756.0	840	42.75	30.25	60
9	Amonia Nitrogen	mg/l	40	1.12	62	14.75	0.38	0.375	450	440	39.0	29.37	1
10	Total Phosphorus	mg/l	2.139	0.93	0.527	0.496	0.434	0.465	9.455	9.455	0.26	0.26	6
11	Iron	mg/l	0.58	0.13	0.49	0.2	0.5	0.5	4.60	4.60	820	0.92	5
12	Manganese	mg/l	0.230	0.20	0.11	0.09	0.09	0.06	0.85	0.77	4.36	<0.01	1
13	Arsenic	mg/l	0.0092	0.0075	0.0021	0.00087	0.0012	0.0015	0.0302	0.0075	0.0014	0.0011	0.1
14	Cadimium	mg/l	0.0007	0.0004	0.006	0.0002	0.0081	0.0003	0.0006	0.0004	0.003	0.0018	0.02
15	Chromium	mg/l	0.022	0.005	0.0099	0.0099	300	300	0.0540	0.054	0.0014	0.0014	–
16	Hexavalent Chromium	mg/l	0.017	0.005	0.0015	0.0015	6.8	6.8	0.0470	0.047	0.0012	0.0012	0.1
17	Copper	mg/l	0.0014	0.0013	0.018	0.024	1.630	0.130	0.142	0.166	3.85	0.65	1
18	Cyanide	mg/l	0.004	0.001	0.001	0.001	0.004	0.002	0.28	0.35	0.001	<0.001	0.1
19	Lead	mg/l	0.0034	0.0030	0.005	0.0019	0.120	0.0022	0.0392	0.0230	9.78	0.12	0.5
20	Total Mercury	mg/l	$0.9x10^{-4}$	$0.8 x10^{-4}$	$6.1x10^{-4}$	$1.1 x10^{-4}$	$3.0 x10^{-4}$	$4.2 x10^{-4}$	$4.2 x10^{-4}$	$2.4 x10^{-4}$	$1.3 x10^{-4}$	$1.5 x10^{-4}$	0.005
21	Fluoride	mg/l	1.00	1.75	1.75	1.80	0.35	0.42	0.85	0.7	0.67	0.80	2
22	Chloride	mg/l	70.0	39.0	46.0	55.0	32.5	120.7	1313.5	1686.3	266.5	624.5	–
23	Fecal Coliform	MPN/100ml	160	22	2200	680	12	4	2500	2000	0	0	–
24	Total Coliform	MPN/100ml	300	8	6000	1020	28	14	6000	5400	–	–	–
	Characteristics		–	–	Bach Mai hospital	Bach Mai hospital	Mechanical export	–	Tay Mo Solid waster treatment plant		Air polluted by $H_2\uparrow$	Air polluted by $H_2\uparrow$	–

Table A.16 Results of Water Quality Analysis of Industrial Wastewater

N°	Parameters	Unit	IIW1	IIW2	IIW3	IIW4	IIW5	IIW6	IIW7	IIW8	IIW9	IIW10	IIW11	IIW12	IIW13	IIW14	IIW15	Industrial Effluent Standard B
	Sampling Date	–	17/9/98	16/9/98	10/9/98	10/9/98	10/9/98	–	17/9/98	–	11/9/98	11/9/98	17/9/98	11/9/98	11/9/98	21/9/98	11/9/98	–
	Sampling Time	–	14h30	15h00	15h45	15h15	11h40	11h30	15h00	–	10h30	16h5	12h00	18h00	13h10	14h50	11h50	–
	Temperature	°C	35.8	29.7	29.9	32	33	26.1	–	26	29.5	40.4	33.5	32.5	30.8	28.4	30	–
1	pH	–	6.5	7.5	7.15	8.7	7.3	7.5	7.4	7.0	9.5	3.4	8.2	7.2	5.3	6.6	7.0	5 - 9
2	Turbidity	NTU	62.0	152.0	26.6	7.2	85.0	27.0	76.0	60.0	3.4	332.0	28.4	90.0	1200	9.1	46.2	–
3	Electrical Conductivity	$\mu S.cm^{-1}$	558	163	331	1007	587	456	569	415	4100	996	502	459	173.4	130	8230	–
4	DO	mg/l	1.88	9.12	1.74	2.49	3.72	7.01	1.50	0.51	8.9	5.61	1.85	1.12	1.73	8.21	8.91	–
5	BOD_5	mg/l	132.5	14.5	28.7	35.0	19.5	8.5	46.2	63	27.5	17.5	12.5	30.0	171.0	6.0	6.7	50
6	COD	mg/l	472.0	24.0	52.0	109.2	52.4	28.0	80.0	420.0	88.0	48	32.0	96.0	480.0	32.0	72.0	100
7	SS	mg/l	67.0	89.0	34.0	6.0	6.0	22.0	53.0	53.0	1.0	145	21.0	80	1045	7	21	100
8	Total Nitrogen	mg/l	1.80	8.50	1.10	1.20	3.50	13.60	10.60	3.50	1.70	1.75	1.70	2.65	3.00	1.75	2.75	60
9	Amonia Nitrogen	mg/l	1.37	0.84	0.83	1.0	2.25	11.16	7.50	1.32	0.47	0.75	0.95	0.47	1.37	0.55	<0.01	1
10	Total Phosphorus	mg/l	0.67	0.60	0.36	0.21	0.33	0.41	0.99	0.93	0.04	0.37	0.41	0.49	6.94	0.26	0.04	6
11	Iron	mg/l	2.50	11.80	0.03	0.86	1.18	3.24	3.16	1.46	0.82	31.00	1.48	0.92	0.80	0.50	0.30	5
12	Manganese	mg/l	0.59	0.77	<0.01	0.01	0.21	0.09	0.30	0.06	0.02	1.46	0.05	0.05	0.04	0.09	0.01	1
13	Arsenic	mg/l	0.0011	0.0004	0.0004	0.0021	0.0050	00029	0.0021	0.0036	0.0013	0.0014	0.0019	0.0045	0.0011	0.0046	0.0008	0.1
14	Cadimium	mg/l	0.00035	<0.0001	0.0025	0.00040	0.0012	0.0001	0.0012	<0.0001	0.0005	0.0005	0.0006	<0.0001	0.0002	0.0004	0.0003	0.02
15	Chromium	mg/l	0.0084	0.0080	0.0025	0.0448	0.0060	0.0072	0.0060	0.0099	0.0017	0.0016	0.0060	0.0016	0.0023	28.75	0.0026	–
16	Hexavalent Chromium	mg/l	0.0080	0.0080	0.0020	0.0448	0.0060	0.0050	0.0060	0.0072	0.0017	0.0016	0.0060	0.0014	0.0020	28.75	0.0022	0.1
17	Copper	mg/l	0.0370	0.0014	0.010	0.5040	0.0010	0.0035	0.0130	0.008	5.45	0.410	0.040	0.0150	0.033	0.260	0.039	1
18	Cyanide	mg/l	0.012	0.001	0.0051	<0.001	0.001	0.001	0.015	0.050	0.003	<0.001	0.002	0.010	0.002	0.002	0.003	0.1
19	Lead	mg/l	0.0073	0.0046	0.0051	0.0043	0.0085	0.010	0.0076	0.0048	0.0560	0.0042	0.0506	0.0051	0.012	0.0109	0.230	0.5
20	Total Mercury	mg/l	$1.5x10^{-4}$	$1.3 x10^{-4}$	$1.9 x10^{-4}$	$1.9 x10^{-4}$	$2.6 x10^{-4}$	$2.9 x10^{-4}$	$1.4 x10^{-4}$	$1.4 x10^{-4}$	$2.5 x10^{-4}$	$1.5 x10^{-4}$	$1.9x10^{-4}$	$1.4 x10^{-4}$	$7.4 x10^{-4}$	$2 x10^{-4}$	$9.0 x10^{-4}$	0.005
21	Fluoride	mg/l	1.75	1.07	1.04	1.70	4.65	2.20	2.70	0.77	0.95	1.10	1.80	2.10	0.05	1.25	0.92	2
22	Chloride	mg/l	40.8	12.50	19.50	42.50	51.40	30.2	63.90	67.50	284.00	51.50	21.30	24.80	17.80	17.50	248.50	–
23	Fecal Coliform	MPN/100ml	870	1100	60	0	2000	100	110	210	–	0	90	160	190	60	400	–
24	Total Coliform	MPN/100ml	1100	2000	120	0	4700	280	380	440	–	20	120	360	330	190	1250	–
	Characteristics		Hanoi beer factory	Sài Dong industrial zone	Clear greenish	Clear	–	–	Cao Sa La industrial zone	–	Viet Tiep Lock Co., treatment plant	Duc Giang chemical factory	Cau Dien general paint	Vinamilk company	Bac Song Hong beer factory	X-army	Dong Anh Amian cover board factory	–

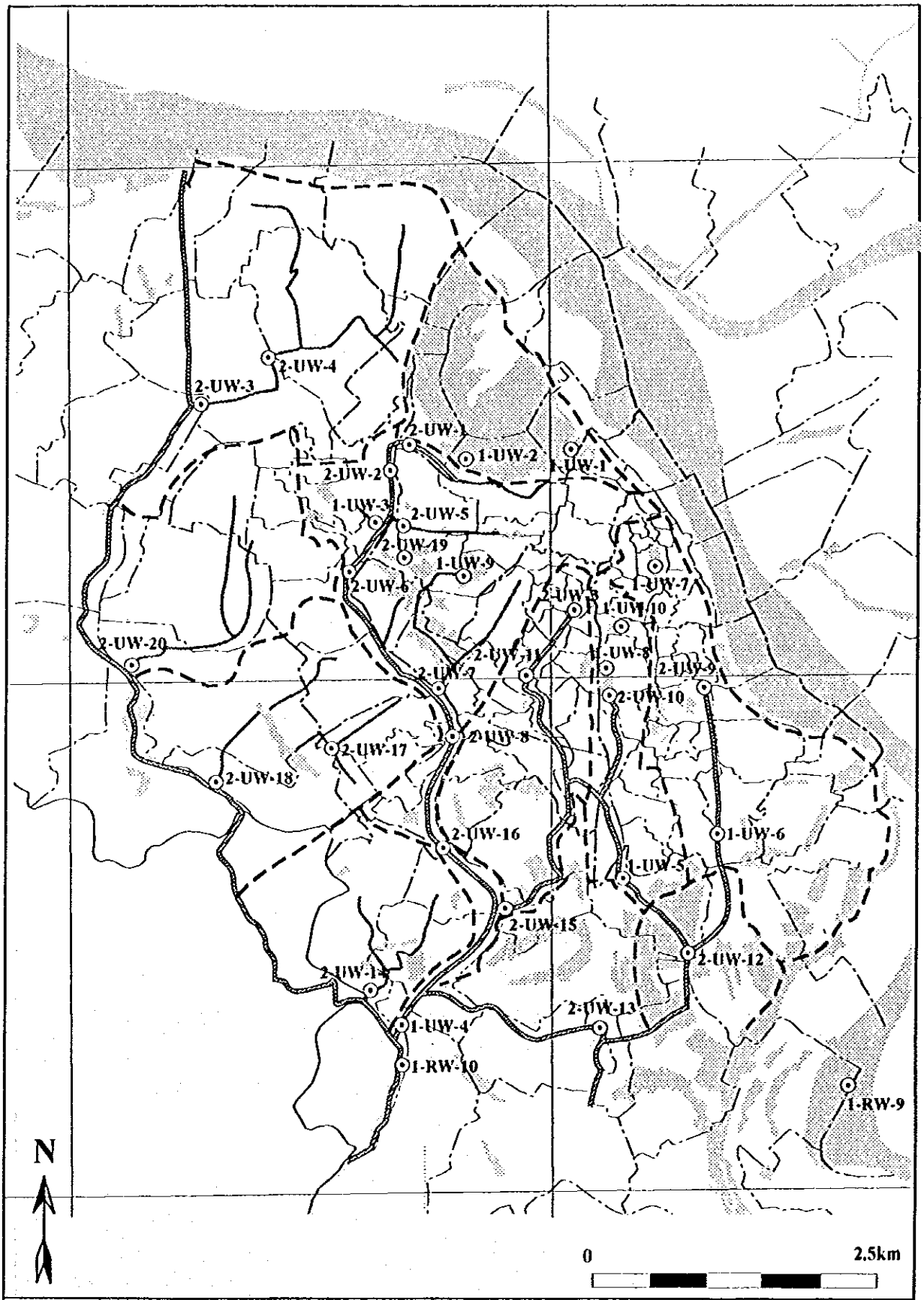

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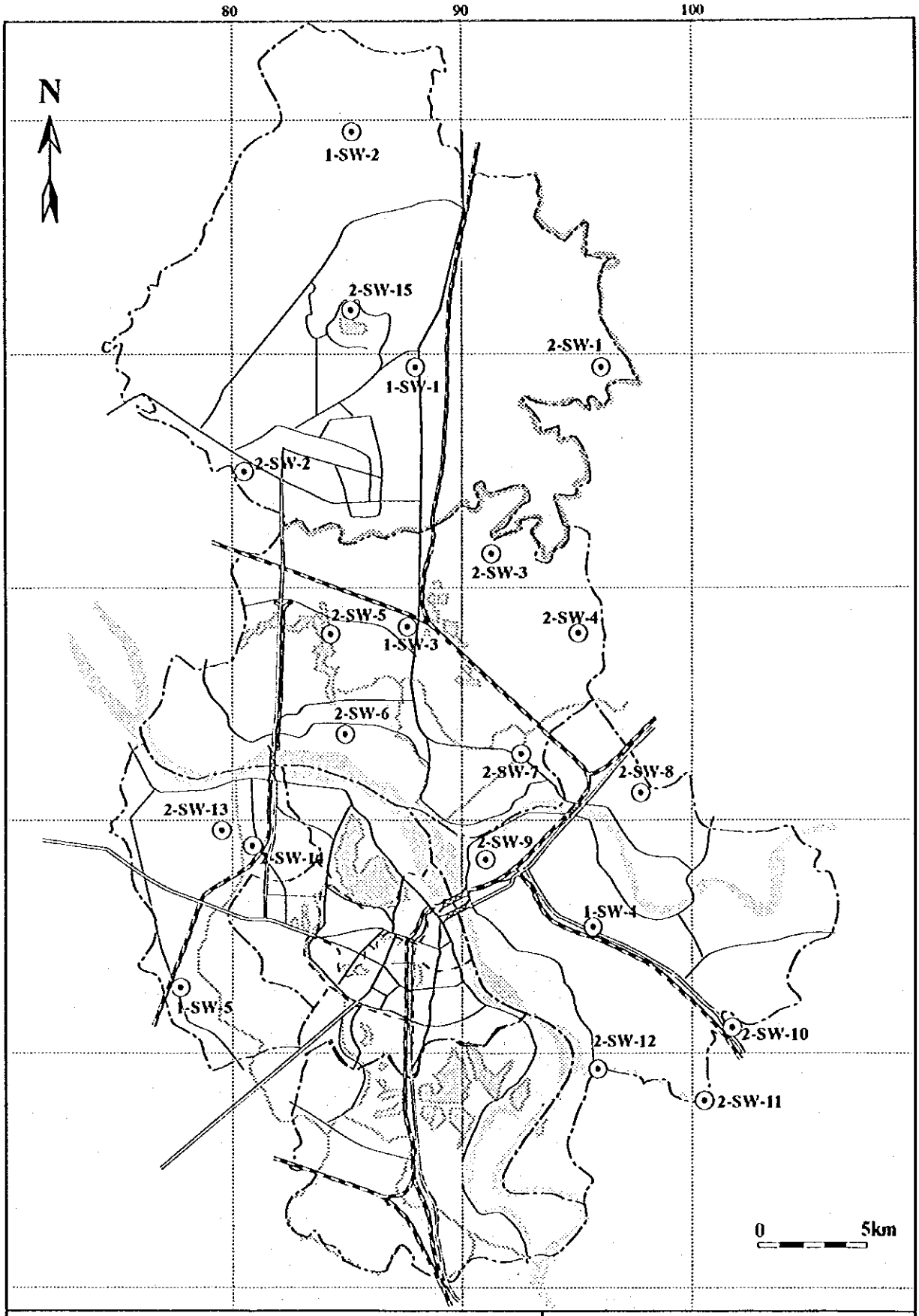
Figure A.1

Sampling Pioints in Urban Area



THE STUDY ON ENVIRONMENTAL IMPROVEMENT FOR HANOI CITY	Figure A.2 Sampling Points in Rural Area
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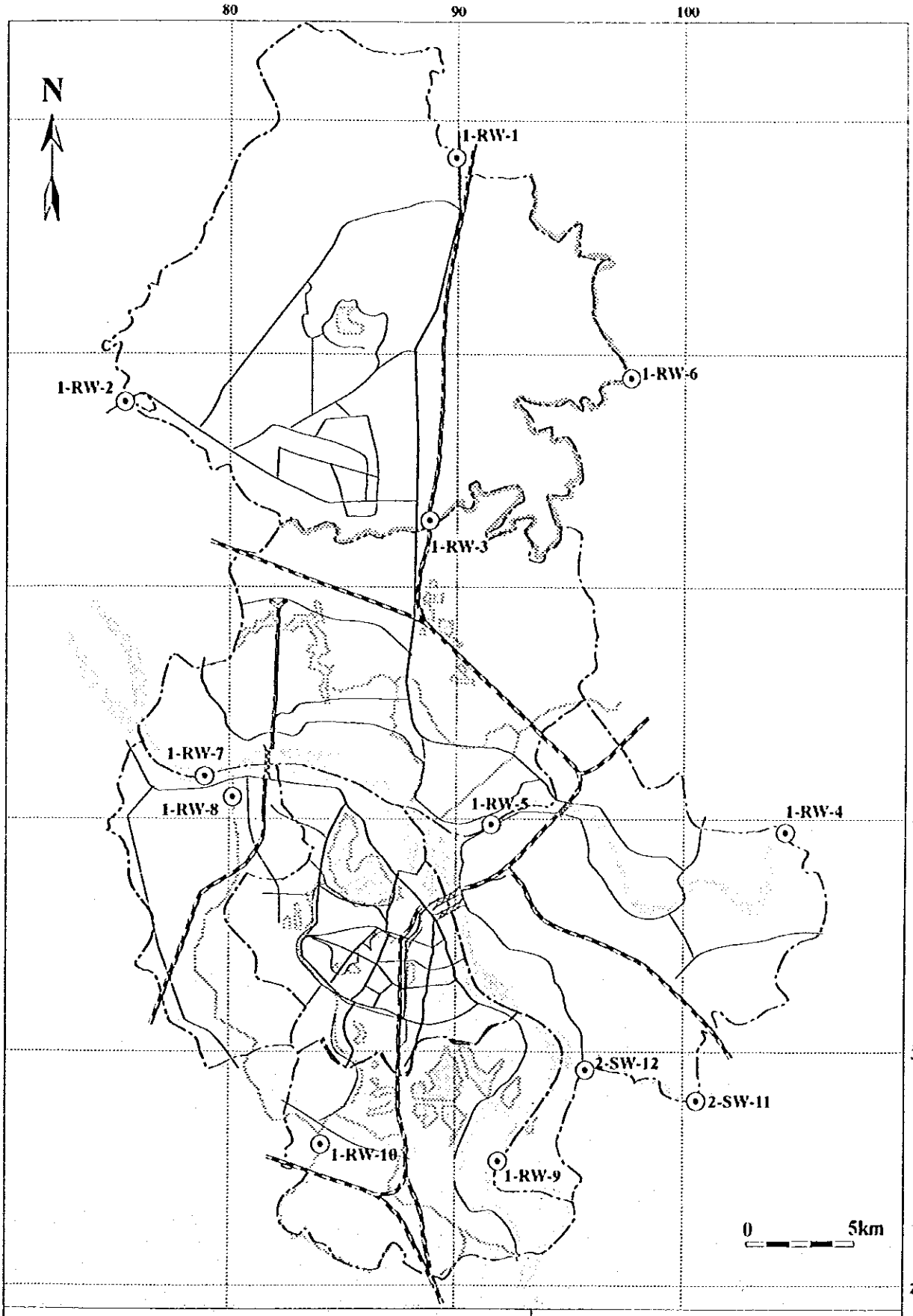

THE STUDY ON ENVIRONMENTAL IMPROVEMENT FOR HANOI CITY

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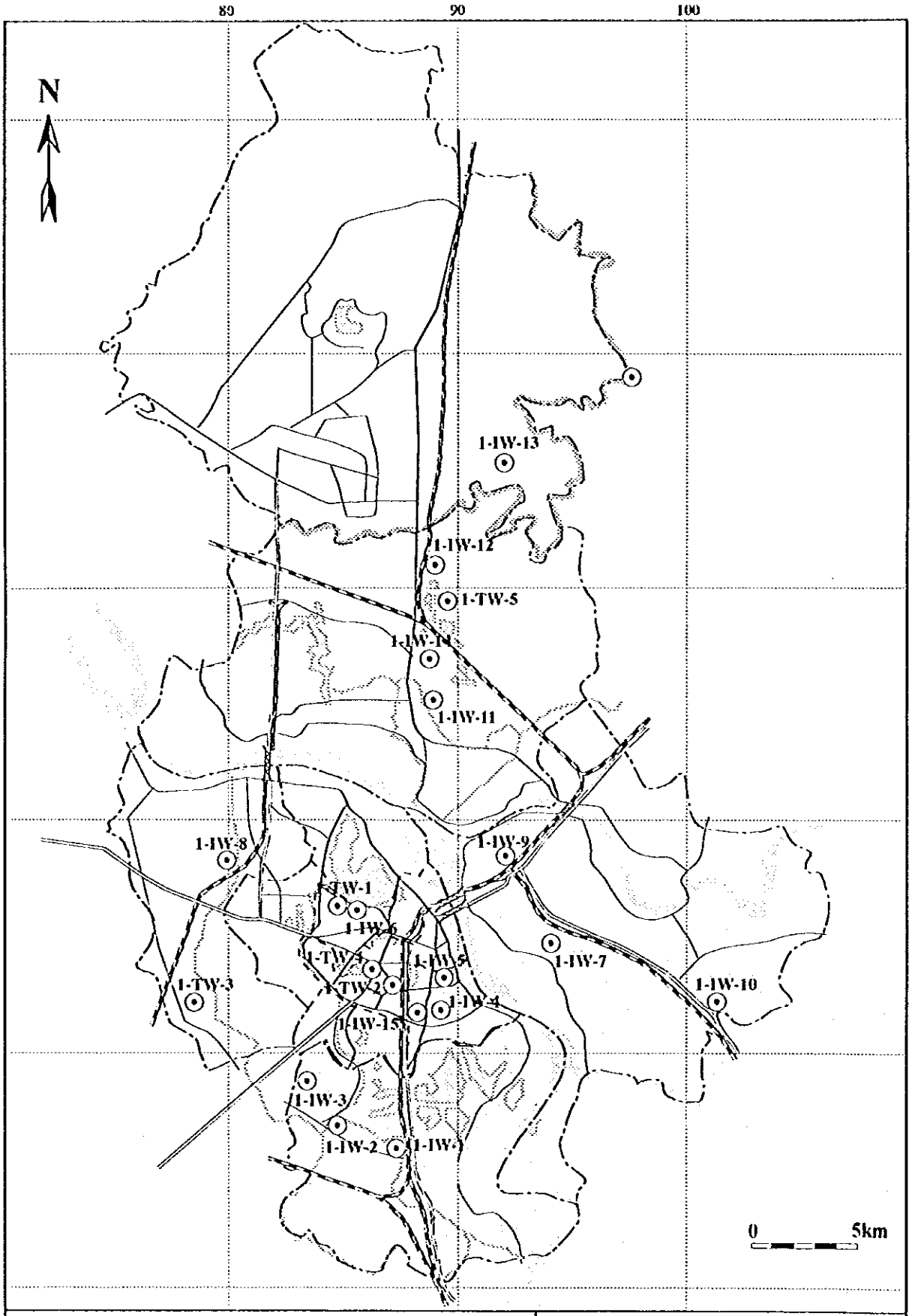
Figure A.3

Sampling Points in Major Big River



THE STUDY ON ENVIRONMENTAL IMPROVEMENT FOR HANOI CITY

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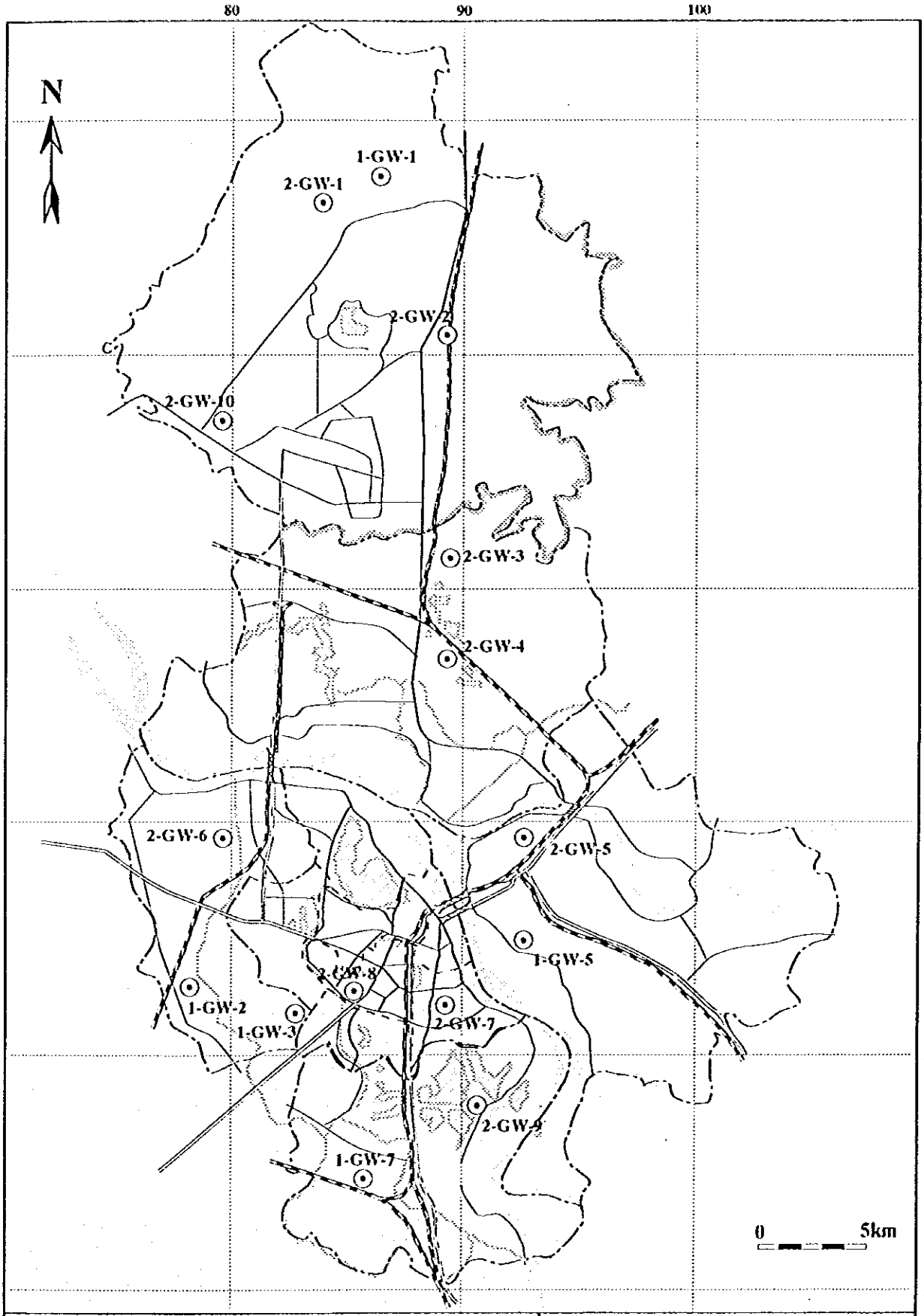
Figure A.4

Sampling Points in Industrial Factories and Wastewater Treatment Plants



THE STUDY ON ENVIRONMENTAL IMPROVEMENT FOR HANOI CITY	Figure A.5 Sampling Points in Groundwater
JAPAN INTERNATIONAL COOPERATION AGENCY	

B. Air Quality Survey

Figure B.1 Location of sampling points for the Air Quality survey

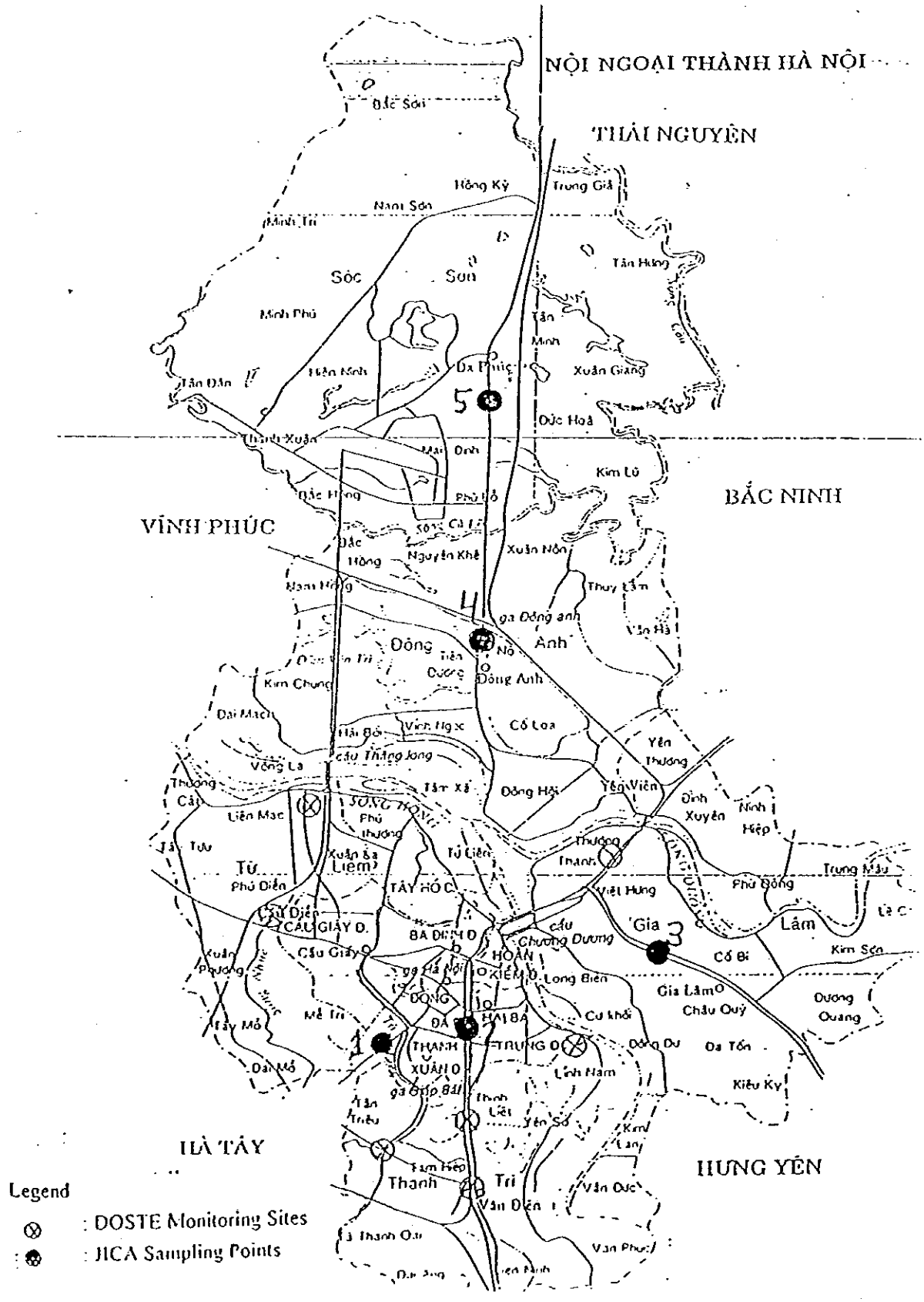


Table B.1 Recorded meteorological parameters during the air quality survey in Thuong Dinh
(10^{th} october - 16^{th} october 1998)

Time	Parameters	10^{th}. october	11^{th}. october	12^{th}. october	13^{th}. october	14^{th}. october	15^{th}. october	16^{th}. october
6.00-8.00	T°C	29	30	28	27	28	27,5	28,5
	Humidity(%)	70	70	65	75	60	78	80
	Wind velocity(m/s)	1-2	1-2	1-3	1-2	1-2	1-2	1-2
	Wind direction	East	East	East	East- Notrh	East	East	East
10.00-12.00	T°C	33	34	30	29	32	32,2	34
	Humidity(%)	60	60	60	70	60	65	60
	Wind velocity(m/s)	1-2	1-2	1-2	1-3	1-2	1-2	1-2
	Wind direction	East	East	East	East- North	East	East	East
14.00-16.00	T°C	34	34	30,5	33	34	32,5	35
	Humidity(%)	50	50	65	65	55	65	64
	Wind velocity(m/s)	1-2	1-2	1-3	1-3	1-2	2-4	1-2
	Wind direction	East	East	East	East- North	East	East	East
18.00-20.00	T°C	32	33	30	28	34	32	34
	Humidity(%)	55	55	65	60	50	65	55
	Wind velocity(m/s)	1-2	1-2	1-3	2-4	1-2	2-4	1-2
	Wind direction	East	East	East	East- North	East	East	East
22.00-24.00	T°C	28	30	29	27	32	30	32
	Humidity(%)	65	65	70	80	55	70	60
	Wind velocity(m/s)	1-2	1-2	1-3	2-4	1-2	1-3	1-2
	Wind direction	East	East	East	East- North	East	East	East
2.00-4.00	T°C	28	29	29	25	30	29	31
	Humidity(%)	70	70	70	80	65	65	65
	Wind velocity(m/s)	1-2	1-2	1-2	1-3	1-2	1-2	1-2
	Wind direction	East	East	East	East- North	East	East	East

Table B.2 Recorded meteorological parameters during the air quality survey in Bach Mai area
(10^{th} october - 16^{th} october .1998)

Time	Parameters	10^{th}. october	11^{th}. october	12^{th}. october	13^{th}. october	14^{th}. october	15^{th}. october	16^{th}. october
6.00-8.00	T^0C	29	30	28	27	27,5	27	28
	Humidity(%)	70	70	65	75	60	78	70
	Wind velocity(m/s)	1-2	1-2	1-3	1-3	1-2	1-2	1-2
	Wind direction	East	East	East	East- North	East	East	East
10.00-12.00	T^0C	33	33,5	31	29	32,5	32,5	34
	Humidity(%)	62	60	60	69	60	65	60
	Wind velocity(m/s)	1-2	1-2	1-3	1-2	1-2	1-2	1-2
	Wind direction	East	East	East	East-North	East	East	East
14.00-16.00	T^0C	34,5	34	31	34	34	33	35
	Humidity(%)	52	50	65	65	54	64	55
	Wind velocity(m/s)	1-2	1-3	1-2	1-3	1-2	1-3	1-2
	Wind direction	East	East	East	East-North	East	East	East
18.00-20.00	T^0C	31	33	31	28	34	32	33,5
	Humidity(%)	56	57	65	60	52	64	57
	Wind velocity(m/s)	1-2	1-2	1-2	1-2	1-2	1-2	1-3
	Wind direction	East	East	East	East- North	East	East	East
22.00-24.00	T^0C	28,5	29	29	27	31	29	31
	Humidity(%)	65	65	69	78	57	70	60
	Wind velotocy(m/s)	1-2	1-2	1-2	1-2	1-2	1-2	1-2
	Wind direction	East	East	East	East - North	East	East	East
2.00-4.00	T^0C	28	29	29	26	29	29	30
	Humidity(%)	70	70	70	80	65	64	66
	Wind velocity(m/s)	1-3	1-2	1-2	1-3	1-2	1-3	1-2
	Wind direction	East	East	East	East - North	East	East	East

Table B.3 Recorded meteorological parameters during the air quality survey in Sai Dong area
(10^{th} october - 16^{th} october 1998)

Time	Parameters	10^{th}. october	11^{th}. october	12^{th}. october	13^{th}. october	14^{th}. october	15^{th}. october	16^{th}. october
6.00-8.00	T^0C	29	29	27	27	27	26	27
	Humidity(%)	72	70	66	76	62	78	70
	Wind velocity(m/s)	1-2	1-2	1-2	1-3	1-2	1-2	1-2
	Wind direction	East	East	East	East-North	East	East	East
10.00-12.00	T^0C	32	33	30	28	32	32	33
	Humidity(%)	64	62	61	70	66	66	62
	Wind velocity(m/s)	1-2	1-2	1-2	1-2	1-2	1-2	1-2
	Wind direction	East	East	East	East-North	East	East	East
14.00-16.00	T^0C	34	33	30	33.5	34	33	34
	Humidity(%)	55	54	62	67	57	65	57
	Wind velocity(m/s)	1-2	1-2	1-2	1-3	1-3	1-3	1-2
	Wind direction	East	East	East	East-North	East	East	East
18.00-20.00	T^0C	31	32	29	28	34	32	32
	Humidity(%)	57	58	65	60	55	64	58
	Wind velocity(m/s)	1-3	1-2	1-2	1-2	1-3	1-2	1-3
	Wind direction	East	East	East	East-North	East	East	East
22.00-24.00	T^0C	28	28	28	27	31	30	30
	Humidity(%)	66	66	69	78	60	61	62
	Wind velocity(m/s)	1-2	1-2	1-2	1-2	1-2	1-2	1-2
	Wind direction	East	East	East	East-North	East	East	East
2.00-4.00	T^0C	27	27	28	25,5	28	28	29
	Humidity(%)	70	71	72	81	65	67	68
	Wind velocity(m/s)	1-3	1-2	1-2	1-3	1-2	1-3	1-3
	Wind direction	East	East	East	East -North	East	East	East

Table B.4 Recorded meteorological parameters during the air quality survey in Dong Anh area
(10^{th} october - 16^{th} october .1998)

Time	Parameters	10^{th}. october	11^{th}. october	12^{th}. october	13^{th}. october	14^{th}. october	15^{th}. october	16^{th}. october
6.00-8.00	T^0C	29	29	27,5	27	27	26,5	27,5
	Humidity(%)	73	74	70	81	71	80	72
	Wind velocity(m/s)	1-2	1-2	1-3	1-2	1-2	1-2	1-2
	Wind direction	East	East	East	East-North	East	East	East
10.00-12.00	T^0C	34,5	33	31	34	33	33	32
	Humidity(%)	63	60	63	64	60	66	59
	Wind velocity(m/s)	1-2	1-3	1-2	1-2	1-3	1-2	1-2
	Wind direction	East	East	East	East-North	East	East	East
14.00-16.00	T^0C	34	33	31	32	33	31	34
	Humidity(%)	58	55	68	64	56	64	55
	Wind velocity(m/s)	1-2	1-2	1-3	1-2	1-2	1-3	1-3
	Wind direction	East	East	East	East-North	East	East	East
18.00-20.00	T^0C	31	31	29	29	32	30	32
	Humidity(%)	58	59	68	64	59	66	58
	Wind velocity(m/s)	1-3	1-3	1-2	1-3	1-2	1-2	1-2
	Wind direction	East	East	East	East-North	East	East	East
22.00-24.00	T^0C	26,5	28	28	26	30	29	31
	Humidity(%)	70	69	68	77	65	68	64
	Wind velocity(m/s)	1-2	1-2	1-3	1-2	1-2	1-2	1-2
	Wind direction	East	East	East	East-North	East	East	East
2.00-4.00	T^0C	26	28	27	25	28	27	29
	Humidity(%)	74	72	70	79	68	70	68
	Wind velocity(m/s)	1-2	1-2	1-2	1-3	1-2	1-2	1-2
	Wind direction	East	East	East	East-North	East	East	East

Table B.5 Recorded meteorological parameters during the air quality survey in Soc Son area
(10^{th} october - 16^{th} october 1998)

Time	Parameters	10^{th}. october	11^{th}. october	12^{th}. october	13^{th}. october	14^{th}. october	15^{th}. october	16^{th}. october
6.00-8.00	T°C	28	29	27	27	27	26	27
	Humidity(%)	73	75	72	83	70	82	74
	Wind velocity(m/s)	1-2	1-3	1-2	1-2	1-2	1-2	1-3
	Wind direction	East	East	East	East - North	East	East	East
10.00-12.00	T°C	35	32	31	33	32	32	32
	Humidity(%)	60	62	64	66	61	68	60
	Wind velocity(m/s)	1-3	1-2	1-3	1-2	1-2	1-3	1-2
	Wind direction	East	East	East	East- North	East	East	East
14.00-16.00	T°C	33	32	30	32	32	31	33
	Humidity(%)	55	57	65	64	58	65	57
	1-3	1-3	1-2	1-3	1-2	1-2	1-3	1-2
	Wind direction	East	East	East	East- North	East	East	East
18.00-20.00	T°C	30	31	29	27	31	30	32
	Humidity(%)	57	58	67	62	60	68	58
	Wind velocity(m/s)	1-3	1-3	1-2	1-2	1-3	1-2	1-3
	Wind direction	East	East	East	East- North	East	East	East
22.00-24.00	T°C	26	28	27	25	30	28	30
	Humidity(%)	70	70	70	80	65	70	65
	Wind velocity(m/s)	1-2	1-2	1-3	1-2	1-2	1-2	1-2
	Wind direction	East	East	East	East- North	East	East	East
2.00-4.00	T°C	25	27	27	24	27	26	29
	Humidity(%)	75	74	72	82	68	72	70
	Wind velocity(m/s)	1-2	1-2	1-2	1-3	1-2	1-2	1-2
	Wind direction	East	East	East	East- North	East	East	East

Table B.6 Air sampling results for NO_2 (mg/m^3)

Sample	Date	Exposure (days)	Thuong Dinh	Bach Mai	Sai Dong	Dong Anh	Soc Son
1	Oct. 10	1	0.064	0.086	0.038	0.029	0.041
2a	Oct. 10-11	2	0.054	0.064	0.026	0.021	0.032
2b	Oct. 10-11	2	0.053	0.063	0.026	0.022	0.033
3	Oct. 10-13	4	0.049	0.054	0.026	0.018	0.028
4	Oct. 13	1	0.073	0.078	0.039	0.027	0.036
5	Oct. 13-14	2	0.060	0.061	0.031	0.021	0.033
6a	Oct. 13-16	4	0.047	0.050	0.023	0.020	0.026
6b	Oct.13-16	4	0.046	0.049	0.022	0.019	0.026
7	Oct. 10-16	7	0.042	0.044	0.019	0.019	0.025

Samples 2a, 2b and 6a, 6b are duplicates

Vietnam air quality standard for NO_2 : 0.4 mg/m^3 for 1 hour, 0.1 mg/m^3 for 24 hours

Table B.7 Air sampling results for SO_2 (mg/m^3)

Sample	Date	Exposure (days)	Thuong Dinh	Bach Mai	Sai Dong	Dong Anh	Soc Son
1	Oct. 10-16	7	0.047	0.058	0.059	0.027	0.030
2	Oct. 10-16	7	0.049	0.048	0.062	0.018	0.026
3	Oct. 10-16	7	0.053	0.053	0.054	0.024	0.021
4	Oct. 10-16	7	0.045	0.074	0.054	0.051	0.038
5	Oct. 10-16	7	0.049	0.053	0.065	0.064	0.019
6	Oct. 10-16	7	0.067	0.083	0.087	0.043	0.047
7	Oct. 10-16	7	0.049	0.055	0.095	0.040	0.032
Minimum			0.045	0.048	0.054	0.018	0.019
Maximum			0.067	0.083	0.095	0.064	0.047
Average			0.052	0.061	0.068	0.038	0.031

Vietnam air quality standard for SO_2 : 0.5 mg/m^3 for 1 hour, 0.3 mg/m^3 for 24 hours

C. Noise, Vibration and Traffic Volume Survey

Table C-1 The Result of Noise Survey at Thuong Dinh

(L50)

	Oct.10, 1998	Oct.11, 1998	Oct.12, 1998	Oct.12, 1998	Oct.14, 1998	Oct.15, 1998	Oct.16, 1998	Average
6.00-8.00	71.5	73.8	74.6	77.5	76.4	72.4	78.4	74.9
8.00-10.00	75.7	71.6	73.7	78.6	79.0	77.5	72.6	75.5
10.00-12.00	77.4	74.1	73.4	82.5	81.5	68.7	75.5	76.2
12.00-14.00	73.3	74.6	76.5	77.6	75.7	71.7	75.3	75.0
14.00-16.00	74.2	72.7	75.2	77.4	75.4	74.6	74.6	74.9
16.00-18.00	71.8	73.2	74.6	73.6	73.6	77.5	76.5	74.4
18.00-20.00	71.4	77.8	71.7	72.5	74.5	73.4	76.3	73.9
20.00-22.00	66.9	58.5	63.9	68.7	63.7	68.5	67.5	65.4
22.00-24.00	54.2	49.7	59.9	65.7	58.9	66.7	59.9	59.3
24.00-2.00	51.1	59.0	49.0	56.8	51.0	60.0	56.9	54.8
2.00-4.00	56.0	52.1	56.8	66.7	60.9	58.9	57.7	58.4
4.00-6.00	66.9	69.7	70.4	70.0	68.7	63.9	66.6	68.0

Table C-2 The Result of Noise Survey at Bach Mai

(L50)

	Oct.10, 1998	Oct.11, 1998	Oct.12, 1998	Oct.12, 1998	Oct.14, 1998	Oct.15, 1998	Oct.16, 1998	Average
6.00-8.00	73.3	73.1	74.9	72.8	80.5	74.9	76.9	75.2
8.00-10.00	69.4	72.2	73.2	74.3	74.8	74.5	71.1	72.8
10.00-12.00	70.7	71.0	74.4	72.5	73.2	72.8	71.7	72.3
12.00-14.00	70.1	71.6	73.8	75.4	74.5	77.2	73.2	73.7
14.00-16.00	67.3	69.2	75.3	70.5	80.0	74.6	73.7	72.9
16.00-18.00	71.3	75.5	73.0	69.2	95.0	88.6	72.5	77.9
18.00-20.00	70.0	70.8	70.3	67.7	73.1	74.0	67.4	70.5
20.00-22.00	64.5	63.0	55.2	65.2	60.7	72.5	67.3	64.1
22.00-24.00	56.7	54.7	53.7	57.8	59.2	59.7	58.2	57.1
24.00-2.00	58.6	56.4	61.6	58.8	66.0	57.4	57.5	59.5
2.00-4.00	65.6	66.5	69.2	62.3	68.6	60.5	64.2	65.3
4.00-6.00	73.5	72.5	72.8	68.6	69.5	68.1	70.2	70.7

Table C-3 The Result of Noise Survey at Sai Dong

(L50)

	Oct.10, 1998	Oct.11, 1998	Oct.12, 1998	Oct.12, 1998	Oct.14, 1998	Oct.15, 1998	Oct.16, 1998	Average
6.00-8.00	86.2	73.4	84.1	78.3	80	76.3	73.9	78.9
8.00-10.00	83.1	78.4	78.3	74.2	77.5	84.9	85.4	80.3
10.00-12.00	70.6	70.2	72.5	70.6	72.2	77.6	80.2	73.4
12.00-14.00	68.4	64.6	70.5	69.8	73.7	69.5	73.2	70.0
14.00-16.00	70.7	78.1	73.3	73.5	74.2	72.5	74.5	73.8
16.00-18.00	72.1	70.2	76.4	76.4	78.5	76.8	80	75.8
18.00-20.00	74.4	62.6	66.5	66.2	67.5	70.2	72.2	68.5
20.00-22.00	66.9	61.1	57.6	62	62.4	65.5	67.9	63.3
22.00-24.00	64.2	58.5	50.1	59.8	61.4	65.1	65.6	60.7
24.00-2.00	54.7	56.2	48	48.2	52.1	53.4	54.3	52.4
2.00-4.00	49.1	51	47.2	64.2	56.3	56.2	60.7	55.0
4.00-6.00	62.3	60.4	61.6	67.6	65.7	66.2	66.5	64.3

Table C-4 The Result of Noise Survey at Donh Anh

(L50)

	Oct.10, 1998	Oct.11, 1998	Oct.12, 1998	Oct.12, 1998	Oct.14, 1998	Oct.15, 1998	Oct.16, 1998	Average
6.00-8.00	66.8	65.9	73.9	73.5	69.7	73.7	72.5	70.9
8.00-10.00	68.0	67.0	71.0	71.5	66.2	66.9	73.4	69.1
10.00-12.00	71.5	74.6	70.5	77.2	65.9	67.4	67.1	70.6
12.00-14.00	64.0	66.0	66.2	68.6	60.5	61.1	62.0	64.1
14.00-16.00	71.0	65.0	75.8	67.8	74.0	76.0	74.2	72.0
16.00-18.00	70.8	73.0	76.2	67.0	75.5	76.1	68.8	72.5
18.00-20.00	58.0	58.2	67.2	55.9	68.6	67.6	63.7	62.7
20.00-22.00	53.1	54.0	54.7	52.0	66.6	68.5	57.0	58.0
22.00-24.00	48.0	50.0	57.1	53.0	65.9	59.7	57.2	55.8
24.00-2.00	47.5	45.5	46.2	50.9	51.9	50.9	48.3	48.7
2.00-4.00	46.6	47.0	44.0	49.5	49.7	47.1	42.1	46.6
4.00-6.00	65.0	65.9	67.3	55.6	69.5	69.5	55.9	64.1

Table C-5 The Result of Noise Survey at Soc Son

(L50)

	Oct.10, 1998	Oct.11, 1998	Oct.12, 1998	Oct.12, 1998	Oct.14, 1998	Oct.15, 1998	Oct.16, 1998	Average
6.00-8.00	66.0	69.5	75.4	73.2	73.3	74.3	72.4	72.0
8.00-10.00	66.0	68.5	72.5	71.4	66.5	67.6	72.5	69.3
10.00-12.00	66.0	68.8	72.2	74.4	70.2	67.5	69.5	69.8
12.00-14.00	70.5	67.3	67.3	68.5	59.7	61.6	70.4	66.5
14.00-16.00	68.7	68.5	77.2	70.4	74.2	75.3	66.4	71.5
16.00-18.00	67.5	74.4	77.3	68.5	68.5	75.4	65.5	71.0
18.00-20.00	57.8	55.8	56.0	55.8	53.8	59.7	52.8	56.0
20.00-22.00	50.0	48.9	50.4	48.8	50.8	48.9	48.8	49.5
22.00-24.00	48.6	48.7	48.8	47.9	47.7	46.2	47.9	48.0
24.00-2.00	47.9	47.0	46.8	46.9	46.0	46.4	46.0	46.7
2.00-4.00	46.9	46.9	47.0	47.0	46.9	48.9	47.9	47.4
4.00-6.00	67.5	65.5	68.6	67.5	63.6	66.5	68.4	66.8

Table C-6 Vibration Level in a Whole Day

(Unit: dB)

Time Zone	Daytime (8:00h-19:00h)			Nighttime (19:00h-8:00h)		
Axis	Z	X	Y	Z	X	Y
Thuong Dinh	82.7	82.4	83.7	73.5	73.7	73.0
Bach Mai	85.2	83.4	84.2	76.3	76.1	76.1
Sai Dong	62.0	71.9	71.9	61.9	67.8	69.0
Dong Anh	64.6	61.8	61.6	59.9	59.6	59.6
Soc Son	62.4	59.6	59.7	54.9	59.0	59.4

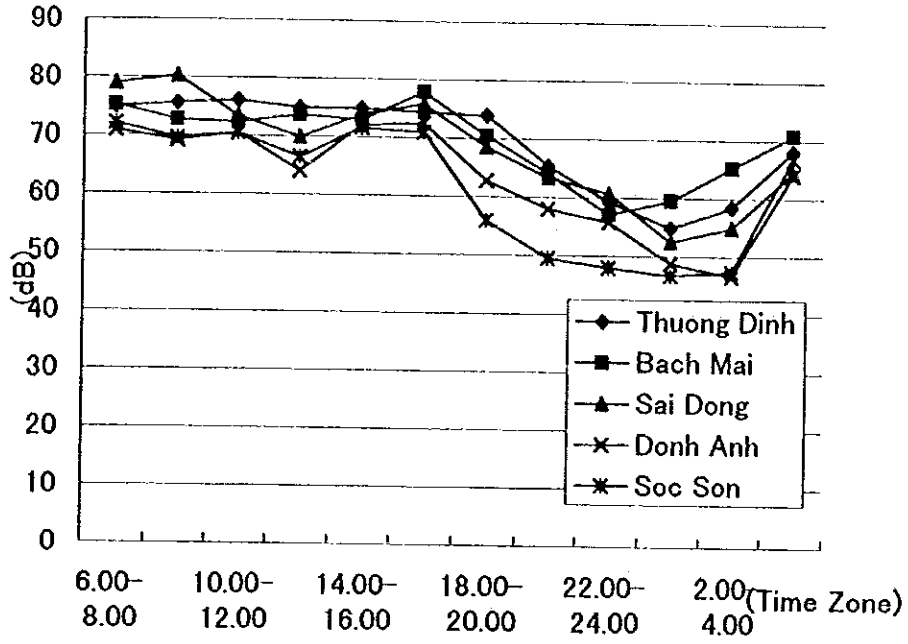


Figure C-1 Noise Level in a Whole Day

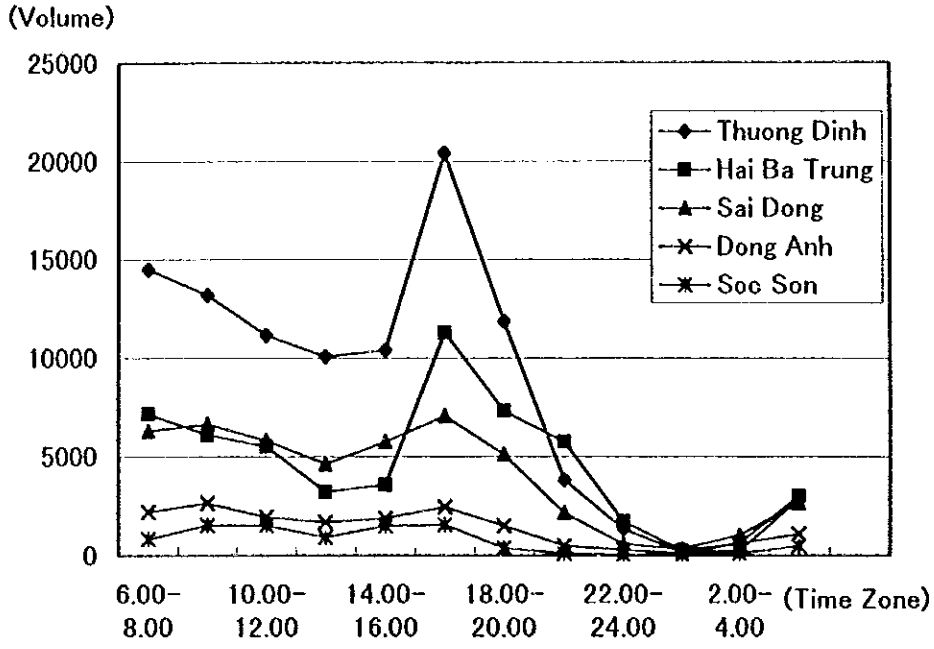


Figure C-2 Traffic Volume in Hanoi

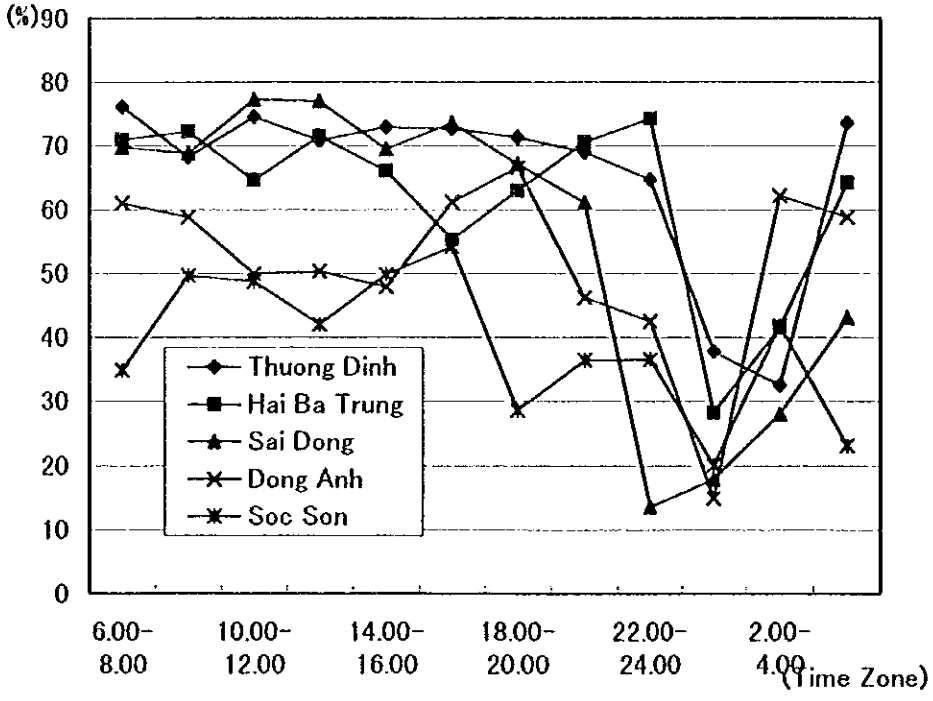


Figure C-3 Percentage of Motorbikes in Traffic

D. Environmental Impact Assessment at Nam Son

Table D.1 Surface water quality at the project area at 23.10.1998

Parameter	Unit	Analytical method	Analytical Result	
			SW1	SW2
1. Temperature	°C	2550 B	26.5	27.0
2. pH		4500-H^+B	6.72	6.85
3. Chloride	mg/l	4500 -Cl^-B	7.10	31.95
4. DO	mg/l	4500-O G	9.92	6.40
5. Suspended Solids	mg/l	2540 D	64.8	52.4
6. COD	mg/l O_2	5220 B	37.3	32.0
7. BOD_5	mg/l O_2	5210 B	16.67	12.95
8. Total N	mg/l	4500-N org. B	2.60	2.50
9. Sulfate (SO_4)	mg/l	4500-SO_4^{--} E	7.6	28.4
10. Cyanide CN-	mg/l	4500 CN^- E	0.005	0.001
11. Total Coliform	MPN/100 ml	9222 B	46 x 10^2	24 x 10^2
12. Arsenic As	mg/l	3030 E +3500 - As B	0.015	0.012
13. Cadmium Cd	mg/l	3030 E +3500 - Cd B	0.0014	0.0031
14. Tin Sn	mg/l	3030 E + 3500 - SnB	< 0.001	< 0.001
15. Chromium Cr	mg/l	3030 E +3500 -Cr B	0.042	0.035
16. Copper Cu	mg/l	3030 E +3500 - Co B	0.001	0.001
17. Lead Pb	mg/l	3030 E +3500 -Pb B	0.003	0.001
18. Mercury Hg	mg/l	3030 E +3500 - Hg B	0.002	0.002
19. Nickel Ni	mg/l	3030 E +3500 -Ni B	0.037	0.030
20. Zinc Zn	mg/l	3030 E +3500 -Zn B	0.033	0.010

Note: SW 1: Sample of Phu thinh lake at 23.10.1998
SW 2: Sample of Phu xuan channel at 23.10.1998
Analytical method : Standard methods for the Examination of Water and Wastewater of American Water Works Association 1992

Table D.2 Surface water quality at the project area at 1.1998
(Data source: From EPC)

Parameter	Unit	Analytical Result					
		SW3	SW4	SW5	SW6	SW7	SW8
Temperature	°C	16.1	17.1	18.2	17.5	20.5	18.0
pH		7.94	7.40	7.50	7.55	7.30	7.20
Chloride	mg/l	0.2	0.3	0.2	0.3	1.5	0.5
DO	mg/l	7.65	8.21	7.80	6.50	8.10	7.50
SS	mg/l	37	89	120	130	20	45
COD	mg/l O_2	41	52	32	68	12	32
BOD_5	mg/l O_2	32	31	15	42	5	15
Sulfate SO_4	mg/l	9.5	34.1	10.5	7.5	15.0	5.0
Total Coliform	MPN/100 ml	12.10^3	3.10^4	5.10^3	5.10^4	2.10^2	5.10^2
Zinc Zn	mg/l	0.21	0.15	0.10	0.25	0.15	0.15
Phenol	mg/l	0.025	0.031	0.020	0.050	0.020	0.020
Conductivity	µS/cm	60	180	120	50	50	50
NO_2^-	mg/l	0.05	0.05	0.05	0.10	0.05	0.10
NO_3^-	mg/l	3.40	4.80	2.50	4.50	1.20	1.50
PO_4^{---}	mg/l	0.32	0.45	0.30	0.50	0.10	0.20
Turbidity	NTU	31	123	150	50	10	18
Iron Fe	mg/l	1.5	1.6	1.2	1.2	0.5	0.8

Note: SW 3: Sample of Phu thinh lake (Xuan thinh lake) at 1.1998

SW 4: Pond nearby the Phu thinh lake at 1.1998

SW 5: Stream in the project area at 1.1998

SW 6: Sample of Xuan bang lake at 1.1998

SW 7: Sample of Cong river at 1.1998

SW 8: Sample of lake next to Thanh giong Memorium temple at 1.1998

The location of surface water quality survey points of EPC see figure H - 3.7

Table D.3 Surface water quality at the project area in July and August 1998
(Data source: from CERECE)

Parameter	Unit	Analytical Result		
		Streams	Phu thinh lake	Ponds
Temperature	°C	29.6	29.2	29.6 - 31.3
pH		6.12 - 7.67	6.41 - 6.57	6.22 - 7.45
Chloride	mg/l	9.1 - 26.2	9.9 - 10.8	15.1 - 54.0
DO	mg/l	4.4 - 6.7	4.9 - 5.6	4.4 - 8
SS	mg/l	13 -323	42.9 - 46.7	29.3 - 324.4
COD	mg/l O_2	6.4 - 44.8	16 - 48	6.4 - 48.0
BOD_5	mg/l O_2	3.84 - 12.48	8.88 - 12.68	1.44 - 32.32
Sulfate SO_4	mg/l	6.24 - 13.74	7.81 - 8.52	6.24 - 14.09
Total Coliform	MPN/100 ml	450 - 11250	2000 - 3500	2100-16000
Conductivity	µS/cm	65 - 228	59	37 - 203
NO_2^-	mg/l	< 0.02	< 0.02	0.02 - 0.05
NO_3^-	mg/l	0.03 - 0.90	0.2 - 0.27	6.24 - 14.09
Total P	mg/l	0.017 - 0.081	0.081 - 0.371	0.018 - 0.084
Total hardness	mg/l $CaCO_3$	12 - 56	14 - 16	12 - 46
Phenol	µmg/l	2.56	2	2.25
Arsenic As	µmg/l	< 4	< 4	< 4
Cadmium Cd	µmg/l	0.16 - 0.21	< 0.16	0.16 - 0.28
Chromium Cr	µmg/l	< 0.5 - 2.4	0.8 - 1.4	0.5 - 1.7
Copper Cu	µmg/l	2 - 21	1	1 - 5
Lead Pb	µmg/l	2 - 11	2 - 3	< 2
Mercury Hg	µmg/l	0.2 - 0.24	< 0.2 - 0.28	0.2 - 0.31
Manganese Mn	µmg/l	2 - 339	137 - 201	12 - 71
Zinc Zn	µmg/l	2 - 15	2 - 10	1 - 20

* Detail see appendices 14;15;16
* Analytical methods and instruments:

Parameter	Analytical methods and instruments
Temperature	Thermometer
pH; DO; COD; BOD_5	pH meter, DO meter, COD meter, BOD meter
Cl^-; SO_4, Total P; Phenol	Spectrometer 1201, ASTM
SS	Gravimetric method
Total Coliform , NO_2^- , NO_3^-	Paqualab 50
Conductivity	Conductivity instrument
Total hardness	EDTA titrimetric method
As; Cd; Cr; Cu; Pb; Hg; Mn; Zn	Atomic absorption spectrometeter AA- 6501

* Location of surface water quality survey points of CERECE see figure H- 3.8

Table D.4 Groundwater quality in the project area at 23.10.1998

Parameter	Unit	Analytical method	Analytical Result	
			GW1	GW2
1.Temperature	°C	2550 B	26.0	25.0
2. pH		4500-H^+B	7.36	6.91
3. Chloride	mg/l	4500 -Cl^-B	4.79	13.49
4. DO	mg/l	4500-O G	4.85	4.19
5. SS	mg/l	2540 D	16.8	21.4
6. COD	mg/l O_2	5220 B	4.05	8.62
7. BOD_5	mg/l O_2	5210 B	2.14	2.18
8. Total N	mg/l	4500-N org. B	0.63	0.47
9. SO_4^{--}	mg/l	4500-SO_4^{--} E	1.20	1.56
10. CN^-	mg/l	4500 CN^- E	0.002	0.001
11. Total Coliform	MPN/100 ml	9222 B	29	43
12. Arsenic As	mg/l	3030 E +3500 -As B	< 0.001	0.012
13. Cadmium Cd	mg/l	3030 E +3500 -Cd B	< 0.001	0.0032
14. Tin Sn	mg/l	3030 E + 3500 -SnB	< 0.001	< 0.001
15.Chromium Cr	mg/l	3030 E +3500 -Cr B	0.0032	0.031
16. Copper Cu	mg/l	3030 E +3500 -Co B	0.0011	0.0015
17. Lead Pb	mg/l	3030 E +3500 -Pb B	0.001	0.001
18. Mercury Hg	mg/l	3030 E +3500 -Hg B	< 0.001	< 0.001
19. Nickel Ni	mg/l	3030 E +3500 -Ni B	0.015	0.031
20. Zinc Zn	mg/l	3030 E +3500 -Zn B	0,032	0.035

Note:GW 1: Sample of shallow dug well in Lai son hamlet - Hong ky commune at 23.10.1998

GW 2: Sample of shallow dug well in Phu xuan hamlet - Nam son commune at 23.10.1998

Table D.5 Groundwater quality in the project area at 1.1998
(Data source: From EPC)

Parameter	Unit	Analytical Result				
		GW3	GW4	GW5	GW6	GW7
Temperature	°C	21.7	19.3	20.5	21.2	21.0
pH		6.45	5.79	6.65	5.93	5.2
Chloride	mg/l	0.3	1.02	0.6	0.8	0.55
DO	mg/l	5.25	3.15	1.5	2.5	3.72
SS	mg/l	6.9	9.4	15.3	18.9	19.7
COD	mg/l O_2	9.8	23.5	26.5	19.8	17.2
BOD_5	mg/l O_2	7.5	21.0	19.6	12.4	14.8
Sulfate (SO_4)	mg/l	5.2	5.4	17.2	8.5	18
Total Coliform	MPN/100 ml	12	720	83	13	110
Zinc Zn	mg/l	0.18	0.11	0.17	0.14	0.12
Phenol	mg/l	0.027	0.021	0.020	0.009	0.011
Conductivity	µS/cm	170	230	220	240	180
NO_2^-	mg/l	0.05	0.05	0.03	0.03	0.04
NO_3^-	mg/l	3.8	3.1	2.9	3.5	5.6
PO_4^{---}	mg/l	0.07	0.24	0.24	0.12	0.07
Turbidity	NTU	4.66	7.5	32.1	16.9	21.9
Iron Fe	mg/l	1.07	2.02	2.11	1.89	1.16

Note: GW 3: Sample of shallow dug well of Mr. Ng.Ng. Oanh, Phu xuan hamlet at 1.1998

GW 4: Sample of shallow dug well of Mr. B. Th. Tinh, Phu thinh hamlet at 1.1998

GW 5: Sample of shallow dug well of Mr. Ng. V. Tru, Xuan thinh hamlet at 1.1998

GW 6: Sample of shallow dug well of Mr. Ng.Ng. Tiep, Xuan thinh hamlet at 1.1998

GW 7: Sample of shallow dug well of Mrs. Tr. Th. Chu, Xuan thinh hamlet at 1.1998

The location of groundwater quality survey points of EPC see figure H - 3.7

Table D.6 Groundwater quality of shallow well in the project area in July and August 1998 (Data source: From CERECE)

Parameter	Unit	Analytical Result			
		Sample Nº1	Sample Nº2	Sample Nº3	Sample Nº4
pH		7.01	6.29	4.34	4.59
Total hardness	mg/l $CaCO_3$	106	90	12	30
Fluoride F	mg/l	0.43	< 0.03	< 0.03	< 0.03
Chloride	mg/l	10.84	13.79	14.57	77.53
NO_3^-	mg/l	< 0.03	9.12	8.08	34.68
Cadmium Cd	mg/l	0.00016	< 0.002	0.00016	0.0003
Lead Pb	mg/l	0.003	0.002	< 0.002	0.005
Zinc Zn	mg/l	0.341	0.221	0.012	0.017
Manganese Mn	mg/l	0.214	0.012	0.007	0.469
Copper Cu	mg/l	0.003	0.001	0.003	0.002
Iron Fe	mg/l	< 0.1	< 0.1	-	-
Arsenic As	mg/l	< 0.004	< 0.004	< 0.004	< 0.004
Mercury Hg	mg/l	< 0.0002	< 0.0002	0.00036	0.00053
Total Coliform	MPN/100 ml	0	0	0	15

* Location of groundwater quality survey points of CERECE see figure H- 3.8

Table D.7 Air quality in project area at 20-22 January 1998
(Data source: From EPC)

Parameter	Analytical times for each parameter	Value	Sampling site and Concentration (mg/m^3)				
			A3	A4	A5	A6	A7
CO	5	Minimum value	Undetectable	Undetectable	Undetectable	1.756	1.262
		Maximum value	1.791	1.379	1.540	2.559	2.368
		Average value	0.478	0.659	0.594	2.287	2.086
SO_2	5	Minimum value	Undetectable	Undetectable	0.0030	Undetectable	Undetectable
		Maximum value	0.0065	0.0065	0.0064	Undetectable	0.0094
		Average value	0.0026	0.0019	0.0043	Undetectable	0.0063
NO_2	5	Minimum value	Undetectable	Undetectable	0.006	Undetectable	0.003
		Maximum value	0.003	Undetectable	0.027	Undetectable	0.012
		Average value	0.001	Undetectable	0.016	Undetectable	0.007
CH_4	5	Minimum value	Undetectable	Undetectable	Undetectable	Undetectable	Undetectable
		Maximum value	Undetectable	Undetectable	Undetectable	Undetectable	Undetectable
		Average value	Undetectable	Undetectable	Undetectable	Undetectable	Undetectable
Dry dust	5	Minimum value	0.146	0.146	0.175	0.146	0.172
		Maximum value	0..215	0.205	0.210	0.205	0.215
		Average value	0.172	0.173	0.195	0.177	0.193

Note: The location of air quality survey points of EPC see figure H - 3.7
Detection limit (Undetectable) of CO, SO_2, NO_2, CH_4: < 0.001 mg/m^3

Table D.8 Air quality in project area in July and August 1998
(Data source: From CERECE)

Parameter	Unit	Survey result
SO_2	mg/m^3	0.0066 - 0.015
NO_2	mg/m^3	0.006 - 0.013
CO	mg/m^3	0.22 - 0.97
H_2S	mg/m^3	0.0004 - 0.0011
CH_4	mg/m^3	< 0.1 - 84.43
Dry dust	mg/m^3	0.087 - 0.22
Pb	mg/m^3	0.0008 - 0.0032
Cd	mg/m^3	0.00009 - 0.00015

Note:
- Sampler and Analyzer for CO: Carbon Monoxide Analyzer ML9832 MONITOR LAB- USA
- Air Sampling: Air Sampler DESAGA 212 - Germany
- Analyzing instrument : Spectrophotometer UV-1201, Shimadzu - Japan
- Sampler for Dust: High Volume Air Sampler SIBATA - Japan
- Analyzing instrument for heavy metals in dust: Atomic Absorption Spectrmeter AA-6501S, Shimadzu - japan
- Analyzing instrument for CH_4: Gas Chromatography GC-14BPs- Shimadzu - japan

Table D.9 Noise level in project area at 23 - 24 October 1998 (Station N)
Equipment: SOUND LEVEL METER OCTAVE BAND ANALYZER MODEL NA - 29 RION - JAPAN

Time	dBA		
	L_{Aeq}	L_{Amax}	L_{A50}
24.10.1998			
0h - 1h	31.4	65.3	30.7
1h - 2h	31.0	33.5	30.5
2h -3h	31.3	65.5	30.6
3h - 4h	32.5	77.2	31.2
4h - 5h	32.8	78.9	31.6
5h - 6h	33.5	79.4	31.8
6h - 7h	39.7	82.8	34.8
7h - 8h	45.2	85.3	41.6
8h - 9h	51.5	86.2	42.3
9h - 10h	40.0	84.4	38.4
23.10.1998			
10h - 11h	44.1	84.6	41.5
11h - 12h	44.5	84.8	41.5
12h - 13h	38.2	83.7	36.8
13h - 14h	33.5	80.0	32.2
14h - 15h	32.1	79.1	31.6
15h - 16h	37.5	84.0	33.5
16h - 17h	43.2	78.2	38.2
17h - 18h	42.4	79.8	39.6
18h - 19h	41.8	76.6	39.2
19h - 20h	39.3	76.7	37.2
20h - 21h	35.7	78.5	34.3
21h - 22h	33.5	68.3	32.8
22h - 23h	32.6	65.2	31.4
23h - 24h	32.7	66.5	30.6

Table D.10 Noise level in project area at Uncle Ho's Hill - Station N_5
(20 -22 January 1998 - Data source: From EPC)

Time	dBA		
	L_{Aeq}	L_{Amax}	L_{A50}
09h - 10 h	49.3	72.0	41.2
10h - 11h	49.6	70.0	40.3
11h - 12h	43.5	66.8	37.5
12h - 13h	46.6	64.4	38.6
13h- 14h	46.4	63.7	41.5

Table D.11 Traffic volume in project area at 23 -24 October (Station N)

Time	Traffic volume							
	Lorry (> 5 ton)	Cong nong Lorry (1-2 ton)	Bus	Minibus	Automobile	Motorcycle	Bicycle	Pedestrian
24.10.1998 : 0-1 AM						1		
1-2 AM								
2-3 AM						1		
3-4 AM		2				2	3	
4-5 AM		1				6	10	
5-6 AM		1				11	69	3
6-7 AM	3	1		1		53	290	
7-8 AM	3	2	1		1	62	135	2
8-9 AM	2	6				46	97	4
9-10 AM	1	6			2	30	94	1
23.10.1998 : 10-11 AM	3	7			1	40	85	6
11-12 AM	2	5				37	152	3
12-1 PM	2	4			2	14	124	6
1-2 PM		3				16	80	4
2-3 PM		2			3	27	77	2
3-4 PM	2	8			1	39	34	3
4-5 PM		4				60	85	4
5-6 PM	2	2				31	108	1
6-7 PM		2				10	24	2
7-8 PM		1				9	16	5
8-9 PM		3				11	14	
9-10 PM						9	10	4
10-11 PM					3	6	3	
11-12 PM						2	1	
Total	**18**	**60**	**1**	**1**	**13**	**523**	**1505**	**50**

Table D.12 Percent of means of transport in project area (Station N)
Survey date: From 23 to 24 October 1998

Means of transport	Quantity	Percentage %
Lorry (> 5 ton)	18	0.83
Cong nong Lorry (1-2 ton)	60	2.76
Bus	1	0.05
Minibus	1	0.05
Automobile	13	0.60
motorcycle	523	24.09
Bicycle	1505	69.32
Pedestrian	50	2.30
Total	2171	100

Table D.13 Characteristics on administratively Soc Son District

N°	Community	Area (ha)	Population	Density (p/ha)	Number of Households	Average family size
1	Bac Phu	998.1	7,671	7.7	1,467	5.23
2	Bac Son	3,630.6	10,844	3.0	1,923	5.64
3	Dong Xuan	646.2	8,642	13.4	1,786	4.84
4	Duc Hoa	716.2	6,106	8.5	1,137	5.37
5	Hien Ninh	897.1	8,114	9.0	1,483	5.47
6	Hong Ky	1,800.0	8,199	4.6	1,663	4.93
7	Kim Lu	470.9	6,875	14.6	1,335	5.15
8	Mai Dinh	1,375.0	12,430	9.0	2,432	5.11
9	Minh Phu	2,181.0	8,376	3.8	3,149	2.66
10	Minh Tri	2,435.1	10,149	4.2	2,428	4.18
11	Nam Son	2,900.0	6,679	2.3	1,275	5.24
12	Phu Cuong	901.7	7,423	8.2	1,583	4.69
13	Phu Linh	1,496.0	6,706	4.5	1,355	4.95
14	Phu Lo	596.8	10,857	18.2	1,891	5.74
15	Phu Minh	743.8	6,948	9.3	1,289	5.39
16	Quang Tien	1,469.7	6,066	4.1	994	6.10
17	Soc Son Town	80.0	2,497	31.2	626	3.99
18	Tan Dan	998.1	8,801	8.8	1,531	5.75
19	Tan Hung	899.9	8,230	9.1	1,488	5.53
20	Tan Minh	1,072.4	10,381	9.7	1,933	5.37
21	Thanh Xuan	726.6	9,173	12.6	2,210	4.15
22	Tien Duoc	1,426.2	9,751	6.8	1,829	5.33
23	Trung Gia	833.3	9,861	11.8	1,813	5.44
24	Viet Long	695.4	6,055	8.7	1,340	4.52
25	Xuan Giang	835.5	7,270	8.7	1,374	5.29
26	Xuan Thu	641.3	7,082	11.0	1,437	4.93
Total of Rural Area		27,342.7	167,009	6.1	34,206	4.88
Total of Densely Inhabited District		4,124.2	44,177	10.7	8,565	5.16
Total		**31,466.9**	**211,186**	**6.7**	**42,771**	**4.94**

Table D.14 - The current land-used of Nam son commune

Land-used	Area (ha)	%
Ancestral land	100	3.33
Agricultural land	500	16.6
Hills, Forests	1,800	60.0
Ponds, Lakes	65	2.19
Roads, Cemetery	17	0.58
Other uses	518	17.3
Total	3000	100

Table D.15 - The current land-used of Bac son commune

Land-used	Area (ha)	%
Ancestral land	250	6.88
agricultural land	912	25.12
Hills, Forests	2000	55.09
Ponds, Lakes	53	1.46
Roads, Cemetery	40	1.10
Other uses	375	10.33
Total	3630	100

Table D.16 - The current land-used of Hong ky commune

Land-used	Area (ha)	%
Ancestral land	198	13.8
Agricultural land	513	35.75
Hills, Forests	300	20.91
Ponds, Lakes	46	3.21
Roads, Cemetery	17.8	1.24
Other uses	360	25.09
Total	1434.8	100

Table D.17 Land use in project and influential area

Land-used	Nam son		Bac son		Hong ky	
	Area (m^2)	%	Area (m^2)	%	Area (m^2)	%
Ancestral land	322,831	30.48	5,515	8.67	39,181	53.18
Agricultural land	450,000	42.49			16,100	21.85
Hills, Forests	142,500	13.46	58,085	91.33	18,400	24.97
Ponds, Lakes	77,100	7.28				
Roads	56,000	5.29				
Cemetery	8,000	0.76				
Kindergarten , court of village	2,516	0.24				
Total	1,058,947	100	63,600	100	73,681	100

E. Solid Waste Management Survey Data

E.1 Household Waste Generation Quantity Survey

E.2 Waste Collection Quantity Survey Using Truck Scale

E.3 Time and Motion Study

E.4 Solid Waste Quality Analysis

E1 Household Waste Generation Quantity Survey

Outline

1. Objective	To estimate quantity of household waste generated in HPC area
2. Survey date	Sampling was conducted during 24 – 31 August 1998.
3. Number of sample households surveyed	100 household of which, -government house (2 stories): 20 - private houses in urban area: 20 - commercial/residential house: 20 - sub urban houses: 20 - farmers and traditional job: 20 See Table E1-1 for details.
4. Survey method	Surveyors visited sample household, and delivered a plastic bag. Households put solid waste in the plastic bag. Surveyor collected the sample waste next day.
5. Survey results	Table E1-2 shows unit generation rate/household/day. Waste generation in HPC area is shown in Table E1-3. Data on number of household and population living is the government apartments are shown in E1-4.

Table E1-1 Sample Sources and Quantities of Household Waste Generation quantity Survey

Category		Number of sample households	District		Type of house or occupation
A		20	Dong Da	Urban	Governmental apartment (2 stories building)
B	B1	20	Hoan Kiem		Private tube house (commercial shop on street side, and residence backside)
	B2	20	Tay Ho		Individual private houses
C	C1	20	Gia Lam	Sub-urban	Private individual house or small business
	C2	10			Farmer
	C3	10			Farmer and traditional job
Total		100			

Table E1-2 Household Waste Generation Quantity Survey Data Summary

(Unit generation rate: Gram/person/day)

Area code	Total Persons living (persons) (a)	7 days total weight (kg) (b)	Total plastic bags weight (kg) (c)	7 days net waste weight (kg) - (c) = (d)	Unit generation rate (g/person/day) (d)/(a)/7days x 1,000 = (e)*1
A1	93	373.03	5.67	367.36	583
B1	96	200.17	3.83	196.34	311
B2	117	318.91	3.92	315.00	398
B1, B2 Total/average	213	519.08	7.75	511.34	359
C1	102	168.60	2.34	166.26	233
C2	55	113.20	1.17	112.03	291
C3	47	222.40	1.04	221.36	697
C1, C2, C3 Total/average	204	504.20	4.55	499.65	355

*1) Unit generation rates were calculated by disregarding the days when household waste samples were not collected because of the absence

Table E1-3 Summary of Household Waste Generation Quantity Survey

Area Code	Unit generation rate (gram/person/day) (a)	Population (persons) (b)	Generation weight (ton/day) (a) x (b) / 1,000,000 = (c)
A	(aA) 583	(bA) 473,637	(cA) 276.1
B1, B2	(aB) 359	(bB) 839,465	(cB) 301.4
7 Urban districts (A, B1, B2)	Calculate (cAB)/(bAB) = 440	(bAB)=(bA)+(bB)= **1,313,102**	(cAB)=(cA)+(cB)= **577.5**
5 sub-urban districts (C1, C2, C3)	(aC) **355**	(bC) **1,167,482**	(cC) **414.5**
12 districts (Hanoi) (A, B1, B2, C1, C2, C3)	Calculate (cABC)/(bABC) = *400*	(bABC)=(bAB)+(bC) = *2,480,584*	(cABC)=(cAB)+(cC) = *992.0*

Table E1-4 Households and Population living in the Government Apartments in Hanoi

	Number of households having contract for renting government houses a	Estimated number of households living in the government houses without contracts b	Total number of households living in the government houses c (a+b)	Number of population having contract for renting government houses A	Estimated number of population living in the government houses without contract B	Estimated Total population living in the government houses C (A+B)
Urban Districts						
1 Tay Ho	60	540	600	270	1,890	2,160
2 Ba Dinh	16,845	5,703	22,548	77,487	21,670	99,157
3 Hoan Kiem	14,794	4,016	18,810	68,052	14,860	82,912
4 Hai Ba Trung	19,603	6,963	26,566	84,293	28,548	112,841
5 Dong Da	26,800	7,829	34,629	123,280	29,750	153,030
6 Thanh xuan	2,422	1,043	3,465	12,110	5,215	17,325
7 Cau Giay+Tu Liem	3,063	604	3,667	14,174	2,174	16,348
Sub-Total	83,587	26,698	110,285	379,666	104,107	483,773
Sub urban districts						
8 Soc Son	0	0	0	0	0	0
9 Dong Anh	611	175	786	2,915	652	3,567
10 Gia Lam	1,711	174	1,885	8,165	713	8,878
11 Tu Liem (_ 7)	0	0	0	0	0	0
12 Thanh Tri	356	152	508	1,531	578	2,109
Sub-Total	2,678	501	3,179	12,611	1,943	14,554
Hanoi Grand Total	86,265	27,199	113,464	392,277	106,050	498,327

Source: Hanoi Department of Land Housing

E2 Waste Collection Quantity Survey Using Truck Scale

Outline

1. Objective	To estimate quantity of solid waste received at Tay Mo landfill site
2. Survey date	Weights of all solid waste transported to Tay Mo landfill site were measured by truck scale during the following 4 weeks: 1st week: 19 – 25 October 1998 2nd week: 26 – October – 1 November 1998 3rd week: 24 – 30 November 1998 4th week: 14 – 20 December 1998
4. Survey method	During the above 4 weeks, weights of solid waste transported by all trucks to Tay Mo landfill site were measured.
5. Survey results	Tables E2-1a and Table E2-1b are summary of the 4 weeks data in terms of weight and number of trips respectively. Tables E3, E4, E5 and E6 are each of the 4 weeks data.

Table E2-1a Summary of Truck Scale Data on Waste Collection Amounts in Hanoi

(Unit: ton/day)

	7 days for 19-25 Oct.1998	7 days for 26 Oct-1 Nov.1998	7 days for 24-30 Nov.1998	7 days for 14-Aug Dec.1998	Average of 4 Weeks
A. URENCO (Exclude Item D)					
1st Shift	214	201	204	251	218
2nd Shift	749	728	855	827	790
Sub total	964	929	1059	1079	1008
B. Collection by Non-URENCO					
1st Shift	33	20	31	28	28
2nd Shift	23	14	11	11	15
Sub total	56	34	42	39	43
C. Total of A & B					
1st Shift	247	221	235	279	245
2nd Shift	772	742	866	838	805
Total	1019	963	1101	1118	1050
D. Soil/Demolition Waste					
1st Shift	258	294	233	294	270
2nd Shift	0	34	0	87	30
Sub total	258	328	233	381	300
E. Grand Total (C+D)					
1st Shift	505	515	468	573	515
2nd Shift	772	776	866	925	835
Total	1278	1290	1334	1499	1350

Note on the Truck scale recording hours:

1st shift: 07:00 -- 19:00

2nd shift: 19:00 - 07:00 (Actually, there were almost no trucks coming between 02:00 - 07:(

Table E2-1b Summary of Truck Scale Data on Waste Collection Trips in Hanoi

(Unit: Number of trips)

	7 days for 19-25 Oct.1998	7 days for 26 Oct-1 Nov.1998	7 days for 24-30 Nov.1998	7 days for 14-Aug Dec.1998	Average of 4 Weeks
A. URENCO (Exclude Item D)					
1st Shift	69	70	61	76	69
2nd Shift	193	193	197	196	195
Sub total	262	263	258	272	264
B. Non-URENCO					
1st Shift	7	7	8	12	9
2nd Shift	4	4	3	3	4
Sub total	11	11	11	15	12
C. Total of A & B					
1st Shift	76	77	69	88	78
2nd Shift	197	197	200	199	198
Total	273	274	269	287	276
D. Soil/Demolition Waste (Not included in the transfer plan)					
1st Shift	41	45	35	44	41
2nd Shift	0	5	0	13	5
Sub total	41	50	35	57	46
E. Total (C+D)					0
1st Shift	117	122	104	132	119
2nd Shift	197	202	200	212	203
Grand Total	314	324	304	344	322

Note on the Truck scale recording hours:
1st shift: 07:00 – 19:00
2nd shift: 19:00 – 07:00 (Actually, there were almost no trucks coming between 02:00 – 07:00.

Table E2-2 Daily Waste Collection Amounts Recorded during 19 - 25 October 1998

	19-Oct Monday	20-Oct Tuesday	21-Oct Wednesday	22-Oct Thursday	23-Oct Friday	24-Oct Saturday	25-Oct Sunday	7 days Average(kg)	7days Average(ton)
A. General Waste									
1st Shift	267575	208060	229105	217715	181935	195600	201015	214429	214
2nd Shift	799265	756510	775120	753620	740420	737385	682210	749219	749
Sub total	1066840	964570	1004225	971335	922355	932985	883225	963648	964
B. Collection by Non-URENCO									
1st Shift	52870	36550	63220	27550	21200	15220	11320	32561	33
2nd Shift	28770	39200	35110	6390	10550	22410	20060	23213	23
Sub total	81640	75750	98330	33940	31750	37630	31380	55774	56
C. Soil/Demolition Waste									
1st Shift	236160	266680	229295	257580	250125	242245	326375	258351	258
2nd Shift	0	0	0	0	0	0	0	0	0
Sub total	236160	266680	229295	257580	250125	242245	326375	258351	258
D. Total (A+B+C)									
1st Shift	556605	511290	521620	502845	453260	453065	538710	505342	505
2nd Shift	828035	795710	810230	760010	750970	759795	702270	772431	772
Total	1384640	1307000	1331850	1262855	1204230	1212860	1240980	1277774	1278

Trips

	19-Oct Monday	20-Oct Tuesday	21-Oct Wednesday	22-Oct Thursday	23-Oct Friday	24-Oct Saturday	25-Oct Sunday	7 days Average
A. General Waste								
1st Shift	72	66	68	74	65	71	67	69
2nd Shift	193	194	194	200	194	191	187	193
Sub total	265	260	262	274	259	262	254	262
B. Non-URENCO								
1st Shift	7	8	7	10	8	9	3	7
2nd Shift	3	4	4	2	4	5	4	4
Sub total	10	12	11	12	12	14	7	11
C. Soil/Demolition Waste								
1st Shift	40	42	35	41	40	42	50	41
2nd Shift	0	0	0	0	0	0	0	0
Sub total	40	42	35	41	40	42	50	41
D. Total (A+B+C)								
1st Shift	119	116	110	125	113	122	120	118
2nd Shift	196	198	198	202	198	196	191	197
Total	315	314	308	327	311	318	311	315

Table E2-3 Daily Waste Collection Amounts Recorded during 26 October - 1 November 1998

	26-Oct Monday	27-Oct Tuesday	28-Oct Wednesday	29-Oct Thursday	30-Oct Friday	31-Oct Saturday	1-Nov Sunday	7 days Average (kg)	7days Average (ton)
A. General Waste									
1st Shift	206895	181930	191585	210865	199210	207765	208030	200897	201
2nd Shift	727800	763693	738115	524195	773520	778825	790495	728092	728
Sub total	934695	945623	929700	735060	972730	986590	998525	928989	929
B. Collection by Non-URENCO									
1st Shift	20220	19810	15590	19030	21230	22860	18170	19559	20
2nd Shift	11060	23040	11060	15380	15290	13060	9270	14023	14
Sub total	31280	42850	26650	34410	36520	35920	27440	33581	34
C. Soil/Demolition Waste									
1st Shift	323555	356675	463805	333555	247970	181550	151890	294143	294
2nd Shift	0	176045	59525	0	0	0	0	33653	34
Sub total	323555	532720	523330	333555	247970	181550	151890	327796	328
D. Total (A+B+C)									
1st Shift	550670	558415	670980	563450	468410	412175	378090	514599	515
2nd Shift	738860	962778	808700	539575	788810	791885	799765	775768	776
Total	1289530	1521193	1479680	1103025	1257220	1204060	1177855	1290366	1290

Trips

	26-Oct Monday	27-Oct Tuesday	28-Oct. Wednesday	29-Oct. Thursday	30-Oct Friday	31-Oct Saturday	1-Nov Sunday	7 days Average
A. General Waste								
1st Shift	68	65	68	73	73	70	73	70
2nd Shift	194	196	193	191	190	192	195	193
Sub total	262	261	261	264	263	262	268	263
B. Non-URENCO								
1st Shift	7	12	8	5	7	5	5	7
2nd Shift	4	4	4	4	4	3	2	4
Sub total	11	16	12	9	11	8	7	11
C. Soil/Demolition Waste								
1st Shift	51	53	69	51	38	28	23	45
2nd Shift	0	27	9	0	0	0	0	5
Sub total	51	80	78	51	38	28	23	50
D. Total (A+B+C)								
1st Shift	126	130	145	129	118	103	101	122
2nd Shift	198	227	206	195	194	195	197	202
Total	324	357	351	324	312	298	298	323

Table E2-4 Daily Waste Collection Amounts Recorded during 24 - 30 November 1998

	30-Nov Monday	24-Nov Tuesday	25-Nov Wednesday	26-Nov Thursdday	27-Nov Friday	28-Nov Saturday	29-Nov Sunday	7 days Average(kg)	7days Average(t)
A. General Waste									
1st Shift	211,030	178,545	183,849	172,585	201,190	241,320	240,385	204,129	204
2nd Shift	883,810	848,295	828,710	838,115	838,635	846,895	898,365	854,689	855
Sub total	1,094,840	1,026,840	1,012,559	1,010,700	1,039,825	1,088,215	1,138,750	1,058,818	1,059
B. Collection by Non-URENCO									
1st Shift	30,050	38,940	52,790	20,455	19,990	33,761	21,430	31,059	31
2nd Shift	14,840	9,110	14,160	11,260	10,520	8,060	11,080	11,290	11
Sub total	44,890	48,050	66,950	31,715	30,510	41,821	32,510	42,349	42
C. Soil/Demolition Waste									
1st Shift	249,740	204,140	237,920	255,735	201,350	221,745	257,850	232,640	233
2nd Shift	0	0	0	0	0	0	0	0	0
Sub total	249,740	204,140	237,920	255,735	201,350	221,745	257,850	232,640	233
D. Total (A+B+C)									
1st Shift	490,820	421,625	474,559	448,775	422,530	496,826	519,665	467,829	468
2nd Shift	898,650	857,405	842,870	849,375	849,155	854,955	909,445	865,979	866
Total	1,389,470	1,279,030	1,317,429	1,298,150	1,271,685	1,351,781	1,429,110	1,333,808	1,334

Trips

	30-Nov Sunday	24-Nov Monday	25-Nov Tuesday	26-Nov Wednesday	27-Nov Thursday	28-Nov Friday	28-Nov Saturday	7 days Average(kg)	7days Average(t)
A. General Waste									
1st Shift	59	56	58	54	60	66	74	61	
2nd Shift	198	199	197	195	196	197	196	197	
Sub total	257	255	255	249	256	263	270	258	
B. Non-URENCO									
1st Shift	9	9	10	5	6	12	6	8	
2nd Shift	4	2	4	3	3	2	3	3	
Sub total	13	11	14	8	9	14	9	11	
C. Soil/Demolition Waste									
1st Shift	39	32	36	38	29	34	39	35	
2nd Shift	0	0	0	0	0	0	0	0	
Sub total	39	32	36	38	29	34	39	35	
D. Total (A+B+C)									
1st Shift	107	97	104	97	95	112	119	104	
2nd Shift	202	201	201	198	199	199	199	200	
Total	309	298	305	295	294	311	318	304	

Table E2-5 Daily Waste Collection Amounts Recorded during 14 - 20 December 1998

	14-Dec. Monday	8-Dec Tuesday	9-Dec Wednesday	10-Dec Thursday	11-Dec Friday	12-Dec Saturday	13-Dec Sunday	7 days Average(kg)	7days Average(t)
A. General Waste									
1st Shift	179,775	255,075	200,360	175,070	186,105	186,675	575,520	251,226	251
2nd Shift	792,685	852,145	824,745	837,605	843,400	788,860	852,230	827,381	827
Sub total	972,460	1,107,220	1,025,105	1,012,675	1,029,505	975,535	1,427,750	1,078,607	1,079
B. Collection by Non-URENCO									
1st Shift	26,920	43,015	22,480	37,320	20,070	23,320	24,000	28,161	28
2nd Shift	10,310	11,700	14,440	12,780	11,130	8,050	9,220	11,090	11
Sub total	37,230	54,715	36,920	50,100	31,200	31,370	33,220	39,251	39
C. Soil/Demolition Waste									
1st Shift	280,835	296,370	274,575	260,685	256,250	339,070	349,410	293,885	294
2nd Shift	154,615	0	64,620	138,805	153,964	49,165	47,250	86,917	87
Sub total	435,450	296,370	339,195	399,490	410,214	388,235	396,660	380,802	381
D. Total (A+B+C)									
1st Shift	487,530	594,460	497,415	473,075	462,425	549,065	948,930	573,271	573
2nd Shift	957,610	863,845	903,805	989,190	1,008,494	846,075	908,700	925,388	925
Total	1,445,140	1,458,305	1,401,220	1,462,265	1,470,919	1,395,140	1,857,630	1,498,660	1,499

Trips

	14-Dec Monday	8-Dec Tuesday	9-Dec Wednesday	10-Dec Thursday	11-Dec Friday	12-Dec Saturday	13-Dec Sunday	7 days Average(tr.)
A. General Waste								
1st Shift	57	74	58	56	58	56	175	76
2nd Shift	197	202	195	199	195	190	195	196
Sub total	254	276	253	255	253	246	370	272
B. Non-URENCO								
1st Shift	12	14	12	16	9	13	7	12
2nd Shift	3	3	4	4	4	2	2	3
Sub total	15	17	16	20	13	15	9	15
C. Soil/Demolition Waste								
1st Shift	42	42	42	39	40	50	54	44
2nd Shift	23	0	9	21	24	7	7	13
Sub total	65	42	51	60	64	57	61	57
D. Total (A+B+C)								
1st Shift	111	130	112	111	107	119	236	132
2nd Shift	223	205	208	224	223	199	204	212
Total	334	335	320	335	330	318	440	345

E 3 Time and Motion Study

Outline

1. Objective	To diagnose the efficiency of the waste collection
2. Survey date	1 – 9 November 1998
3. Number of sample trucks	15 waste collection trucks
4. Survey method	Surveyors followed sample vehicles from start until end of daily operation. Surveyors recorded time of start and end of each activity of the sample trucks.
5. Method of Cost efficiency measurement	Costs of the trucks and fuel consumption of each truck were also studied to estimate unit cost of collection, which has been estimated with the following formular: Unit cost/ton = (A + B)/C Where, A: Annual depreciation (amortization) cost B: Annual cost of fuel C: Annual waste amount collected by sample truck Assumption: 1. Useful period of trucks: 10 years 2. Residual value of the trucks are 5 % of purchase cost 3. Fuel cost: $0.5/litter 4. Working days: 340 days/year
6. Survey results	An average cost performance of all the sample vehicles was USD3.8/ton. Among 15 sample vehicles, the highest cost performance was shown by IFA92 (belonging to Transport Unit 1, covering Hoan Kiem, daytime shift.) at USD2.0/ton. IFA 92 collects waste from hand cars. The second were Maz5335 (belonging to Transport Unit 2, covering Hai Ba Trung, night shift) and IFA container (belonging to Transport Unit 2, covering Hai Ba Trung, night shift) showing the performance at USD2.3/ton each. Both trucks collect waste from large communal containers (about 6 m3). The worst one was Mercedes (belonging to Transport Unit 1, covering Hoan Kiem, daytime shift) at USD8.9/ton. It collects waste from handcarts. The second worst one was Nissan at USD5.3/ton. The above shows general tendency of the cost performance. For more precise comparison, the data on salary, cost of handcarts or containers, maintenance costs are needed.

Table E3-1 Efficiency of the surveyed collection vehicles

	Type	Garage	Collected from:	No.	Waste (tons)	M-time (min.)	L-time (min.)	U-time (min.)	Trips	Depr. (USD)	Fuel (USD)	Efficiency Cost	Efficiency Time	Rank by C-effic.
	IFA92	Unit 1	Hand cart	65	7.61	49	78	19	2	655	4,590	**2.0**	**19**	**1**
1)	Maz5335	Unit 2	Container	2	8.03	0	20	20	2	1,219	4,930	**2.3**	**5**	**2**
2)	IFA con.	Unit 2	Container	5	13.84	0	103	44	5	836	10,200	**2.3**	**11**	**2**
3)	MTR92Z	Unit 2	Hand cart	72	10.38	40	129	18	3	847	7,480	**2.4**	**18**	**4**
4)	IFA92	Unit 1	Hand cart	82	6.94	65	95	20	2	655	4,930	**2.4**	26	**4**
5)	IFA con.	Unit 1	Container	5	10.21	0	25	33	5	836	8,500	**2.7**	**6**	**6**
6)	Hyundai	Unit 1	Hand cart	90	9.06	69	108	15	3	3,568	5,100	**2.8**	**21**	**7**
7)	Sanxing	Unit 2	Container	5	6.10	0	25	20	5	1,331	5,610	**3.3**	**7**	8
8)	Sanxing	Unit 1	Container	4	5.25	0	20	16	4	1,331	4,930	**3.5**	**7**	9
9)	KO413	Unit 1	Other	52	9.78	94	95	29	3	322	11,390	**3.5**	22	9
10)	Nissan	Unit 1	Hand cart	74	4.16	89	108	6	3	744	5,100	4.1	49	11
11)	KO413	Unit 2	Other	50	5.13	75	55	20	2	322	7,820	4.7	29	12
12)	Nissan	Unit 1	Hand cart	23	3.70	80	70	15	3	744	5,950	5.3	45	13
13)	Mercede:	Unit 1	Hand cart	101	8.20	81	107	12	1	9,926	7,140	6.1	24	14
14)	Mercede:	Unit 1	Hand cart	87	5.81	65	90	7	1	9,926	7,650	8.9	28	15
	Average				7.61	47	75	20	3.0	2,329	6,909	**3.9**	**21**	

Source: Regarding cost: URENCO, 1998. Other record: JICA Study Team, 1998.

M-time: Moving time

L-time: Loading time

U time: Unloading time

E4 Solid Waste Quality Analysis

Outline

1. Objective	To know typical quality of Hanoi solid waste in terms of 1. physical composition on wet base 2. physical composition on dry base 3. chemical composition (3 components: water, combustible and ash) 4. chemical composition (6 elements: C, H, N, Cl, O, Sulfur)
2. Sampling number	A total of 6 samples were collected and analyzed. 3 samples of household waste (M1, M2 and M3) were taken on 28 August 1998, 3 samples of domestic waste collected by truck (M4, M5 and M6) were taken on 8 September 1998.
4. Sampling method	The 3 samples of household waste were taken from samples collected through household waste generation survey. The 3 samples of domestic waste were prepared from waste collected by 3 waste collection trucks (2 open trucks and 1 small compactor) of URENCO.
5. Analysis of samples	Analytical part of the survey was carried out by the Center for Environmental Engineering of Towns and Industrial Area -- CEETIA.
6. Survey results	Survey results are summarized in Tables E4-1 and E4-2. A survey report prepared in September b1998 by the CEETIA is attached hereto.

Table E4-1 Solid Waste Composition Ratio on Wet Base

(Unit: %)

Types of Waste	M1	M2	M3	Ave.	M4	M5	M6	Ave.	Total Ave.
Bulk Density in Car [kg/m^3]	-	-	-	-	487.6	425.2	505.3	-	-
Bulk Density [kg/m^3]	380.0	368.0	378.0	375.3	384.4	408.9	362.2	385.2	380.3
Kitchen waste	39.50	30.60	37.70	36.45	34.90	42.40	67.50	47.51	41.98
Paper	3.20	4.10	2.40	3.25	11.50	5.40	4.90	7.28	5.27
Plastics, rubbers	6.70	9.60	4.10	6.90	9.80	6.50	6.10	7.47	7.19
Bricks, stones	14.60	7.30	5.20	9.36	4.60	7.00	1.20	4.41	6.89
Timber, rags	1.30	1.20	2.10	1.58	1.70	2.70	1.20	1.92	1.75
Bones, shells	1.10	1.50	2.10	1.58	1.20	1.20	0.60	0.96	1.27
Metal, tin cans	1.10	0.60	0.60	0.79	0.70	0.60	0	0.38	0.59
Glass	1.90	4.8	0.30	2.07	1.70	0.60	0	0.77	1.42
Sand and Dust	30.60	40.30	45.50	38.03	34.10	33.60	18.50	29.31	33.67
Moisture Content	38.8 %	34.9 %	36.9 %	36.9 %	43.0 %	40.4 %	46.6 %	43.3 %	40.1 %

Table E4-2 Solid Waste Composition Comparison

(Unit: %)

URENCO Study (1994)		JICA Team Study			
Types of Waste		M1–M3 Ave.	M4-M6 Ave.	Total Ave.	Types of Waste
Bulk Density	416	375.3	385.2	380.3	Bulk Density
Organic waste	50.27	36.45	47.51	41.98	Kitchen waste
Paper	2.72	3.25	7.28	5.27	Paper
Plastics, rubber	0.71	6.90	7.47	7.19	Plastics, rubbers
Bricks, Clay	7.43	9.36	4.41	6.89	Bricks, stones
Wood, linen	6.27	1.58	1.92	1.75	Timber, rags
Bone, shells	1.06	1.58	0.96	1.27	Bones, shells
Metal parts	1.02	0.79	0.38	0.59	Metal, tin cans
Glassware	0.31	2.07	0.77	1.42	Glass
Fine fraction	30.21	38.03	29.31	33.67	Sand and Dust
Moisture Content	67%	36.9%	43.3%	40.1%	Moisture Content