6.5.5 Hospital Waste Management Plan

(1) Present Conditions

1) Quantity of Solid Waste Generate by Hospitals and Collected by URENCO

There are 14 hospitals in Hanoi, and many private clinics. According to the report "Overview of Medical Waste Management in Vietnam" prepared by Ms. Nguyen Huy Nga, Ministry of Health, the hospitals generate about 600 m^3/month of solid waste, of which URENCO collects about 502 m^3/month. (This collection amount does not agree with the total of collection amounts shown in the table though.) Bulk density of the hospital waste is 0.5 kg/liter according to the report. Therefore, hospital waste generation and collection amounts in the 14 hospitals in Hanoi are estimated to be 20 m^3 (10 ton) per day, and 16.7 m^3 (8.4 ton) per day.

Solid Waste Generation and Collection Amount of Hospitals in Hanoi in 1996

Name of Hospitals	Number of Patient Beds	Solid Waste Generation (m^3/month)	Solid Waste Collection (m^3/month)	Collection Rate (%)
a	b	C	d	e = d/c
1. Bach Mai	1,000	126	83	66
2. Saint Paul	500	60	32	53
3. Dong Da Hospital	300	22	7	33
4. Hanoi Traditional Medicine Hospital	250	30	30	100
5. K Hospital	150	13	11	85
6. Huu Nghi Hospital	359	22	15	68
7. Vietnam-Sweden Hospital for Children	450	40	30	75
8. Hanoi Phu San Hospital	200	30	21	70
9. Central Eyesight Hospital	220	30	30	100
10. 108 Military Hospital	200	55	45	82
11. T.B. and Lung-related Hospital	375	50	21	42
12. Hai Ba Trung Hospital	600	40	21	53
13. Viet Duc Hospital	600	63	40	64
14. Railways Hospitals	300	20	11	56
Total	5,504	601	397	66

2) Types of Solid Waste Generated in Hospitals

According to the report, about 23% of the solid waste generated in hospitals are considered hazardous as shown in the table below.

Waste composition of 5 Hospitals in Different Regions in Vietnam

Hospital Waste Composition	Weight (kg)	Ratio (%)	Contain Hazardous Materials
1. Organic waste	146.7	52.9	
2. PP, PE, PVC bottles and bags	27.9	10.1	*
3. Bandage, plaster	24.3	8.8	*
4. Metal, cans	8.0	2.9	
5. Glass, syringes, medicine tubes	6.5	2.3	*
6. syringes and syringe needles	2.4	0.9	*
7. Waste paper, cartons, paper	2.1	0.8	
8. Human parts for lab analysis	1.6	0.6	*
9. Soil, cobble, china, and other solid matters	58.0	20.9	
Total	277.5	100.0	
Total of Hazardous items only	62.7	22.6	

According to the report, bulk density of the hospital waste is 149 kg/m^3 on average; water content is 42 %; calorific value is 2,150 kcal/kg.

2) Current Treatment

In December 1998, HPC installed a hospital waste incinerator with capacity of incinerating 3.2 ton/day. Test operation has been done from January – August 1999. The incinerator is not equipped with an appropriate gas treatment facility, and emission of black smoke was observed.

3) Current Problems

The following problems exist:

a. No sorting at sources or measures to minimize the generation volume of waste

b. Insufficient equipment for appropriate collection and sorting of waste

c. Inadequate training of hospital staff and waste collectors concerning management of hospital waste

d. Backward treatment technology

e. Inadequate regulations and non-enforcement system, no inspection

f. Inadequate fund

(2) Estimation of Future Hospital Waste Quantity

Future quantity of hospital waste in Hanoi is estimated as shown in the table below based on the current quantity, and assuming that 1) hazardous waste

content contained in total solid waste generated in hospital is 25 %, and 2) hospital waste generation quantity will increase by 6% each year.

Hazardous waste content contained in hospital waste in Hanoi is estimated to be 3.2 ton/day in 2000, 5.7 ton/day in 2010, and 10.1 ton/day in 2020.

Estimated Quantity of Hospital Waste in Hanoi

Year	Generation (ton/day)	Hazardous Content (ton/day)	Rate of Collection	Collection of Hazardous Hospital Waste (ton/day)
a	b	c = 25% of b	d	e
1996	10.0	2.5		
1997	10.6	2.7		
1998	11.2	2.8		
1999	11.9	3.0		
2000	12.6	3.2	100%	3.2
2001	13.4	3.3	100%	3.3
2002	14.2	3.5	100%	3.5
2003	15.0	3.8	100%	3.8
2004	15.9	4.0	100%	4.0
2005	16.9	4.2	100%	4.2
2006	17.9	4.5	100%	4.5
2007	19.0	4.7	100%	4.7
2008	20.1	5.0	100%	5.0
2009	21.3	5.3	100%	5.3
2010	22.6	5.7	100%	5.7
2011	24.0	6.0	100%	6.0
2012	25.4	6.4	100%	6.4
2013	26.9	6.7	100%	6.7
2014	28.5	7.1	100%	7.1
2015	30.3	7.6	100%	7.6
2016	32.1	8.0	100%	8.0
2017	34.0	8.5	100%	8.5
2018	36.0	9.0	100%	9.0
2019	38.2	9.5	100%	9.5
2020	40.5	10.1	100%	10.1

(3) Proposed Measures and Actions

There are three actors that are involved in hospital waste management and administration.

- Central government
- HPC
- Each hospital

The following measures and actions are proposed for each level.

a. At central government level
    1. Enactment and enforcement of specific regulation on hospital waste management
    2. Dissemination of guidelines (Ministry of Health issued a document No. 2575/QD-BYT dated on 27 August 1999 that serves as guidelines.)
    3. Training of those involved in hospital waste management
b. At HPC level
    1. Enactment and enforcement of city regulation on the hospital waste management (that should clarify responsibility of hospital waste generators.)
    2. Preparation and diffusion of guidelines (Section 6.5.10 presents a proposed Guidelines for Hanoi prepared by the JICA Study Team.)
    3. Establishment of system of collection of hospital waste
    4. Provision and operation of central hospital waste incinerator(s) with adequate capacity serving for all the hospitals in Hanoi (See technical note below.)
c. Generators of hospital waste (hospitals and clinics)
    Each hospital should establish an in-hospital waste management system and practice that include:
    a. Appointment of a hospital staff responsible for management of hospital waste within each hospital
    b. Separation of hazardous waste from non-hazardous one
    c. Provision of hazardous waste containers with clear label indicating hazardous waste
    d. In-hospital staff training

Technical Note on Capacity of Incinerator Needed

HPC should provide incinerators of adequate capacity to receive all hospital waste (excluding non-hazardous content). Estimated future quantity is indicated in the above table. In deciding on the capacity of incinerator, the following factors should be considered:

1. An incinerator needs at least 45 days of maintenance period per year during which incinerators stop operation.
2. It is extremely difficult to always maintain 100% rate of operation. Experience of other cities in the world show that actual incineration quantity may ranges from 60% to 100% with an average of 80%.

6.5.6 Industrial Waste Management

(1) Disposal Policy

Principle

- Industrial waste that consists of both hazardous and non-hazardous substances generated from industries in Hanoi should be managed on each waste generator's own responsibility.
- Industrial hazardous waste management should follow the national regulation on hazardous waste management.

1) General Outlines on Industrial Waste Management

In all countries worldwide, even in those where the industry is highly developed, there still remain hazardous substances in industrial waste. Such heavily polluting industries like metallurgy, fertilizer production, leather processing and fabric production, etc., are expanding in developing countries. The management and control of hazardous industrial waste comprises the following steps:

- Minimizing the generation of the hazardous waste by modifying the production process and applying less-waste generating technology;
- Reproducing and recycling waste as there are useful components/substances in the waste, which are recyclable or reusable;
- Use of materials discharged as waste by one industry as input materials for another industry;
- Separating hazardous waste from industrial waste for biological, chemical and physical treatment;
- Disposal of hazardous waste at a well controlled sanitary landfill.

In several developing countries, the industrial waste management/control system for environment protection has been established and developed. Nevertheless, the management of hazardous industrial waste in developing countries is facing certain obstacles as follows:

- Limited budget leading to lack of capital for the management task;
- Lack of skillful and professional technicians and staff for the management, operation and maintenance of the hazardous waste treatment facilities;
- Shortage of infrastructure and staff for monitoring and law-enforcement.

At present, in developing countries, the dominant industrial hazardous waste treatment method is to burying in the ground together with urban waste. However, the prevention and minimization of the waste at its generation source proves an effective measure.

Many developing countries face difficulties in the drafting, application and enforcement of regulations on industrial waste management. Some countries prepared legal documents with reference to those of other countries, thus leading to the fact that the enacted regulations cannot be effectively applied to these countries. Vietnam just established "Regulation on Hazardous Waste Management" approved by the Prime Minister in July 1999.

The experience in the reduction of waste and industrial pollution in developed countries has shown that the following methods have yielded good results in the management of industrial waste:

- Reduction of raw materials and product losses caused by leakage and over-flowing;
- Examination of the components prior to treatment in order to cut down the quantity of unqualified products;
- Uniform in the equipment or chemicals in order to reduce the quantity and the varieties of waste;
- Improvement of the cleaning process with cleaning and drying methods in order to reduce the generation of soluble waste mixture;
- Separation /sorting of the waste for recycling purposes;
- Optimization of such parameters like temperature, pressure, reaction time and concentration, etc. in order to reduce by-products and waste generation;
- Emphasis on staff training for the reduction of waste;
- Cutting down of unnecessary steps;
- Collection of leakage materials.

2) Regulation on Hazardous Waste Management

Vietnamese government has established the regulation on hazardous waste management. This regulation applies to organizations, individuals working in Vietnam who are involved in such activities as generation, collection, transport, transfer, storing, treatment and disposal of hazardous waste. The regulation also applies to foreign organizations, individuals working in Vietnam who are involved in the above activities with the exception that international treaty signed or joined by The Socialist Republic of Vietnam stipulates otherwise.

The regulation includes a list of hazardous waste, responsibilities of hazardous waste generators, collectors and transporters, and treatment and disposal organizations. Role of the government is also stipulated in the regulation.

3) Basic Disposal Policy

Fundamentally polluter pay principle (PPP) should be applied for industrial waste management.

In developing countries it makes a sense for local governments to construct industrial waste treatment facilities because there do not exist strong initiatives on the part of the private sector to do this kind of business.

In Hanoi, URENCO and a foreign company have been planning to establish a joint venture company for industrial waste management. However treatment capacity of its first phase is not enough to treat all generated hazardous waste. In future the private companies can enter the waste management business.

(2) Definition and Classification of Industrial Waste

Principle

- Definition and classification of industrial waste should follow the national regulations of hazardous waste management.
- Waste discharged from factories contain non-industrial ordinary waste such as kitchen waste. It is necessary to determine who should be responsible for disposal of this type of waste. (non-industrial waste generated from industry)

1) Definition of Industrial Waste

According to Article 3 of "Regulation on Hazardous Waste Management", "Waste" is defined in "Law on Environmental Protection" which says "Wastes means substances discharged from daily life, production processes or other activities. Waste may take solid, gaseous, liquid or other forms". Thus, industrial waste can be defined as the waste discharged from industrial activities. In the broad sense, there are two types of the waste generated from industries, one is process waste from production processes and the other is domestic waste from office and kitchen. Major hazardous substances are contaminated process wastes and it is called industrial hazardous waste.

"Hazardous waste" is also defined in the regulation as follows: "Hazardous waste is waste having as constituents or compounds with direct hazardous characteristics (flammable, explosive, poisonous, corrosive, contagious and other hazardous characteristics), or when reacting with other substance it can do harm to environment and human health".

2) Classification of Industrial Hazardous waste

The following types of industrial waste are identified as hazardous waste under the regulation.

- Class No.1 (Code – H1) – Explosive
- Class No.2 (Code – H3) – Flammable liquids
- Class No.3 (Code – H6.1) – Poisonous (Acute)
- Class No.4 (Code – H8) – Corrosives

The code is referred from the Annex III, List of Hazardous Characteristics, of Basel Convention Text.

Description of each code is as follow.

- H1 Explosive

An explosive substance or waste is a solid or liquid substance or waste (or mixture of substances or wastes) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings.

- H3 Flammable liquids

Flammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc., but not including substances or wastes otherwise classified on account of their dangerous characteristics) which give off a flammable vapor at temperatures of not more than 60.5°C, closed-cup test, or not more than 65.6°C, open-cup test. (Since the results of open-cup tests and of closed-cup tests are not strictly comparable and even individual results by the same test are often variable, regulations varying from the above figures to make allowance for such differences would be within the spirit of this definition.)

- H6.1 Poisonous (Acute)

Substances or wastes liable either to cause death or serious injury or to harm human health if swallowed or inhaled or by skin contact.

- H8 Corrosives

Substances or wastes which, by chemical action, will cause severe damage when in contact with living tissue, or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport; they may also cause other hazards.

(3) Current Industrial Waste Generated in Hanoi

Principle

- It is estimated that approximately 51,000 tons of the industrial wastes were generated in 1997 from industrial sectors in Hanoi including domestic waste such as kitchen waste or office waste from industries.
- In which, quantity of the hazardous industrial wastes generated was about 53.6 tons in 1997.
- Various type of hazardous industrial wastes that need to be appropriately treated are generated such as toxic liquid waste, waste acid & waste alkali, sludge contaminated heavy metals, waste oil & combustible oily waste, and waste plastics.

1) Current Status of Industrial Waste Generation

URENCO and CEETIA carried out current industrial waste management survey in Hanoi including the composition survey in 1998. The current status of waste management of several industrial areas was evaluated through the interviewing, collecting, and surveying the generation of wastes from industrial activities.

The brief conclusion of survey on each industry is as follow.

(a) Mechanical industries

This group is one of the most important industrial groups in Hanoi. The waste from many factories and enterprises contain toxic and hazardous substances. Especially in mechanical industries, the metal plating process (Chromium, Nickel, and Copper) has high concentration of heavy metal. More than 50% of total wastes generated from the whole mechanical industry are either hazardous waste (corrosive or toxic or flammable waste.

(b) Textile, garments and leather industries:

The major processes of this group are starching, taking out of starch, bleaching, polishing, dying, and printing. The waste from this field is generated from many sources and mainly come from packing of raw materials, sludge from wastewater treatment plant, sludge from dying process etc. Approximately 44.6% of total wastes from these industries are hazardous waste, toxic or biological reactively.

(c) Electrical and electronic industries:

Basic types of technologies used in these industries are similar to the ones

used in mechanical industries such as plating, painting of spare parts or welding which cause heavy pollution on environment. A lot of heavy metal sludge is generated. More than 70% of total waste from the electrical and electronic industries are toxic.

(d) Chemical group:

This group is the biggest industrial sector, which generate a large amount of toxic and hazardous wastes of many kinds as the industry uses so many kinds of materials. The wastes from the industry contain high chemicals, dissolved metals that cause very negative impact on human health. Approximately 62.5 % of total waste from this sector are toxic.

(e) Food processing industries

This is a big scale industrial group in Hanoi at present and future. Current major food processing industries are beverage, canning and confectionery industries. Most wastes from these industries are fermented residues, organic matters, peels and food flavorings. These substances are very good circumstance for growing up of bacteria including of pathogenic.

About 20% of total waste from food industry are biodegradable waste.

(f) Other industries:

The other industries such as leather tanning, detergent/soap, pulp/paper/paper product, printing and drug/medicines also generate some hazardous waste.

2) Current Industrial Waste Generation Quantity

The industrial waste management survey report, prepared by a Japanese firm that plans to establish a joint venture company with URENCO, figured out the generation quantity of industrial waste based on each industrial sector and industrial waste characteristics in Hanoi in 1997.

Approximately 51,000 tons of industrial waste was generated in 1997 equal to about 140 tons per day, of which approximately 20,000 tons, about 40%, was hazardous waste. There are 19 types of hazardous waste categorized in the report such as heavy metal sludge, halogen solvents, organic chemical residues, acid & alkali, oil waste, etc. Heavy metal sludge is large portion, about 22%, of hazardous waste and 70% of sludge is generated from mechanical industries. Mechanical industries and chemical industries are large hazardous waste generators, which discharge more than half of total

industrial waste.

Although cinder which is almost coal residual ash is not categorized as hazardous waste, the generation quantity is very large about 16.2 tons per day.

Tables 6.5.19 – 6.5.22 show the summary of industrial waste generation quantity.

(4) Future Industrial Waste Generation

Principle

It is estimated that the hazardous industrial waste will increase to approximately 78,500 tons per year in 2020, or about 215 tons per day on average.

1) Industrial Zone Development Plan

It is assumed that the generation quantity of industrial hazardous waste will increase in proportion to increases in area of industrial zones demanded.

According to Hanoi Urban Master Plan for 2020, total area of industrial zones will be 1,242.7 ha by 2005 including existing industrial zones as well as those planned in North & South Thang Long, Dong Anh and Soc Son. It will be 1,682.7 ha by 2010 and 2,537.7 ha by 2020.

2) Estimation of Hazardous Industrial Waste Quantity

It is estimated that 105.4 tons per day of hazardous industrial waste will be collected in 2005 and 215.2 tons per day (approximately 78,500 ton/year) in 2020. Table 6.5.21 and 6.5.22 shows the result of waste quantity estimation.

For this estimation, it is assumed that the whole industrial zone will be occupied by the industries as soon as the area planned in Hanoi Urban Master Plan are developed. And also it is assume that current waste collection ratio of industrial hazardous waste is 70 %, and the collection amount will increase in proportion to increase in industrial zone area.

6.5.7 Recycling

(1) Recycling Policy for Hanoi

Principle

- It is desirable that recycling activity will be carried out by the private sectors on a market basis, not on a mandatory basis as far as the recyclable has enough value for recycling.
- A common problem with recycling activities by the public sector is that collected materials are not used due to insufficient demand. Therefore, the demand development is very important for promotion of recycling in case public sector is involved in the recycling activities.

As next section describes, recycling of recyclable materials from municipal solid waste stream is currently almost perfectly carried out in Hanoi by the private sectors as business, not by URENCO or other public sectors except municipal composting activity in Cau Dien by URENCO.

As far as the current private recycling system can work on a market basis, municipality does not have to intervene in that system and to construct its own recycling facility.

As the experiences of developed countries such as USA, Japan, and European countries demonstrate, the current recycling system in Hanoi would collapse in future because the current recycling industries will face the difficulties in continuing their business. Values of recyclable materials may become lower.

In Europe such as France and Germany recently, recyclable materials are collected, transported, and sorted by the private company or municipality under the responsibility of material producer or users.

In Japan, residents or waste generators are held responsible for source separating, municipalities are responsible for collecting, and manufacturer has responsibility for utilizing collected recyclable materials. This system poses a financial burden on municipalities because cost of collection of recyclable materials is very high.

In the US, some municipalities have mandatory recycling ordinances and have recyclables collected either by municipal public works departments or by contractors.

In Vietnam, it is recommended to establish its own proper recycling system not repeating the same government failure as experienced by many developed countries. In case the natural recycling market shrinks, it is advisable that the government takes such policy as to strengthen the manufacturers' responsibility for recycling certain items, and provide incentives to increase reuse or recycling.

(2) Current Recycling Activities in Hanoi

Principle

- More than 200 tons of recyclable materials such as metal, paper and plastics are currently collected by private collectors from the generation sources. Compared to this amount, materials recovered from waste dumping sites are not significant in terms of amount.
- Collected recyclable are mostly processed to make other goods in the craft villages adjacent to Hanoi city.

Recyclable materials are currently collected by private collectors, private buyers or scavengers at the generation sources like households, hotels, restaurants and market, at the streets during waste collection by URENCO, and at the landfill site.

There is the strong monetary incentive for people at the waste generation sources to separate recyclable materials from other ordinary waste because they can earn the money by selling them to recycling buyer.

According to the survey report in 1997 "City and Countryside in the Red River Delta, Notes on Hanoi's Recycling Industry" by Center for Natural Resources and Environmental Studies (CRES), there are more than 6,000 junk buyers in Hanoi city, and a junk buyer collected 35.5 kilograms of recyclable materials per day on average in 1996. The total amount collected by the junk buyers in Hanoi is estimated to be 213 ton/day. On the other hand, total amount of materials collected by scavengers in the landfill site is estimated to be 5.5 ton/day including those recovered at Cau Dien compost plant in 1996. The total amount is therefore 218.5 ton/day, which is about 20% of the waste generation amount of about 1,100 ton in 1996.

The same report also shows composition of recycled materials in Hanoi surveyed in 1996; 37.2% was metal, 30.7% was paper, 20.0% was bottles and glass, 9.4% was plastics, and 2.8% was bone and feathers. This means that about 81 tons of metal, 67 tons of paper, 44 tons of glass bottles, and 21 tons of plastics were recycled in 1996 from Hanoi.

There are about 400 scavengers collecting the recyclable such as metal, paper, plastics, and some organic matters at Nam Son Landfill site since it started the operation in May 1999. About 30 to 40 % of them are those who moved from Tay Mo landfill site and the rest of them are local residents living in surrounding area.

Buyers visit and buy organic waste or kitchen waste from mainly markets or restaurants, and sell it to farmers.

Adjacent to Hanoi, there are some small craft villages where people are engaged in recycling industries, for example, plastic recycling village of Minh Khai, located 22 km east from Hanoi, the metal recycling village of Da Hoi, 32 km east, and the paper recycling village of Duong O, 64 km east. These industries have been developed during the past 20 years with mechanical technology as main one. People have diversified types of products.

These recycling industries are facing difficulties to continue their business because of financial, health, and environmental problems. They do not have suitable pollution control equipment and do not have enough landfill area for disposal of residues generated from their recycling process. If they reflect such environmental costs in their product price, they might lose in the tough competition against other producers.

(3) Prediction of the change of waste composition

Principle

- Amount of recyclable materials collected by junk buyers will reduce as prices fall. The quantity of the waste discharged will increase by the same amount as the reduction.
- With the upgrading of the economic standard, such waste as paper and plastics will increase. To control the increase in such types of waste, the government must strengthen manufacturers' responsibility for recycling and waste disposal.
- In Hanoi, the ratio of the coal residual ash from cooking activity will decrease as people change the fuel for cooking from coal to gas.
- As the result of above change, waste composition will change. The bulk density will become lighter and calorific value will become bigger. The plastic for packaging content ratio will increase like developed countries.

Although it is very difficult to predict the waste composition change in future in Hanoi practically, there is an indicator, which shows the typical waste composition in different-income countries. According to the table below, composition ratio of food waste and dirt & ash will become smaller and the ratio of paper and plastics will become larger as the country develops. One of notable features of the waste composition in Hanoi is the residual ash from coal cooker. Although usage ratio of gas cooker has been increased gradually in place of coal cooker, there is still large portion of Hanoi people using coal cooker. However, in coming two decades, as people will change certainly their cooking style from coal to gas, amount of coal ash will decrease.

Typical distribution of components in Residential MSW for low-, middle-, and upper-income countries excluding recycled materials1

Component	Low-income Countries	Middle-income countries	Upper-income Countries[2]
Organic			
Food waste	40-85[3]	20-65	6-30
Paper	1-10	8-30	20-45
Cardboard			5-15
Plastics	1-5	2-6	2-8
Textiles	1-5	2-10	2-6
Rubber	1-5	1-4	0-2
Leather			0-2
Yard wastes	1-5	1-10	10-20
Wood			1-4
Misc. organic	-	-	-
Inorganic			
Glass	1-10	1-10	4-12
Tin cans			2-8
Aluminum	1-5	1-5	0-1
Other metal			1-4
Dirt, ash, etc	1-40	1-30	0-10

1: Low-income countries: per capita income of less than U.S. $750 in 1990.
Middle-income countries: per capita income of more than U.S. $750 and less than U.S. $5000 in 1990.
Upper-income countries: per capita income of more than U.S. $5000 in 1990.
2: Upper-income countries are more highly industrialized.
3: Food waste composed predominantly of waste from the preparation of food (cornhusks, melon rinds, banana leaves, etc.).
Source: Integrated Solid Waste Management, p50

(4) Role of Hanoi City for Promoting the recycling

Principle

- Hanoi City has to monitor the private recycling situation and change of the composition of the waste to be disposed of at landfills.
- Hanoi City has to keep trying to support the current recycling activities that are helpful for avoiding increases in waste generation amount.
- Hanoi City can use private collectors practically as manual sorting system at the landfill site in sanitary condition.

It is not widely known that recycling activities has been carried out by private sector in Hanoi. Almost of all kind of recyclable materials such as organic matters, plastic, metals, papers that corresponds about 20% of total waste generation quantity are collected. As the result of such private recycling activity, large amount of the municipal cost for waste management could have been saved in Hanoi.

However, there is the risk that those recyclable will be back into the waste stream

by the reason of recycling failure in future and Hanoi will have to pay large cost for handling such waste.

Thus, it is highly recommended that Hanoi should carry out the recycling survey in order to monitor the latest recycling market situation including types and quantity of recyclable, and prices, etc.

In principle, recycling activity should be done on market base by the private sector. It is not possible for HPC to replace the role of the private sector. A thing HPC can do is to allow recycling people dump sorting residue at the municipal landfill sites. Another assistance could be the provision of subsidies to support the prices of recyclable material though this needs further careful discussion. Also Hanoi can organize and manage activities of scavengers at landfill sites to make their activities more efficient and safer.

Many developed countries such as USA, Japan, and EU are now promoting to establish the resource circulating economy society after the recycling market failure. It is advisable for HPC to learn lessons from the experiences of some countries about the way in which recycling is promoted.

6.5.8 Implementation Schedule

A proposed schedule for the implementation of the planned investment projects is shown in Figure 6.5.6.

Procurement of waste collection trucks should be made year by year. Upgrading of the existing garages will be made in 2002, and construction of new garages will be 2004. Design and construction of the proposed transfer system and Nam Son Phase 2 landfill is scheduled so that they can start operation in the beginning of 2004.

6.5.9 Costs of Solid Waste Management

It is estimated that total investment expenditures needed for solid waste management for the urban Hanoi during 2000 – 2005 is $70 million. Of the $70 million, $47 million is for the new transfer system and Nam Son Phase 2 landfill, and the remaining $23 million for collection and transport up to the transfer station and water sprinkling for streets.

In addition, total operation and maintenance (O&M) cost during the same period is estimated to be $47 million. Therefore, the total expenditure during the same period including both investment and O/M is estimated to be $117 million.

Estimated investment expenditures, operation and maintenance costs and

aggregate expenditures are shown in Tables 6.5.23, 6.5.24, and 6.5.25, respectively. These tables show annual expenditures from 2000 – 2020.

Table 6.5.1 Projection of Waste Generation and Proposed URENCO's Collection Target in the Urban Districts of Hanoi

Unit: ton/day

Year	Demolition waste & soil waste			Other solid waste			Total Solid Waste		
	Generation	Collection by URENCO	Target coverage	Generation	Collection by URENCO	Target Coverage	Generation	Collection by URENCO	Target Coverage
a	b	c	d	e	f	g	h	i	j
			c/b*100			f/e*100	b+e	c+f	i/h*100
1997	353	257	73%	1,195	872	73%	1,548	1,129	73%
1998	370	278	75%	1,256	942	75%	1,626	1,219	75%
1999	389	300	77%	1,319	1,017	77%	1,708	1,317	77%
2000	409	324	79%	1,385	1,098	79%	1,794	1,422	79%
2001	429	350	82%	1,455	1,186	82%	1,884	1,536	82%
2002	451	378	84%	1,528	1,281	84%	1,979	1,659	84%
2003	474	408	86%	1,605	1,384	86%	2,079	1,792	86%
2004	**497**	**441**	**89%**	1,686	1,494	**89%**	2,184	1,935	**89%**
2005	523	476	91%	1,771	1,614	91%	2,294	2,090	91%
2006	548	514	94%	1,857	1,743	94%	2,405	2,257	94%
2007	575	546	95%	1,948	1,850	95%	2,522	2,396	95%
2008	602	572	95%	2,042	1,940	95%	2,645	2,513	95%
2009	632	600	95%	2,142	2,035	95%	2,773	2,635	95%
2010	662	629	95%	2,246	2,133	95%	2,908	2,763	95%
2011	687	652	95%	2,328	2,211	95%	3,014	2,864	95%
2012	712	676	95%	2,413	2,292	95%	3,124	2,968	95%
2013	738	701	95%	2,501	2,376	95%	3,238	3,077	95%
2014	765	726	95%	2,592	2,462	95%	3,357	3,189	95%
2015	793	753	95%	2,687	2,552	95%	3,479	3,305	95%
2016	821	780	95%	2,785	2,645	95%	3,606	3,426	95%
2017	851	809	95%	2,886	2,742	95%	3,738	3,551	95%
2018	883	838	95%	2,992	2,842	95%	3,874	3,681	95%
2019	915	869	95%	3,101	2,946	95%	4,016	3,815	95%
2020	948	901	95%	3,214	3,053	95%	4,162	3,954	95%

Table 6.5.2 Target Waste Collection Amount by Urban Districts of Hanoi

	Solid Waste Excluding Demoliton Waste & Soil Waste										Demolition & Soil Waste	
	7 Urban Districts Total			Each District							7 Urban Districts	
	Estimated	Target		Target Collection (ton/day)							Target Collection	
Year	Generation	Collection		Unit 1			Unit 2				Unit 4	Unit 3
	t/d	t/d		Enterprise 1		Enterprise 2	Enterprise 3	Enterprise 4		Enterprise 5	& Soil Waste	Night Soil & Watering
a	b	c	d	Ba Dinh	Cau Giay	Hoan Kiem	Hai Ba Trung	Dong Da	Thanh Xuan	Tay Ho	7 Urba Districts	7 Urban Districts
	1,312,102		Populatio n in 1997	181,350	104,196	181,800	337,211	289,552	133,339	84,654		
Growth Rate												
1998	5.04%	6.00%		5.00%	9.07%	5.00%	5.00%	5.00%	9.07%	9.07%	6.00%	8.00%
1999-2005	5.04%	8.00%		5.00%	9.07%	5.00%	5.00%	5.00%	9.07%	9.07%	8.00%	8.00%
2006	4.86%	8.00%		5.00%	9.07%	5.00%	5.00%	5.00%	9.07%	9.07%	8.00%	8.00%
2007-2010	4.86%	See	Coverage	2.90%	8.01%	2.90%	2.90%	2.90%	8.01%	8.01%	See	8.00%
2011-2020	3.65%	Note 1	%	2.20%	5.28%	2.20%	2.20%	2.20%	5.28%	5.28%	Note 1	8.00%
Year												
1998	1,333	1,000	75%	138	79	139	257	221	102	65	300	100
1999	1,401	1,060	76%	145	87	145	270	232	111	70	318	108
2000	1,471	1,145	78%	152	101	153	283	243	130	82	343	117
2001	1,545	1,236	80%	160	117	160	298	255	150	95	371	126
2002	1,623	1,335	82%	168	135	168	312	268	173	110	401	136
2003	1,705	1,442	85%	176	155	177	328	282	198	126	433	147
2004	1,791	1,557	87%	185	177	186	344	296	226	144	467	159
2005	1,881	1,682	89%	194	201	195	362	311	257	163	505	171
2006	1,973	1,817	92%	204	227	205	380	326	291	184	545	185
2007	2,068	1,962	95%	210	264	211	391	335	337	214	589	200
2008	2,169	2,061	95%	216	285	217	402	345	364	231	618	216
2009	2,274	2,161	95%	222	306	223	414	355	392	249	648	233
2010	2,385	2,266	95%	229	329	230	426	366	420	267	680	252
2011	2,472	2,348	95%	234	346	235	435	374	443	281	705	272
2012	2,562	2,434	95%	239	365	240	445	382	467	297	730	294
2013	2,656	2,523	95%	244	384	245	454	390	492	312	757	317
2014	2,753	2,615	95%	250	405	250	464	399	518	329	785	343
2015	2,853	2,710	95%	255	426	256	475	408	545	346	813	370
2016	2,957	2,809	95%	261	448	262	485	417	573	364	843	400
2017	3,065	2,912	95%	267	471	267	496	426	603	383	874	432
2018	3,177	3,018	95%	272	495	273	507	435	634	402	905	466
2019	3,293	3,128	95%	278	520	279	518	445	666	423	939	503
2020	3,413	3,243	95%	285	546	285	529	454	699	444	973	544

Table 6.5.3 Solid Waste Generation and Collection Amount in the 5 Sub Urban Districts

Unit: ton/day

	Soc Son			Dong Anh			Gia Lam			Tu Liem			Thanh Tri			Total		
Annual growth	Generation	Collection	Rate	Generation	Collection	Rate	Generation	Collection	Rate	Generation	Collection	Rate	Generation	Collection	Rate	Generation	Collection	Rate
1998–2010	2.0%	6.0%		3.0%	10.0%		4.0%	7.0%		3.0%	7.0%		3.0%	8.0%				
2011–2020	2.0%	6.0%		3.0%	9.0%		3.0%	7.0%		3.0%	6.0%		3.0%	7.0%				
a	b	c	d c/b	e	f	g f/e	h	i	j i/h	k	l	m l/k	n	o	p o/n	q	r	s r/q
1998	91	23	25%	95	18	19%	122	45	37%	66	19	29%	81	19	23%	456	124	27%
1999	93	24	26%	98	20	20%	127	48	38%	68	21	30%	83	20	24%	470	133	28%
2000	95	25	27%	101	22	22%	132	51	39%	70	22	32%	86	22	25%	484	143	29%
2001	97	27	28%	105	24	23%	138	55	40%	73	24	33%	88	23	26%	500	153	31%
2002	99	29	29%	109	27	24%	143	59	41%	75	25	34%	91	25	28%	517	165	32%
2003	101	30	30%	114	29	26%	149	63	42%	77	27	35%	94	27	29%	534	177	33%
2004	103	32	31%	118	32	27%	155	67	44%	79	29	37%	97	29	30%	551	190	34%
2005	105	34	33%	123	35	29%	161	72	45%	82	31	38%	100	32	32%	570	204	36%
2006	107	36	34%	128	39	30%	167	77	46%	84	33	40%	103	34	33%	589	220	37%
2007	109	38	35%	133	43	32%	174	82	47%	87	36	41%	106	37	35%	608	236	39%
2008	111	41	37%	138	47	34%	181	88	49%	89	38	43%	109	40	37%	628	254	40%
2009	113	43	38%	144	52	36%	188	94	50%	92	41	45%	112	43	39%	649	273	42%
2010	115	46	39%	150	57	38%	196	101	52%	95	44	46%	115	47	40%	671	294	44%
2011	118	48	41%	155	62	40%	202	108	54%	97	46	48%	119	50	42%	691	315	46%
2012	120	51	43%	162	68	42%	208	116	56%	100	49	49%	122	53	44%	712	337	47%
2013	123	54	44%	168	74	44%	214	124	58%	103	52	50%	126	57	45%	734	361	49%
2014	125	58	46%	175	81	46%	220	132	60%	107	55	52%	130	61	47%	757	387	51%
2015	127	61	48%	182	88	48%	227	142	62%	110	59	53%	134	65	49%	780	414	53%
2016	130	65	50%	189	96	51%	234	152	65%	113	62	55%	138	70	51%	804	444	55%
2017	133	69	52%	197	104	53%	241	162	67%	116	66	57%	142	75	53%	829	476	57%
2018	135	73	54%	205	114	56%	248	174	70%	120	70	58%	146	80	55%	854	510	60%
2019	138	77	56%	213	124	58%	256	186	73%	124	74	60%	151	86	57%	880	546	62%
2020	141	82	58%	221	135	61%	263	199	76%	127	78	62%	155	92	59%	908	586	65%
																5,201,313	2,440,485	

Note:

1. Generation amounts were estimated using per capita generation rate survey of the JICA Study conducted in August 1999, and assumptions on growth rates.
2. Waste collection amounts were estimated based on interview of each Urenco of sub urban districts, and by setting targets.

Table 6.5.4 Projection of Waste Quantity to be Received at the Planned Transfer Stations and Nam Son Landfill Sites

	7 Urban Districts Area																Waste Receive at Nam Son Landfill Phase 2 Site	
YEAR	WASTE GENERATED at Beginning of the Year	WASTE COLLECTED by URENCO at Beginning of the Year (h=c+d+e)	Collection Coverage (c/b)	WASTE TRANSPORTED by URENCO			WASTE RECEIVED AT TRANSFER STATIONS						RECEIVED AT NAM SON LANDFILL					
				Cau Dien New Compost Plant	Cau Dien Hospital Waste Treatment Facility	Nam Son Industrial Treatment Facility	Directly to Transfer Stations (c-e-f-g)	Residue of Compost	Residue of Hospital Waste	Collected by Private Enterpises	Collected by Tu Liem & Thanh Tri Districts	Received at Dong Ngac (h+i+j+k+l)	Sub total (h+i+j+k+l)	Collected by Soc Son District	Residue of Industrial Waste Treatment	Total (n+o+p)	Annual Quantity	Cummulative Quantity
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
1,998	1256	942	75%	0	0	0	942	0	0	12	29	0	982	0	0	0	0	0
1,999	1319	1017	77%	0	3	0	1,014	0	1	13	30	0	1,058	0	0	0	0	0
2,000	1385	1098	79%	0	3	0	1,095	0	1	14	32	0	1,142	47	0	47	0	0
2,001	1455	1186	82%	137	3	50	996	62	1	15	33	0	1,107	50	20	70	0	0
2,002	1528	1281	84%	137	3	50	1,091	62	1	16	35	0	1,205	52	20	72	0	0
2,003	1605	1384	86%	137	3	50	1,194	62	1	18	0	0	1,274	55	20	75	0	0
2,004	1686	1494	89%	137	3	50	1,304	62	1	19	0	1,386	1,386	57	20	1,464	535,766	535,766
2,005	1771	1614	91%	137	3	50	1,424	62	1	21	0	1,507	1,507	60	20	1,588	579,541	1,115,307
2,006	1857	1743	94%	137	6	100	1,500	62	2	22	0	1,586	1,586	63	40	1,690	616,689	1,731,996
2,007	1948	1850	95%	137	6	100	1,607	62	2	24	0	1,695	1,695	66	40	1,802	657,706	2,389,702
2,008	2042	1940	95%	137	6	100	1,697	62	2	26	0	1,787	1,787	70	40	1,897	694,343	3,084,044
2,009	2142	2035	95%	137	6	100	1,792	62	2	28	0	1,884	1,884	73	40	1,997	728,898	3,812,942
2,010	2246	2133	95%	137	6	100	1,890	62	2	30	0	1,985	1,985	77	40	2,102	767,147	4,580,089
2,011	2328	2211	95%	137	12	150	1,912	62	4	33	0	2,011	2,011	81	60	2,152	785,450	5,365,539
2,012	2413	2292	95%	137	12	150	1,993	62	4	35	0	2,094	2,094	85	60	2,239	819,581	6,185,120
2,013	2501	2376	95%	137	12	150	2,077	62	4	38	0	2,181	2,181	89	60	2,330	850,459	7,035,579
2,014	2592	2462	95%	137	12	150	2,163	62	4	41	0	2,271	2,271	94	60	2,424	884,851	7,920,430
2,015	2687	2552	95%	137	12	150	2,253	62	4	45	0	2,364	2,364	98	60	2,522	920,568	8,840,999
2,016	2785	2645	95%	137	18	200	2,290	62	6	48	0	2,407	2,407	103	80	2,590	947,845	9,788,844
2,017	2886	2742	95%	137	18	200	2,387	62	6	52	0	2,507	2,507	108	80	2,695	983,787	10,772,630
2,018	2992	2842	95%	137	18	200	2,487	62	6	56	0	2,611	2,611	114	80	2,805	1,023,811	11,796,441
2,019	3101	2946	95%	137	18	200	2,591	62	6	61	0	2,719	2,719	119	80	2,919	1,065,389	12,861,830
2,020	3214	3053	95%	137	18	200	2,698	62	6	65	0	2,832	2,832	125	80	3,037	1,111,621	13,973,452

Note:

1. It is assumed that waste amount collected by Tu Liem, Thanh Tri, and Soc Son districts will increase by 5 % per year.
2. It is assumed that waste amount collected by private companies will increase by 8 % per year.
3. It is assumed that Tu Liem and Thanh Tri districts will open their own landfill sites in 2003 respectively.
4. Cumulative solid waste amount to be disposed at Nam Son Phase 2 Landfill site during 14 years from beginning of 2004 - beginning of 2018 will be 10,852,554 ton.

Table 6.5.5 Comparison of Handcart/truck collection and Direct Collection with Truck
(Case 1: Salary of Worker: $40 and & Driver $50/month)

	Handcart collection & Truck transport			Direct Collection	
	Handcart Collection	Transport by Truck	Total		
	a	b	a + b = c	d	
1. Waste Amount Collected (ton/day)	800	800	800	800	
2. Amount of waste collected					
a. Handcart (ton/worker/day)	0.4	0.0		0.0	
b. Truck (ton/trip)	0.0	3.5		3.5	
c. Truck (ton/day)	0.0	10.5		7.0	
3. Other Assumptions					
a. Number of drivers per truck (driver/truck)		1		1	
b. Number of truck collection worker (worker/truck)		1		2	
c. Spare truck (%)		15%		15%	
d. Running distance for collection (km)		0		10	
e. Distance from last collection point to transfer		13		13	
f. Fuel milage (km/liter)		5		5	
4. Number of workers & equipment					Difference (c - d)
a. Number of drivers	0	88	88	131	
b. Number of other workers (persons)	2,000	88	2,088	263	
c. Total (a + b)	2,000	175	2,175	394	1,781
d. Handcart (units)	2,000	0	2,000	0	
e. Truck (incl. Spare:15%)	0	88	88	131	
5. Unit Price ($)					
a. Salary of driver ($/month)	50	50		50	
b. Salary for others ($/month)	40	40		40	
c. Handcart ($/unit)	122	122		122	
d. Truck ($/unit)	70,000	70,000		70,000	
e. Fuel ($/liter)	0.26	0.26		0.26	
6. Usful period (years)					
a. handcart	0.5				
b. Trucks		10.0		10.0	
7. Annual cost ($/year)					Difference (c - d)
a. Salary of driver & others ($/month)	960,000	94,629	1,054,629	205,029	849,600
b. Handcart	488,000	0	488,000	0	488,000
c. Truck	0	613,333	613,333	920,000	-306,667
d. Fuel	0	37,598	37,598	78,089	-40,491
e. Annual maintenance cost (4% of equipment purchase)	19,520	245,333	264,853	368,000	-103,147
f. Administrative cost	98,440	70,796	169,236	112,503	56,733
g. Total (a+b+c+d+e+f)	1,565,960	1,061,690	2,627,650	1,683,621	944,029
h. Cost Index			100	64	

Note: Annual administrative cost is estimated to be 10% of labor cost plus 1% of equipment purchase.

Table 6.5.6 Comparison of Handcart/truck collection and Direct Collection with Truck

(Case 2: Salaries are doubled)

	Handcart collection & Truck transport			Direct Collection	
	Handcart Collection	Transport by Truck	Total		
	a	b	a + b = c	d	
1. Waste Amount Collected (ton/day)	800	800	800	800	
2. Amount of waste collected					
a. Handcart (ton/worker/day)	0.4	0.0		0.0	
b. Truck (ton/trip)	0.0	3.5		3.5	
c. Truck (ton/day)	0.0	10.5		7.0	
3. Other Assumptions					
a. Number of drivers per truck (driver/truck)		1		1	
b. Number of truck collection worker (worker/truck)		1		2	
c. Spare truck (%)		15%		15%	
d. Running distance for collection (km)		0		10	
e. Distance from last collection point to transfer station (km)		13		13	
f. Fuel milage (km/liter)		5		5	
4. Number of workers & equipment					Difference (c - d)
a. Number of drivers	0	88	88	131	
b. Number of other workers (persons)	2,000	88	2,088	263	
c. Total (a + b)	2,000	175	2,175	394	1,781
d. Handcart (units)	2,000	0	2,000	0	
e. Truck (incl. Spare:15%)	0	88	88	131	
5. Unit Price ($)					
a. Salary of driver ($/month)	100	100		100	
b. Salary for others	80	80		80	
c. Handcart ($/unit)	122	122		122	
d. Truck ($/unit)	70,000	70,000		70,000	
e. Fuel ($/liter)	0.26	0.26		0.26	
6. Usful period (years)					
a. handcart	0.5				
b. Trucks		10.0		10.0	
7. Annual cost ($/year)					Difference (c - d)
a. Salary of driver & others ($/month)	1,920,000	189,257	2,109,257	410,057	1,699,200
b. Handcart	488,000	0	488,000	0	488,000
c. Truck	0	613,333	613,333	920,000	-306,667
d. Fuel	0	37,598	37,598	78,089	-40,491
e. Annual maintenance cost (4% of equipment purchase)	19,520	245,333	264,853	368,000	-103,147
f. Administrative cost	194,440	80,259	274,699	133,006	141,693
g. Total (a+b+c+d+e+f)	2,621,960	1,165,781	3,787,741	1,909,152	1,878,589
h. Cost Index			100	50	

Note: Annual administrative cost is estimated to be 10% of labor cost plus 1% of equipment purchase.

Table 6.5.7 Comparison of Handcart/truck collection and Direct Collection by Trucks

Case 3: Salaries & Waste collection amount are doubled.

	Handcart collection & Truck transport			Direct Collection	
	Handcart Collection	Transport by Truck	Total		
	a	b	a + b = c	d	
1. Waste Amount Collected (ton/day)	1,600	1,600	1,600	1,600	
2. Amount of waste collected					
a. Handcart (ton/worker/day)	0.4	0.0		0.0	
b. Truck (ton/trip)	0.0	3.5		3.5	
c. Truck (ton/day)	0.0	10.5		7.0	
3. Other Assumptions					
a. Number of drivers per truck (driver/truck)		1		1	
b. Number of truck collection worker (worker/truck)		1		2	
c. Spare truck (%)		15%		15%	
d. Running distance for collection (km)		0		10	
e. Distance from last collection point to transfer		13		13	
f. Fuel milage (km/liter)		5		5	
4. Number of workers & equipment					Difference (c - d)
a. Number of drivers (persons)	0	175	175	263	
b. Number of other workers (persons)	4,000	175	4,175	526	
c. Total (a + b)	4,000	350	4,350	789	3,562
d. Handcart (units)	4,000	0	4,000	0	
e. Truck (incl. Spare:15%)	0	175	175	263	
5. Unit Price ($)					
a. Salary of driver ($/month)	100	100		100	
b. Salary for others ($/month)	80	80		80	
c. Handcart ($/unit)	122	122		122	
d. Truck ($/unit)	70,000	70,000		70,000	
e. Fuel ($/liter)	0.26	0.26		0.26	
6. Usful period (years)					
a. handcart	0.5				
b. Trucks		10.0		10.0	
7. Annual cost ($/year)					Difference (c - d)
a. Salary of driver & others ($/month)	3,840,000	378,514	4,218,514	820,114	3,398,400
b. Handcart	976,000	0	976,000	0	976,000
c. Truck	0	1,226,667	1,226,667	1,840,000	-613,333
d. Fuel	0	75,197	75,197	156,178	-80,981
e. Annual maintenance cost (4% of equipment purchase)	39,040	490,667	529,707	736,000	-206,293
f. Administrative cost	388,880	160,518	549,398	266,011	283,387
g. Total (a+b+c+d+e+f)	5,243,920	2,331,563	7,575,483	3,818,304	3,757,179
h. Cost Index			100	50	

Note: Annual administrative cost is estimated to be 10% of labor cost plus 1% of equipment purchase.

Table 6.5.8 Estimated Number of Trucks including Spare trucks by Districts

	Each District							7Districts					
	Target Collection (ton/day)							Target					
	Unit 1			Unit 2				Unit 4					
	Enterprise 1		Enterprise 2	Enterprise 3	Enterprise 4		Enterprise 5	Demolition & Soil Waste					
	Ba Dinh	Cau Giay	Hoan Kiem	Hai Ba Trung	Dong Da	Thanh Xuan	Tay Ho	7 Urba Districts					
Population	181,350	104,196	181,800	337,211	289,552	133,339	84,654						
Year									Unit1 Total	Unit 2 Total	Units1,2 & Enterprise 5 total	Units 1,2 & Enterprise 5	Units1,2& 4 & Enterprise5
1998	18	10	18	33	28	13	9	10	46	74	129	139	149
1999	19	11	19	34	29	14	9	11	49	77	135	146	157
2000	20	13	20	36	31	17	11	12	53	84	148	160	172
2001	20	15	21	38	32	19	12	13	56	89	157	170	183
2002	21	17	22	40	34	22	14	14	60	96	170	184	198
2003	23	20	23	42	36	25	16	15	66	103	185	200	215
2004	24	23	24	44	37	29	18	16	71	110	199	215	231
2005	25	26	25	46	39	33	21	17	76	118	215	232	249
2006	26	29	26	48	41	37	24	19	81	126	231	250	269
2007	27	33	27	49	42	43	27	20	87	134	248	268	288
2008	28	36	28	51	44	46	29	21	92	141	262	283	304
2009	28	39	28	52	45	49	32	22	95	146	273	295	317
2010	29	42	29	54	46	53	34	23	100	153	287	310	333
2011	30	44	30	55	47	56	36	24	104	158	298	322	346
2012	30	46	30	56	48	59	38	25	106	163	307	332	357
2013	31	49	31	57	49	62	40	26	111	168	319	345	371
2014	32	51	32	59	50	65	42	27	115	174	331	358	385
2015	32	54	32	60	51	69	44	28	118	180	342	370	398
2016	33	57	33	61	53	72	46	29	123	186	355	384	413
2017	34	59	34	62	54	76	48	30	127	192	367	397	427
2018	35	62	35	64	55	80	51	31	132	199	382	413	444
2019	35	66	35	65	56	84	53	32	136	205	394	426	458
2020	36	69	36	67	57	88	56	33	141	212	409	442	475

Table 6.5.9 Required Vehicles and Replacement Schedule

	Waste Collection Trucks			Water Sprinkling Vehicles			Containers (350–700 liter)		
Year	Quantity required	Discarded	New Purchase	Quantity required	Discarded	New Purchase	Quantity Required	Discarded	New Purchase
1999	146	0	0	43	0	0	0	0	0
2000	160	30	44	46	5	8	200	0	200
2001	170	30	40	52	5	11	400	0	200
2002	184	30	44	55	5	8	600	0	200
2003	200	20	36	58	5	8	800	0	200
2004	215	20	35	61	5	8	1,000	0	200
2005	232	16	33	62	5	6	1,200	0	200
2006	250	0	18	63	5	6	1,400	0	200
2007	268	0	18	64	5	6	1,600	0	200
2008	283	0	15	65	3	4	1,800	0	200
2009	295	0	12	66	0	1	2,000	0	0
2010	310	44	59	66	8	8	2,000	200	200
2011	322	40	52	66	11	11	2,000	200	200
2012	332	44	54	66	8	8	2,000	200	200
2013	345	36	49	66	8	8	2,000	200	200
2014	358	35	48	66	8	8	2,000	200	200
2015	370	33	45	66	6	6	2,000	200	200
2016	384	18	32	66	6	6	2,000	200	200
2017	397	18	31	66	6	6	2,000	200	200
2018	413	15	31	66	4	4	2,000	200	200
2019	426	12	25	66	1	1	2,000	0	0
2020	442	59	75	66	8	8	2,000	200	200
a. Sub Total 2000–2005		146	232		30	49		0	1,200
b. Sub Total 2006–2010		44	122		21	25		200	800
c. Sub Total 2011–2020		310	442		66	66		1,800	1,800
e. Total (a+b+c+d) 2000–2020		500	796		117	140		2,000	3,800

Table 6.5.10 New Vehicle Purchase Schedule

	Quantity of Vehicles to be Purchased				Purchase Costs ($US in 1999 price)			
Year	Waste Collection Truck	Water Sprinkling truck	Vehicles Total	Containers (350 – 700 liter)	Waste Collection Truck	Water Sprinkling truck	Containers (350 – 700 liter)	Total
					70,000	40,000	100	
1999	0	0	0	0	0	0	0	0
2000	44	8	52	200	3,080,000	320,000	20,000	3,420,000
2001	40	11	51	200	2,800,000	440,000	20,000	3,260,000
2002	44	8	52	200	3,080,000	320,000	20,000	3,420,000
2003	36	8	44	200	2,520,000	320,000	20,000	2,860,000
2004	35	8	43	200	2,450,000	320,000	20,000	2,790,000
2005	33	6	39	200	2,310,000	240,000	20,000	2,570,000
2006	18	6	24	200	1,260,000	240,000	20,000	1,520,000
2007	18	6	24	200	1,260,000	240,000	20,000	1,520,000
2008	15	4	19	200	1,050,000	160,000	20,000	1,230,000
2009	12	1	13	0	840,000	40,000	0	880,000
2010	59	8	67	200	4,130,000	320,000	20,000	4,470,000
2011	52	11	63	200	3,640,000	440,000	20,000	4,100,000
2012	54	8	62	200	3,780,000	320,000	20,000	4,120,000
2013	49	8	57	200	3,430,000	320,000	20,000	3,770,000
2014	48	8	56	200	3,360,000	320,000	20,000	3,700,000
2015	45	6	51	200	3,150,000	240,000	20,000	3,410,000
2016	32	6	38	200	2,240,000	240,000	20,000	2,500,000
2017	31	6	37	200	2,170,000	240,000	20,000	2,430,000
2018	31	4	35	200	2,170,000	160,000	20,000	2,350,000
2019	25	1	26	0	1,750,000	40,000	0	1,790,000
2020	75	8	83	200	5,250,000	320,000	20,000	5,590,000
a. Sub Total 2000–2005	232	49	281	1,200	16,240,000	1,960,000	120,000	18,320,000
b. Sub Total 2006–2010	122	25	147	800	8,540,000	1,000,000	80,000	9,620,000
c. Sub Total 2011–2020	442	66	508	1,800	30,940,000	2,640,000	180,000	33,760,000
e. Total (a+b+c+d) 2000–2020	796	140	936	3,800	55,720,000	5,600,000	380,000	61,700,000

Table 6.5.11 - Assumptions regarding number of street washing vehicles

Year	Incremental no. of vehicles	Total number of vehicles required	Planning Assumptions
1999	existing	43	3 new vehicles per year until 2005, required to improve service levels and match urban growth
2000	3	46	
2001	3	49	
2002	3	52	
2003	3	55	
2004	3	58	
2005	3	61	
2006	1	62	Implemention of direct collection of waste after 2005 and improved demolition waste collection will result in cleaner streets. Street cleaning service levels can therefore be reduced. Increase fleet by 1 vehicle per year to match expanding urban area.
2007	1	63	
2008	1	64	
2009	1	65	
2010	1	66	

Table 6.5.12 - Septage collection vehicles for Hanoi City (Nhue River Basin)[1]

Year	Qty of septage m3/d	Septage collection		
		m3/d	% of total	No. of trucks [2]
1999	356	75	21%	17
2000	345	80	23%	10
2001	335	85	25%	11
2002	320	90	28%	11
2003	305	95	31%	12
2004	290	95	33%	12
2005	274	95	35%	12
2006	250	100	40%	13
2007	225	105	47%	13
2008	200	110	55%	14
2009	175	115	66%	14
2010	148	110	74%	14

(1) Sub-urban areas of Thanh Tri and Nhue West are excluded

(2) Assumed collection capacity per vehicle
1 truck = 5 m3 x 2 trips/day x 80% availability = 8 m3/day

Table 6.5.13 - Garage Workshop Tools and Equipment

No	Description	Qty	Units	Unit cost ($)	Extensions
1	**Tyre Service Shop**				
	air compressor	1	each	45	45
	tire service tool set	1	each	18	18
	air chuck	1	each	51	51
	tire changing machine	1	each	380	380
	wheel balancing machine	1	each	1,620	1,620
	pressure gauge	2	each	1,870	3,740
				Sub-total	5,854
2	**Repair Shop**				
	hydraulic jack 10 ton	1	each	2,200	2,200
	portable lubricator (oil)	1	each	5,100	5,100
	portable lubricator (grease)	1	each	4,200	4,200
	mobile work bench	1	each	1,600	1,600
	oil drain	1	each	2,800	2,800
	grease gun	2	each	91	182
	mech, tool set	1	each	3,500	3,500
	tool cabinet	1	each	2,200	2,200
	battery charger	1	each	4,300	4,300
	battery caddy	1	each	600	600
	electronic tool set	1	each	320	320
	multimeter	1	each	1,010	1,010
	soldering iron	1	each	59	59
	bench electric grinder	1	each	1,200	1,200
	work bench	1	each	1,270	1,270
	bench drill press	1	each	3,000	3,000
	drill press vise	1	each	100	100
	highg pressure washer	2	each	11,900	23,800
	steam cleaner	1	each	7,100	7,100
	arc welding set	1	each	2,200	2,200
	gas welding set	1	each	1,290	1,290
	tips for welding	1	each	560	560
	tips for cutting	1	each	530	530
				Sub-total	69,121
				Total	74,975

Table 6.5.14 - Cost Estimate for a New Garage Facility

No	Description	Qty	Units	Unit Cost ($)	Extensions
1	Land	10,000	m2	25	250,000
2	Buildings (steel with concrete block walls, sheet metal roof)				
	a) Mtce Garage c/w vehicle wash without finishings	500	m2	250	125,000
	b) Office & personnel building with finishings	350	m2	400	140,000
	c) M&E services	1	L.S.	25,000	25,000
3	Fence	425	m	50	21,250
4	Septic Tank (75,000 l)	1	each	25,000	25,000
5	Tools and equipment	1	L.s.	75,000	75,000
6	Bulk fuel	1	each	30,000	30,000
7	Water filling station	1	each	50,000	50,000
8	Site work				
	a Grading	1	ha	3,500	3,500
	b Excavation	1,000	m3	3	3,000
	c Backfill	4,000	m3	2	8,000
	d Paving & lines	5,000	m2	10	50,000
	e drainage	1	ha	9,000	9,000
	f landscaping	1	L.S.	5,000	5,000
	Total				819,750

Table 6.5.15 - Cost to Upgrade Existing Garage Sites

No	Description	Qty	Units	Unit Cost ($)	Extensions
Garage No.1					
1	Buildings (steel with concrete block walls, sheet metal roof) a) Mtce Garage c/w vehicle wash without finishings	500	m2	250	125,000
2	Tools and equipment	1	L.s.	50,000	50,000
3	Bulk fuel	1	each	30,000	30,000
4	Site work				
	a Grading	0.30	ha	3,500	1,050
	b Excavation	500	m3	3	1,500
	c Backfill	2,000	m3	2	4,000
	d Paving & lines	1,250	m2	10	12,500
	e drainage	0.30	ha	2,500	750
	Total				224,800
Garage No.2					
1	Buildings (steel with concrete block walls, sheet metal roof) a) Mtce Garage c/w vehicle wash without finishings	500	m2	250	125,000
2	Tools and equipment	1	L.s.	50,000	50,000
3	Bulk fuel	1	each	30,000	30,000
4	Water filling station	1	each	50,000	50,000
5	Site work				
	a Grading	0.30	ha	3,500	1,050
	b Excavation	500	m3	3	1,500
	c Backfill	2,000	m3	2	4,000
	d Paving & lines	1,250	m2	10	12,500
	e drainage	0.30	ha	2,500	750
	Total				274,800

Table 6.5.16 - Equipment and tools for central maintenance workshop (1of3)

Item	Description	Quantity	Unit Price (JPY)	Amount (JPY)	Amount (USD)
1	ENGINE SERVICE SHOP				
1.01	Mobile Floor Crane, 1,100kg with Hydraulic Hand Pump	1	570,000	570,000	5,182
1.02	Hydraulic Shop Press, 60 ton with Hydraulic Hand Pump	1	800,000	800,000	7,273
1.03	Work Bench with Cabinet and Locker	2	330,000	660,000	6,000
1.04	Machinists Vise (Swivel Base Type)	2	56,000	112,000	1,018
1.05	Bench Electric Grinder	1	117,000	117,000	1,064
1.06	Hand Truck Load Cap. 300kg	1	90,000	90,000	818
1.07	Parts Rack	2	127,000	254,000	2,309
1.08	Parts Wagon	1	540,000	540,000	4,909
1.09	Cylinder Head Work Bench	1	480,000	480,000	4,364
1.10	Air Hose Real	2	129,000	258,000	2,345
1.11	Air Blow Gun	2	2,090	4,180	38
1.12	Engine Cleaning Gun	2	24,000	48,000	436
1.13	Eccentric Valve Seat Grinder	1	840,000	840,000	7,636
1.14	Valve Refacer	1	720,000	720,000	6,545
1.15	Valve Spring Tester	1	170,000	170,000	1,545
1.16	Cylinder Gauge (Bore Gauge)	1	43,000	43,000	391
1.17	Piston Feeler Gauge	2	2,860	5,720	52
1.18	Piston Ring Tool	2	3,950	7,900	72
1.19	Piston Ring Compressor	2	3,240	6,480	59
1.20	Piston Heater (Bearing Heater)	1	360,000	360,000	3,273
1.21	Connecting Rod Aligner	1	125,000	125,000	1,136
1.22	Mechanic Tool Set	2	350,000	700,000	6,364
1.23	Cylinder Head Hydraulic Test Stand	1	300,000	300,000	2,727
1.24	Engine Hanger	1	290,000	290,000	2,636
1.25	Valve Spring Tool	2	47,000	94,000	855
1.26	Diesel Compression Gauge	1	71,000	71,000	645
1.27	Cylinder Liner Puller (Manual Type)	1	125,000	125,000	1,136
1.28	Piston Vise	1	21,000	21,000	191
1.29	Portable Engine Dynamometer set	1	10,790,000	10,790,000	98,091
1.30	Fuel injection pump test stand	1	11,430,000	11,430,000	103,909
			Sub-total	30,032,280	273,021
2	HYDRAULIC & POWER TRAIN SERVICE EQUIPMENT				
2.01	Mechanic Tool Set	2	350,000	700,000	6,364
2.02	Tool Cabinet	2	220,000	440,000	4,000
2.03	Work Bench	2	127,000	254,000	2,309
2.04	Engineers Vise	2	66,000	132,000	1,200
2.05	Air Hose Reel	1	129,000	129,000	1,173
2.06	Air Blow Gun	1	2,090	2,090	19
2.07	Portable Hydraulic Tester	1	580,000	580,000	5,273
2.08	Hydraulic Cylinder checker & Emergency Power Unit	1	1,510,000	1,510,000	13,727
2.09	Engine Positioner	1	290,000	290,000	2,636
2.10	Overhead crane	1	3,330,000	3,330,000	30,273
			Sub-total	7,367,090	66,974
3	TIRE SERVICE SHOP				
3.01	Tire Pressure Gauge, Bar Type	3	4,460	13,380	122
3.02	Air Chuck	2	1,780	3,560	32
3.03	Tire Service Tool	2	51,000	102,000	927
3.04	Tube Vulcanizer Set	1	74,000	74,000	673
3.05	Cold Patch for Tube Repair Various Sizes	2	4,110	8,220	75
3.06	Tool Locker with Sliding Door	1	105,000	105,000	955
3.07	Air Compressor	1	380,000	380,000	3,455
3.08	Tire changer	1	1,620,000	1,620,000	14,727
3.09	Portable Wheel Balancer	1	1,870,000	1,870,000	17,000
			Sub-total	4,176,160	37,965

Table 6.5.16 - Equipment and tools for central maintenance workshop (2of3)

Item	Description	Quantity	Unit Price (JPY)	Amount (JPY)	Amount (USD)
4	CHASSIS REPAIR SHOP				
4.01	Overhead Travelling Crane, 3 ton, Double Girder Type, 12m span	1	6,670,000	6,670,000	60,636
4.02	Hand Truck, Load Cap.: 300kg	1	90,000	90,000	818
4.03	Pallet Truck	1	155,000	155,000	1,409
4.04	Sling Chain Kit	1	690,000	690,000	6,273
4.05	Portable Hydraulic Jack, Capacity: 10 ton	1	53,000	53,000	482
4.06	Parts Rack	4	127,000	508,000	4,618
4.07	Parts Wagon	1	540,000	540,000	4,909
4.08	Mechanic Tool Set	2	350,000	700,000	6,364
4.09	Hydraulic Garage Jack	2	220,000	440,000	4,000
4.10	Hydraulic Garage Jack	2	126,000	252,000	2,291
4.11	Air Operated Lubricator	1	510,000	510,000	4,636
4.12	Portable Chassis Lubricator (Grease)	1	420,000	420,000	3,818
4.13	Transmission Jack (standard)	1	240,000	240,000	2,182
4.14	Air Hose Reel	2	129,000	258,000	2,345
4.15	Air Blow Gun	2	1,730	3,460	31
4.16	Mobile Work Bench (Wood Cover)	3	160,000	480,000	4,364
4.17	Engineers Vise	3	52,000	156,000	1,418
4.18	Oil Drain	1	280,000	280,000	2,545
4.19	Diaphragm Pump with Suction	1	158,000	158,000	1,436
4.20	Grease Gun, Cap. 300cc	2	9,140	18,280	166
4.21	4-Post Car Lift (scissors type), Capacity: 20 ton	1	3,990,000	3,990,000	36,273
4.22	Frame lift, X type, Max. capacity: 12 ton	1	1,670,000	1,670,000	15,182
4.23	Jib Crane with Chain Block, Capacity: 1 ton	1	270,000	270,000	2,455
			Sub-total	18,551,740	168,652
5	ELECTRIC COMPONENTS REPAIR SHOP				
5.01	Starter Generator Test Bench	1	3,590,000	3,590,000	32,636
5.02	Circuit Tester	1	13,120	13,120	119
5.03	Armature Tester	1	220,000	220,000	2,000
5.04	Regulator Tester	1	126,000	126,000	1,145
5.05	Insulation Tester	1	58,000	58,000	527
5.06	Motor Puller Set	2	290,000	580,000	5,273
5.07	Work Bench	2	127,000	254,000	2,309
5.08	Engineers Vise	2	52,000	104,000	945
5.09	Tool Cabinet	2	144,000	288,000	2,618
5.10	Multi-meter	1	101,000	101,000	918
5.11	Silicon Quick Charger	2	430,000	860,000	7,818
5.12	Battery Tester	2	37,000	74,000	673
5.13	Water Purifier	1	420,000	420,000	3,818
5.14	Battery Caddy	1	60,000	60,000	545
5.15	Electric tool set	2	32,000	64,000	582
			Sub-total	6,812,120	61,928
6	MACHINE SHOP				
6.01	Crankshaft grinding machine	1	11,110,000	11,110,000	101,000
6.02	Cylinder boring machine	1	5,550,000	5,550,000	50,455
6.03	Cylinder honing machine	1	5,690,000	5,690,000	51,727
6.04	Valve Seat boring machine	1	3,840,000	3,840,000	34,909
6.05	Liner boring machine	1	5,680,000	5,680,000	51,636
6.06	Surface grinding	1	6,080,000	6,080,000	55,273
6.07	Cam-Rod boring machine	1	2,600,000	2,600,000	23,636
6.08	Cement Carbide Tipped Bits	2	350,000	700,000	6,364
6.09	High-Speed Steel Tool Bits	2	190,000	380,000	3,455
6.10	Bench Electric Grinder	1	170,000	170,000	1,545
6.11	Work Bench	1	127,000	127,000	1,155
6.12	Tool Locker & Cabinet	1	147,000	147,000	1,336
6.13	Bench drill press	1	290,000	290,000	2,636
6.14	Taper Shank Twist Drill Set	1	220,000	220,000	2,000
6.15	Milling Machine	1	12,300,000	12,300,000	111,818
6.16	Cutting Tools for Milling Machine	1	390,000	390,000	3,545
6.17	Universal Press	1	2,470,000	2,470,000	22,455
			Sub-total	57,744,000	524,945

Table 6.5.16 - Equipment and tools for central maintenance workshop (3of3)

Item	Description	Quantity	Unit Price (JPY)	Amount (JPY)	Amount (USD)
7	CLEANING AND PAINTING AREA				
7.01	Hot Water High Pressure Wahser	1	1,190,000	1,190,000	10,818
7.02	Steam Cleaner	1	710,000	710,000	6,455
7.03	Water Hose Reel	1	110,000	110,000	1,000
7.04	Spray Gun, Suction Type	2	23,000	46,000	418
7.05	Infrared Drying Stand	4	350,000	1,400,000	12,727
			Sub-total	3,456,000	31,418
8	WELDING AND FABRICATION SHOP				
8.01	AC Arc Welder	1	270,000	270,000	2,455
8.02	Gas Welder Set	1	129,000	129,000	1,173
8.03	Portable Spot Welder Set	1	1,350,000	1,350,000	12,273
8.04	Hydraulic Shop Press, 60 ton	1	760,000	760,000	6,909
8.05	Hand Lever Shear	1	250,000	250,000	2,273
8.06	Clamp for Sheet Metal, Capacity: 2 ton	2	130,000	260,000	2,364
			Sub-total	3,019,000	27,445
9	TOOLS				
9.01	Torque Wrench, 100-1200 kgf.cm	2	32,000	64,000	582
9.02	Torque Wrench, 600-3200 kgf.cm	2	43,000	86,000	782
9.03	Torque Wrench, 1000-7000 kgf.cm	2	133,000	266,000	2,418
9.04	Bearing & Gear Puller Set for Construction Machinery	1	710,000	710,000	6,455
9.05	Adjustable Reamer with Pilot Set	2	137,000	274,000	2,491
9.06	Portable Hydraulic Jack, Capacity: 50 ton	2	120,000	240,000	2,182
9.07	Portable Hydraulic Jack, Capacity: 30 ton	2	69,000	138,000	1,255
9.08	Air Impact Wrench (1/2' Sq.), Capacity (Bolt dia.): M16	4	63,000	252,000	2,291
9.09	Air Impact Wrench (3/4' Sq.), Capacity (Bolt dia.): M20	2	100,000	200,000	1,818
9.10	Electric Drill, Drilling Cap.: 13mm dia.	2	66,000	132,000	1,200
9.11	Electric Drill, Drilling Cap.: 25mm dia.	1	260,000	260,000	2,364
9.12	Electro-Magnetic Drill Press	1	480,000	480,000	4,364
9.13	Straight Shank Twist Drill Set	4	23,000	92,000	836
9.14	Taper Shank Drill Set	2	143,000	286,000	2,600
9.15	Electric Portable Grinder	1	124,000	124,000	1,127
9.16	Electric Hand Grinder	1	108,000	108,000	982
9.17	Mechanic Tool Set	6	350,000	2,100,000	19,091
9.18	Tap & Die	1	200,000	200,000	1,818
9.19	Diesel Timing and Tacho	1	280,000	280,000	2,545
9.20	Diesel Engine Vacuum Tester	2	30,000	60,000	545
			Sub-total	6,352,000	57,745
10	PARTS WAREHOUSE				
10.01	Rack for Medium Sized Parts, 5 Shelves, 240kg/shelf	20	104,000	2,080,000	18,909
10.02	Rack for Medium and Large Parts, 5 shelves, 480 kg/shelf	20	145,000	2,900,000	26,364
10.03	Rack for Small Parts, 5 shelf, 100kg/shelf	20	160,000	3,200,000	29,091
10.04	Pallet Rack	3	142,000	426,000	3,873
10.05	Rack for Long Heavy Items	3	117,000	351,000	3,191
			Sub-total	8,957,000	81,427
11	AUXILIARY EQUIPMENT				
11.01	Fork lift, Capacity: 2 ton	1	3,790,000	3,790,000	34,455
11.02	Air compressor	1	910,000	910,000	8,273
			Sub-total	4,700,000	42,727
			Total	151,167,390	1,374,249
				Engineering 5%	68,712.45
				Admin 3%	41,227.47
				Contingency 10%	137,424.90
				Grand-total	1,621,614

Table 6.5.17 Comparison of waste management in some countries

Nation	Population	Area	Pop. Density	GDP	Waste	Landfill	Incineration	Composting	Recycling
	Million	Kkm2		USD	Kg/y	%	%	%	%
Japan	125.4	378	332	41,080	400	22.5	72.8	-	3.1
USA	269.4	9,289	29	27,590	701	67	16	2	15
Germany	81.9	356	230	28,860	417	68.9	15.5	3.1	12.5
France	58.3	550	106	26,280	348	50	40	10	
UK	58.1	244	238	19,800	347	83	13	-	-
Netherlands	15.6	40.9	387	25,850	484	52	27	8	13
Sweden	8.8	440	20	25,770	314	38	55	7	-
Spain	39.7	502	79	14,200	323	75	5	20	-
Swiss	7.2	41	175	43,420	406	11	76	13	-
Denmark	5.2	43	122	32,250	351	16	71	13	
Canada	29.7	9,971	3	19,200	646	82	8	-	10
Vietnam	77	331	233	-	-	-	-	-	-

* Waste data is based on around 1990.

Table 6.5.18 Required area estimation for sanitary landfill

YEAR	WASTE GENERATED at Beginning of the Year	Waste Receive at Landfill site		
		Annual Quantity	Cumulative Volume	Required Area
	t/d	t/y	m3/d	ha
2,000	1,385	435,229	497,287	2.4
2,001	1,455	430,811	989,527	4.7
2,002	1,528	467,501	1,523,688	7.3
2,003	1,605	493,735	2,087,824	9.9
2,004	1,686	535,766	2,699,983	12.9
2,005	1,771	579,541	3,362,160	16.0
2,006	1,857	616,689	4,066,782	19.4
2,007	1,948	657,706	4,818,268	22.9
2,008	2,042	694,343	5,611,616	26.7
2,009	2,142	728,898	6,444,446	30.7
2,010	2,246	767,147	7,320,979	34.9
2,011	2,328	785,450	8,218,425	39.1
2,012	2,413	819,581	9,154,869	43.6
2,013	2,501	850,459	10,126,594	48.2
2,014	2,592	884,851	11,137,614	53.0
2,015	2,687	920,568	12,189,445	58.0
2,016	2,785	947,845	13,272,441	63.2
2,017	2,886	983,787	14,396,504	68.6
2,018	2,992	1,023,811	15,566,299	74.1

Table 6.5.19 Daily Generation Quantity of Industrial Waste in Hanoi

UNIT: Tons/day

No.	Components	Characteristics defined by URENCO	Mechanical Industries	Chemical Industries	Textile and Dying Industries	Electrical and Electronic Industries	Food Processing Industries	Sub TOTAL	Other Industries	TOTAL
1	PCB's wastes	Toxic	0.0	0.0	0.0	0.3	0.0	0.3		
2	Heavy metal sludges	Toxic	6.9	1.0	2.0	0.8	0.0	10.7		
3	Halogen solvents	Toxic	0.0	0.0	2.4	0.0	0.0	2.4		
4	Non halogen solvents	Toxic	0.0	4.3	0.0	0.0	0.0	4.3		
5	Biocide wastes	Toxic	0.0	3.2	0.0	0.0	0.0	3.2		
6	Organic chemical residues	Toxic	0.0	5.0	0.0	0.0	0.0	5.0		
7	Colouring and flavourings	Toxic	0.0	0.0	0.0	0.0	0.0	0.0		
8	Paints and resins	Toxic	0.0	1.9	0.0	0.0	0.0	1.9		
9	Plastics	Toxic	0.0	0.0	0.0	2.1	0.0	2.1		
10	Solvents and Ag	Toxic	0.0	0.0	0.0	0.0	0.0	0.0		
		Sub-total	6.9	15.3	4.4	3.2	0.0	29.8		
11	Acid and alkali	Corrosives	2.5	0.0	0.0	0.0	0.0	2.5		
12	Detergents	Corrosives	0.0	0.0	0.0	0.0	0.0	0.0		
		Sub-total	2.5	0.0	0.0	0.0	0.0	2.6		
13	Organic wastes	Biological	0.0	0.0	0.0	0.0	4.1	4.1		
14	Putrescible organic wastes	Biological	0.0	0.0	3.7	0.0	0.0	3.7		
		Sub-total	0.0	0.0	3.7	0.0	4.1	7.8		
15	Rags, textile	Combustion	1.0	0.0	0.0	0.0	0.0	1.0		
16	Feathers	Combustion	0.0	0.0	0.0	0.0	0.3	0.3		
17	Oil and greases	Combustion	0.0	0.0	0.0	0.0	0.7	0.7		
18	Oil wastes	Combustion	2.0	0.0	0.0	0.0	0.0	2.0		
19	Waste oil	Combustion	0.0	0.4	0.2	0.4	0.2	1.2		
		Sub-total	3.0	0.4	0.2	0.4	1.2	5.2		
	Hazardous Sub-total		12.4	15.7	8.3	3.6	5.4	45.5	8.1	53.6
20	Dusts and sand		0.0	0.0	0.0	0.0	6.9	6.9		
21	Rubbers		0.0	0.0	0.0	0.0	0.0	0.0		
22	Cinder		5.0	0.0	6.4	0.3	4.6	16.2		
23	Others		6.3	8.5	3.9	0.6	3.0	22.2		
		Sub-total	11.3	8.5	10.3	0.8	14.5	45.4	40.5	85.9
	Total		23.6	24.1	18.5	4.4	19.9	90.7	48.8	139.5

Source: Evaluation of current industrial waste management in Hanoi City - by CEETIA

Table 6.5.20 Annual Generation Quantity of Industrial Waste in Hanoi

UNIT: Tons/year

No.	Components	Characteristics	Mechanical Industries	Chemical Industries	Textile and Dying Industries	Electrical and Electronic Industries	Food Processing Industries	Sub TOTAL	Other Industries	TOTAL
1	PCB's wastes	Toxic	0.0	0.0	0.0	100.4	0.0	100.4		
2	Heavy metal sludges	Toxic	2511.9	348.2	744.2	296.5	0.0	3900.8		
3	Halogen solvents	Toxic	0.0	0.0	865.9	0.0	0.0	865.9		
4	Non halogen solvents	Toxic	0.0	1571.5	0.0	0.0	0.0	1571.5		
5	Biocide wastes	Toxic	0.0	1151.8	0.0	0.0	0.0	1151.8		
6	Organic chemical residues	Toxic	0.0	1812.6	0.0	0.0	0.0	1812.6		
7	Colouring and flavourings	Toxic	0.0	0.0	0.0	0.0	14.5	14.5		
8	Paints and resins	Toxic	0.0	696.5	0.0	0.0	0.0	696.5		
9	Plastics	Toxic	0.0	0.0	0.0	751.7	0.0	751.7		
10	Solvents and Ag	Toxic	0.0	0.0	0.0	14.6	0.0	14.6		
		Sub-total	2511.9	5580.6	1610.1	1163.2	14.5	10880.3		
11	Acid and alkali	Corrosive	923.6	0.0	0.0	0.0	0.0	923.6		
12	Detergents	Corrosive	0.0	0.0	0.0	0.0	7.3	7.3		
		Sub-total	923.6	0.0	0.0	0.0	7.3	930.9		
13	Organic wastes	Biological	0.0	0.0	0.0	0.0	1503.6	1503.6		
14	Putrescible organic wastes	Biological	0.0	0.0	1332.7	0.0	0.0	1332.7		
		Sub-total	0.0	0.0	1332.7	0.0	1503.6	2836.4		
15	Rags, textile	Combustion	362.5	0.0	0.0	0.0	0.0	362.5		
16	Feathers	Combustion	0.0	0.0	0.0	0.0	94.4	94.4		
17	Oil and greases	Combustion	0.0	0.0	0.0	0.0	261.5	261.5		
18	Oil wastes	Combustion	725.1	0.0	0.0	0.0	0.0	725.1		
19	Waste oil	Combustion	0.0	133.9	74.4	149.0	87.2	444.6		
		Sub-total	1087.6	133.9	74.4	149.0	443.1	1888.1		
	Hazardous Sub-total		4523.3	5714.6	3017.2	1312.2	1968.5	16535.7	3079.5	19665.3
20	Dusts and sand		0.0	0.0	0.0	0.0	2535.1	2535.1		
21	Rubbers		0.0	0.0	0.0	8.1	0.0	8.1		
22	Cinder		1812.7	0.0	2333.9	94.0	1670.7	5911.3		
23	Others		2296.1	3098.4	1413.9	205.7	1089.6	8103.7		
		Sub-total	4108.8	3098.4	3747.8	307.8	5295.5	16558.3	14782.5	31340.8
	Total		8,632.0	8,812.9	6,765.0	1,620.0	7,264.0	33,093.9	17862	50955.9

Source: Evaluation of current industrial waste management in Hanoi City - by CEETIA

Table 6.5.21 Daily Future Quantity Estimation of Industrial Hazardous Waste

UNIT: Tons day

No.	Components	Characteristics defined by URENCO	1997 (not including other industries)	1997 (from all Industries)	1997 (collection rate = 70%)	1999 (=1997)	2005	2010	2020
	Industrial Zone Area (m2)	-	-	-	-	441.3	1242.7	1682.7	2537.7
1	PCB's wastes	Toxic	0.3	0.3	0.2	0.2	0.6	0.9	1.3
2	Heavy metal sludges	Toxic	10.7	12.6	8.8	8.8	24.9	33.7	50.8
3	Halogen solvents	Toxic	2.4	2.8	2.0	2.0	5.5	7.5	11.3
4	Non halogen solvents	Toxic	4.3	5.1	3.6	3.6	10.0	13.6	20.5
5	Biocide wastes	Toxic	3.2	3.7	2.6	2.6	7.3	9.9	15.0
6	Organic chemical residues	Toxic	5.0	5.9	4.1	4.1	11.6	15.6	23.6
7	Colouring and flavourings	Toxic	0.0	0.0	0.0	0.0	0.1	0.1	0.2
8	Paints and resins	Toxic	1.9	2.3	1.6	1.6	4.4	6.0	9.1
9	Plastics	Toxic	2.1	2.4	1.7	1.7	4.8	6.5	9.8
10	Solvents and Ag	Toxic	0.0	0.0	0.0	0.0	0.1	0.1	0.2
		Subtotal	29.8	35.2	24.6	24.6	69.3	93.9	141.6
11	Acid and alkali	Corrosives	2.5	3.0	2.1	2.1	5.9	8.0	12.0
12	Detergents	Corrosives	0.0	0.0	0.0	0.0	0.0	0.1	0.1
		Subtotal	2.6	3.0	2.1	2.1	5.9	8.0	12.1
13	Organic wastes	Biological	4.1	4.9	3.4	3.4	9.6	13.0	19.6
14	Putrescible organic wastes	Biological	3.7	4.3	3.0	3.0	8.5	11.5	17.3
		Subtotal	7.8	9.2	6.4	6.4	18.1	24.5	36.9
15	Rags, textile	Combustion	1.0	1.2	0.8	0.8	2.3	3.1	4.7
16	Feathers	Combustion	0.3	0.3	0.2	0.2	0.6	0.8	1.2
17	Oil and greases	Combustion	0.7	0.8	0.6	0.6	1.7	2.3	3.4
18	Oil wastes	Combustion	2.0	2.3	1.6	1.6	4.6	6.3	9.4
19	Waste oil	Combustion	1.2	1.4	1.0	1.0	2.8	3.8	5.8
		Subtotal	5.2	6.1	4.3	4.3	12.0	16.3	24.6
	Hazardous Subtotal		45.3	53.5	37.4	37.4	105.4	142.7	213.2

Table 6.5.22 Annual Future Quantity Estimation of Industrial Hazardous Waste

UNIT: Tons year

No.	Components	Characteristics	1997(not including other industries)	1997 (from all Industries)	1997 (collection rate = 70%)	1999 (=1997)	2005	2010	2020
				-	-	441.3	1242.7	1682.7	2537.7
1	PCB's wastes	Toxic	100	119	83	83	234	316	477
2	Heavy metal sludges	Toxic	3,901	4,603	3,222	3,222	9,073	12,286	18,526
3	Halogen solvents	Toxic	866	1,022	715	715	2,014	2,727	4,113
4	Non halogen solvents	Toxic	1,572	1,854	1,298	1,298	3,655	4,950	7,465
5	Biocide wastes	Toxic	1,152	1,359	951	951	2,679	3,628	5,471
6	Organic chemical residues	Toxic	1,813	2,139	1,497	1,497	4,216	5,709	8,610
7	Colouring and flavourings	Toxic	15	17	12	12	34	46	69
8	Paints and resins	Toxic	696	822	575	575	1,620	2,194	3,308
9	Plastics	Toxic	752	887	621	621	1,748	2,367	3,570
10	Solvents and Ag	Toxic	15	17	12	12	34	46	69
		Subtotal	10,880	12,839	8,987	8,987	25,308	34,268	51,681
11	Acid and alkali	Corrosive	924	1,090	763	763	2,148	2,909	4,387
12	Detergents	Corrosive	7	9	6	6	17	23	35
		Subtotal	931	1,098	769	769	2,165	2,932	4,422
13	Organic wastes	Biological	1,504	1,774	1,242	1,242	3,498	4,736	7,142
14	Putrescible organic wastes	Biological	1,333	1,573	1,101	1,101	3,100	4,197	6,330
		Subtotal	2,836	3,347	2,343	2,343	6,597	8,933	13,472
15	Rags, textile	Combustion	363	428	299	299	843	1,142	1,722
16	Feathers	Combustion	94	111	78	78	220	297	449
17	Oil and greases	Combustion	262	309	216	216	608	824	1,242
18	Oil wastes	Combustion	725	856	599	599	1,687	2,284	3,444
19	Waste oil	Combustion	445	525	367	367	1,034	1,400	2,112
		Subtotal	1,888	2,228	1,560	1,560	4,392	5,947	8,968
	Hazardous Subtotal		16,536	19,513	13,658	13,658	38,462	52,080	78,543

Table 6.5.23 Proposed Aggregate Investment for Solid Waste Mangement for Urban Hanoi

Unit: US Dollar in 1999 price including contingency and administration cost

	Waste	Solid Waste Collection & Primary Transport				Transfer & Nam Son Phase 2				
Year	Collection Amount (ton/year)	Purchase of New Vehicles	Construction & Upgrading of Garages	Equipment for Central Workshop	Sub total	Nam son Phase 2 Landfill	Waste Transfer System	Upgrading of Roads & Bridges	Sub Total	Total
a		c	d	e	f (c + d +e)	g		h	i (g + h)	i (e + h)
2000	520,584	3,420,000			3,420,000	0		0	0	3,420,000
2001	560,694	3,260,000		1,622,000	4,882,000	0		0	0	4,882,000
2002	605,550	3,420,000	1,389,000		4,809,000	3,480,000	886,963	339,000	4,705,636	9,514,636
2003	653,994	2,860,000			2,860,000	14,576,000	12,552,683	3,137,000	30,265,630	33,125,630
2004	708,248	2,790,000	2,029,000		4,819,000	4,706,000	0	,000	4,706,000	9,525,000
2005	762,818	2,570,000			2,570,000	6,847,000	300,300	,000	7,147,300	9,717,300
2006	823,844	1,520,000			1,520,000	250,000	431,200	,000	681,200	2,201,200
2007	874,621	1,520,000			1,520,000	1,547,000	300,300	,000	1,847,300	3,367,300
2008	919,640	1,230,000			1,230,000	89,000	500,500	,000	589,500	1,819,500
2009	961,700	880,000			880,000	250,000	0	,000	250,000	1,130,000
2010	1,008,439	4,470,000			4,470,000	1,547,000	300,300	,000	1,847,300	6,317,300
2011	1,045,247	4,100,000			4,100,000	0	200,200	,000	200,200	4,300,200
2012	1,086,366	4,120,000			4,120,000	0	200,200	,000	200,200	4,320,200
2013	1,122,942	3,770,000			3,770,000	3,727,000	300,300	,000	4,027,300	7,797,300
2014	1,163,930	3,700,000			3,700,000	0	5,336,100	,000	5,336,100	9,036,100
2015	1,206,413	3,410,000			3,410,000	0	500,500	,000	500,500	3,910,500
2016	1,253,873	2,500,000			2,500,000	1,797,000	600,600	,000	2,397,600	4,897,600
2017	1,296,088	2,430,000			2,430,000	250,000	731,500	,000	981,500	3,411,500
2018	1,343,396	2,350,000			2,350,000	0	600,600	,000	600,600	2,950,600
2019	1,392,430	1,790,000			1,790,000	0	800,800	,000	800,800	2,590,800
2020	1,447,207	5,590,000			5,590,000	0	300,300	,000	300,300	5,890,300
a. Sub Total 2000-2005		18,320,000	3,418,000	1,622,000	23,360,000	29,609,000	13,739,946	3,475,620	46,824,566	70,184,566
b. Sub Total 2006-2010		9,620,000	0	0	9,620,000	3,683,000	1,532,300	0	5,215,300	14,835,300
c. Sub Total 2011-2020		33,760,000	0	0	33,760,000	5,774,000	9,571,100	0	15,345,100	49,105,100
e. Total (a+b+c+d) 2000-2020	20758024	61,700,000	3,418,000	1,622,000	66,740,000	39,066,000	24,843,346	3,475,620	67,384,966	134,124,966

Table 6.5.24 Estimated Operation & Maintenance Costs of Solid Waste Management for Urban hanoi

Unit: US Dollar in 1999 price including contingency and administration cost

	Exporarated	Transfer & Nam Son Phase 2			
Year	Operation & Maintenance Costs of URENCO	Nam Son Phase 2 Landfill	Transfer System	Sub Total	Total
a	b	c	d	e	f
				(c + d)	(b + e)
2000	6,625,152	0	0	0	6,625,152
2001	6,655,164	0	0	0	6,655,164
2002	6,727,577	0	0	0	6,727,577
2003	7,265,783	0	0	0	7,265,783
2004	7,847,046	1,225,009	726,768	1,951,777	9,798,823
2005	8,474,810	1,286,117	782,623	2,068,740	10,543,550
2006	9,152,795	1,522,518	819,090	2,341,608	11,494,402
2007	9,691,936	1,591,821	869,405	2,461,226	12,153,162
2008	10,116,827	1,638,746	911,873	2,550,619	12,667,446
2009	10,587,821	1,693,165	956,649	2,649,814	13,237,635
2010	11,102,389	1,758,729	1,003,272	2,762,001	13,864,390
2011	11,486,251	1,783,452	1,015,274	2,798,726	14,284,977
2012	11,883,085	1,826,531	1,053,587	2,880,118	14,763,203
2013	12,316,817	1,871,264	1,093,747	2,965,012	15,281,829
2014	12,766,381	1,944,352	1,135,292	3,079,644	15,846,025
2015	13,232,354	1,992,598	1,178,222	3,170,820	16,403,174
2016	13,715,335	2,025,944	1,198,071	3,224,015	16,939,350
2017	14,215,945	2,077,991	1,244,232	3,322,223	17,538,168
2018	14,734,827	944,939	1,292,239	2,237,178	16,972,005
2019	15,272,648	832,726	1,342,093	2,174,819	17,447,467
2020	15,830,099	832,726	1,394,255	2,226,981	18,057,081
a. Sub Total 2000-2005	43,595,533	2,511,126	1,509,390	4,020,516	47,616,049
b. Sub Total 2006-2010	50,651,767	8,204,978	4,560,289	12,765,268	63,417,035
c. Sub Total 2011-2020	135,453,741	16,132,523	11,947,013	28,079,536	163,533,278
e. Total (a+b+c+d) 2000-2020	229,701,041	26,848,628	18,016,693	44,865,320	274,566,362

Table 6.5.25 Estimated Future Costs of SWM Expenditures

Unit: US Dollar in 1999 price including contingency and administration cost

	Primary Collection & Transport, Street Sweeping			Waste Transfer System & Nam Son Phase 2 Landfill			Total SWM		
Year	Investment	O & M	Total	Investment	O & M	Total	Investment	O & M	Total
a	b	c	d	e	f	g	h	i	j
			(b+c)			(e+f)	(b+e)	(c+f)	(g+h)
2000	3,420,000	6,625,152	10,045,152	0	0	0	3,420,000	6,625,152	10,045,152
2001	4,882,000	6,655,164	11,537,164	0	0	0	4,882,000	6,655,164	11,537,164
2002	4,809,000	6,727,577	11,536,577	4,705,636	0	4,705,636	9,514,636	6,727,577	16,242,214
2003	2,860,000	7,265,783	10,125,783	30,265,630	0	30,265,630	33,125,630	7,265,783	40,391,413
2004	4,819,000	7,847,046	12,666,046	4,706,000	1,951,777	6,657,777	9,525,000	9,798,823	19,323,823
2005	2,570,000	8,474,810	11,044,810	7,147,300	2,068,740	9,216,040	9,717,300	10,543,550	20,260,850
2006	1,520,000	9,152,795	10,672,795	681,200	2,341,608	3,022,808	2,201,200	11,494,402	13,695,602
2007	1,520,000	9,691,936	11,211,936	1,847,300	2,461,226	4,308,526	3,367,300	12,153,162	15,520,462
2008	1,230,000	10,116,827	11,346,827	589,500	2,550,619	3,140,119	1,819,500	12,667,446	14,486,946
2009	880,000	10,587,821	11,467,821	250,000	2,649,814	2,899,814	1,130,000	13,237,635	14,367,635
2010	4,470,000	11,102,389	15,572,389	1,847,300	2,762,001	4,609,301	6,317,300	13,864,390	20,181,690
2011	4,100,000	11,486,251	15,586,251	200,200	2,798,726	2,998,926	4,300,200	14,284,977	18,585,177
2012	4,120,000	11,883,085	16,003,085	200,200	2,880,118	3,080,318	4,320,200	14,763,203	19,083,403
2013	3,770,000	12,316,817	16,086,817	4,027,300	2,965,012	6,992,312	7,797,300	15,281,829	23,079,129
2014	3,700,000	12,766,381	16,466,381	5,336,100	3,079,644	8,415,744	9,036,100	15,846,025	24,882,125
2015	3,410,000	13,232,354	16,642,354	500,500	3,170,820	3,671,320	3,910,500	16,403,174	20,313,674
2016	2,500,000	13,715,335	16,215,335	2,397,600	3,224,015	5,621,615	4,897,600	16,939,350	21,836,950
2017	2,430,000	14,215,945	16,645,945	981,500	3,322,223	4,303,723	3,411,500	17,538,168	20,949,668
2018	2,350,000	14,734,827	17,084,827	600,600	2,237,178	2,837,778	2,950,600	16,972,005	19,922,605
2019	1,790,000	15,272,648	17,062,648	800,800	2,174,819	2,975,619	2,590,800	17,447,467	20,038,267
2020	5,590,000	15,830,099	21,420,099	300,300	2,226,981	2,527,281	5,890,300	18,057,081	23,947,381
a. Sub Total 2000-2005	23,360,000	43,595,533	66,955,533	46,824,566	4,020,516	50,845,083	70,184,566	47,616,049	117,800,615
b. Sub Total 2006-2010	9,620,000	50,651,767	60,271,767	5,215,300	12,765,268	17,980,568	14,835,300	63,417,035	78,252,335
c. Sub Total 2011-2020	33,760,000	135,453,741	169,213,741	15,345,100	28,079,536	43,424,636	49,105,100	163,533,278	212,638,378
e. Total (a+b+c+d) 2000-2020	66,740,000	229,701,041	296,441,041	67,384,966	44,865,320	112,250,286	134,124,966	274,566,362	408,691,328

Fig.6.5.1 Waste Flow in the Beginning of 1999 in 7 Urban Hdistricts

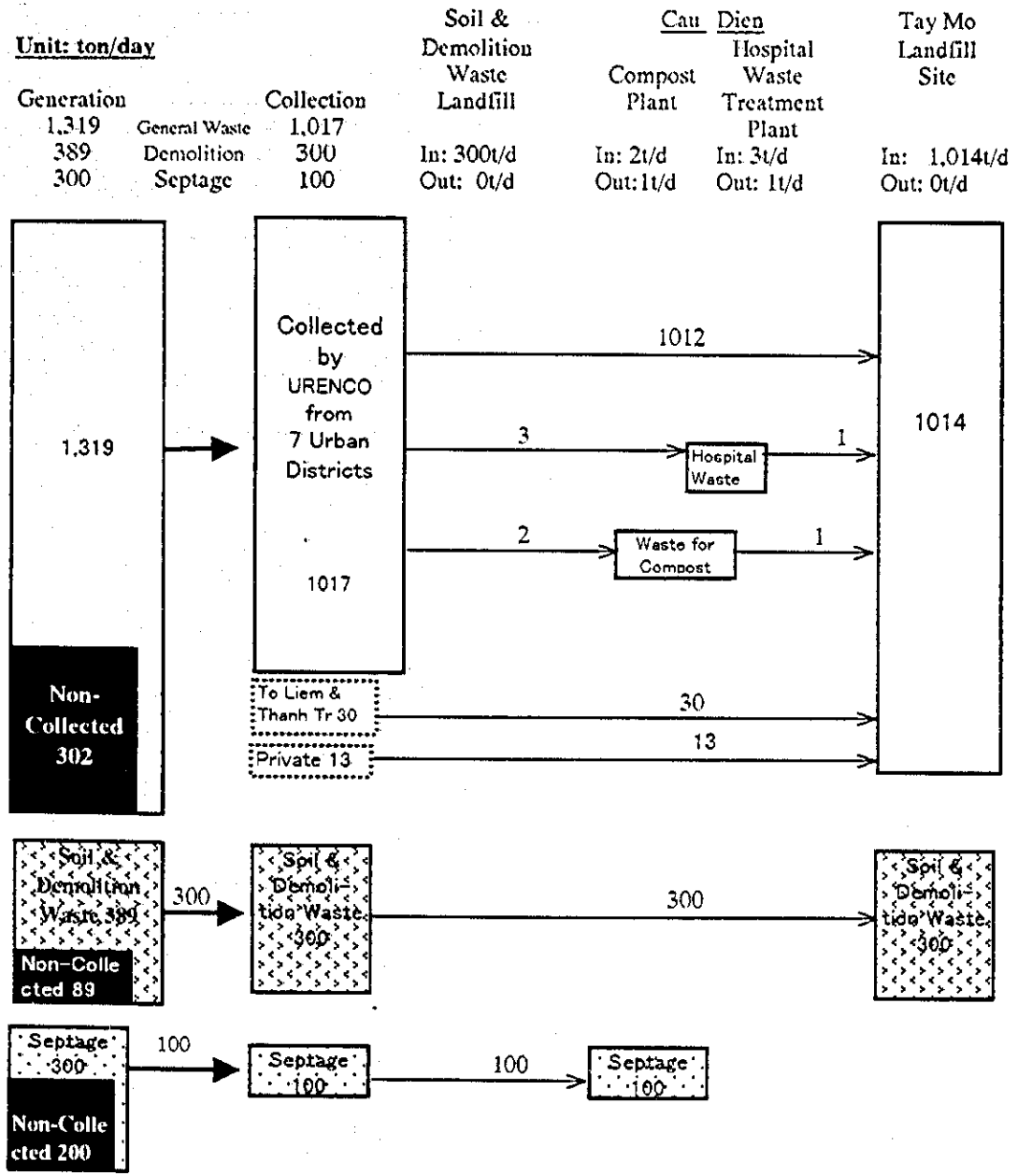
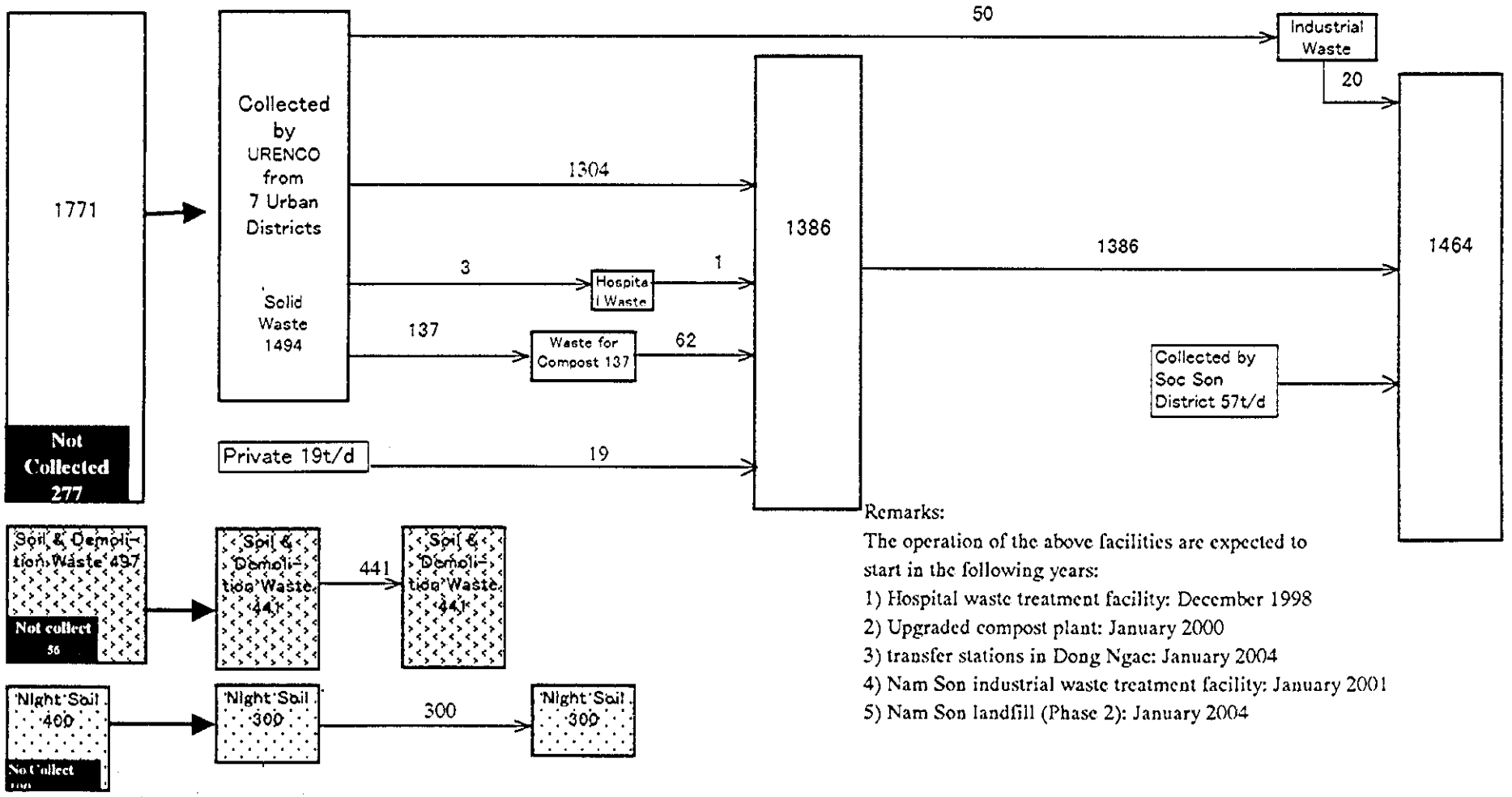


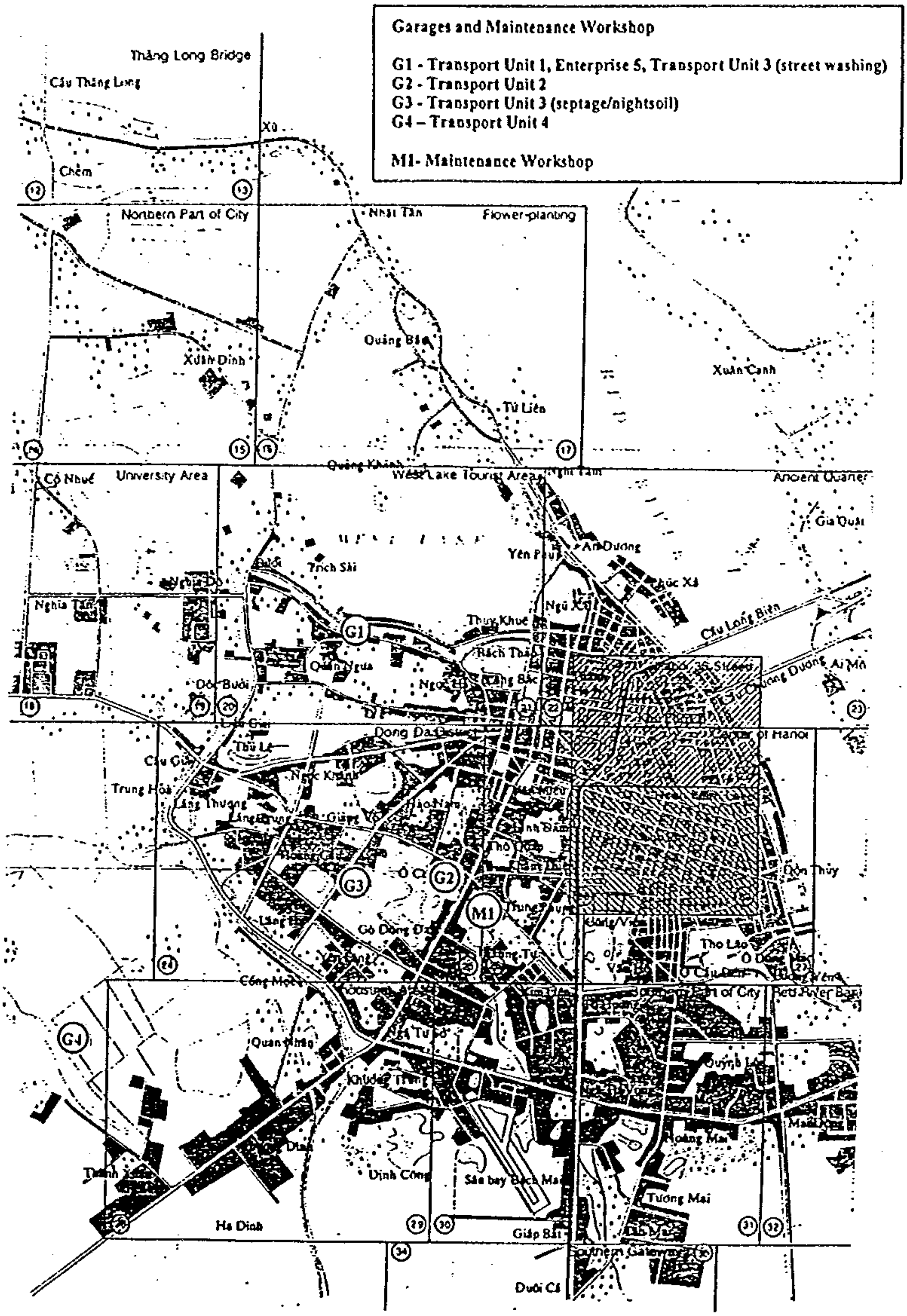
Fig.6.5.2 Waste Flow in the Beginning of 2004 in the Urban Hanoi

Unit: ton/day

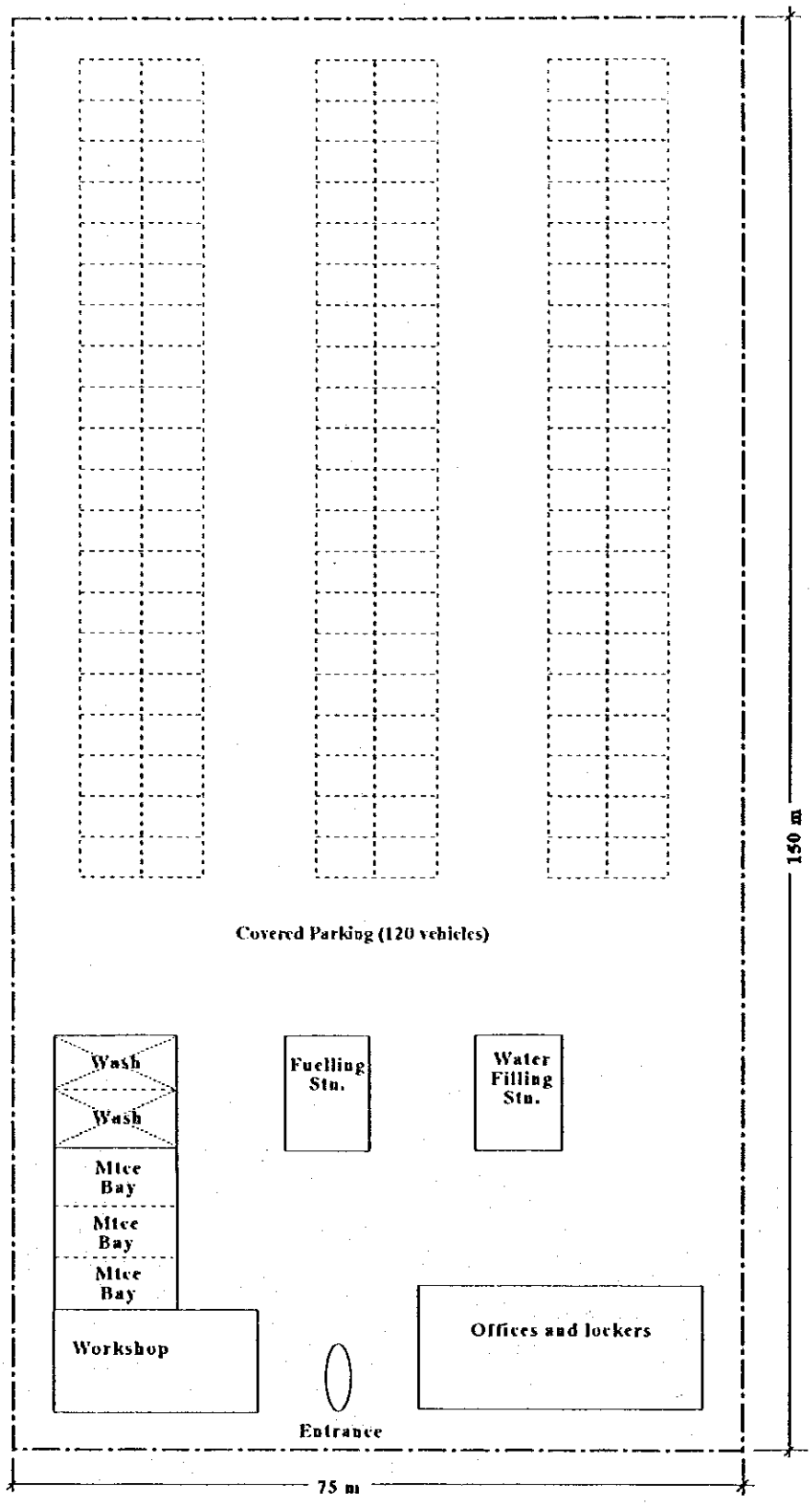
Generation		Collection	Soil & Demolition Waste Landfill	Cau Dien Upgraded Compost Plant	Hospital Waste Treatment Plant	Dong Ngac Transfer Stations	Nam Son Industrial Waste Treatment Plant	Nam Son Sanitary Landfill Site
1771	General Waste	1494						
497	Demolition	378	In: 378t/d	In: 137t/d	In: 3t/d	In: 1,386t/d	In: 50t/d	In: 1,464t/d
400	Septage	300	Out: 0t/d	Out:62t/d	Out: 1t/d	Out: 1,386t/d	Out: 20t/d	Out: 0 t/d



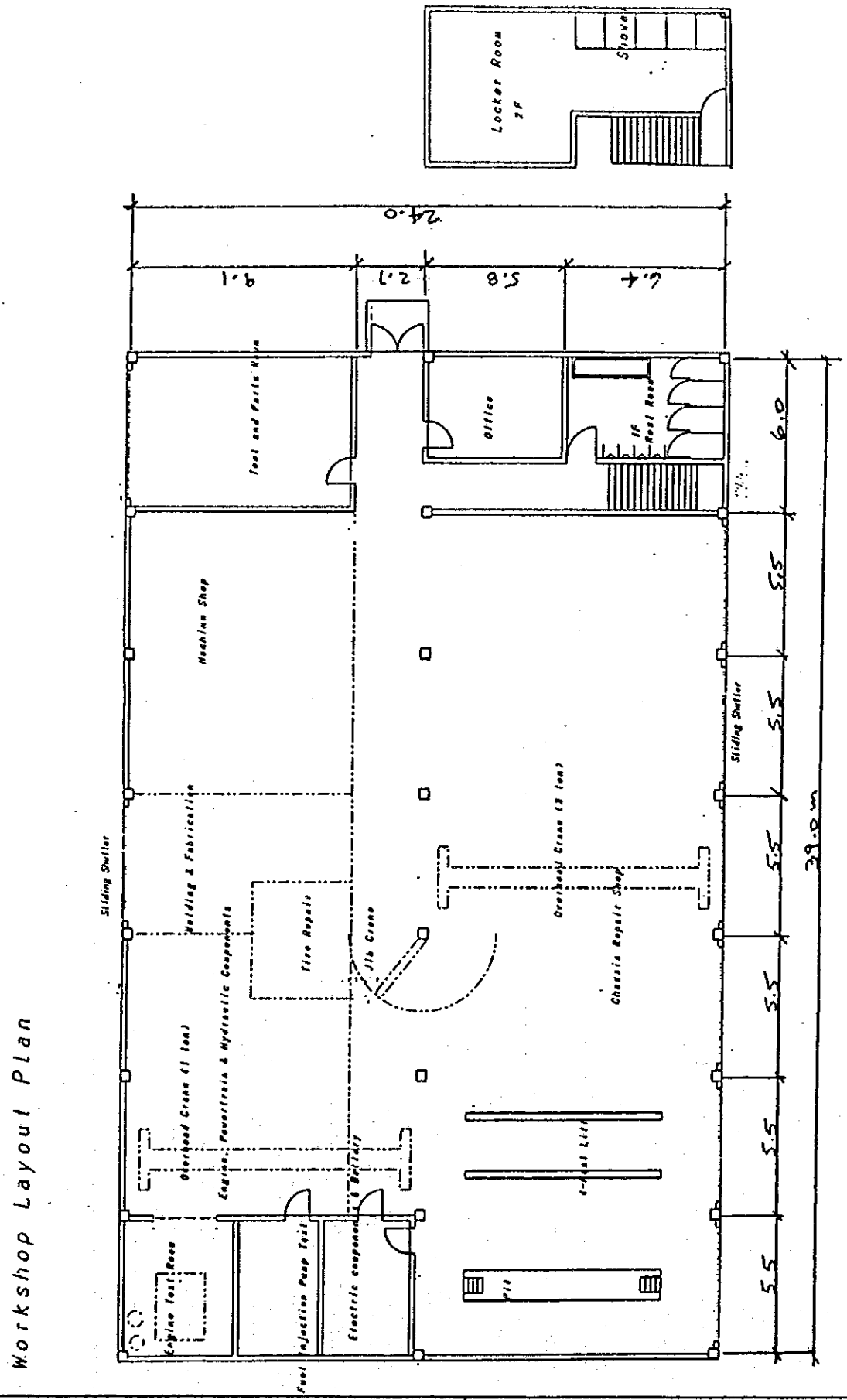
Remarks:
The operation of the above facilities are expected to start in the following years:
1) Hospital waste treatment facility: December 1998
2) Upgraded compost plant: January 2000
3) transfer stations in Dong Ngac: January 2004
4) Nam Son industrial waste treatment facility: January 2001
5) Nam Son landfill (Phase 2): January 2004



THE STUDY ON ENVIRONMENTAL IMPROVEMENT FOR HANOI CITY	Figure -6.5.3 URENCO Garage Facilities Map
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON ENVIRONMENTAL IMPROVEMENT FOR HANOI CITY	Figure -6.5.4 Typical Garage Facility
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON ENVIRONMENTAL IMPROVEMENT FOR HANOI CITY	Figure 6.5.5 Central Maintenance Facility Layout
JAPAN INTERNATIONAL COOPERATION AGENCY	

Figure 6.5.6 Overall Implementation Schedule for Solid Waste Management Improvement Projects

		Proposed Project	Cost US$mil	Cost US$ mil	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Remark
			2000 - 2005	2006 - 2020																														
	A	**Improvement of Waste Collection and Primary Transport**	23.5																															
	A1.	Procurement of vehicles	18.3	43.4																														
		1 Phase 1 (2000 - 2005)	18.3	0.0																														
		2 Phase 2 (2006 - 2010)	0.0	9.6																														
		3 Phase 3 (2011 - 2015)	0.0	19.1																														
		4 Phase 4 (2016 - 2020)	0.0	14.7																														
	A2	Construction and Upgrading of Garages	3.4	0.0																														
		1 Upgrading and expansion of the existing 3 garages	1.4	0.0																														
		2 Construction of New Garages	2.0	0.0																														
	A3	Procurement of maintenance equipment for the central workshop	1.8	0.0																														
	B	**Transfer System & Nam Son Phase 2 Landfill**	46.8	24.8																														
	B1	Nam Son Phase 2 Landfill	29.6	11.1																														
	B2	Waste Transfer System	13.7	13.7																														
	B3	Upgrading of Roads and Bridges	3.5	0.0																														
	B4	Operation of B1, B2 & B3																																
		Total of A & B	70.4	24.8																														
	C	**Institutional Arrangement**																																
		Step 1: Devolution of SWM responsibility to districts																																
		Step 2: Fee collection responsibility goes to Districts																																
		Step 3: District will transport waste to Dong Ngac transfer station																																
		Step 4: Districts will start contracting out a part of SWM services																																
		Step 5 URENCO will become a private enterprise																																
		Step 6. Participation of multiple companies in SWM services																																

Study Design Financing/Tender-Contract Construction Operation

( ) Approx. Estimate

Cost : 1999 Base Price (excl. price contingency)

6.6 Strategies for Achieving Quiet City Environment

It is sure that the quiet environment will be rather achieved by reducing the noise and vibration originated from the vehicles, factories, and commercial activities. It is clear that traffic is the main source of noise and vibration, therefore, the establishment of traffic management system in Hanoi City is recommended to achieve quiet environment. Traffic management system is the system expected to decrease the necessity of use of horns by making the smooth traffic flow. For reducing the noise and vibration pollution problems, attaining the proposed standards and the targets, the following strategies are recommended.

6.6.1 Proposed Regulations and Education

(1) Education for drivers:

As the horns of the vehicles are used frequently, it is estimated that the degree of influence of horns on the noise pollution is rather high. The Assessment Law prohibits the use of horn in the densely populated residential areas from 11:30 and 13:00, and after 22:00. It is necessary to let the drivers know the law and educate them not to use horns so frequently.

In Hanoi City, cars often drive in the middle of the roads. This situation is caused by slow moving motorbikes and bicycles, which fully occupy the edge of the roads. As a result, automobiles are squeezed towards the centerlines. It makes drivers difficult to make the turns and causes the noise pollution by the horns. The discipline for drivers to drive in a line and have "give way" manner is strongly recommended.

(2) Polluter Pay Principle:

Even if the government set the strong regulations and standards on noise and vibration, sometimes they do not work in case they do not have the legal force. The application of Polluter Pay Principle is considered to be effective for reducing the noise and vibration level. Under this principle, those who generate the noise or vibration, e.g. the owner of the factory, the producer of motorized vehicles or the drivers, should pay some penalty when they generate the noise or vibration, which go over the standards. The way of checking the noise and vibration level and deciding the amount of the penalty should be further studied.

(3) Licensing

To obtain a drivers license in Vietnam, the applicants must be 18 years of age or older, physically and mentally fit to drive a motor vehicle and literate. License process in Hanoi City has been undertaken at several centers, which test the driving skill and knowledge of traffic regulation of applicants. Thinking their ways of drive, it is hard to believe that they know driving regulation as they drive at will. Proper knowledge of traffic regulations and driving manners should be taught before getting the drivers license.

There are considerable drivers who drive without getting drivers license and do not know the traffic regulations, traffic signs much. By punishing these drivers severely, improvement of the driving manners will be established.

(4) Introduction of Traffic Information System

In Japan, we can get traffic information such as traffic congestion and car accidents through the radio program, which is broadcast by the police. The information is renewed very frequently (every 5 or 10 minutes at rush hours) and we can try to avoid traffic congestion by changing the route or delaying the departure. To introduce such kind of radio program to Hanoi City is recommended as the volume of cars is expected to increase rapidly in the near future. If cars can avoid the traffic jam, the traffic flow will be rather smooth.

6.6.2 Improvement of Traffic Management System

(1) Signals, markings and crosswalks

In order to attain safe, smooth and efficient traffic flow through the maintenance of traffic signals as well as traffic signs and markings are essential tools. The installation of signals generally shows that they have been highly effective not only to reduce the number of accidents but to improve the flow of the traffic in Hanoi. Without installation of signals, there is the chaotic situation at intersections where motorbikes, cars and bicycles are passing from different direction. There are some signals installed in the city area of Hanoi City. But some of them are hard to see because of poor visibility and low height. The signals for pedestrians sometimes do not work at all and in case they work, duration of green light is too short to cross the street. More study should be conducted to improve this situation.

The proper establishment of crosswalks is good for pedestrians to cross the streets safe. At present, people seem to ignore crosswalks and cross the street anywhere they want, as drivers do not make the speed slow before the crosswalks. The improvement of manners of the drivers as well as establishment of crosswalks should be done immediately.

The lane marking and guide markings (arrows) are necessary especially for intersections, which is usually the source of confusion and noise. Cleaning of the roads is also needed to keep the marking clear.

(2) Sidewalks and trees:

By building the sidewalks or planting the trees on main roads, the noise and vibration levels at the houses on roadsides will be mitigated. Generally, broadleaf trees are good at absorbing the noise and providing good quality air.

(3) Porous asphalt pavement:

Though the road surface is often ill-maintained in Hanoi, asphalt pavement using the porous materials can reduce the reflected noise and vibration produced by tires and pavement from the road surface. It is expected that the noise level will be reduced by 3 dB by porous asphalt pavement.

(4) Maintenance of lights:

The noise survey done by JICA Study Team found that noise pollution is serious even at nighttime in the city center. The percentage of the vehicles including bicycles, which do not or can not use the headlight, is considerably high. It is really dangerous for drivers and pedestrians and causes the use of horns or accidents. The good maintenance of the vehicles is strongly required. Setting up the light at roadsides can be supposed to have the power to reduce the noise at night.

(5) Barriers:

Barriers between the sound source and receiver can be used effectively to reduce noise. In case of the elevated road such as highway, establishment of a 5 m-high barrier can reduce the noise level by 5-10 dB at the height of 1-3 m behind it. For the normal road in the city, establishment of high barriers is not recommendable from the functional point of view. Establishment of the low

barriers, which are about 1m-high, can reduce the noise level by 2-3 dB in the area of 2-3 m high behind the barrier. To have the medians also contributes not only to decrease the noise and vibration level but to form the appropriate traffic flow. As it costs much to build the barriers for all roads, it is also effective to make traffic flow smooth by marking the centerlines very clearly. There are nine national highways, some of which are under construction, are passing Hanoi City. For these highways, which a large number of traffic is passing, the barriers are considered to be valuable enough to be established.

6.6.3 Other Strategies for Quiet City Environment

(1) Campaign and workshop

Generally, people who live in Hanoi City do not know much about the condition of current environmental pollution. To have the campaigns and workshops to let the public be aware of seriously polluted environment including water pollution and air pollution in the city can be good opportunities to reduce the environmental pollution inside city.

(2) Regulations for commercial activities and factories :

In the alleys, many open stores are on roadsides disturbing the flow of traffic and people, and it causes the noise by the horn. Any regulations for opening the stores on roadsides are required. The regulations to limit the operation or working time should also be established for factories and shops, which produce big noise or vibration.

(3) Walls for factories and nightclubs

To construct the walls thicker as a role of silencer for factories and nightclubs such as Karaoke and Disco seems effective to reduce noise pollution caused by music at midnight. Using the materials which absorb noise and vibration for interior of factories and nightclubs are also desirable.

6.7 Strategies for Co-existing with Nature and Provision of Amenity

In Hanoi, it is said that natural environment such as green area and water zone is good considering the fact that many beautiful parks, trees along the roads and big lakes are seen in the center of the city. But green and water area per capita is still not enough compared with that of developed countries. The population of urban area of Hanoi city is expected to be almost doubled in the year of 2020. Strategies for co-existing with nature should be discussed as far as possible to avoid being inorganic city.

Concerning the amenity in the city, modern-enjoying facilities such as disco, bowling are getting popular recently and mainly young people are enthusiastic for them. In Hanoi, they will experience larger scale of amusement facilities in the near future as there are some plans of building big amusement parks by foreign capitals.

The following strategies are proposed for co-existing with nature and provision of amenity as written hereunder.

6.7.1 General Strategies for whole Hanoi City

(1) Basic Strategies

① Restrict diversion of nature type land use including agriculture, forestry and water surface into urban type land use including industrial and residential uses.

② Increase park and green areas.

③ Improve the quality of surface water of lakes, ponds and rivers upgrade the access to their waterfronts.

④ Construct green and water friendly amenities facility.

(2) Proposed Plan, Institution and Education

1) Increase of green area target described in urban master plan

It is highly appreciated that HPC has published the Hanoi Urban Master Plan for 2020 in 1999, because it means they have the clear perspective of their urban planning. The master plan says that the land for green trees and parks shall be raised from 0.83 m^2/capita to 7 m^2/capita including

entertainment spots in 2020. But the proposed figure seems to be too small even it is the area only for green trees and parks. To co-exist with nature, the area of green trees and parks per capita should be at least 20 m^2/capita. It is more realistic to set the target figure of green and water zone for each district. The expected green area of each district in 2020 is described in the table below. In Old City Center, which has dense population, green area is expected to be about 45% of total area. The zone is the restricted area for development and population will decrease, therefore it will be possible to attain the target.

Expected Green Area by Each Environmental Zone

Environmental Zones	Expected Green Area in 2020 (ha)
1. Old City Center	1,600
2. Red River Right Bank North – West	766
3. Red River Right Bank South	570
4. Dong Anh urban area	1,344
5. Gia Lam urban area	656
6. Suburban Area	2,015
7. Ho Tay Area	64
Total	7,015

2) Environmental education

The people living in Hanoi City seem to be have the minds to love trees and water environment as many of them like to plant trees in their backyards or veranda and be in the parks arranged near the lakes. To have the rich natural environment in Hanoi, it is effective to educate them not only on the beauty of trees and water area, but the roles of them as the purifier of the air, reservoir when floods happen, foundation of the ground etc. They will understand the importance of the trees and water in urban area easily if they have chances to be educated.

(3) Establishment of Infrastructures and Improvement of the Growing Environment

1) Infrastructures for friendly natural environment

Around some big lakes, there are promenades constructed, and they make it easy to access the water safely. But concerning the small open canals, they

are cared very poorly and the sources of the nasty smell. They should be treated appropriately first, and the creation of the biotope is preferable.

Some of the trees in the parks and roadsides are covered with concrete frames to prevent the invasion of humanbeings, but the sizes of frames are not always precise ones and prevent the growth of the trees. These frame should be well designed depending on the kinds of planted trees.

2) Establishment of the amenity facilities

Since October of 1999, Vietnam Government and related organizations have started to take two days off per week and the chances to spend time at old or modern enjoying facilities will increase.

There are big projects planned to build the amusement facilities in Hanoi City, e.g. Ho Tay Amusement Center, which will be opened in May 2000. But it is the key to know the fact that Hanoian are not so generous and apt to tired soon. To attract their attention continuously, these facilities should keep providing them with new events and equipment.

In the suburban area, a rich natural environment is seen. There are chances to start new enjoying facilities in that area such as camping, birds watching and fishing parks for people who are in the urban area and tourists who want to enjoy the natural atmosphere easily.

3) Care of trees and soil improvement

Green Trees and Parks Company, which is under TUPWS is in charge of taking care of trees. They use an insecticide around November every year especially for trees planted close to the roads, because the color of the insecticide is vivid white and makes it easy for drivers to know the lines of the roads at night. Therefore, there is the fact that the trees planted far from the roads are not treated carefully. It is because of the limited budget for the care of trees.

It will be more practical to improve the soil for the care of trees, while it is thought not so important. Without enough supply of nutrition from the soil, trees can not live healthy lives. Soil improvement should be considered, as it is not needed to be done every year and is more economical than the use of the insecticides.

4) Introduction of the flower gardens

Though about 30 major kinds of trees are seen in the parks and roadsides, many of them do not have the flowers because the trees with flowers are prohibited to plant under the French era. The diversion of the trees, namely planting the trees with flowers will give fresh accent to the green environment in Hanoi. Building the small flower gardens, which are rarely seen now, is also needed.

6.7.2 Proposed Strategies for Each Environmental Zones

To attain the targets, which have been set by the JICA Study Team, the strategies are proposed by each environmental zone also as shown in the Table 6.7.1.

Table 6.7.1 Strategies for Co-existing with Nature and Provision of Amenity by each Environmental Zone

Environmental Zones	Proposed Strategies
1. Old City Center	For the preservation of water surface area and water quality of Hoan Kiem Lake, restriction of the development around the lake and direct inflow of waste water is recommended. The trees around the lake should be preserved also to give recreational space to the people living in the urban area. The number of the lakes in this zone should also be kept by establishing the regulation because they are used for relaxation area for many people including tourists. Main City Lakes (14 lakes) located in this zone should be improved by dredging, construction of lakeshore roads, environmental revetments, provision for parks and promenades, and other environmental measures in order to restore functions for storm-water retarding ponds and waterfront resort.
2. Red River Right Bank North - West	The preservation of the natural area and turning out the new natural zone should be considered as well as the development of commercial area. Thang Long South Highway is the key road in this area and development along the road should be done carefully so that some green area can be preserved there.
3. Red River Right Bank South	There is a plan to construct the park of 60 ha around Yen So Lake. The project should be carried out for keeping natural area in this zone and the wastewater from the dwellings should be purified before the discharge into the lake.
4. Dong Anh urban area	There is a plan to construct the Cau Doi park, which is about 300 ha including the botanical garden, in this area spending 103 billion VND. It will be the second botanical garden in Hanoi. The diversity of the trees and flowers there should be of great attention, because in Hanoi, there are limited kinds of trees and flowers seen.
5. Gia Lam urban area	The clear zoning for each land use category, such as residential area, commercial area, industrial area should be done especially for this area because this area will be the main industrial area in Hanoi. The zoning will be useful for keeping the water and green area.
6. Sub-urban Area	About 3,000 ha of agricultural area is planned to be changed into urban land use by the year of 2020. Agricultural area can be considered as one form of the green area, and the conversion of farmland should be restricted as far as possible for coexistence with nature.

Environmental Zones	Proposed Strategies
7. Ho Tay Area	A big amusement center will be constructed near Ho Tay in 2000 spending 130 billion VND. The coexistence among people, nature and enjoying amenity is expected to realize in this zone. For the preservation of rich water space of Ho Tay, establishment of promenade around whole lake should be done. The promenade makes it easier to access to water and give people more opportunities to commune with nature by fishing, boating etc. Projects should be implemented to enhance the water environment, such as sewerage development project and lake sediment dredging project. At present, HPC is undertaking the Phase I: Infrastructure Project of the West Lake Conservation Project including lakeshore road/park and small-scale sewerage developments. The preservation of the trees along the streets constructed in French period should be maintained properly because these streets have unique atmosphere with wide sidewalk and quiet living environment.

6.8 Strategies for Preserving Cultural and Historical Assets

6.8.1 General Strategies

(1) Basic Strategies

a) Concentrate efforts in preserving the two environmental zones of Old City Center and Ho Tay where most of the valuable cultural assets and historical assets are located.

b) Prepare the inventory of the assets with the records of their conditions, needs for preservation, relative values for preservation and others.

c) Rehabilitate the aged assets and renew the preservation facility.

d) Continue to utilize the assets including building and bridge by allowing particular and appropriate manners of use.

e) Secure the appropriate living conditions for the residents living within the assets as well as living in their vicinities.

f) Enact new regulation for restricting heights, setback, color and others of the buildings and urban landscape worth preserving.

(2) Proposed Institution and Education

1) Listing and grading of assets

There should be the institution that grades the cultural and historical assets to clarify the priority of the preservation. For grading, making out the list of assets comes first. Listing and grading will lead to the careful preservation of the assets. The height of the assets, color of the wall, renovation of the building etc. shall be determined by the grades.

2) Holding the workshop and tours

Although there are so many cultural and historical relics in Hanoi, some of which are affected by Chinese or French culture, the others originate from Vietnamese culture, it is hard to say that these relics are recognized by the public to be valuable for Hanoi City. To hold the workshops by the experts of Vietnamese culture, history and architecture, which are open to anybody, on the value of the assets will be good opportunities for the public to feel or rediscover the importance of their heritages.

Touring the assets such as old pagodas, buildings or museums with the

experts is also considered important not only to realize their value but to draw attention of Vietnamese or foreign investor, who can contribute to the preservation of the relics. For the preservation, finding the source of fund is the big problem. The workshops and tours work as one of the campaigns to get donors.

(3) Proposed preservation and reuse of the assets

1) Selection of appropriate manners for the preservation

It is quite natural that the ways of the preservation of the cultural and historical assets change by their importance and characteristics. The following ways are taken as example.

- Preserve the whole building both outside and inside and do not permit renovation
- Preserve only the outside of the building and it is permitted to modernize the interior
- Preserve the symbolic parts of the building, e.g. gate, window, front wall, roof etc. and renovate the other parts of the building
- Reconstruct the old assets without losing the image of the former building
- Move the assets that are located in the dense population area and hard to preserve appropriately

The precise way of the preservation should be chosen according to the condition, importance and location of the assets.

2) Reuse and coexistence with assets

Opera House and Long Bien Bridge are good examples of the reuse of the cultural and historical assets. Opera House was renewed in 1998 with remaining the image of the French architecture, and having the performance inviting the famous opera singers or performer from Vietnam and foreign countries. Long Bien Bridge is almost 100 years old, and now used only for trains, walkers and bicycles. Now, motorbikes and cars are prohibited completely to cross the bridge as it is too old enough for them to cross, though 15 years ago it was opened to the motorized vehicles also.

Regarding the coexistence with assets, the relationship between Hanoi

Tower and Hoa Lo Prison, Horizon Hotel and Big Chimney are seen. Hanoi tower is the one of the biggest complex of business office and apartment in Hanoi. It was built in the site of Hoa Lo Prison, which was used for a long time during Vietnam war. The front gate of prison and a part of the building were left, and used as a museum. Horison Hotel is a modern hotel built in 1997, in which site there is a big chimney of about 25m high. Originally, the brick factory was there some decades ago and the big chimney was the symbol of the development of Hanoi City. Only the chimney was preserved after the repair, and now used as a symbol of the hotel.

As seen above, there are good cases of reuse and coexistence with assets in Hanoi and these kinds of reuse and coexistence should be done continuously because it is impossible to keep all the assets as they were especially in the urban area. Coexistence of living environment and preservation of the relics should be focused especially on Ancient Quarters, which is considered to be valuable relics used routinely. Reuse of an old French style building as a museum, library or restaurant is also proposed.

6.8.2 Proposed Strategies for Each Environmental Zones

To attain the targets, which have been set by the JICA Study Team, strategies are proposed by each environmental zone as shown in the Table 6.8.1.

Table 6.8.1 Strategies for Preserving Cultural and Historical Assets by Environmental Zone

Environmental Zones	Proposed Strategies
1. Old City Center	In Hanoi, they have made the list of cultural and historical relics such as pagodas and old houses only for Ancient Quarters last year. The grades are divided into two categories depending how old the assets are. Ancient Quarter itself is the historical asset and it is meaningful to list the assets there, to be sure, but it is proposed to widen the area for registering the assets at least for two environmental zones, namely Old City Center and Ho Tay Area. Making more categories for grading depend on the age and value of the relics is also essential. In Ancient Quarter, which is one of the cultural relics itself, improvement of living environment by building drainage system and sanitary facilities as well as preservation of the old buildings an pagodas is strongly recommended. For precious pagodas, museums and architectures, regular maintenance such as reinforcement of the wall, painting and introduction of new technology for the preservation of the exhibitions (for museums) are required.
7. Ho Tay Area	Specially, concerning the Van Mieu, Chua Mot Cot and Ho Chi Minh mausoleum, it costs much for maintenance, which is a skilled job. For precious old pagodas and mausoleum, it may be better to apply for UNESCO to be admitted as one of the world cultural heritages to get the fund for rehabilitation or introduction of modern technology. Regulation on construction density, height of the buildings and land use zoning should be established for the area of many French-style houses and buildings to preserve historical relics, as there are no regulation at present.