

## A.4 Noise Pollution Study

### A.4.1 Noise level and vibration level surveys

#### (1) Noise Standard

Vietnamese Standards (TCVN5949-1995) are shown below.

#### Vietnamese Noise Standards

(Unit: dBA)

Category of Areas	Period of Time		
	6h – 18h	18h – 22h	22h – 6h
Category I: Areas that need quietness such as hospitals, sanatoria, libraries, kindergartens and schools	50	45	40
Category II: Residential areas, hotels, administration offices, houses, apartment, etc.	60	55	45
Category III: Commercial and service areas	70	70	50
Category IV: Handicraft and light industrial manufacturing areas	75	70	50
Category V: Heavy industrial manufacturing areas	80	75	65

According to the regulation, all vehicle owners have to ensure that the noise level does not surpass the stipulated emission level as shown in Table A.4.1.

#### (2) Vibration Standard

Vibration pollution is not regulated by a national standard in Vietnam. The Vietnamese government prepared a guideline of permitted acceleration based on the environmental Protection Law in 1994. Acceleration of vibration of the whole body should not exceed the figures below.

#### Guideline of Permitted Acceleration

Category	Permitted Acceleration (m/s <sup>2</sup> )		Permitted Line Acceleration (m/s <sup>2</sup> )
	Vertical Vibration	Horizontal Vibration	
Category I	0.540	0.380	-
Category II	0.270	0.190	-
Category III	0.081	0.057	0.066
Category IV	0.054	0.038	0.045

Note: Category I: Vibration affecting driver's seat in vehicles that often operate on bad roads.  
 Category II: Vibration affecting driver's seat in different vehicles from Category I.  
 Category III: Vibration in industrial workshops, in surrounding areas, 15 meters from the main traffic ways.  
 Category IV: Vibration in areas different from areas in Category III.

Vibrations in each octave band are regulated as follows.

Vibrations in Each Octave Band

Octave Band (Hz)	Permitted Acceleration (m/s <sup>2</sup> )		Permitted Velocity (x10 <sup>-2</sup> m/s)	
	Vertical	Horizontal	Vertical	Horizontal
1 (0.7-1.4)	1.10	0.39	20.0	6.3
2 (1.4-2.8)	0.79	0.42	7.1	3.6
4 (2.8-5.6)	0.57	0.80	2.5	3.2
8 (5.6-11.2)	0.60	1.62	1.3	3.2
16 (11.2-22.4)	1.14	3.20	1.1	3.2
31.5 (22.4-45)	2.26	6.38	1.1	3.2
63 (45-90)	4.49	12.76	1.1	3.2

In general, the vibration level (dB), which corrects vertical vibration acceleration level with weighing of vibration sensation, is adopted for the standard of vibration pollution. As there is no standard of vibration level (dB) in Viet Nam, the permissible vibration level standard in Japan is presented below for reference.

Permissible Vibration Level Standard in Japan

(Unit: dB)

	Daytime (6:00h - 19:00h)	Nighttime (19:00h - 6:00h)
Residential areas	65	60
Commercial & Industrial areas	70	65

Source: Vibration Regulation Law in Japan)

### (3) Surveys

Noise monitoring is being conducted at many sites, such as urban traffic roads and industrial areas in Hanoi by DOSTE and the other organizations involved in environmental issues. In consequence, the JICA Study Team conducted a supplementary noise survey including vibration and traffic volume.

The objectives of the survey are to investigate and analyze noise and vibration, and to review the previous studies in order to appraise the present environmental conditions in Hanoi. Noise level and vibration level measurements were carried out at the same points as the above mentioned air quality survey (see Figure A.4.1). Portable noise and vibration level meters were used. Continuous

measurements of noise and vibration were conducted at the following five points every two hours for seven days from October 9 to 16, 1998.

- i) National road No.1 running nearby hospitals, railway and commercial area at Bach Mai
- ii) National road No.6 running nearby Thuong Dinh industrial area and National University at Thuong Dinh
- iii) National road No.5 running nearby Saing Dong industrial area, railway and commercial area at Gia Lam
- iv) National road No.3 running nearby commercial and housing area at Dong Anh
- v) National road No.3 running nearby a post office and housing area at Da Phuc

The contribution to noise and vibration caused by constantly running vehicles was examined. Traffic volume classified by vehicle type, was counted at intervals of 2 hours a day. The survey of traffic volume was conducted for 3 days on Monday, Thursday and Saturday respectively during the noise survey.

Regarding the method of evaluation for noise and vibration pollution, equivalent level (Leq) and level median (L50) is adopted for fluctuation noise level, while the upper value of 80% range level (L10) is used for fluctuation vibration level. Equivalent level (Leq) of noise level is calculated by the following formula.

$$L_{eq,T} = 10 \log \left\{ (1/N) (10^{L_1/10} + 10^{L_2/10} + \dots + 10^{L_n/10}) \right\}$$

Where,

T: Measurement period (s)

N: Number of measured value

$L_1, L_2, \dots, L_n$ : Measured value

As for vibration level, the method for converting vibration acceleration levels to vibration levels is presented as follows.

$$L_v = 20 \log (a/a_0)$$

Where,

$a_0 = 10^{-5} \text{ m/s}^2$  : Standard of vibration acceleration at 5 (Hz)

$a = (\sum a_n^2 * 10^{c_n/10})^{1/2}$  : Corrected vibration acceleration (m/s<sup>2</sup>)

$a_n$  : Measured vibration acceleration (m/s<sup>2</sup>)

$c_n$  : Weighing of vibration sensation (see a table below)

$n$  : Frequency (Hz)

Weigh of vibration sensation (vertical vibration) is presented below:

Weigh of Vibration Sensation

Frequency (Hz)	1	2	4	6.3	8	16	31.5	63	90
Weighing (dB)	-6	-3	0	0	0	-6	-12	-18	-21

#### A.4.2 Other surveys, data collection and interviews

Previous studies on noise and vibration in Hanoi are listed as follows.

- i. The master plan of urban transport for Hanoi City in January, 1997 (JICA)
- ii. Report on the current condition of the air environment in Hanoi City on July 1998 (DOSTE)
- iii. Report on analysis of air pollution at 6 industrial areas (10/11/12, 1997) DOSTE
- iv. Forecast of Hanoi Environmental Changing Trend – Proposal of Environmental Management System, 2000 (DOSTE, 1997)
- v. EIA Report of Tay Mo Solid Waste Disposal Site (MOSTE, 1998)
- vi. Report on Environmental Assessment and Proposal of General Methods to Mitigate Environmental Pollution in Hanoi (DOSTE, 1998)
- vii. Noise Survey Data for Factories and Traffic Roads, etc (DOSTE)

Results of the above mentioned previous studies are summarized in Tables A.4.2 to A.4.8 and locations of measured points are shown in Figures A.4.2 to A.4.4. Present conditions (1996) of urban traffic noise pollution and forecasted noise pollution (2000) are presented in Figures A.4.5 and A.4.6 respectively.

#### A.4.3 Findings

The following findings emerge from this study.

- i) In urban areas and areas along main roads, the results show noise levels in daytime are higher than the maximum of Vietnamese noise level standard by 3 to 18 dBA, and those in the nighttime are higher than the maximum level by 10 to 25 dBA.
- ii) In rural areas, such as Soc Son and Dong Anh districts, the results indicates that the noise levels still below the stipulated levels as shown in Tables A.4.6 and A.4.7
- iii) The result for the Thang Long area shows that noise pollution in rural areas is influenced by distance from the main road since noise level at point far from the highway dwindle as shown in Table A.4.8.

- iv) It is presumed that an instantaneous degree of influence of the horn noise is high since the horns of vehicles are observed to be used so frequently. Maximum noise levels in areas along the main roads are caused by horns, which the drivers use constantly.
- v) The Assessment Law prohibits the use of horns in densely populated residential areas between 11:30 and 13:00 and after 22:00. It is, therefore, necessary to improve the traffic flow and to educate drivers to decrease the use of their horns.
- vi) There is a large difference (more than 5 dBA) between  $L_{eq}$  and  $L_{50}$  at some points such as Nam Son, Doi Can and Nghia Do due to small traffic volumes.
- vii) The results show noise generated from factories does not affect living environment surrounding factories or industrial areas like Duc Giang (see Tables A.4.4 and A.4.5).
- viii) In Noi Bai area, the living environment is greatly affected by aircraft operations operation at the Noi Bai International Airport. In this area, there are no significant sources of noise except the activities at the air port, even taking account of road traffic. Data of noise level in Noi Bai area are summarized below.
- |   |              |
|---|--------------|
| - In case of no airplane operating:       | 54 dBA       |
| - In case of military plane flying over:  | 85 dBA       |
| - In case of military plane accelerating: | over 100 dBA |
| - In case of civilian plane taking-off:   | 80 dBA       |
- (Source: EIA report of NCI Vietnam Company in Noi Bai Industrial Zone)
- ix) Vibration levels  $L_{10}$  on the main roads in rural areas were not high as compared with Japanese standard, and were in the range 55 dB to 65 dB. Even in comparison with Vietnamese standard of the permitted vibration value that is estimated by amplitude of acceleration, the measured values are satisfactory.
- x) Vibration levels on main roads in urban area exceed both Japanese standard and Vietnamese standards. It is a matter of concern that vibration levels at houses located along the main road nearly reach the permissible limit for human tolerance.
- xi) Vibration pollution is caused mainly by operating machinery at factories or construction sites and traffic activities.

**Table A.4.1 MAXIMUM PERMISSIBLE NOISE LEVEL STANDARD OF VEHICLES****(Unit: dBA)**

	Category of Vehicles	Maximum Permissible Noise Level
1	Motorcycles Cylinder capacity of Engine: not exceed 125 cm <sup>3</sup>	80
2	Motorcycles Cylinder capacity of Engine: more than 125 cm <sup>3</sup>	85
3	Motorized tricycles	85
4	Car, Taxi and Passenger Vehicle with not more than 12 passengers	80
5	Passenger Vehicle with more than 12 passengers	85
6	Truck Maximum weight: not exceed 3.5 tones	85
7	Truck Maximum weight: exceed 3.5 tones	87
8	Truck Engine: more than 150 kW	88
9	Tractor or any other truck	90

Table A.4.2 Mean Values of Noise Level (dBA) at Thang Long Area

Street/Road	7:00 - 9:00			11:00 - 13:00			16:00 - 18:00			22:00 - 24:00		
	Noise		Vibration	Noise		Vibration	Noise		Vibration	Noise		Vibration
	Leq	L50	L10	Leq	L50	L10	Leq	L50	L10	Leq	L50	L10
a. Hue	75	72	51	77	73	51	78	74	45	71	67	36
b. Ba Trieu	73	69	51	75	70	52	75	72	49	67	63	48
c. Trang Thi	73	68	47	74	70	45	76	72	46	68	61	45
d. Giai Phong	79	77	47	76	73	55	77	75	51	72	66	47
e. Giang Vo	75	73	51	75	73	54	76	73	51	69	65	51
f. Kim Ma	78	74	47	79	75	49	79	74	47	69	64	49
g. Doi Can	78	72	51	75	70	50	74	71	46	70	61	50
h. Nghia Do	78	73	47	78	71	50	79	74	49	68	59	45
i. Nguyen Luong Bang	79	76	47	79	74	51	80	77	51	73	68	51
k. Lang Ha	77	72	50	77	72	52	79	73	50	72	65	50

(Source: The Master Plan of Urban Transport for Hanoi City by JICA 1997, Measured Date: January 1996)

Table A.4.3 Mean Values of Noise Level (dBA) & Vibration Level (dB)

No.	Street/Road	Measurement Date		1992		1992-1993		27.3.1995	1.1996
		Hourly Traffic Volume (Number/h)	Leq	Hourly Traffic Volume (Number/h)	Leq	Hourly Traffic Volume (Number/h)	Leq	Leq	Leq
1	Chuong Duong - Nguyen Van Cu	4,087	76-77						
2	Tran Quang Khai	3,009	78-79						
3	Tran Khanh Du	1,185	73-74						
4	Ba Trieu	2,085	78-79						
5	Dien Bien Phu	4,068	73-74						75
6	Nguyen Thai Hoc	2,927	73-74						
7	Le Duan (Railway Station)	3,016	74-75						
8	Le Duan (Le Nin Park)	3,253	75-76						
9	Giai Phong	4,418	76-77						
10	Bech Mai	3,340	74-75						
11	Dai La - Mai Dong	1,755	78-79						
12	Truong Chinh	1,307	78-79						
13	Nguyen Luong Bang	4,788	74-75						80
14	Nguyen Trai	4,659	77-78						
15	Hung Vuong (Hoang Van Thu-Phan Dinh Phung) (Phan Dinh Phung-Quan Than)					1,942			
						1,789			
16	Thanh Nien (Quan Thanh-Pho Duc Chin) (Pho Duc Chin-Yen Phu)					1,716			
						2,202			
17	Le Thai To (Trang Thi-Hang Trong) (Hang Trong-Dinh Tien Hoang)					2,199			
						1,567			
18	Dinh Tien Hoang (Hang Gai-Hang Dau) (Hang Dau-Le Thach) (Le Thach-Trang Tien)					2,611			
						3,366			
						3,598			
19	Puan Chu Trinh (Nha Hai Lon-Tran Hung Dao) (Tran Hung Dao-Lo Duc)					2,156			
						1,873			
20	Tay Son (So Intersection)								
29								79.1-84.9	

(Source: DOSTE)



Table A.4.4 Mean Values of Noise Level (dBA) at factories and Industrial Areas

Name of Factories/Industrial Areas (Measured Date)	Name of Measured Points	Mean Values of Noise Level (dBA)		
		Lmin	Lmax	Laverage
Dong Anh Electrical Equipment Manufacturing Plant  (January to March 1998)	1 Transfer Shop	87	96	90
	2 Mechanical Shop	89	100	94
	3 Alluminium Cable Shop	92	104	98
	4 Electric-mechanic Shop	81	104	92
	5 Surrounding Area			
	- During working hours	54	79	69
	- Out of working hours	48	68	58
Advanced Building Systems Manufacturing Factory in Noi Bai Industrial Zone  (31.3.1998)	1 09:00			62
	2 10:00 (Plane taking off)			80
	3 10:10			72
	4 11:15			75
	5 12:00			73
	6 12:30			75
Gia Lam Industrial Area  (27.8.1998)	1 Duc Giang 1			54
	2 Duc Giang 2			50
	3 Duc Giang 3			50
	(around Factories)			
Thuong Dinh Industrial Area  (measuring time: 8:00 to 16:00)	Average of 7 points			
	1 on 15-18.10.1997	60	75	65
	2 on 17-20.11.1997	60	78	76
	3 on 8-12.12.1997	60	75	68
	4 on 15-17.12.1997	70	76	75
Mai Dong Industrial Area  (measuring time: 8:00 to 16:00)	Average of 7 points			
	1 on 15-18.10.1997	68	76	71
	2 on 17-20.11.1997	60	78	73
	3 on 8-12.12.1997	68	70	69
	4 on 16-17.12.1997	68	72	71
Van Dien Industrial Area  (measuring time: 8:00 to 16:00)	Average of 7 points			
	1 on 15-17.10.1997	65	80	70
	2 on 17-20.11.1997	65	70	68
	3 on 8-11.12.1997	68	75	69
	4 on 16-17.12.1997	65	78	69
Cau Dien Industrial Area  (measuring time: 8:00 to 16:00)	Average of 7 points			
	1 on 15-18.10.1997	65	72	68
	2 on 17-20.11.1997	70	80	75
	3 on 8-11.12.1997	60	70	68
	4 on 16-17.12.1997	63	70	69
Phap Van Industrial Area  (measuring time: 8:00 to 16:00)	Average of 7 points			
	1 on 15-17.10.1997	55	70	65
	2 on 17-20.11.1997	68	78	73
	3 on 8-12.12.1997	70	72	71
	4 on 16-17.12.1997	68	70	69
Chem Industrial Area  (measuring time: 8:00 to 16:00)	Average of 7 points			
	1 on 15-17.10.1997	65	70	68
	2 on 17-19.11.1997	60	78	73
	3 on 8-12.12.1997	68	75	69
	4 on 16-17.12.1997	68	70	69

(Source: DOSTE)

**Table A.4.5 Mean Values of Noise Level (dBA) at factories**

	Name of Factories	Mean Values	Compared to VNTS
1	Winter Textile & Sewing Factory	64-80	Light pollution
2	Hanoi Paint Enterprise	66-77	Non pollution
3	Hanoi Needle Enterprise	63-84	Light pollution
4	Hanoi Brewery Factory	67-69	Non pollution
5	8-3 Textile Factory	64-82	Light pollution
6	Pharmacochemistry Enterprise	67-72	Non pollution
7	Minh Khai Lock Factory	68-80	Light pollution
8	South East Asia Brewery Factory	68-76	Non pollution
9	Duc Giang Chemical Enterprise	67-71	Non pollution
10	Van Dien Fertilizer Factory	61-83	Light pollution
11	Hanoi Glass Factory	69-75	Non pollution
12	To Chau Dye Enterprise	68-73	Non pollution
13	Thanh Tri China Company	63-79	Non pollution
14	Central Drug Company	65-80	Light pollution
15	Duc Giang Verminfuge Company	63-76	Non pollution

(Source: DOSTE, Measured Date: End of 1997)

Table A.4.6 Mean Values of Noise Level (dBA) at Nam Son Landfill Site

Time	Existing Data (URENCO, 1997)												URENCO			JICA Study					
	N1			N2			N3			N4			N5			N6 (13.3.1998)			N7 (23-24.10.1998)		
	Leq	Lmax	L50	Leq	Lmax	L50	Leq	Lmax	L50	Leq	Lmax	L50	Leq	Lmax	L50	Leq	Lmax	L50	Leq	Lmax	L50
10h - 11h	49	73	44	57	81	49	50	70	41	52	69	43	50	70	41				44	85	42
11h - 12h	52	69	46	51	69	43	44	68	39	51	69	43	44	68	39				45	85	42
12h - 13h	49	72	43	49	70	43	51	72	41	49	70	42	51	72	41				38	84	37
13h - 14h	49	72	42	48	66	44	49	64	42	56	78	47	49	64	42				34	80	32
14h - 15h																			32	79	32
15h - 16h																54	59	42	38	84	34
16h - 17h																			43	78	38
17h - 18h																			42	80	40
18h - 19h																			42	77	39
19h - 20h																			39	77	37
20h - 21h																			36	79	34
21h - 22h																			34	68	33
22h - 23h																			33	65	31
23h - 24h																			33	67	31
0h - 1h																			31	65	31
1h - 2h																			31	34	31
2h - 3h																			31	66	31
3h - 4h																			33	77	31
4h - 5h																			33	79	32
5h - 6h																			34	79	32
6h - 7h																			40	83	35
7h - 8h																			45	85	42
8h - 9h																			52	86	42
9h - 10h	49	74	45	49	69	44	49	72	41	51	71	42	49	72	41				40	84	38

Table A.4.7 Mean Values of Noise Level (dBA) at Tay Mo Landfill Site

Measured Point	Time	Mean Values of Noise Level (MOSTE, March 1998)								
		Leq			Lmax			L50		
Entrance of Site	5:00	65	63	62	78	78	79	63	64	63
	9:00	78	79	78	80	102	80	78	78	78
	11:40	83	78	77	92	90	79	81	76	76
	21:00	99	92	87	117	119	115	90	87	89
	Average		77			95			64	
Landfill Site	5:00									
	9:00	68	66	66	84	82	85	68	67	60
	11:40	80	77	76	85	87	88	74	77	79
	21:00									
	Average		61			79			65	
Residencial Area at 400 m far from Site	5:00	50	54	53	66	62	63	52	53	51
	9:00	69	57	57	77	78	78	54	52	54
	11:40	57	57	56	81	77	75	50	52	51
	21:00	67	67	66	79	80	79	65	64	63
	Average		59			78			55	

Table A.4.8 Mean Values of Noise Level (dBA) at Thang Long area

Time	Dai Mach Village		Khu Vuc Village		Near Highway	
	11-12.1.1997		9-10.1.1997		9-19.1.1997	
	Leq	Lmax	Leq	Lmax	Leq	Lmax
1h	57	57	55	57	51	73
2	55	56	55	55	53	80
3	53	53	54	55	47	77
4	54	55	53	53	50	74
5	39	40	43	44	51	75
6	42	43	51	49	57	81
7	47	48	51	53	71	87
8	46	47	48	50	71	97
9	48	50	46	49	71	89
10	53	55	44	48	71	88
11	52	54	44	47	67	81
12	47	48	57	60	65	76
13	48	48	43	47	76	98
14	54	55	38	45	70	92
15	49	41	45	47	74	91
16	43	44	43	45	72	89
17	41	42	41	43	70	82
18	40	42	47	49	73	81
19	41	42	46	49	69	83
20			48	50		

(Source: DOSTE)

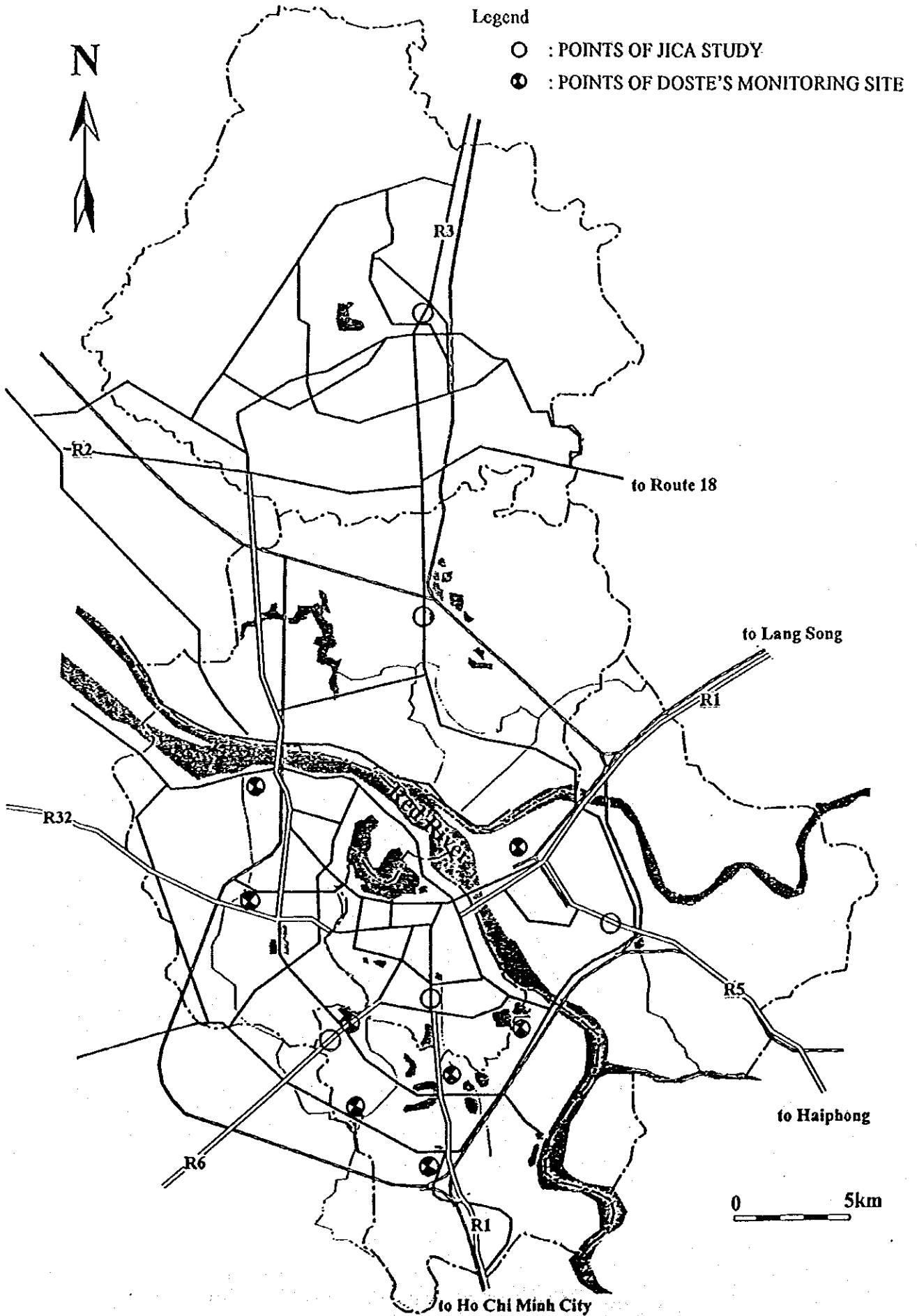


Figure A.4.1 LOCATION OF NOISE & VIBRATION SURVEY POINTS

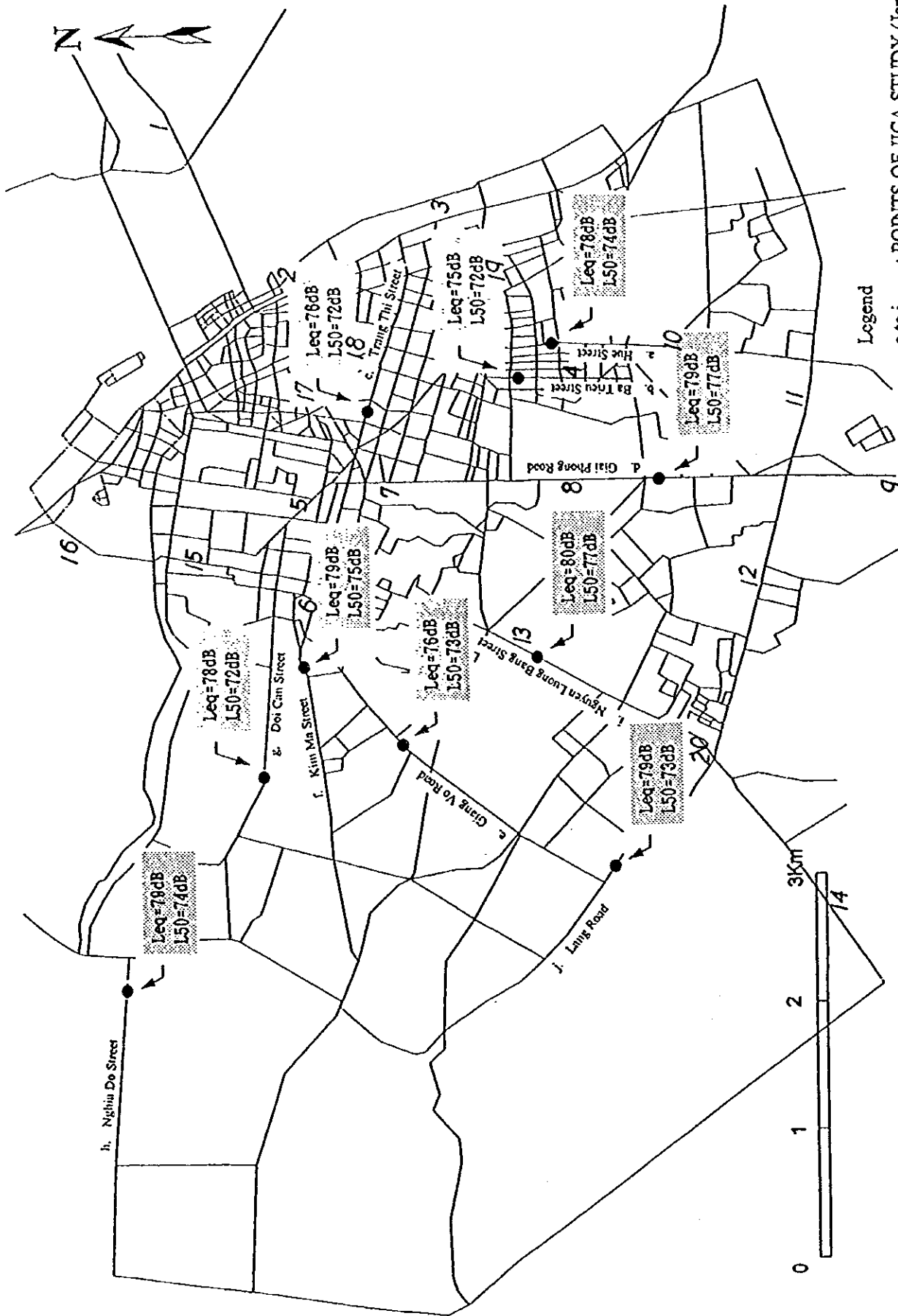


Figure A.4.2 MEASURED POINTS OF TRFFIC ROADS

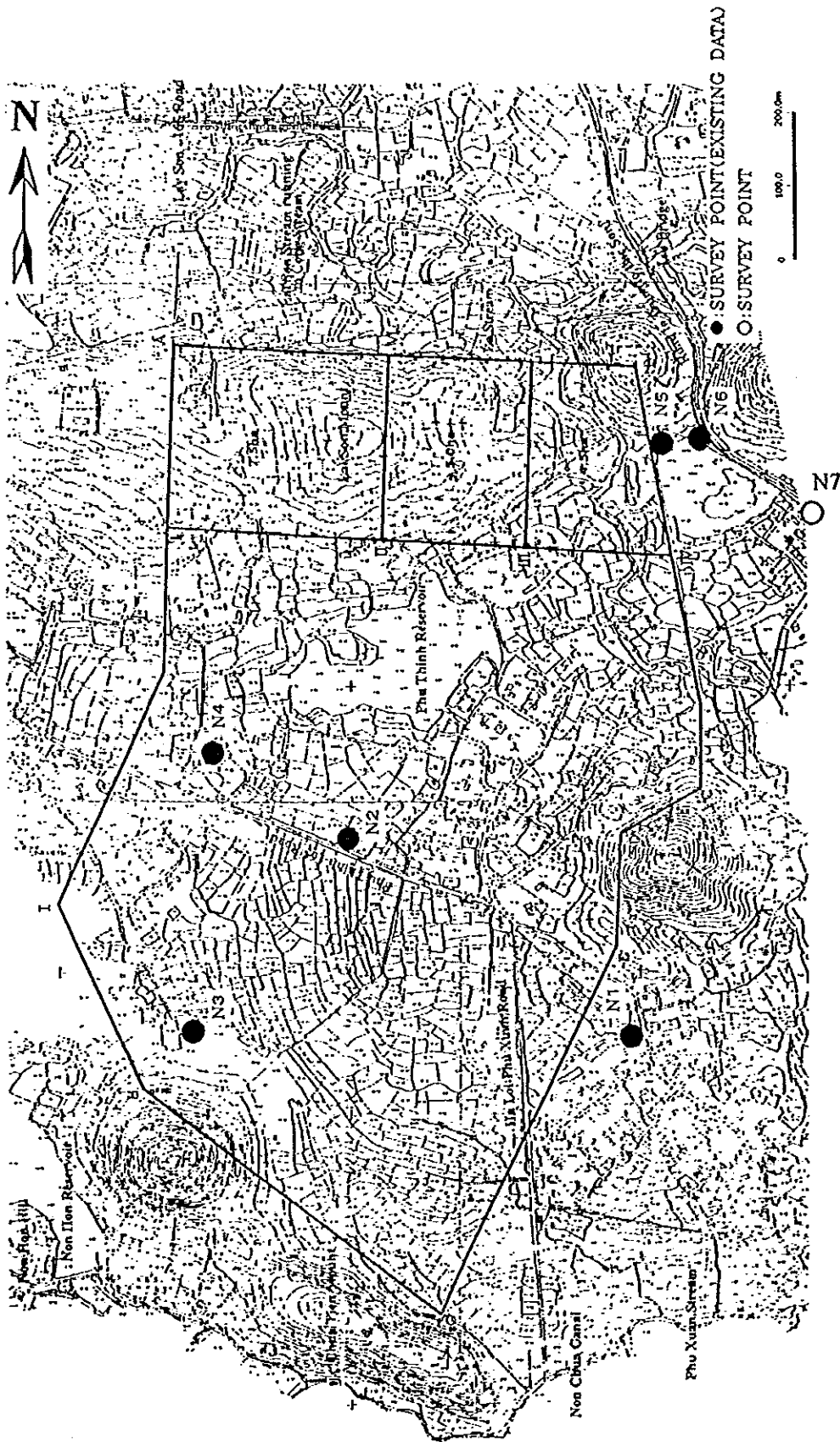


Figure A.4.3 SURVEY POINTS AT NAM SON



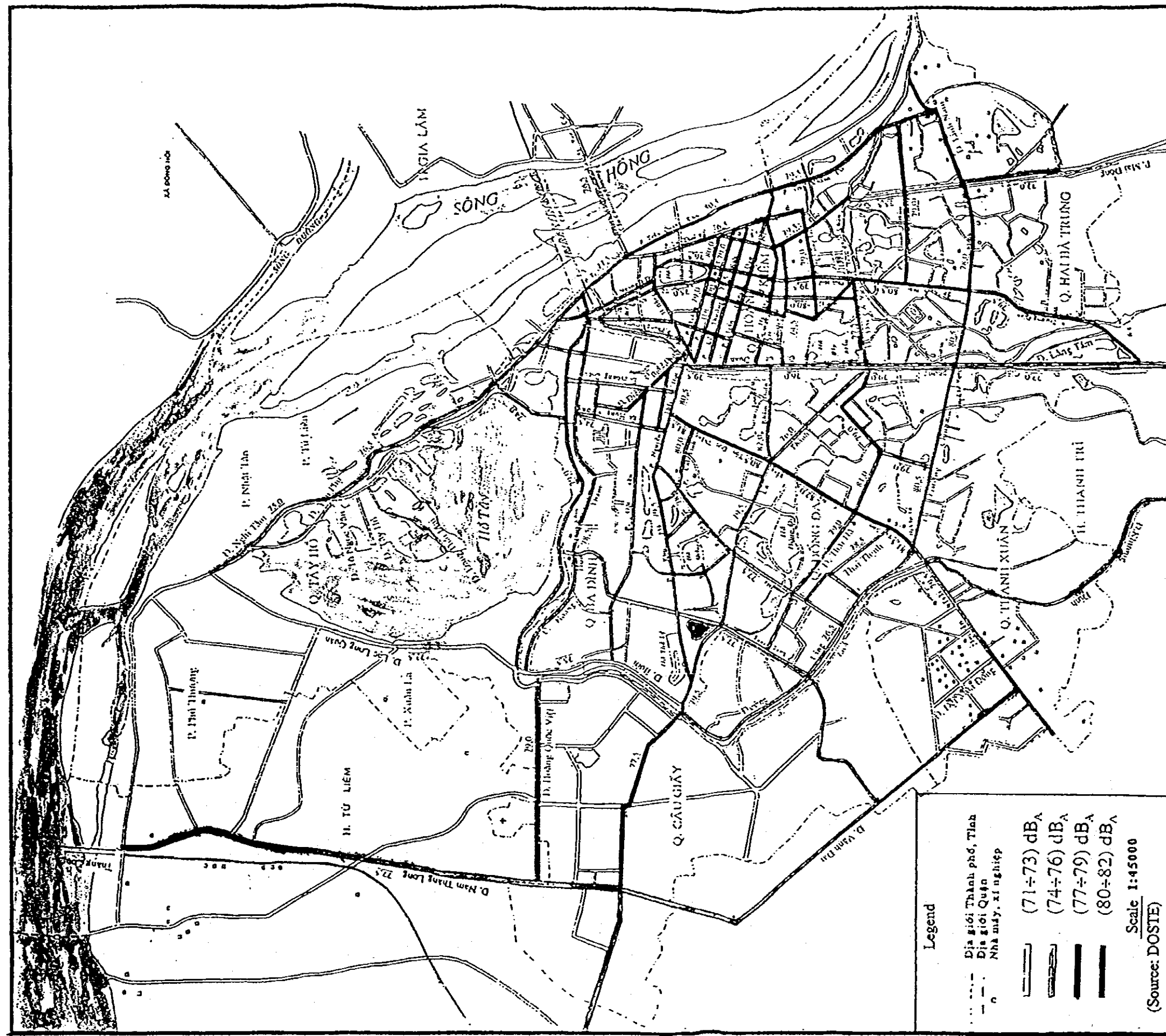


Figure A.4.6 Forecasted Urban Traffic Noise Pollution (2000)

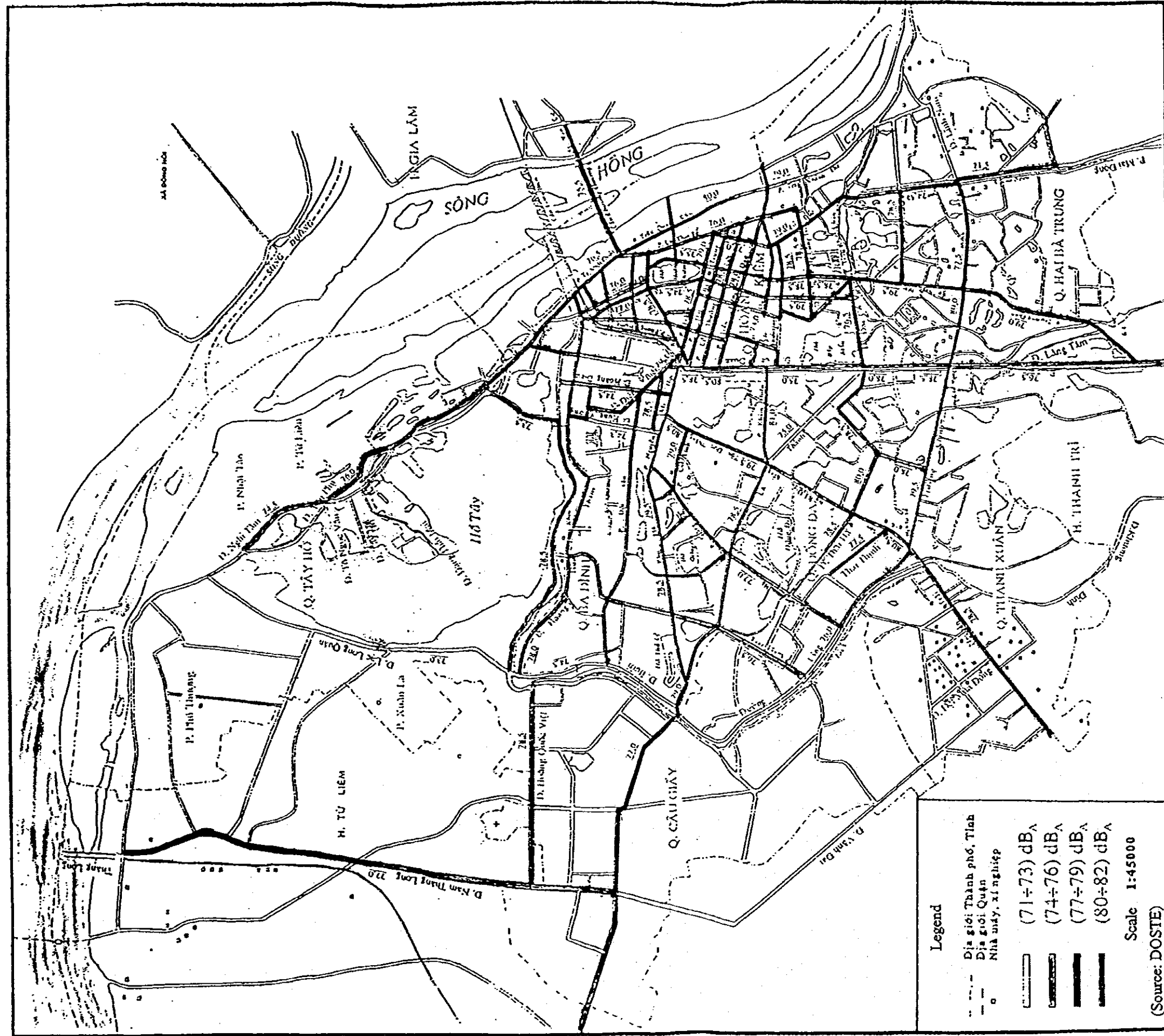


Figure A.4.5 Present Conditions of Urban Traffic Noise (1996)

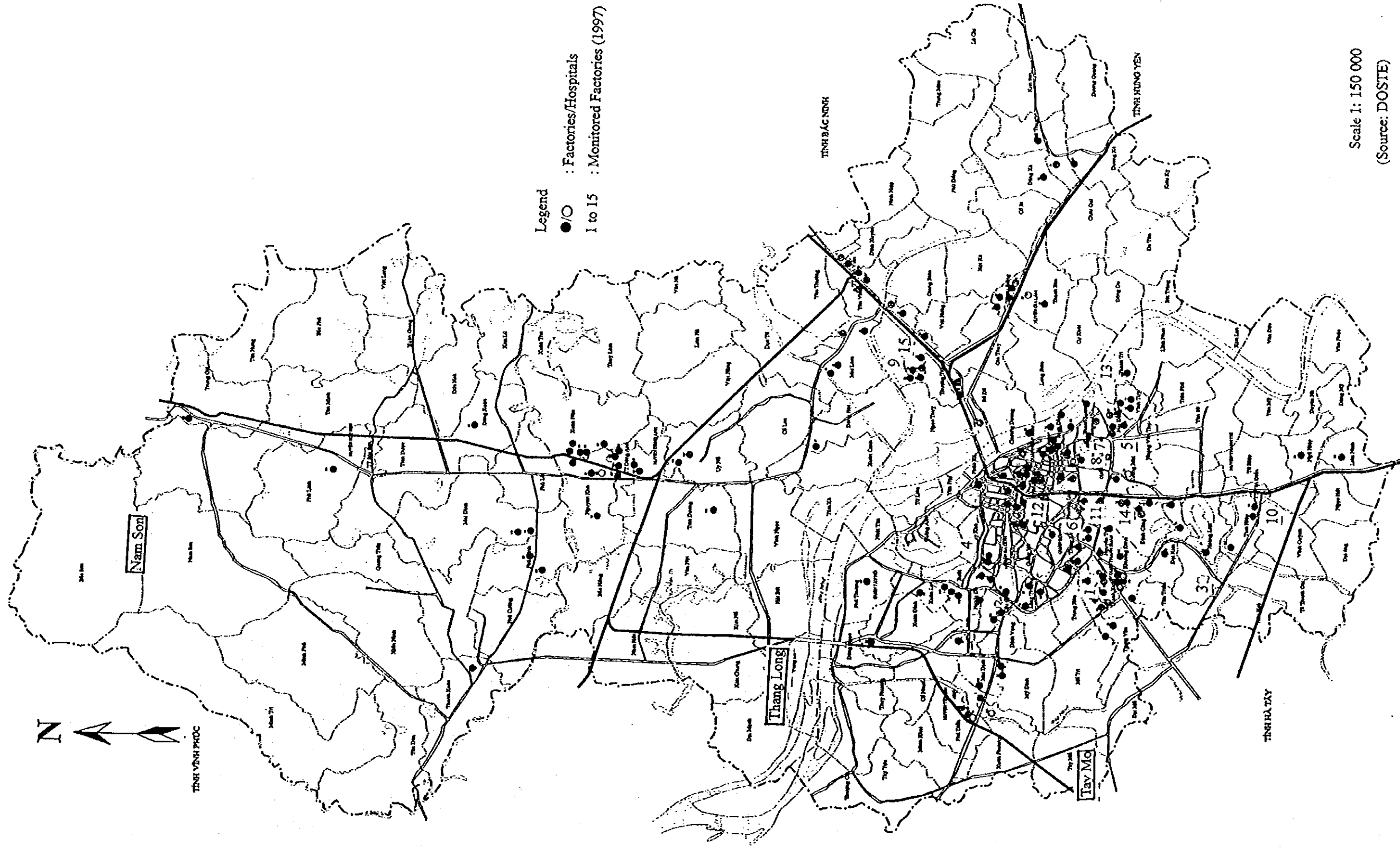


Figure A.4.4 LOCATION OF EXISTING FACTORIES

## **A.5 Land Use Study**

### **A.5.1 Land Use Survey**

Composed of field reconnaissance, analysis of satellite and aerial photos, and referring to the latest land use map made and published by the Cartographic Distributing Center, the land use study was done in both Japan and Vietnam during the first study period in Vietnam, and will be continued for further analysis and mapping in Japan until the end of February 1999.

The main purpose of the study is to formulate a general image of land use in Hanoi as a whole for convenience of the whole study. Accordingly, it had been required that the preliminary result of the study was arranged as early as possible. The land use survey and photo analysis were mostly done intensively in September and October 1998.

Land use survey based on field reconnaissance was done for more than three weeks. Since it was impossible to visit and observe the whole area of Hanoi in such a short time, the survey was done along trunk and main roads in all of 12 districts, and along the Red River, Duong River, and To Lich River as well. The survey was encompassed Pho Noi (outskirt of eastern part of Hanoi along Route 5), Tan Dan and Thuong Cat (western edge of Hanoi), Lien Ninh (southern margin of Hanoi), and Bac Son (northern edge of Hanoi). In addition, several specific places related to solid waste management were observed, including Nam Son, Tay Mo, Lam Du, and so on. Total distance of the survey trip was more than 1,000 kilometers.

Besides obtaining first hand information by direct observation, preparatory analysis of satellite photo was also reconfirmed and/or amended in the survey. Meanwhile some candidate locations for transfer stations for solid waste transport were listed through the survey.

### **A.5.2 Analysis of satellite photos and aerial photos**

#### **(1) Method and Execution**

According to published the Statistic Year Book 1997, the City of Hanoi has 2.3 million population, and some 920 square kilometers of its jurisdictional area. Recently Hanoi has experienced rapid urban development with a high economic growth rate, e.g. 11 percent increase in GRP in both 1995 and 1996. Up to date topographic maps and aerial photos of Hanoi were only available for 1989 and 1994 respectively. Only the satellite image data on 16<sup>th</sup> October 1996 were available and used as the latest basic information, and the data on 21<sup>st</sup> October 1992 were used as a supplementary material.

The satellite images in 1996 are from the United States' LANDSAT 5 which carries the Multi Spectral Scanner (MSS) and the Thematic Mapper (TM) sensors and turns around the sun synchronous orbit at 705 kilometers of altitude with a 16 day 233 orbit repeat cycle. The TM sensors provide images in 7 spectral bands and a high spatial resolution of 30 meters.

Analysis of digital satellite data was done from geometric correction as the first procedure adapted to treat the geometric distortions in a satellite image for the purpose of registering with another image or map. In this study a Non Systematic Correction method was applied using polynomial functions determined from well distributed ground control points selected from scanned topographic maps. Then the data were thrown into different classes of land cover (Image Classification), the process of assigning pixels to classes, in this case each pixel covering 30 meters by 30 meters of spatial unit. Image Classification can be achieved by one of following procedures:

1. Unsupervised classification: without use of ground info. /mathematical model
2. Supervised classification: using samples of known identity

The supervised classification with maximum likelihood statistical classifier made the best result in this study among other classifiers such as ISO clustering method, multi-level slice classifier etc.

The classified image as geographic information collected in a variety of forms of maps, documents, tabular sheets, photos and so on are eventually converted into digital form and stored in the computer database. These data are standardized geographically in terms of a coordinate system, map projection, and spatial accuracy prior to further processing and analysis. At this stage of the processing output can be easily made through Geographic Information System (GIS) for instance. Once the information is captured in the GIS, high quality thematic maps can be realized in accordance with the user's requirements such as emphasis, modification, and visual presentation by graphical display.

Collected raw data and information for the analysis work at the initial and beginning stage were as shown below.

Collected materials for the satellite image analysis

	Specifications	Scale	Year	Remarks
1)	TM images	30mx30m pixel	1992,1994	Landsat5
2)	TM images	30mx30m pixel	1996	Landsat5
3)	Topographic maps	1:10,000	1989	National Department of Measurement & Mapping
4)	Land use map	1:50,000	1995	Cartographic Distributing Center, amended in 1998
5)	Land cover map		1993	JICA
6)	Hanoi Atlas	diverse	1997	The Gioi publishers

As preliminary analysis of satellite images the following tasks were done.

- Separation of digital images of Hanoi area from the quarter scenes of the Landsat images 1992 and 1996
- Scanning of the topographic map with scale 1:10,000 to do geometric correction of the images and to rectify the images to the UTM map projection
- Comparing Landsat TM images 1992 with the land cover map 1993 to identify whether there is possible relation between spectral band ratios computed using satellite digital band data and land use classification namely, residential, commercial, industrial and so on by their characteristic type of physical development

However, in the case of Hanoi it was not possible to classify the urban area into such a classification in this manner by their spectral characteristics. Hence TM images 1992 were classified into urban, village residential, agriculture/fishery, forest/green, water surface and other uses. The land use map 1993 and true color satellite image 1992 were used to obtain the necessary ground actualities for this supervised classification. Similarly TM images 1996 were classified into the same categories. The urban area (7 districts) was further divided into residential, mixed use (residential with commercial/business), industrial, public services and infrastructure using digitized GIS (Geographic Information Systems) data. The areas of scattered clouds were masked and excluded from the analysis and areas of thin clouds (haze) were treated separately.

The preliminary result of the image analysis was verified by a field survey. It was conducted in both the seven urban districts and in the five rural (suburban) districts. GPS was used in this survey. The actual ground conditions during September 1998 were observed and photographed. The causes of some confusion at the preliminary classification land use were, due to the temporal and spatial change in land cover close to the harvesting period of the extensive paddy lands in

the rural districts, and due to the unique pattern of urban land use in the urban districts, proved through the reconnaissance.

Other relevant documents and information were used such as the Hanoi Master Plan 2020 (Report, as of June 1998), a map showing industrial zones in Hanoi, the rainfall data of 1992 and 1996 to coincide with the year of each satellite images.

Well distributed ground control points were chosen by scanning the topographic maps in a scale of 1:10,000 covering the whole city area, and used to rectify the satellite images more accurately to a common UTM map projection. Field notes and true color satellite images were used to classify the satellite images 1996. The land cover map 1993 and true color satellite images were used to classify the satellite image 1992. Both the images were classified into specific categories set based on the Study Team's study policy.

Data sets of roads, railways, rivers, administrative boundaries, were produced by digitizing the land use map 1995 (amended in 1998) in scale of 1:50,000. Data sets of detailed urban land use were produced by digitizing from Hanoi Atlas 1997. These spatial data integrated with the results of the remote sensing analysis within a GIS database by ARC/INFO software were used to produce the present land use map of Hanoi (draft). At the moment the land use map includes most of the important information, however there are still some points to be amended like mixed residential use, industrial, rural residential etc., continuous data collection is done for that purpose by the Study Team in Hanoi. Meanwhile a base map of Hanoi has been prepared to a scale of 1:50,000 which shows main roads, railways, rivers, lakes, and boundaries of municipal jurisdiction, districts, precincts and communes in digital form.

## (2) Preliminary Result of Land Use Survey

The present land use in the 12 different districts within the city computed will be shown in the Interim Report I. The statistical data above are shown here. Vietnamese Land Administration Regulation classifies land use into 5 categories followed by 26 sub-categories. This categories do not show any classification of "Industrial use", "Public Services use", "Commercial use", and "Mixed residential with commercial/business use (Mixed use)". Despite the fact that "mixed use" is prominent in the central city area of Hanoi, this type of land use is put in one category all together with "industrial", "public services", and "commercial" as "Land for Construction". Hence the Study Team re-categorized land use in accordance with purposes of the JICA Study as follows:

### 1) Residential:

*Detached house, row house, Multi-storey house both in urban and rural area*

2) Mixed Residential with Commerce/Business (Mixed):

*Shop or Home Industry with residence (mostly along streets)*

3) Commercial/Business:

*Large shop, Market, Restaurant, Hotel, Amusement, Office building*

4) Industrial:

*Manufacturing, Material production, Mining, Warehouse*

5) Public Services:

*Governmental offices, Military ' s facilities, School, Religious buildings,  
Hospital, Hall, Museum, Monuments, Stadium*

6) Infrastructure:

*Road & Street, Railway, Bridge, Airport, Port, Electricity stations, Drainage  
& Irrigation, Water supply, Waste treatment site*

7) Agriculture/Fishery:

*Cultivated field, Horticulture, Animal husbandry, Grass field, Fishery  
related*

8) Forestry/Green:

*Forest, Park, Cemetery, Botanical garden*

9) Water surfaces:

*River, Lake, Pond, Swamp, Lagoon*

10) Other use:

*Stock yard, Parking, and Miscellaneous*

Calculation of the area by use based on the above categories is not easy to do precisely because of the condition of the base- map at the moment when supplementary survey is still going on. In this progress report neither the map nor the table are available to present yet.



Present Land Use in Hanoi

	Agricultural	Forestry	Const-ruined Super-structure	Road/ Railway	Water way	Military	Other specific	Residential	Water surface	Unused	Total (ha)
Ba Dinh	23	0	203	123	90	91	50	329	1	20	930
Dong Da	34	12	285	97	49	20	14	476	0	0	987
Hoan Kiem	0	0	114	120	7	23	20	215	29	1	529
Hai Ba Trung	110	0	352	167	74	19	16	588	129	10	1,465
Tay Ho	1,180	0	121	113	40	21	39	283	568	28	2,394
Thanh Xuan	145	0	172	68	19	141	44	300	9	15	913
Cau Giay	440	0	235	106	39	63	31	229	28	24	1,195
Tu Liem	4,126	15	516	394	383	162	185	953	679	102	7,515
Thanh Tri	5,386	0	615	480	599	130	309	1,203	867	207	9,796
Gia Lam	9,192	59	902	1,142	1,269	403	313	1,707	1,921	377	17,285
Dong Anh	9,856	5	911	1,027	1,145	59	476	2,082	2,275	335	18,172
Soc Son	12,949	6,658	1,202	1,256	1,593	836	87	3,135	954	851	29,521
Urban	1,932	12	1,482	794	318	378	214	2,420	765	98	8,413
Suburban	41,509	6,737	4,146	4,299	4,990	1,590	1,370	9,080	6,696	1,872	82,289
Total	43,441	6,749	5,628	5,093	5,308	1,968	1,584	11,500	7,461	1,970	90,702

Source: Land Area Statistic by precinct/commune 1998, Hanoi Department of Land Administration

According to the satellite analysis the total area of Hanoi was 94,177ha among which water surface area of Hong River and Duong River were 2,768ha and 605ha respectively. This means that the area of Hanoi excluding the two rivers' surface area was 90,804ha, while the above table shows 90,702. The measurement error is 0.1 percent based on the statistical data. It is not clear which figure represents actuality so far, because some sand bars (small islands in the Hong River) vary their shape every year. In addition, many ponds are sometimes dry and other times wet, which affects satellite data directly, also the boundary of Hanoi jurisdiction is not shown precisely on the topographic map particularly in case of the boundary line on rivers at Soc Son district and Gia Lam district.

### A.5.3 Future Land Use Plan in Urban Master Plan for Hanoi to 2020

The updated Urban Master Plan for Hanoi to 2020 was unveiled with its maps to the JICA Study Team. The description shown below is including some extracts of the latest version of the Plan because time required for review is quite limited at the moment.

The amendment of Hanoi Master Plan by 2000 was approved by the Council of Ministers (now Prime Minister) in Decision No. 132/CT dated 1992. During the implementation process, there have been a lot of changes both socially and economically. In view of a rapid increase of development by both domestic and foreign investors, the projected frame work for condition of infrastructure, land use management, superstructure and architecture management etc. in the former master plan has become outdated.

Based on the above situation, The Ministry of Construction and People's Committee have already submitted the Document No.26/UBTP – BXD dated 24/4/1996 requesting approval of the amendment to the Hanoi master Plan by 2020. The amendment was passed by the Prime Minister and the Executive Council of Political Bureau at the Circulars No. 78/TB dated 4/10/1996 and No.10/TB – TW dated 20/10/1996 respectively. In order to implement the instructions in these Circulars, Hanoi People's Committee and the Ministry of Construction have cooperated with the Ministry of Planning and Investment, the Ministry of Transportation and Communications, the Ministry of Agriculture and Rural Development, the Ministry of Science, Technology and Environment, other ministries and branches, related provincial People's Committees and in cooperation with many local and international consultant organizations, urban planning experts in Vietnam and foreign countries including USA, Japan, Holland, Australia, and Korea to finalize all the revised "General Planning of Hanoi Capital" till the year 2020 and have it submitted to the Prime Minister for consideration and approval.

In reply to the submission, the Prime Minister approved the revision basically in June 1998. The approval has been followed by the approval the Amendment Team to formulate further detail plans by every sector, location and year. The Amendment Team consists, at practical study level, National Institute for Urban and Rural Planning belonging to the Ministry of Construction, Hanoi Chief Architect's Office, Hanoi Transport and Urban Public Works Service (TUPWS), Hanoi Department of Science, Technology and Environment (DOSTE), and other experts at various national institutes, universities and Hanoi People's Committee (HPC).

(1) Overall Objectives

The general objectives of the revised "General Planning of Hanoi Capital City" to the year of 2020 are the renovation and construction of Hanoi into a modern city, a political, economic, cultural and scientific center, and an international communication hub. It is intended to make it an appropriate capital city for a country with a population of 100 million, which will play a significant role in South East Asia, in the 21<sup>st</sup> century.

(2) Specific Objectives

1) Development Direction

A series of Hanoi urban town clusters will be developed, consisting of Hanoi capital and surrounding towns in Ha Tay, Vinh Phuc, Bac Ninh, and Hung Yen provinces. In the immediate future, preference will be given to the development of the northern area of the Red River to make full use of the investment and construction of concentrated industrial parks, international air terminals, highways No.1, No.5, No.18, Cai Lan River ports in compliance with programs and projects of great national significance.

The development of other towns on the west and north of Hanoi aims at fully exploiting the advantages of natural geographical features and communications.

2) Population Size

The population of Hanoi urban town clusters to the year of 2020 shall be between 4.5 and 5 million, including that of the central city 2.5 million. Specially there will be reduction of 800,000 inhabitants in places where development is to be limited (from the 2nd ring road inward).

3) Land Use

The prescribed average land use shall be 100m<sup>2</sup> per capita for the central city and attention shall be paid to the allocation of more land for transportation services, green parks and public facilities in compliance with the standards of a new and modern city.

4) Infrastructure

There will be a gradual construction of comprehensive solid structures to modernize the communication system of land and waterways of public transportation facilities, of electricity supply, of water and sewerage, of telecommunications etc. to attract more investment for the economic

investment and urban development and to provide proper national defense and security.

(3) Natural Feature on the Master Plan 2020

Data are under processing at the moment.

(4) Orientation for Readjustment of the General Planning of Hanoi 2020

The previous study and design of the General Plan was mainly for the inner city consisting of 4 inner districts and a number of suburban districts of local area amounting to nearly 1,000km<sup>2</sup>.

The scope in the readjusted plan has been now enlarged to surrounding areas including those under the authority of Ha Tay, Vinh Phu, Ha Bac and Hai Hung provinces with an influence radius from 30 to 50 km, a territory to be closely related to the shaping and development process of Hanoi urban conglomerations and town clusters, all of a total area amounting to nearly 7,860km<sup>2</sup>.

The Decision No.677/TTg on 23 August 1997 by the Prime Minister ratifying the General Plan for Economic and Social development in the Red River Delta to the Year of 2020 clearly expressed the objective of transforming the economic structure to increase the industrial and service ratio and to decrease the share of the agricultural sector in GDP.

Hanoi will be a very active point in the key economic area in the North in which the industrial and services sectors play the leading role.

The motive force in Hanoi Capital in the following years will be mainly the non material sectors such as services, tourism, trade administration and management, training and education, science and technology, as well as the infrastructure sectors such as industry, basic construction, agriculture and forestry.

(5) Characteristics

Resolution No.08/BCT on 21 January 1983 by the Political bureau already confirmed that "Hanoi will be the political, cultural, scientific and technological center and at the same time the great hub of economic transactions and international exchanges for the whole country."

Hanoi City will be the nucleus, the core for the development for the whole Hanoi urban conglomeration and town clusters, the focus on main economic-technical facilities providing a motive force to the development of the Hanoi areas, of North Vietnam and of the whole country.

Surrounding towns will include urban conglomerations and town clusters acting as "counter weight" and satellite towns, they will be reserve space for Hanoi extension, they will play the role of regulator to the development of the central city, they will accelerate the urbanization process of rural areas depending on their locations and their specific conditions and they will join in the division of functions with the central city to make urban conglomerations and town clusters in Hanoi area.

#### (6) Population Size and Its Distribution

The current population of Hanoi City accounts only for 8.1% of the urban populace and 17% of the population in the Red River Delta. This shows that the urbanization process in the Red River Delta in general and in Hanoi particularly is still significantly low. With a GDP growth rate of 14% in the immediate future, the urbanization rate must be at a rate of 4% per year, which forecasted by ESCAP.

The population distribution in the Hanoi group of urban town clusters is based on the principle to select Hanoi as a center, playing the role of a core for whole the region, to establish independent towns acting as "counter weights" to the central city, all of them connected together by a system of express transportation to ensure a shuttle system with travel time between towns of less than 45 minutes. There will be a ring to delineate the area within which where development will have to be limited and where satellite towns and rural town clusters with similar way of living can be established.

The Master Plan shows The planned population frame till 2020 as follows.

**Population Assumption and Its Distribution in Hanoi Area**

	Classification of Area	Current Population	Assumed Population	
			Yr. 2005	Yr. 2020
I	Hanoi Capital	1,312,000	1,725,000	2,500,000
1.1	Development Restricted Area (DRA)	900,500	839,000	800,000
1.2	Development Extend Area in Red River-Right bank (out of DRA)	322,000	566,000	700,000
1.3	New Development Area in Red River-Left bank (northern)	89,500	320,000	1,000,000
II	Other Urban Conglomerations and Town Clusters	85,000	390,000	1,500,000
2.1	Group of Towns: Mieu Mon-Xuan Mai- Hoa Lac- Son Tay	54,000	280,000	1,000,000
2.2	Group of Phuc Yen and related towns	31,000	110,000	500,000
III	Satellite Towns	294,000	350,000	500,000 to 1,000,000
	Planned Areas Total	1,691,000	2,465,000	4,500,000 to 5,000,000

Source: Urban Master Plan for Hanoi Area to 2020, 1998 amended version

- (7) Orientation on readjustment of the General Planning of Hanoi to the year 2020

## **A.6 Topographic and Geological Survey for the Nam Son Landfill Site (Phase 2)**

The JICA Study Team conducted topographic and geological surveys at the planned area for Nam Son Landfill site (Phase 2).

### **(1) Methodology and contents**

#### **1) Topographic survey**

The topographic survey was carried out using the tachymetric method from September to November 1998. Survey area include an area for landfill site (Phase 2), an access road from Route 35 and the road side area with 30m width including the road itself. Situation of land use and residents in this area and surroundings were surveyed.

#### **2) Geological survey**

The geological survey was started in October. In this survey, five boreholes were planned to be installed. But there has been some protest against the survey, and only two boreholes have been finished. The rest will be finished early December. Documents of previous geological surveys, which had been carried out near the area, were collected and summarized.

### **(2) Results of Topographic Survey**

#### **1) Topographic conditions**

The planned site is located 45 km north of the city center of Hanoi city, and 35km south west of the Provincial Road No 35. The Cong river is located to the east, about 2km from the area.

##### **a) Overview of surface conditions**

The project area is located in a valley surrounded with low range of hills of 29.5 m to 66 m in altitude. There is a lake called Phu Thinh with area of 4ha and small ditch crossing. Land usage of this area is classified into following types :

- Rice fields
- Cultivated Fields for crops and vegetables
- Residential area
- Lake and rivers
- Cemetery

On the basis of the altitude and the terrain surface formation, the topography of the area can be classified into following types :

- *Erosion type* : this terrain type appears mainly in the study area surrounding the survey location. The soil and rock that form this terrain type is Triat sediment of Na Khuat (T2nK) formation. Its petrography components are clay schist mixed with sandstone of green, reddish brown and yellowish brown color.
- *Accumulation type* : this type appears almost everywhere in the area. Impure clay of reddish brown, yellowish brown and whitish gray color is predominant for this type.

The topography in the area is segmented. Its altitude varies from 8 m to 66 m.

## 2) Configurations

Main configurations are followings:

- *Hills on the boundary* : There are three hills on the northern border, two on the southern, and one on the both eastern and western borders. These hills separate the area from the surrounding river and ditches, and form a basin involving Lake Phu Thinh.
- *Lake Phu Thinh* : This lake is located at the center of the area. The water of this lake is normally used for irrigation. Depth of the lake is about 2 m.
- *Channels* : There is a small channel flowing through the project area, from the south to the north. This channel will be relocated to the edge of the dike for landfill site (Phase I).

## (3) Results of geological survey

### 1) Hydrogeological conditions

There exists small channels, a lake and small ponds at the area and its surroundings. Most of these ponds and canals often get dry or shallow during the dry season. No sign of floods are seen in this area.

#### a) Overview of geological conditions

Based on the topographic and geological survey, the formation of the area is composed of sediments of Na Khuat (T2NK). But the area map of Hanoi, the sediments of the Na Khuat formation are those belong to the Mau Son (T3 Kms) formation by geologists.

#### b) Stratum and physical properties



This part is situated to the North of Soc Son District. Its petrography composition from the bottom to the top are as follows:

- Bottom layer : sandstone, clay schist of light green, light violet, and brownish red color, in some parts mixed with big size sandstone or small size grit.
- Middle layer : mainly reddish brown and yellowish brown clay schist mixed with sandstone.
- Top layer : clay schist mixed with green and light red sandstone.

The thickness of this part is from 750m to 800m.

Based on the boring and survey results for the depth of 20m, the stratum in the survey area can be divided into following layers in top-to-bottom order:

a) Layer no.1 (Code: 1)

Covering soil compositions: brown, grayish brown, and reddish brown impure clay. The consistency is from stiff plastic to hard. The structure is porous. This layer appears in all boreholes with its thickness between 0.2m (K8) to 1.0m (K6).

b) Layer no.2 (Code: 2)

Mixture of reddish brown, yellowish brown and whitish gray clay and gravel. Consistency is semi-hard and hard. A thin layer of impure clay is mixed in this layer. This layer exists in all boreholes. Its thickness varies from 2.4m (K12) to 10.2m (K6).

c) Layer No. 3 (Code: 3)

Mixture of mixed clay of yellowish brown, whitish gray, reddish brown color and gravel. Consistency is stiff plastic to hard. This layer appears in all boreholes with its thickness ranges from 3.5m (K14) to 10.4 (K11).

d) Layer No. 4 (Code: 4)

Weathered schist in violet brown, yellowish brown and pinkish brown. This layer exists in almost bore holes. The thickness of this layer has not yet been defined. The depth of the layer varies from 8.6m (K4) to 13.4m (K11).

Physical properties of the layer No.2

Parameters	Symbol	Unit	Value		
			Max.	Min.	Average
Natural water content	W	%	55.4	13.7	29.0
Natural Unit Volume Weight	$\gamma_w$	g/cm <sup>3</sup>	2.06	1.64	1.88
Self-drying Unit Volume Weight	$\gamma_c$	g/cm <sup>3</sup>	1.73	1.06	1.46
Specific Gravity	$\wedge$	g/cm <sup>3</sup>	2.88	2.72	2.77
Natural Void Ratio (Porosity Coefficient)	E	-	1.610	0.553	0.897
Liquid Limit	W <sub>ch</sub>	%	82.3	26.8	46.1
Liquid Limit	W <sub>d</sub>	%	56.5	17.4	29.1
Plasticity Index	I <sub>d</sub>	%	28.7	9.4	17.0
	I <sub>s</sub>	-	0.45	<0	<0
Cohesion	C	KG/cm <sup>2</sup>	0.52	0.28	0.36
Internal Friction Angle	$\varphi$	Degree	22°46'	13°20'	18°20'
Compression Index	a <sub>1,2</sub>	cm <sup>2</sup> /KG	0.064	0.013	0.027
Permeability Coefficient	K	cm/s	7.3x10 <sup>-5</sup>	6.1x10 <sup>-7</sup>	2x10 <sup>-5</sup>
Deformation Module	E°	KG/cm <sup>2</sup>	-	-	177
Calculated Compression Bearing Capacity	R <sub>c</sub>	KG/cm <sup>2</sup>	-	-	2.50

Notice: 20 samples are tested.

Physical properties of the layer No.3

Parameters	Symbol	Unit	Value		
			Max.	Min.	Average
Natural water content	W	%	30.4	16.0	23.6
Natural Unit Volume Weight	$\gamma_w$	g/cm <sup>3</sup>	2.21	1.85	1.99
Self-drying Unit Volume Weight	$\gamma_c$	g/cm <sup>3</sup>	1.91	1.42	1.61
Specific Gravity	$\wedge$	g/cm <sup>3</sup>	2.84	2.74	2.78
Natural Void Ratio (Porosity Coefficient)	E	-	0.946	0.476	0.727
Liquid Limit	W <sub>ch</sub>	%	50.4	29.0	38.8
Liquid Limit	W <sub>d</sub>	%	28.4	18.5	24.6
Plasticity Index	I <sub>d</sub>	%	22.0	10.5	14.2
	I <sub>s</sub>	-	0.65	<0	<0
Cohesion	C	KG/cm <sup>2</sup>	0.54	0.21	0.36
Internal Friction Angle	$\varphi$	Degree	24°42'	15°06'	18°44'
Compression Index	a <sub>1,2</sub>	cm <sup>2</sup> /KG	0.042	0.016	0.023
Permeability Coefficient	K	cm/s	4.1x10 <sup>-5</sup>	2.1x10 <sup>-7</sup>	1.49x10 <sup>-5</sup>
Deformation Module	E°	KG/cm <sup>2</sup>	-	-	232
Calculated Compression Bearing Capacity	R <sub>c</sub>	KG/cm <sup>2</sup>	-	-	2.54

Notice: 17 samples are tested.

Physical properties of the layer No.4

Parameters	Symbol	Unit	Value		
			Max.	Min.	Average
Natural water content	W	%	23.5	4.9	13.7
Natural Unit Volume Weight	$\gamma_w$	g/cm <sup>3</sup>	2.56	1.92	2.25
Self-drying Unit Volume Weight	$\gamma_c$	g/cm <sup>3</sup>	2.44	1.60	1.98
Specific Gravity	^	g/cm <sup>3</sup>	2.85	2.75	2.80
Natural Void Ratio (Porosity Coefficient)	E	-	0.764	0.310	0.414
Porosity	N	%	43	14	29
Saturation Point	G	"	100	74	93
Compression Bearing Capacity	Rn	Kg/cm <sup>2</sup>	42.4	5.4	18.0
Permeability Coefficient	K	cm/s	6.4x10 <sup>-6</sup>	4.1x10 <sup>-7</sup>	3.8x10 <sup>-6</sup>

Notice: 10 samples are tested.

## 2) Hydrogeological features

The surveys have shown that the ground of the site area for Nam Son landfill has 4 layers.

The first one is a thin and porous layer of soil with high deformity and weak bearing capacity. This layer has not enough function of containment for leachate and landfill gas.

Layers no. 2, 3, 4 are of good soil quality with low deformity and small permeability coefficient of  $2 \times 10^{-5}$  -  $3.8 \times 10^{-6}$  cm/s. The second and third layers have almost enough function of containment and enough thickness for current regulation, but not enough for new regulation. The fourth layer has enough function and thickness for current one, but it is located very deep and not enough for the proposed one.

At the area, the groundwater is shallow which runs 1.6m to 7.2m from the ground surface. Therefore this groundwater layer is very sensitive target for probable pollution by leachate from the waste layer.

Water appears in cracks in weathered clay with a small volume.

## **A.7 Field Survey for Environmental Impact Assessment for the Nam Son Landfill site (Phase 2)**

The JICA Study Team has conducted a field survey for the environmental impact assessment for the Phase 2 of Nam Son Landfill Project, the results of which are to be analyzed during the subsequent study in Japan to assess the possible environmental impacts of the project. Hereunder, preliminary findings are given.

### **A.7.1 Method of Implementation**

#### **(1) Reviews of existing documents and data**

Natural and socio-economic data within the project area as well as documents concerning the current situation and the solid waste management plan in Hanoi, and relevant documents were collected and reviewed.

#### **(2) Field surveys**

Field surveys on the natural environmental and social conditions were carried out at the area and surrounding area.

#### **(3) Data analysis**

#### **(4) Preventive and mitigative measures**

### **A.7.2 Initial state of the landfill site**

#### **(1) Topographic and geological conditions**

Please see the section of 2.6.

#### **(2) Climate**

##### **1) Temperature**

Yearly averaged temperature is 23.4C. Higher recorded temperature was 42.8C in May 1926 and lower temperature was 2.7C in December 1955.

##### **2) Precipitation**

Rainy season in the area typically lasts from May to October. Rainfall in this season often accounts for 75-85% of the total annual rainfall. The lowest rainfall is usually in December, January and February.

The highest total annual rainfall is 2038.6 mm. The highest total monthly rainfall is 422 mm. The highest daily rainfall is 277.6 mm.

Average rainfall over the year is 1690 mm and year average evaporation is 938 mm.

### 3) Wind

There is usually a North-East wind during the dry season and a South East Wind during the rainy season in the area.

Average wind speed reaches from 1 to 4 m/s in winter months and from 1.2 to 3.5 m/s in summer months.

## (3) The current environmental conditions of water, air, soil and noise

### 1) Surface water

Organic pollution was observed in some canals and Phu Thin Lake. High concentration of Chloride was also detected. These data shows that the pollution seems to come from house hold wastes and/or night soil.

Heavy metals and other toxic substances were observed but were under the water quality standards for surface water. In another survey, high concentrations of Chromium were detected in Phu Think Lake.

### 2) Groundwater

Shallow groundwater is polluted with Phenol and total coliform at levels exceeding the standards for groundwater. The iron content, BOD and COD of groundwater do not satisfy the standards for drinking water.

### 3) Air

Based on the field survey, the air in this area is rather clean.

Inside the area, high concentrations of methane gas were detected at some points. The sources of methane are believed to be the anaerobic decomposition of waste and other organic matters.

### 4) Soil

The chemical character of soil in this area is very poor, with inadequate humus, Nitrogen, Phosphorous and Potassium.

Other surveys of heavy metal content show that levels of Copper and Chromium are slightly high. Surface soils have inadequate CEC (Cation Exchange Capacity) to hold the nutrient and metals.

5) Noise

The noise level of this area is very low.

6) Traffic volume

Most common means of transport in the area are bicycles (69%) followed by motorcycles (24%) and Cong nong Lorry. Heavy lorries are much less than 1% of total vehicles traffic.

The highest volume of bicycles and motorcycles was observed between the hours of 6 and 7 am, when it is accounted for 16% of total traffic volume.

(4) Current natural ecosystem

There are two ecological systems in this area.

- Aquatic ecosystems: domestic fish pond, Phu Think Lake, ditches and rice fields.
- Terrestrial ecosystems: hills, waste land, residents' gardens, rice fields and vegetation fields.

1) Aquatic ecological system

(a) Flora:

55 floating species were identified. But there are no valuable species to be protected under the regulation.

(b) Fauna:

About 40 species of floating fauna and 18 species of fauna at the bottom were discovered. But there are no valuable species to be protected under the regulation.

2) Terrestrial ecosystem

(a) Flora:

A large part of this area consists of rice fields and hills. Besides the cultivated area, there is much wild vegetation growing along the roads and in the area. About 174 vegetation species were found. The planted

species are poor, mainly wattle and some eucalyptus trees and caribe pine trees. There are tea trees planted for drink by the residents.

Agricultural crops and fruit trees cover a significant area. These include rice, maize, peas, various beans, potatoes, cassava and short. Fruit trees species grow in the resident's gardens. Most common species are banana, local apple and lemon.

But there are no valuable species to be protected under the regulation.

## 2) Fauna:

Terrestrial invertebrate animal generas in this area are plentiful. More than 100 species of more than 10 varieties of class are to be found.

There are many kinds of insects in this area. There are 195 species of 64 families and 10 orders of which 32 species of 13 families, 6 orders are harmful to agricultural trees, 15 species of 10 families harmful to fruit trees, and 17 species harmful to industrial crops.

The terrestrial vertebrate animal area is monotonous and poor. Small animals are found mainly in the area. Most common animals are Muridae family and some kinds of snake. There are 13 amphibious reptiles' species, 44 species of birds and 11 species of animals.

But there are no valuable species to be protected under the regulation.

## (5) Initial sanitary environment

The survey results of infectious animals have proved that at the area:

- 3 kinds of mice: household rat (70%), sewer rat (20%), murk rat (10%)
- Many parasite found over the rats' body:
  - flea Siphoniptera spreading bubonic plague, louse
  - gamasidae spreading hives
- Some mosquitoes: Anopheles Vagus, Anopheles Tessellatus spreading jungle fever
- No Anopheles Minimums, which mainly caused jungle fever
- Culex Triaeniorhynchus causing encephalitis
- Aedesalbopictus is spreading hemmorrhagic fever
- 2 kinds of flies and dung fly: Musca domestic and Chrysome
- 2 kinds of cockroach

### A.7.3 Current socio-economic conditions

#### (1) Population and socio-economic environment in Soc Son District

In Soc Son District the population at the end of 1995 was 211,186. While the area of Soc Son District is 31,466.9 ha, the population density is 6.7 persons per ha. The density is the smallest among all the Districts under HPC.

Administratively Soc Son District is divided into 25 villages and one town. The population is mainly concentrated in the plain area and population density is low in the mountain area, i.e. Bac Son, Nam Son, Hong Ky, Trung Gia.

In Soc Son, agriculture is the basic livelihood. The area of agricultural land is about 700 m<sup>2</sup> per inhabitant all over the district. Agricultural production depends heavily on the irrigation. There is a total of 125 km of irrigation channels in this District.

Industry and handicrafts are very small in comparison with agriculture. The main industries are mechanical, construction material, food processing.

Changes in population structure have been quite small during the last few years.

#### (2) Characteristics of population and socio-economic status in project area

The landfill site ( Phase 1 and 2 ) is located in a part of the following communes:

- Phase 1: Nam Son and Bac Son commune.
- Phase 2: Nam Son, Hong Ky and Bac Son Commune.

In general, these 3 communes are among the poorest communes in Soc Son District. There are no commune central offices, and only an army regiment is located at this site.

The major income of the residents comes from agricultural work. Due to the poor soil and insufficient irrigation, part of the area has two rice crops a year, the rest has subsidiary crops. Rice production contributes about 50% of total income. Subsidiary crops are grown in upper land. The major subsidiary crops are sweet potatoes, potatoes, cassava, sugar cane and corn. Vegetables are also planted to send to Hanoi. Income from these products accounts for 20% of total income. The residents also plant fruit trees, grow cattle, poultry and feed fish for sale. Income from these supplementary products may account for 30% of total income of households.

Estimation of annual income per capita of residents in the Districts is not over 100 USD. However, because of self sufficient economy, although the income is low, the life in the area is not so hard.



The project area of 100 ha (Phase 1 and 2) is located in 3 communes. The characteristics of population in the area are shown in following table.

**Number of households in the area**

Commune	Households
Nam Son	149
Hong Ky	4 households for Phase 1 area and 8 households for Phase 2 area
Bac Son	0

**Number of households along the road ( width of 15 m both side)**

Commune	Households
Nam Son	0
Hong Ky	170
Bac Son	0

### (3) Infrastructure and existing structures in the area

The area is served by a 6kV line and a 6kV/380V electric transformer. Most of residents use electricity for daily activities. Route 35 starting from National Route 3 crosses the area. Route 35 is a road paved with asphalt . In the area, there are inter-village roads without pavement.

In the area, there is no water supply system, and rain and waste water drain according to the natural topography.

In Nam Son commune the historic site is Doan temple. There is also a Christian church. At a distance of 5 km from the project area, there is a Giong temple where is memorial of Vietnam legendary hero, who defeated the Yin army from China.

### (4) Land use

Table below shows the characteristics on land use in the project area of 100 ha.

**Land use in project area and affected area**

Land use	Nam Son		Bac Son		Hong Ky	
	Area (m <sup>2</sup> )	%	Area (m <sup>2</sup> )	%	Area (m <sup>2</sup> )	%
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				
<b>Total</b>	<b>1,058,947</b>	<b>100</b>	<b>63,600</b>	<b>100</b>	<b>73,681</b>	<b>100</b>

**(5) Education, culture, health and other public services in the project area**

In the area, there are preschool, primary school and secondary schools. Most of children go to school. However, there are no engineers or post graduated experts working in the area. Some experts from Nam Son commune work in Hanoi or in other cities.

There is a medical station for health care for the residents. No doctors work at the station, only medical interns. Patients who get serious disease are taken to district or central hospitals.

Cultural activities and entertainment are rarely organized. There are no cultural centers, cinemas, theaters and clubs.