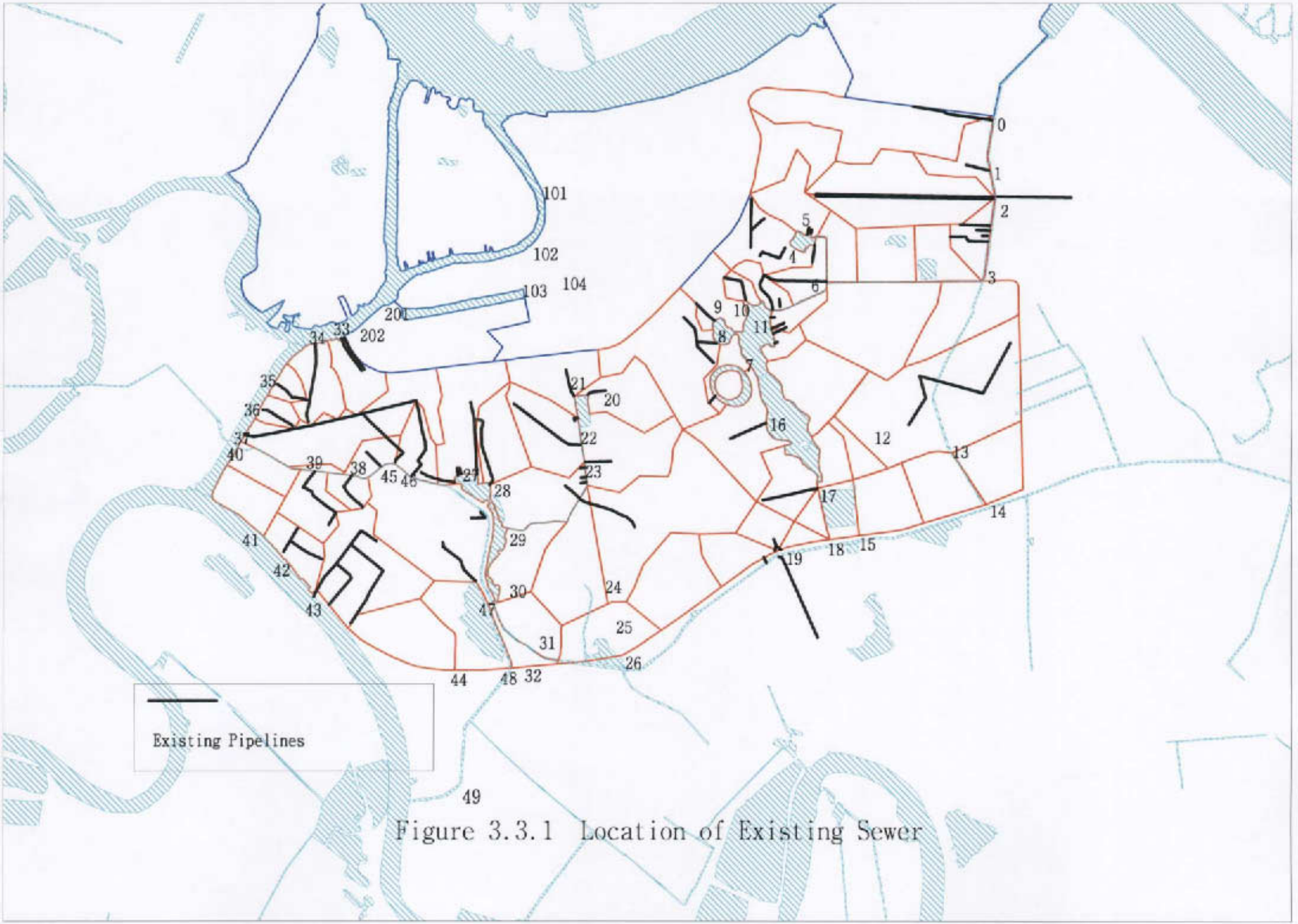
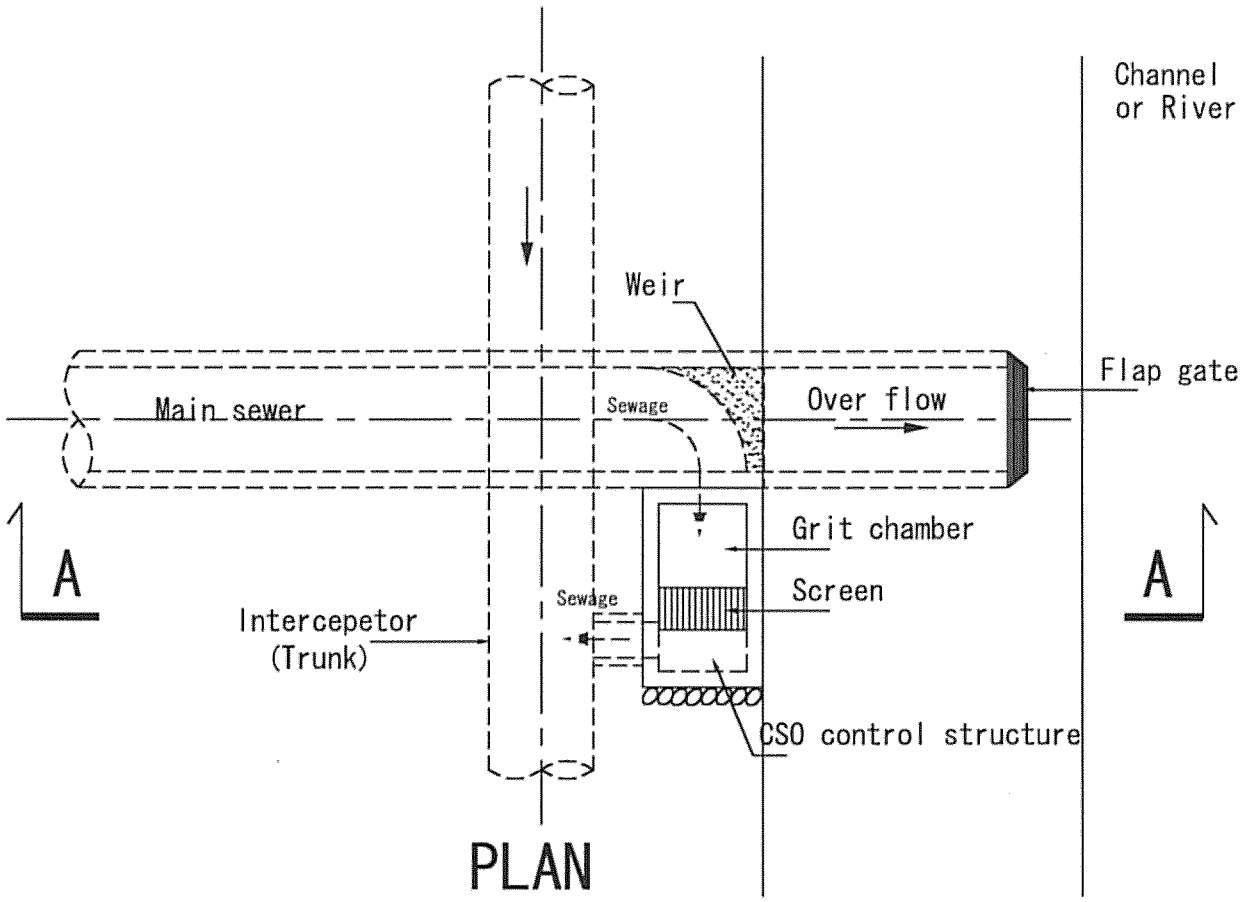
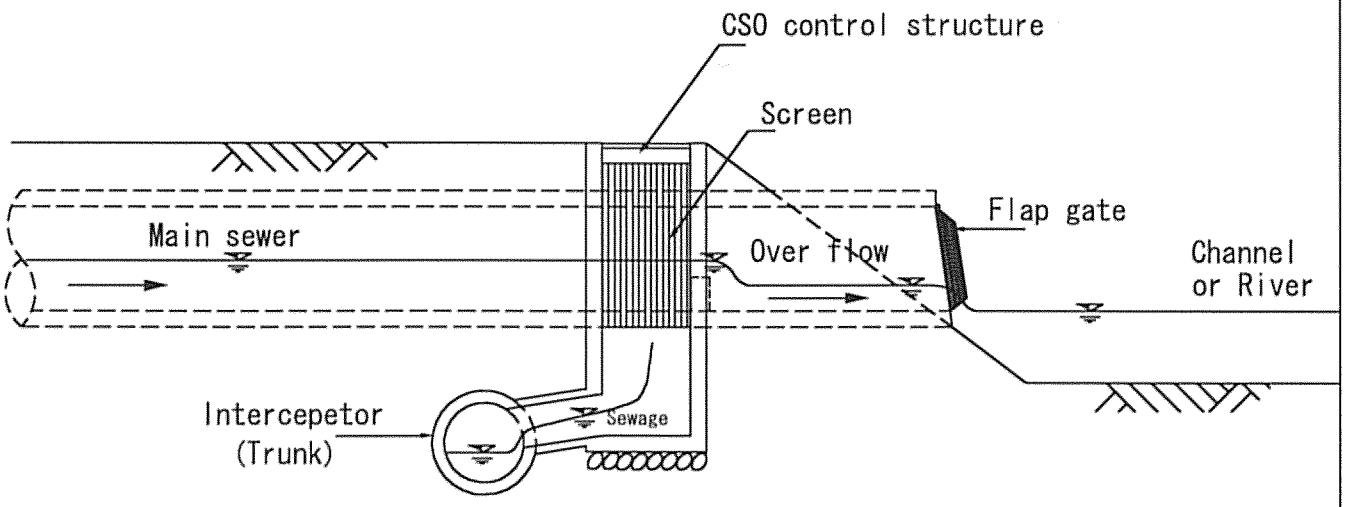


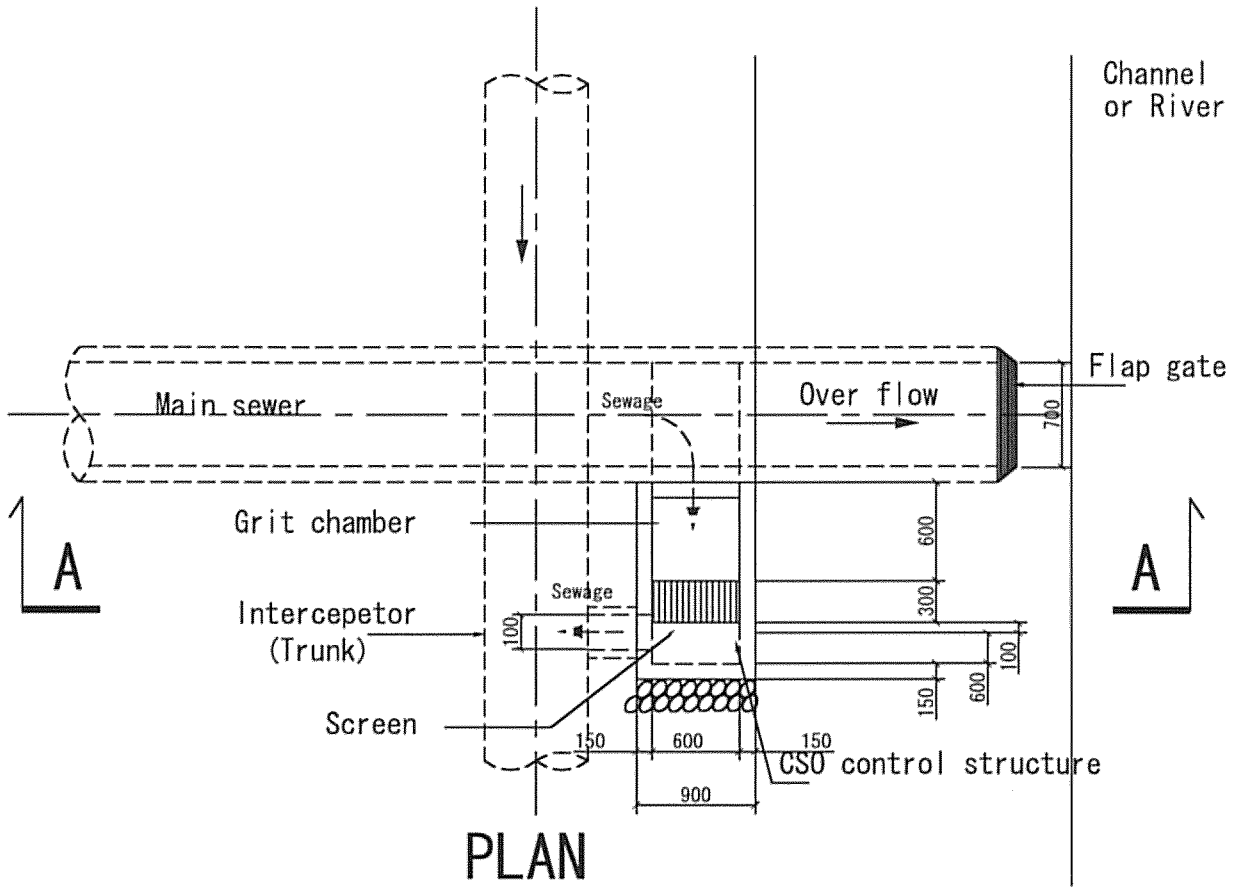
Figure 3.3.1 Location of Existing Sewer

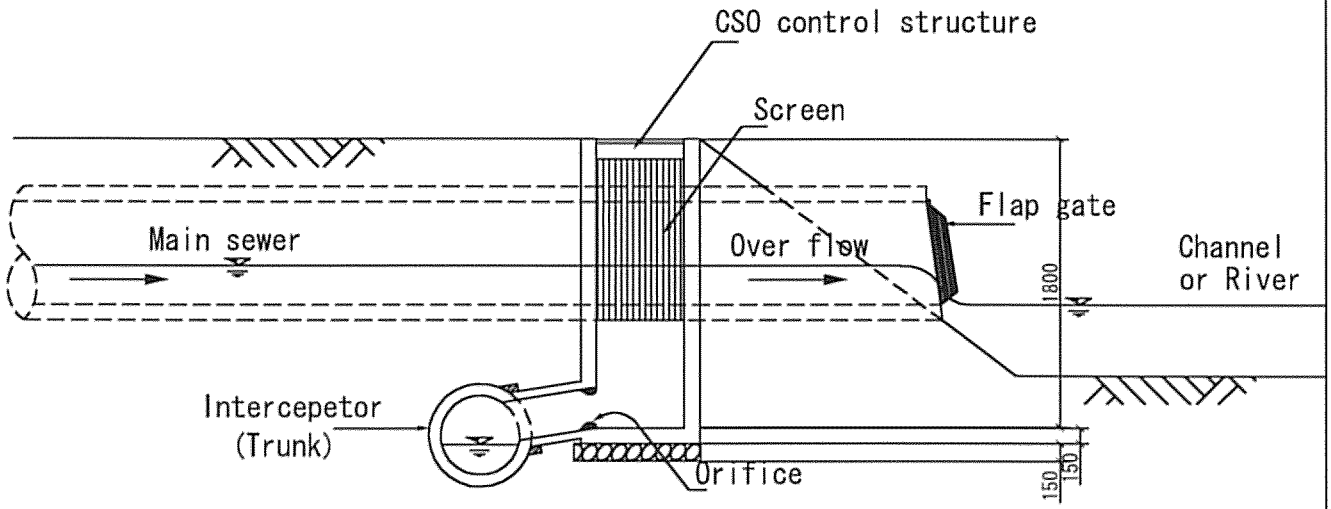




A-A SECTION

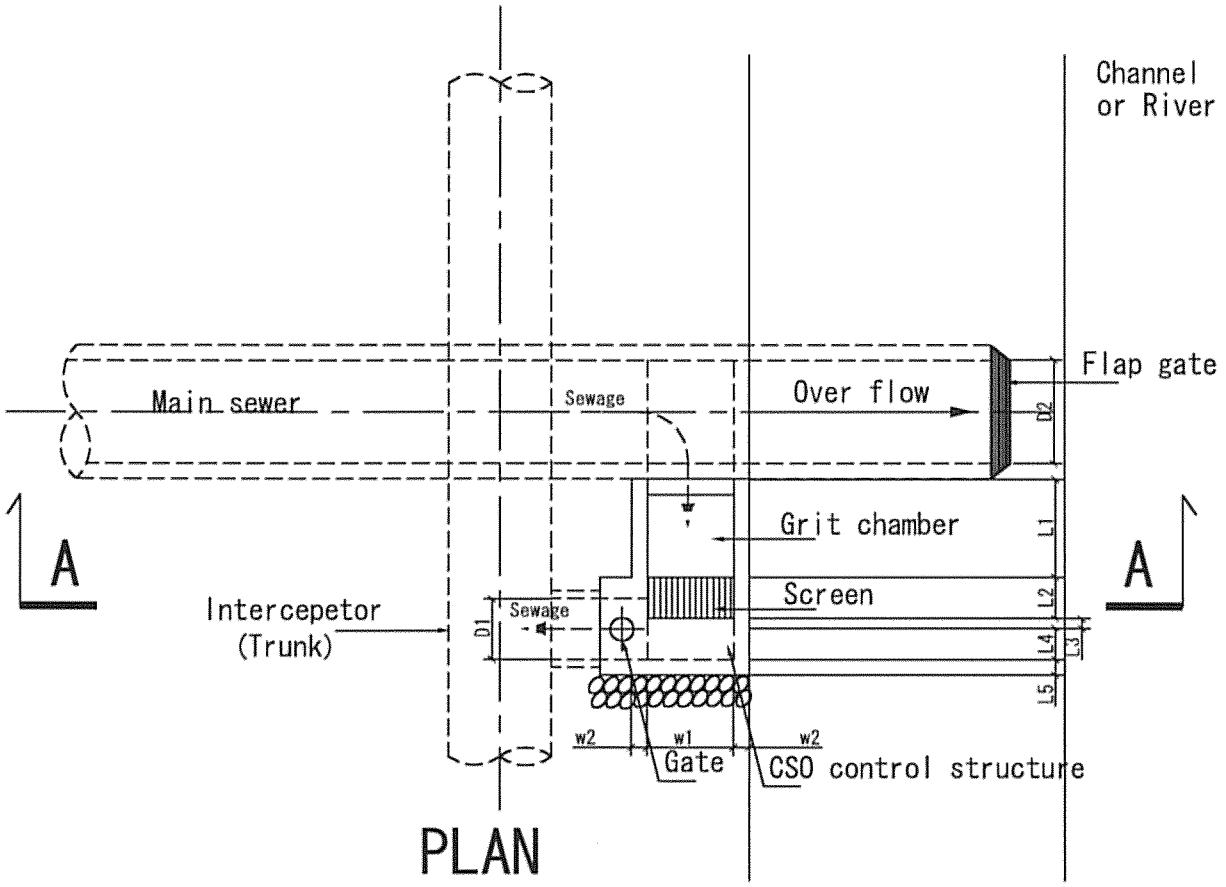
The Study on Sanitation Improvement for Haiphong City in The Socialist Republic of Vietnam	Figure 3.3.2 Weir Type CSO Control Structure
Japan International Cooperation Agency	

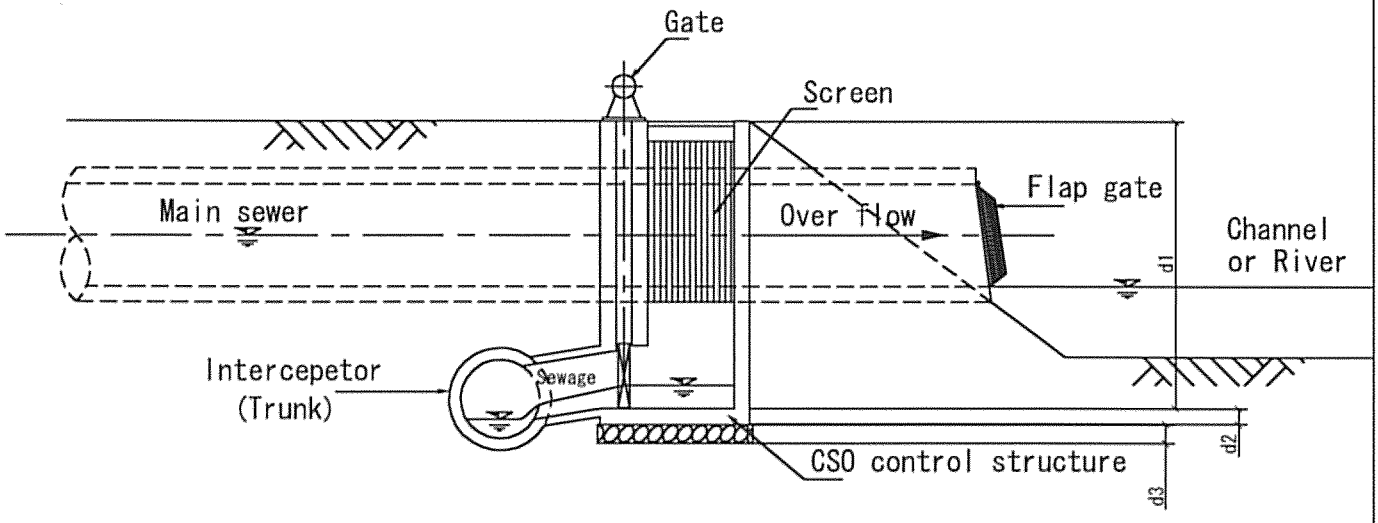




A-A SECTION

The Study on Sanitation Improvement for Haiphong City in The Socialist Republic of Vietnam	Figure 3.3.3 Orifice Type CSO Control Structure
Japan International Cooperation Agency	





The Study on Sanitation Improvement for Haiphong City in The Socialist Republic of Vietnam	Figure 3.3.4 Gate Type CSO Control Structure
Japan International Cooperation Agency	

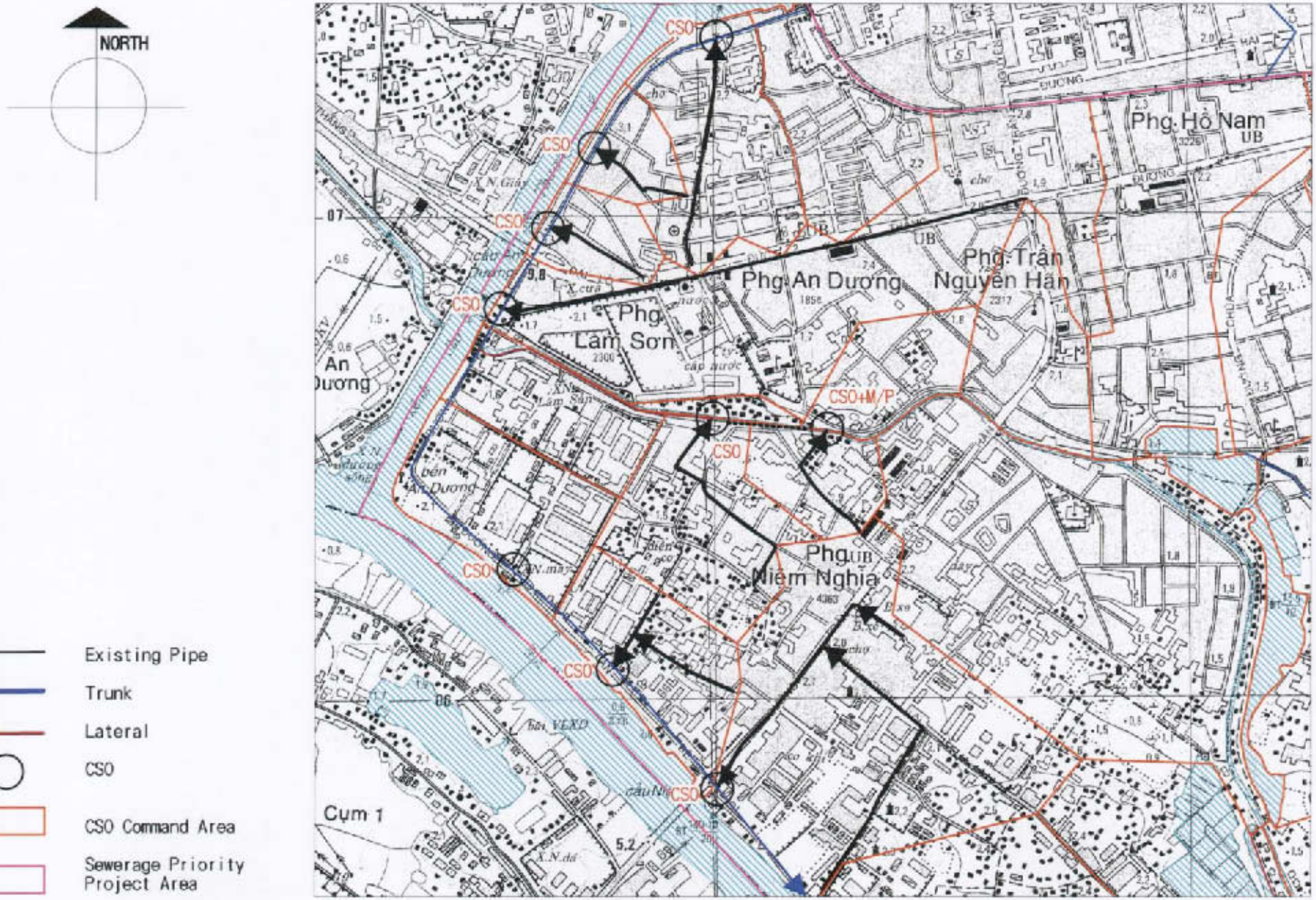


Figure 3.4.1 SELECTION PROCEDURE FOR CSO AND TRUNK

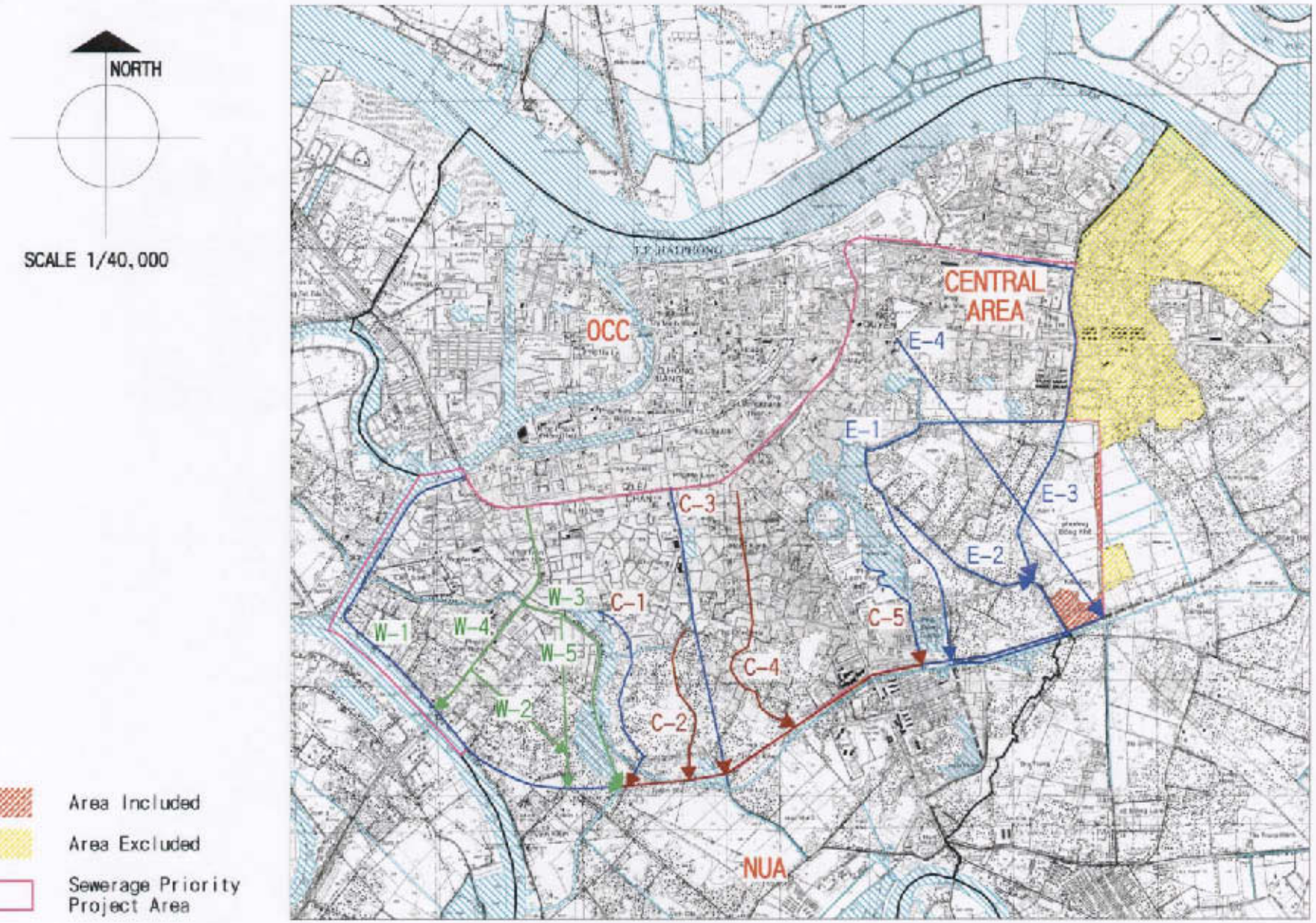


Figure 3.4.2 Alternate Trunk Route

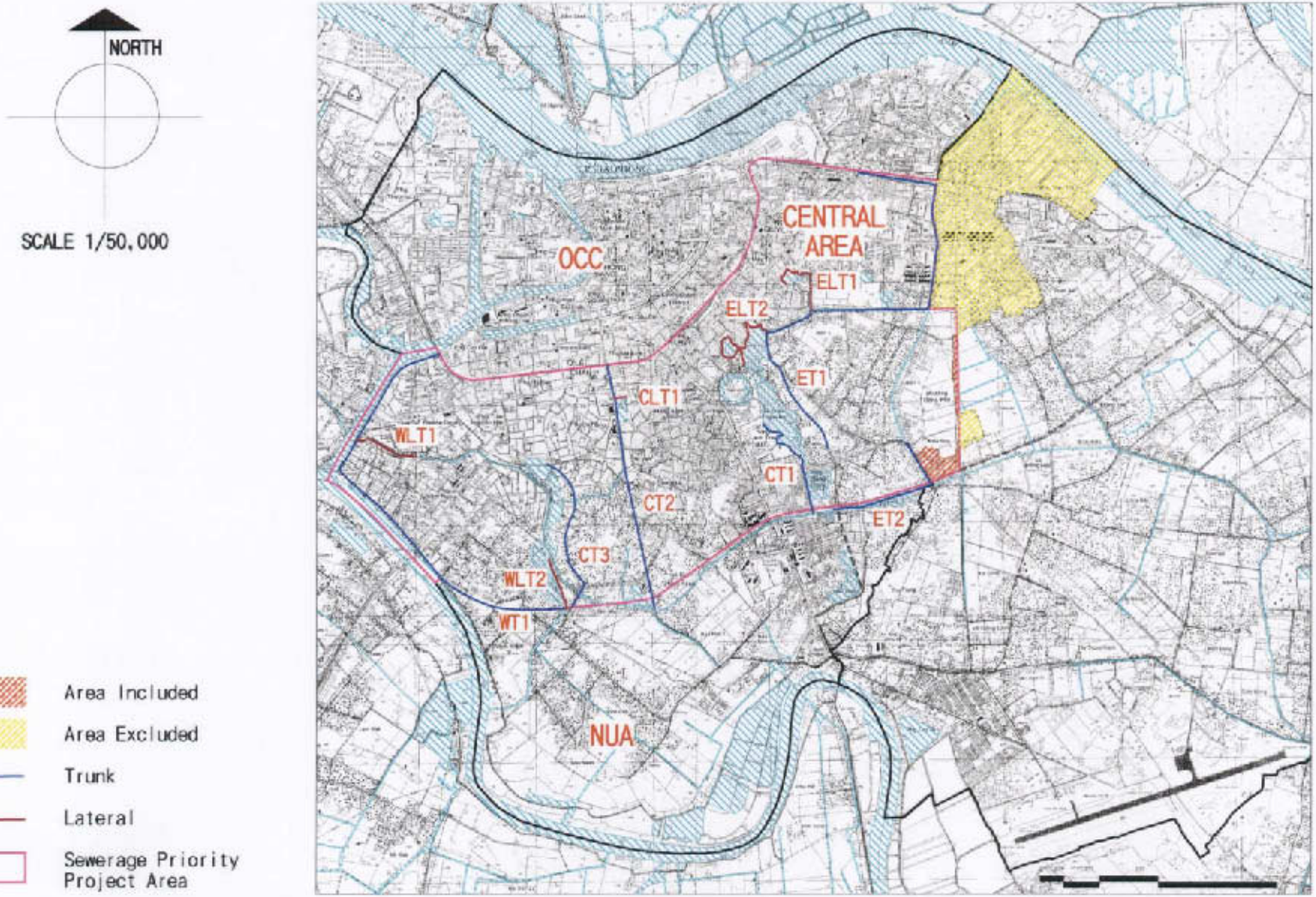


Fig 3.4.3 TRUNK NETWORK

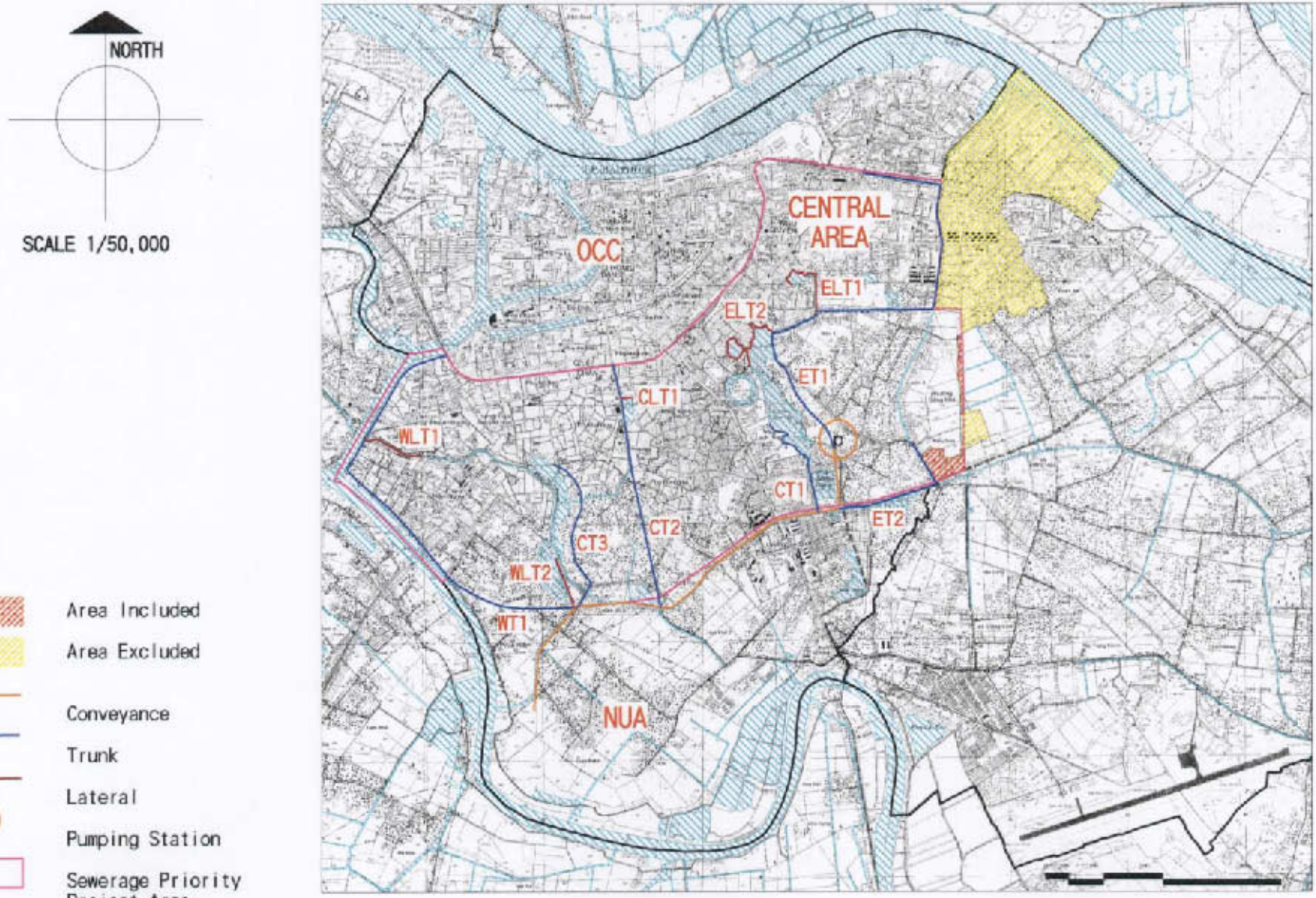
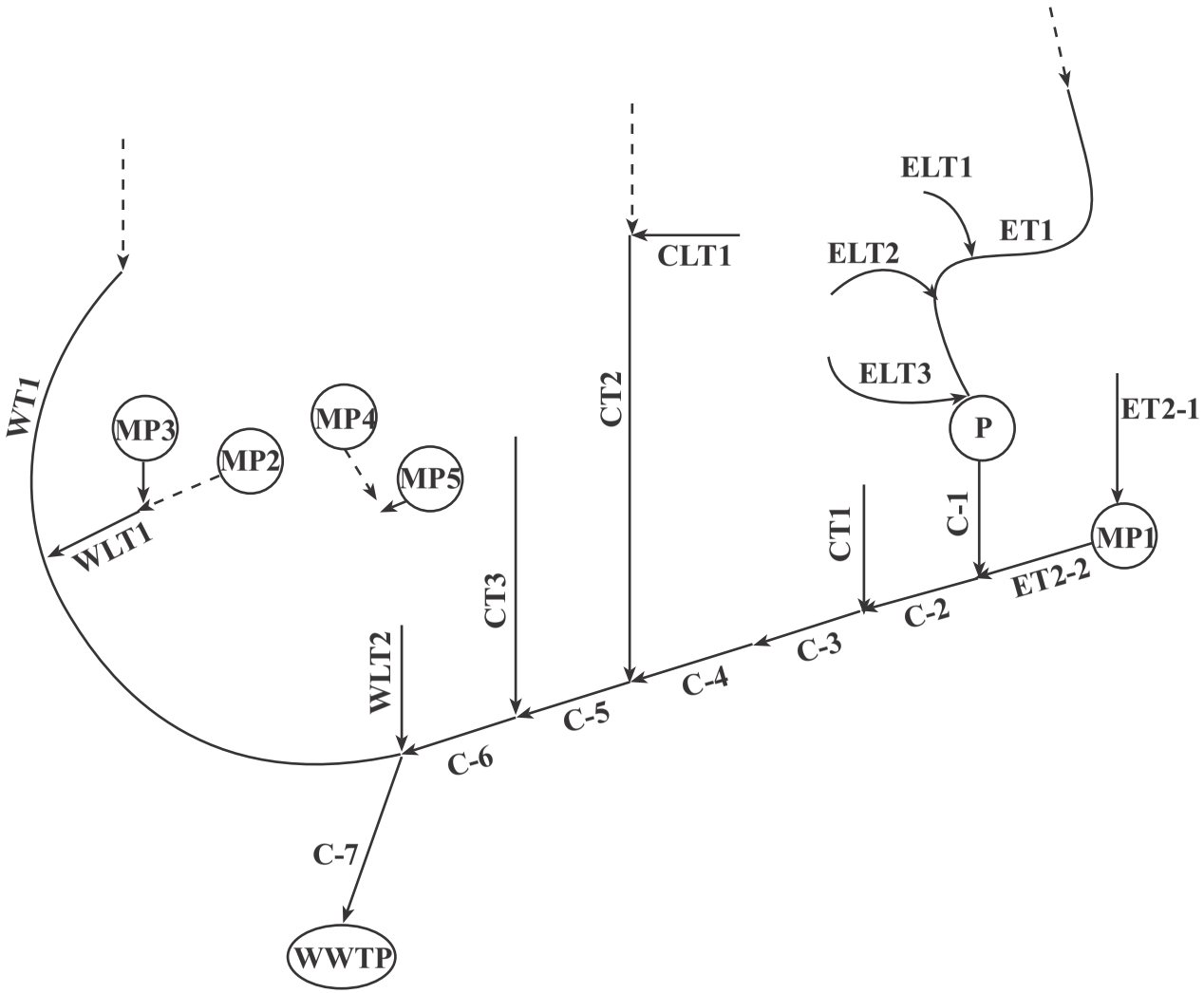
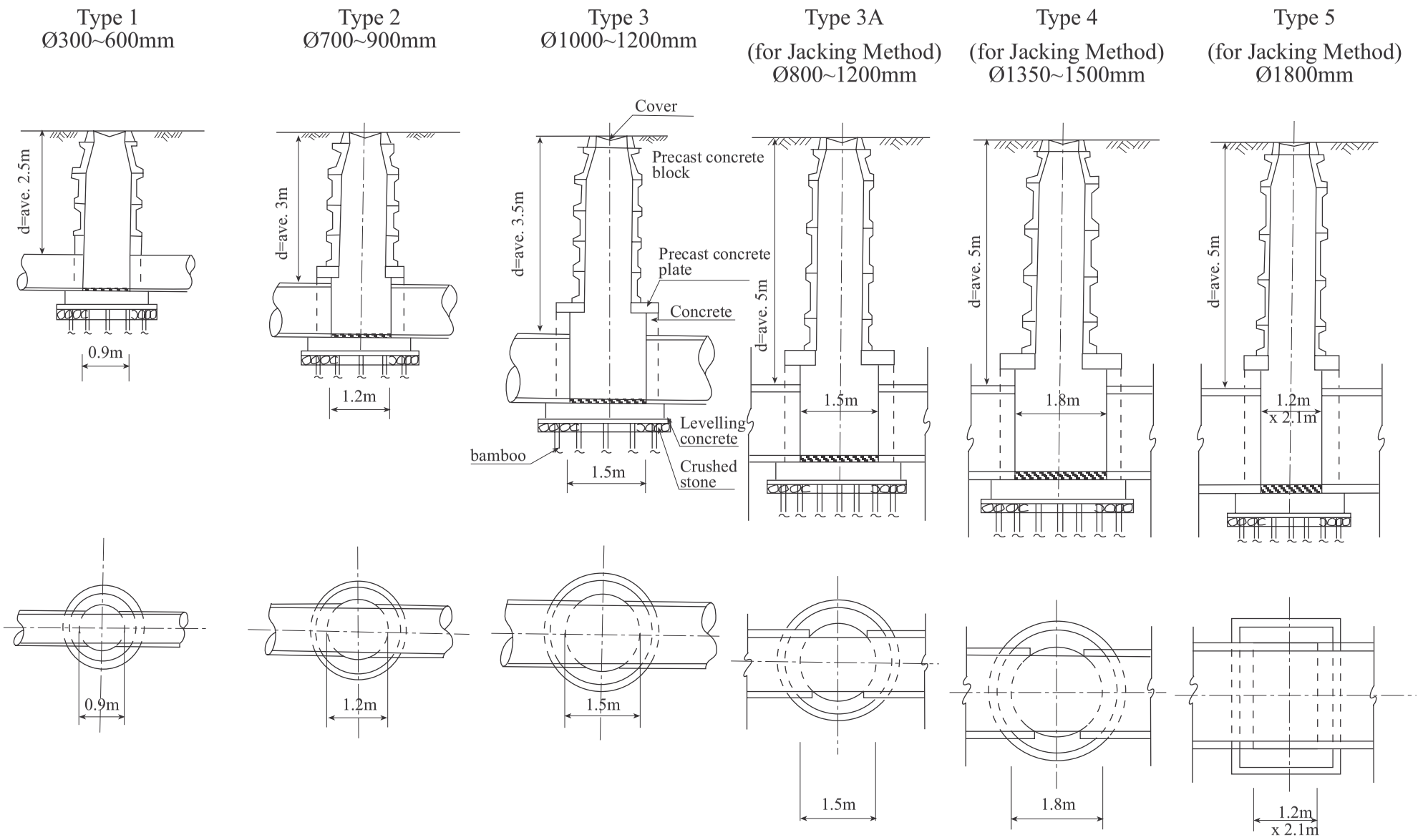


Figure 3.4.4 SEWERAGE NETWORK



The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	Figure 3.4.5 Schematic Layout of Sewer Network
Japan International Cooperation Agency	

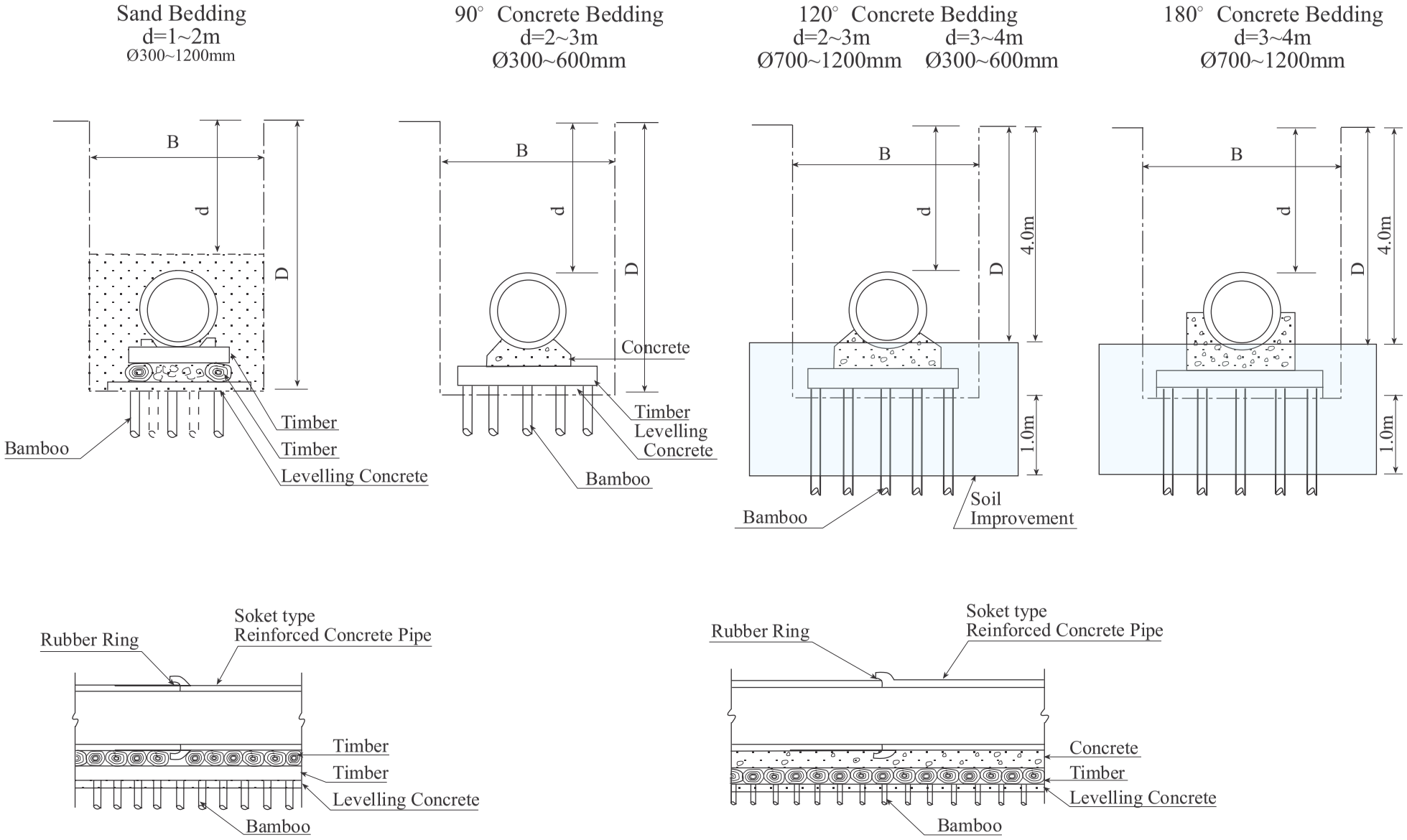


Ø = Pipe diameter in mm
Scale = 1:100

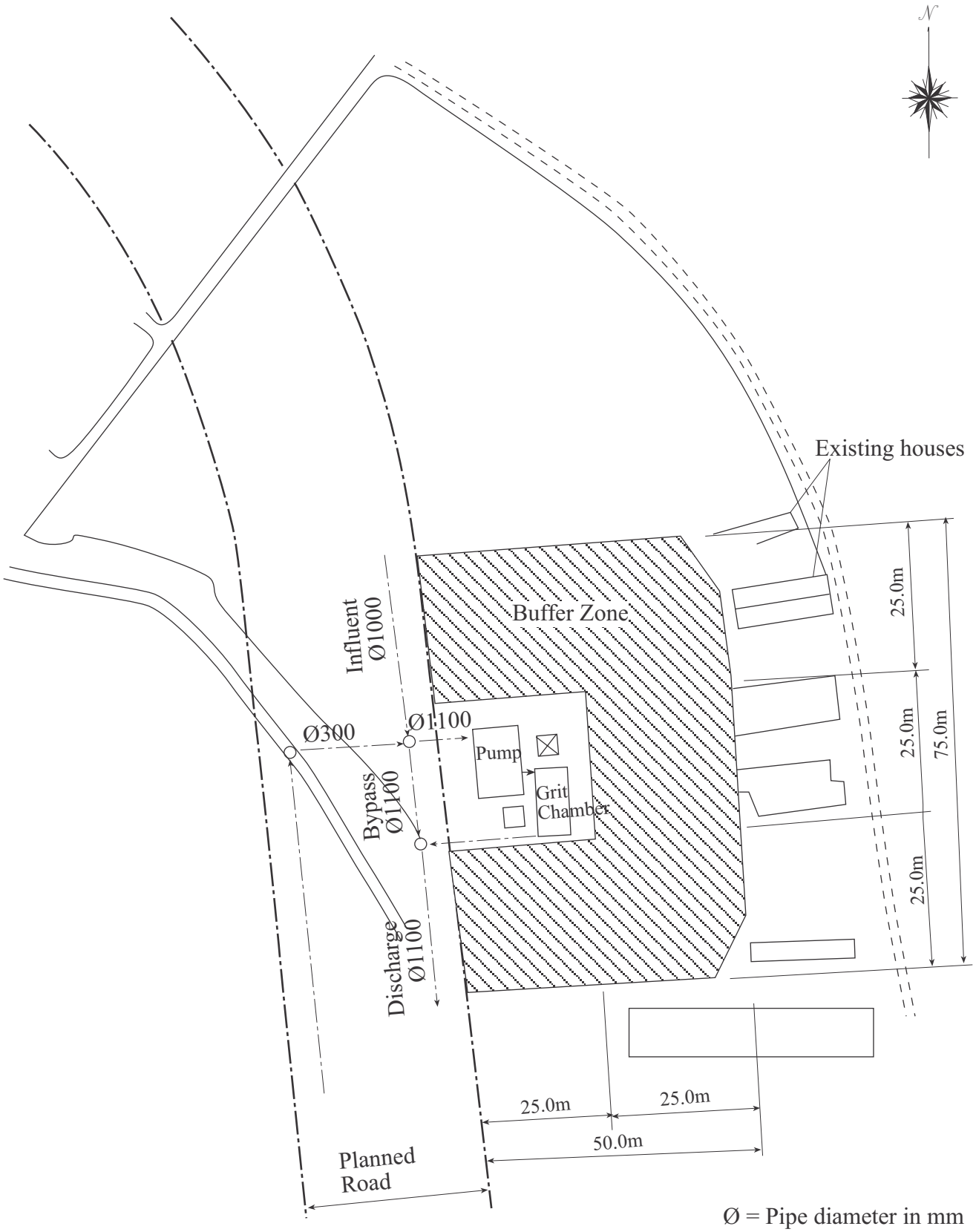
The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam

Japan International Cooperation Agency

Figure 3.4.6 Manhole Plan and Section

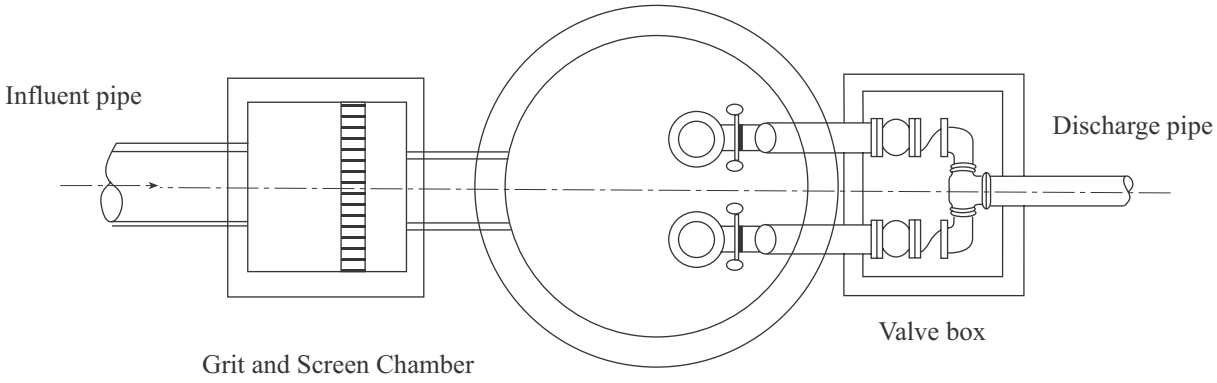


The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.4.7 Sewer Pipe Bedding Section**
Japan International Cooperation Agency	

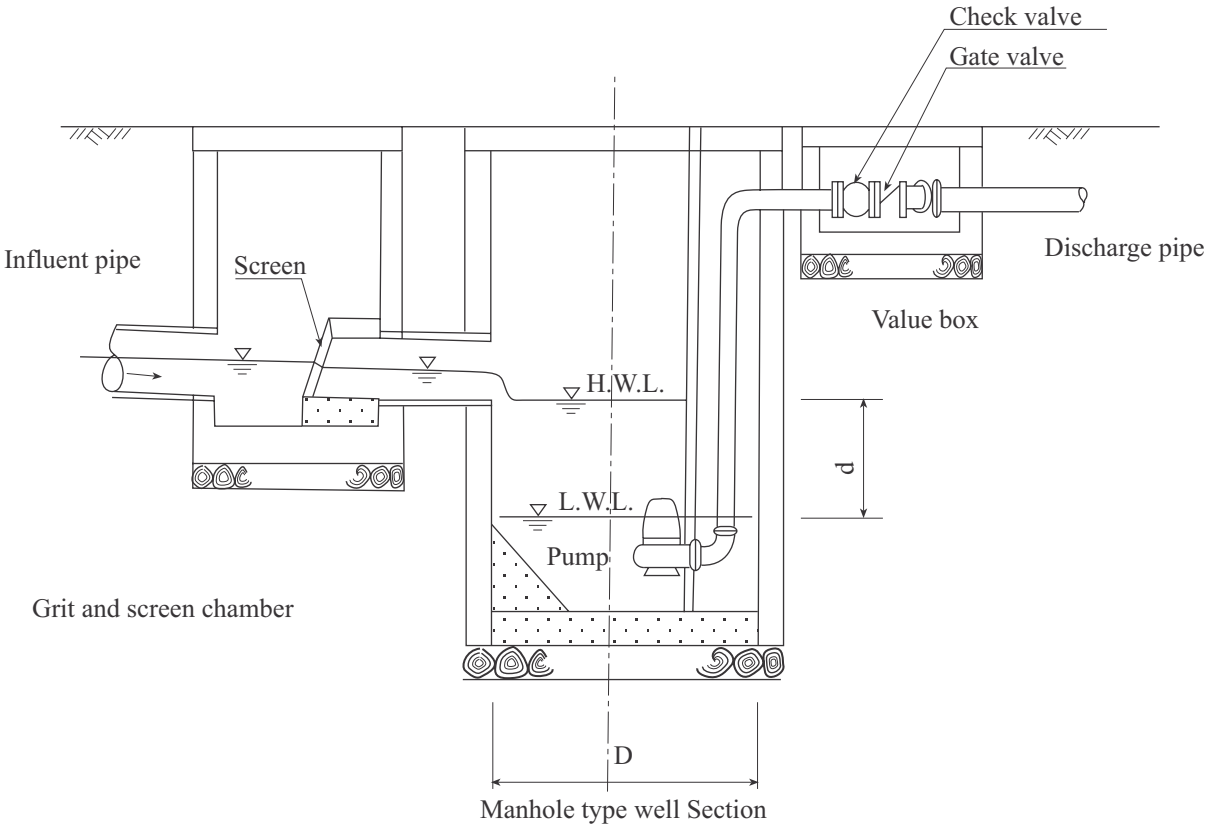


Ø = Pipe diameter in mm
Site Area A=3.800m²
Scale = 1:1000

The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.5.1 An Da Pumping Station Plan**
Japan International Cooperation Agency	



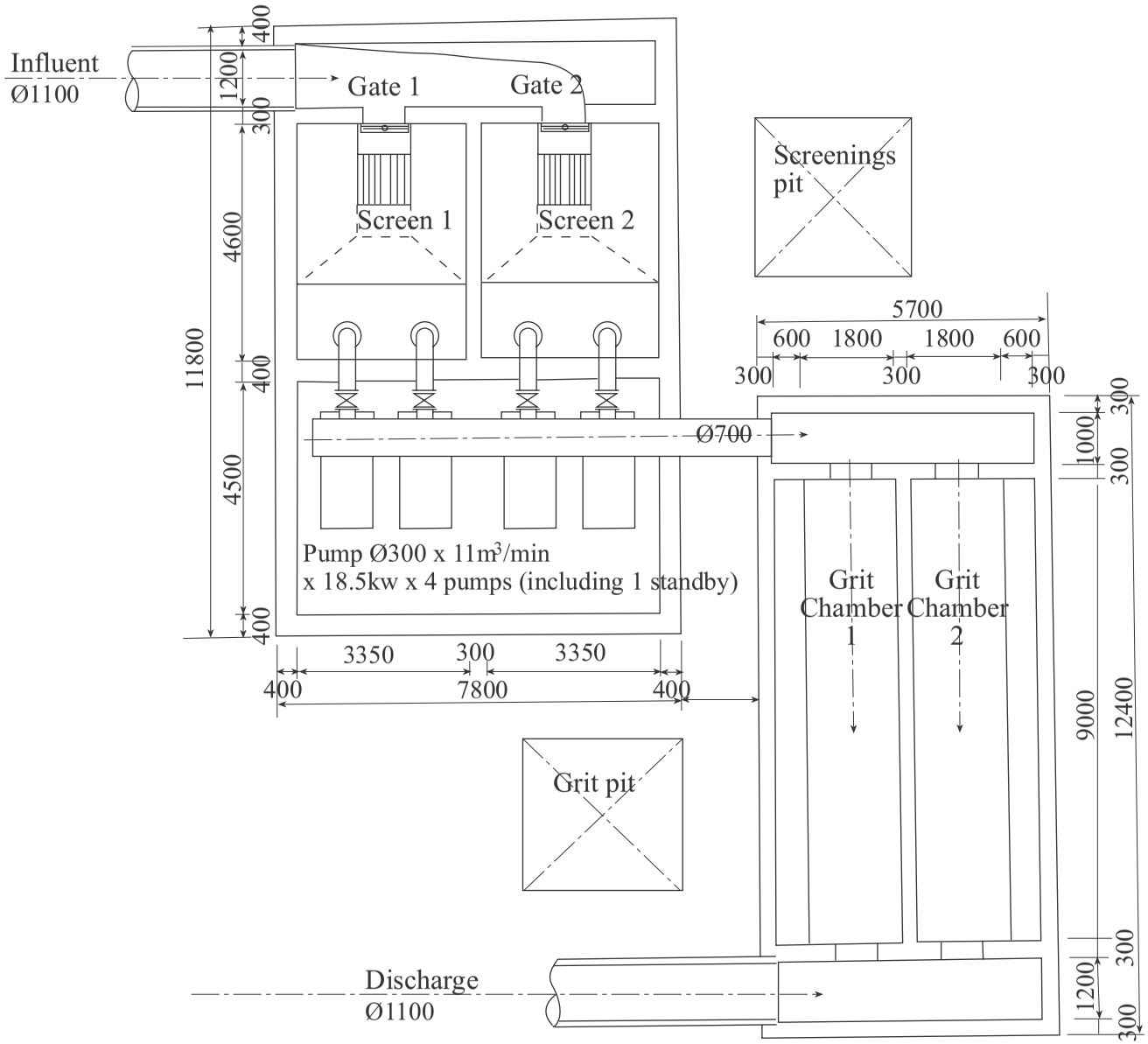
Manhole Type Well
PLAN



Manhole type well Section

Type	Wastewater	Pump dia	Pump no	D (well dia)	d (effective depth)
	m^3/min	mm		m	m
MP1	0.6	80	2	1.5	0.8
MP2	0.9	100	2	1.5	1.2
MP3	1.5	125	2	1.8	0.6
MP4	3	150	2	1.8	1.2

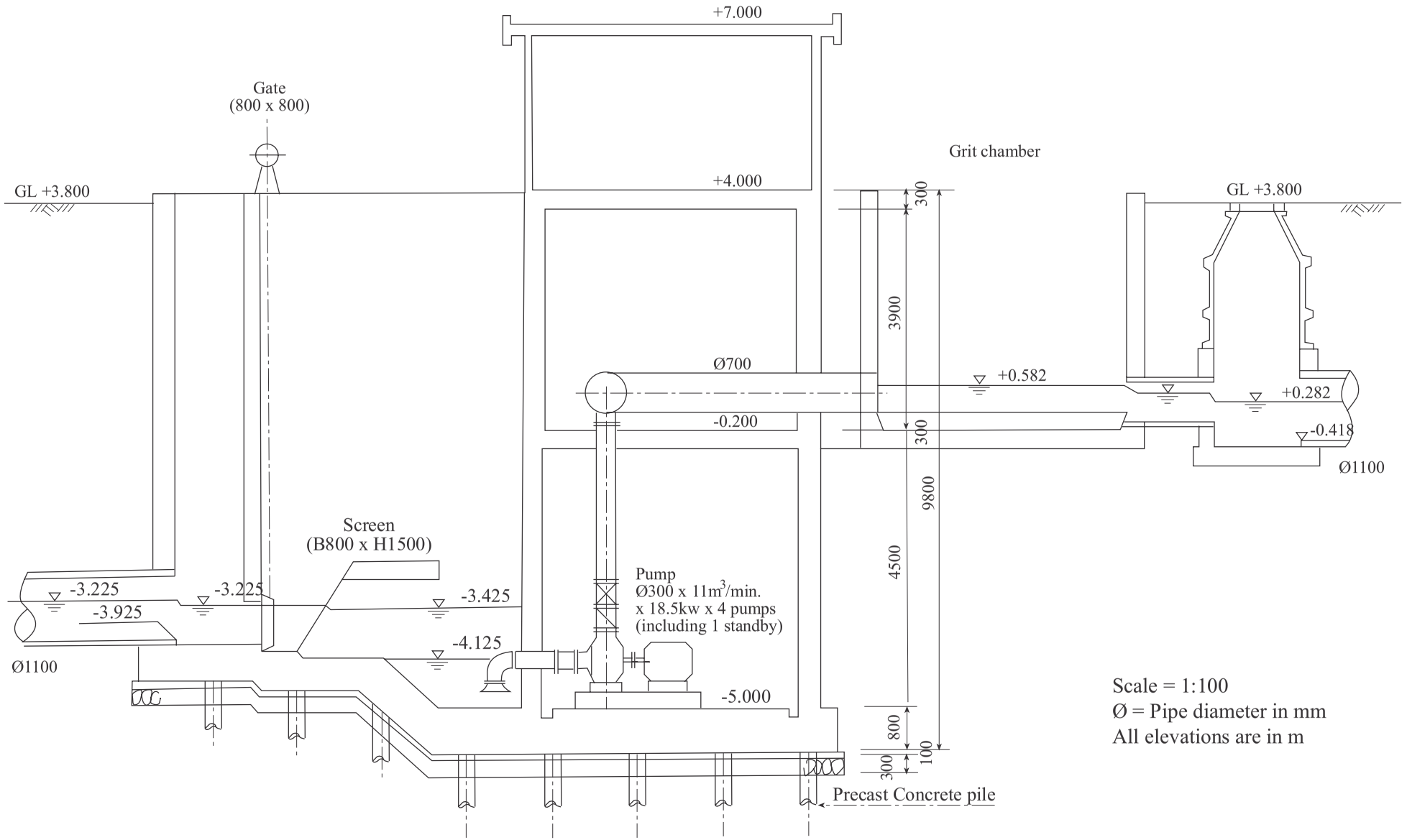
The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.5.2 Manhole Type Pumping Station Plan and Section**
Japan International Cooperation Agency	



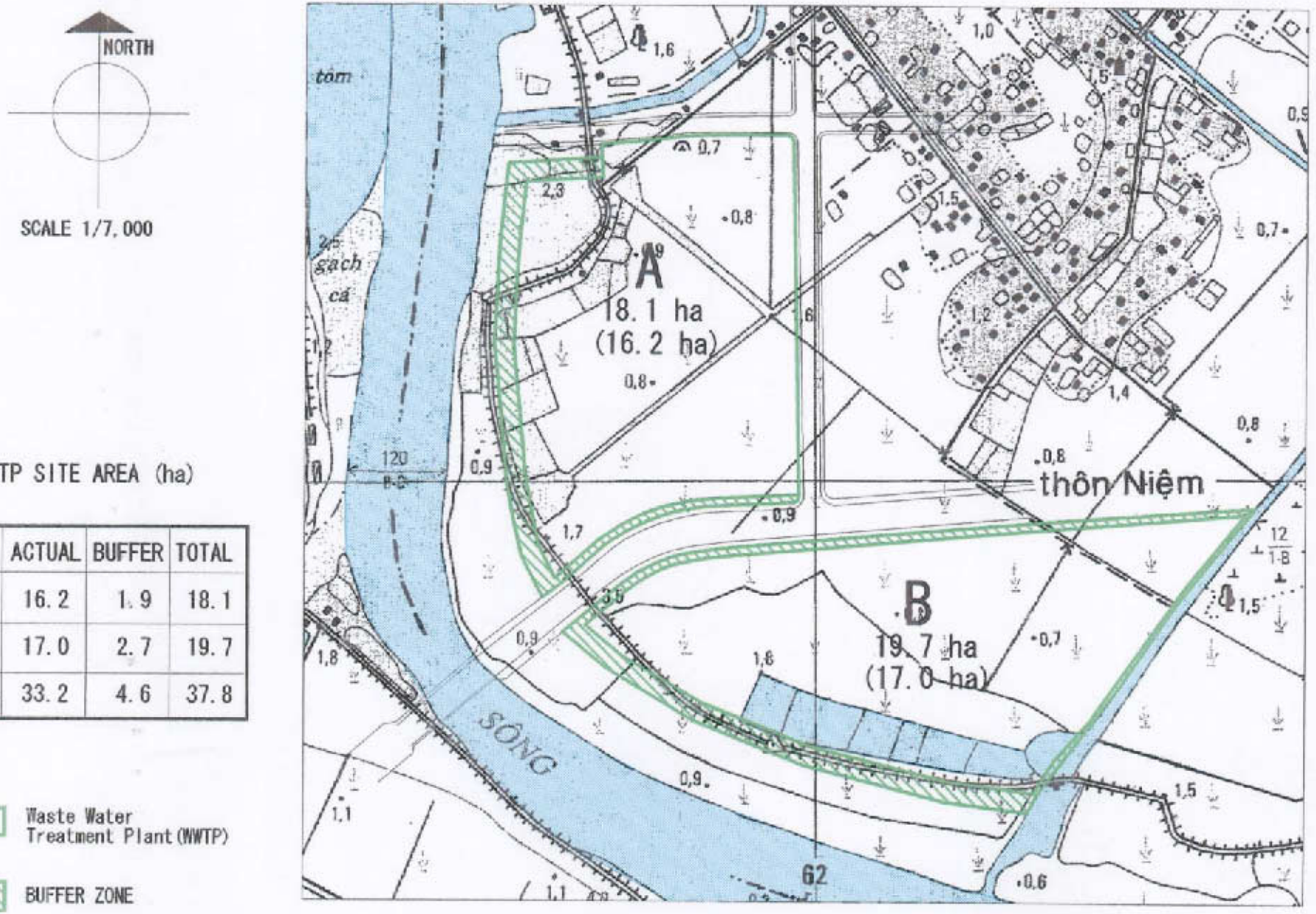
Ø = pipe diameter in mm
All dimensions are in mm

Scale = 1:100

The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.5.3 An Da Pumping Station Plan**
Japan International Cooperation Agency	



The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.5.4 An Da Pumping Station Section**
Japan International Cooperation Agency	



WWTP SITE AREA (ha)

	ACTUAL	BUFFER	TOTAL
A	16.2	1.9	18.1
B	17.0	2.7	19.7
TOTAL	33.2	4.6	37.8

Waste Water Treatment Plant (WWTP)

BUFFER ZONE

Fig 3.6.1 WASTE WATER TREATMENT PLANT

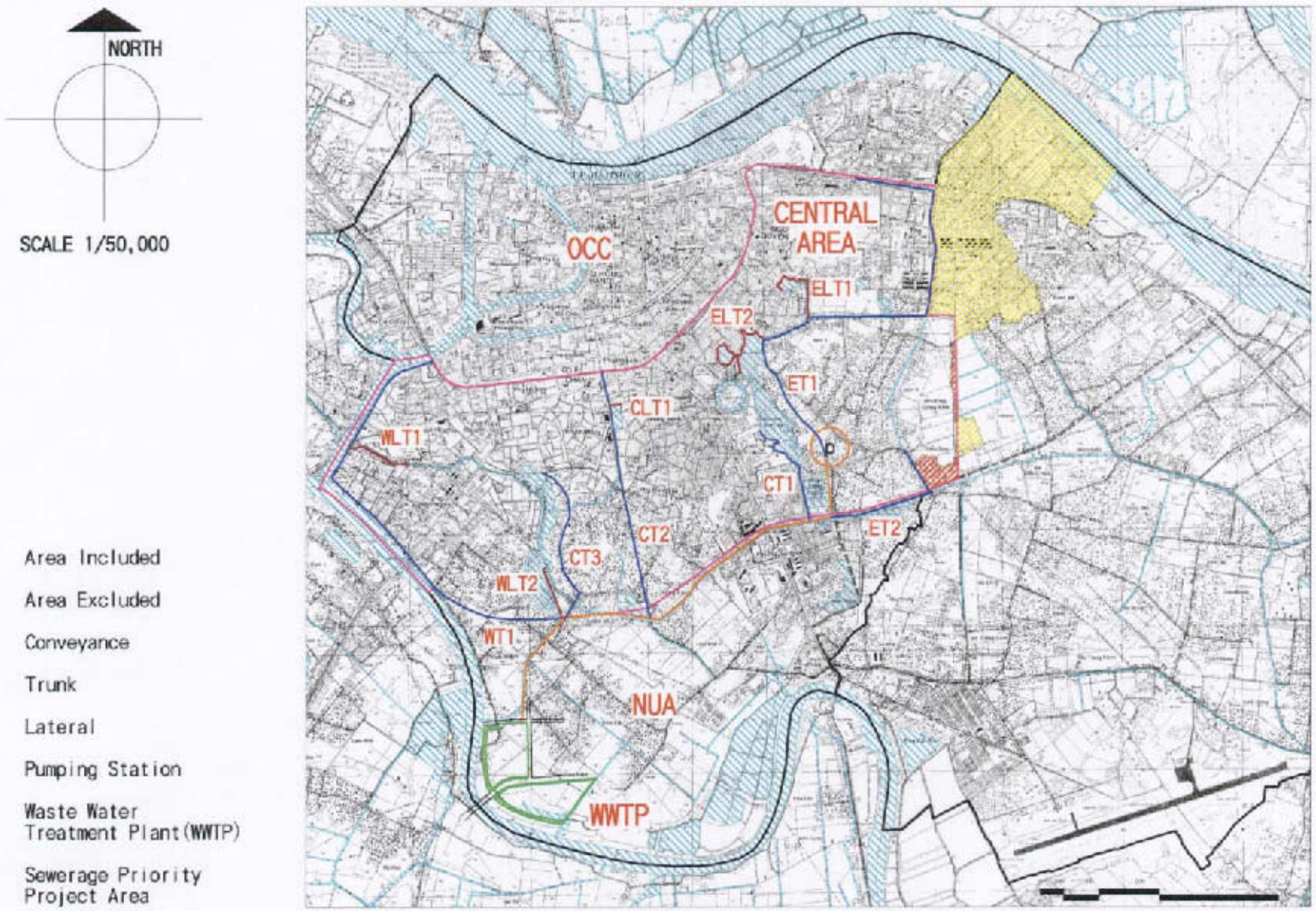
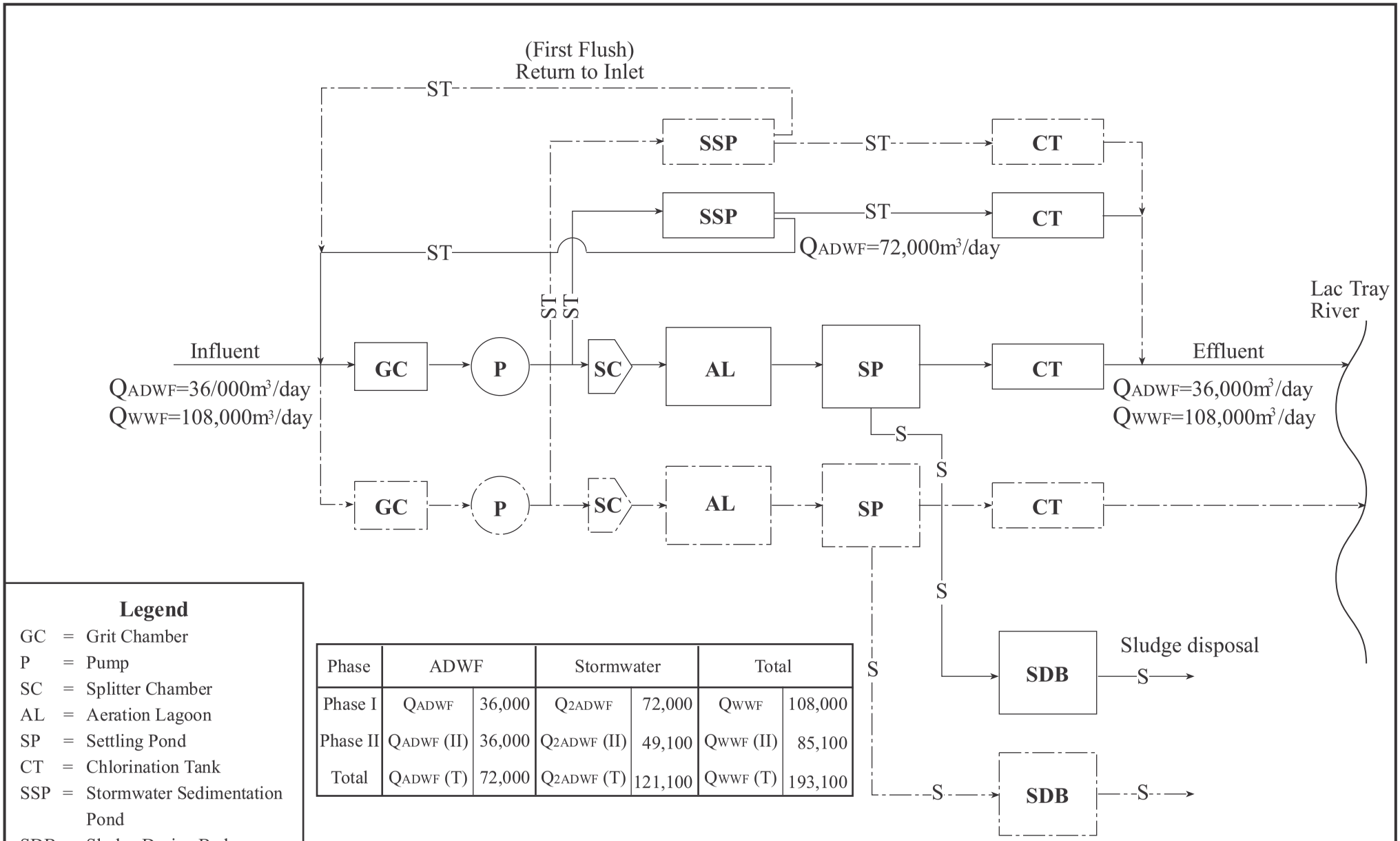


Fig 3.6.2 SEWERAGE PRIORITY PROJECT

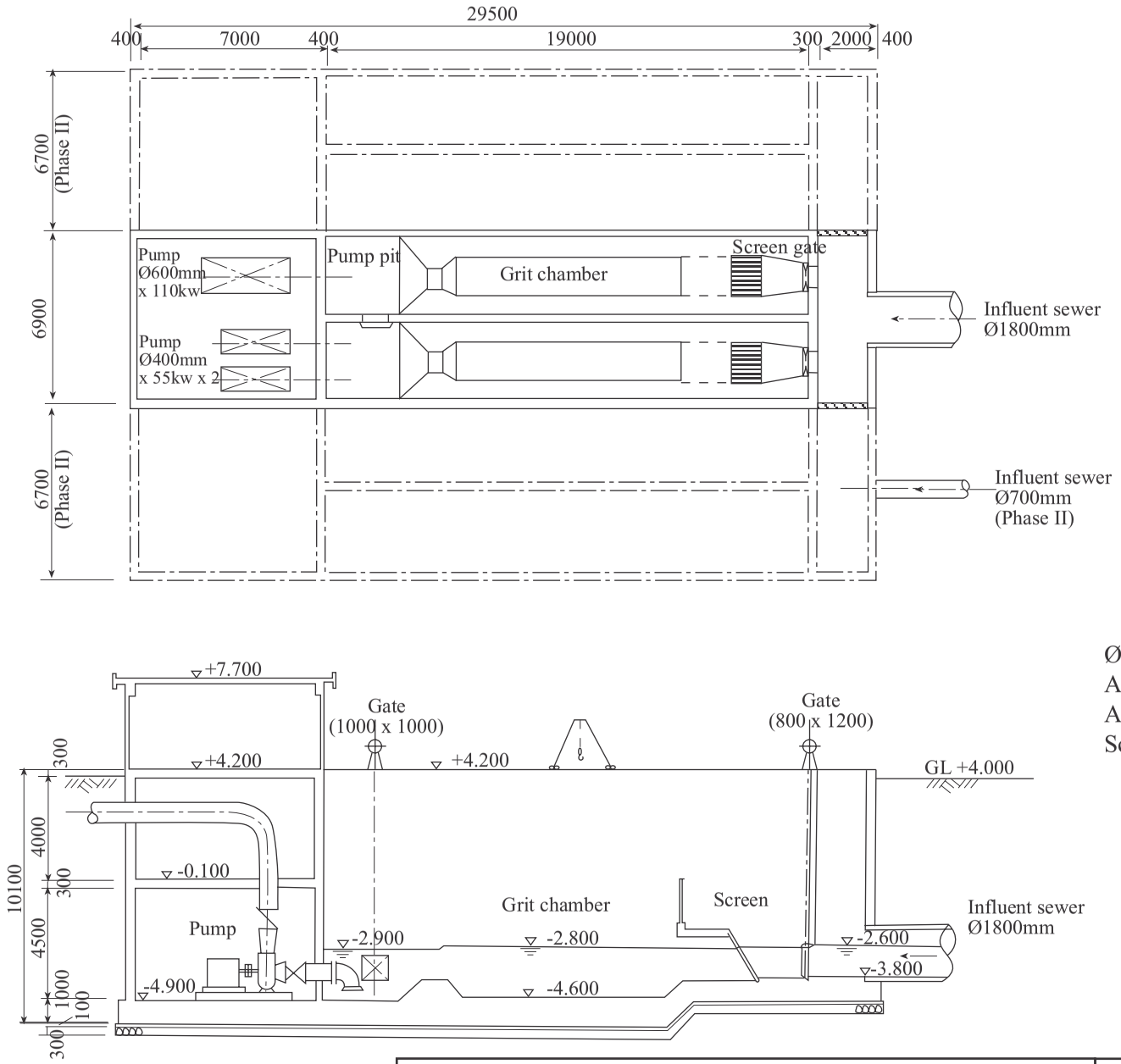


Phase	ADWF		Stormwater		Total	
Phase I	Q_{ADWF}	36,000	Q_{2ADWF}	72,000	Q_{WWF}	108,000
Phase II	Q_{ADWF} (II)	36,000	Q_{2ADWF} (II)	49,100	Q_{WWF} (II)	85,100
Total	Q_{ADWF} (T)	72,000	Q_{2ADWF} (T)	121,100	Q_{WWF} (T)	193,100

The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam

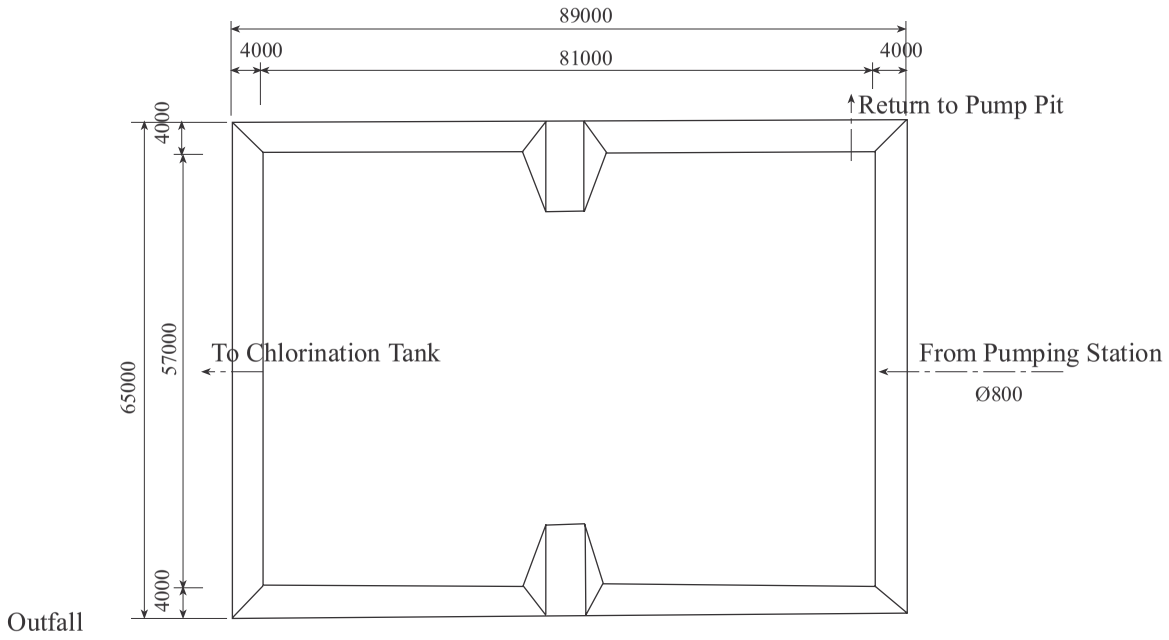
Japan International Cooperation Agency

Figure 3.6.3 Flow Diagram of Treatment Plant

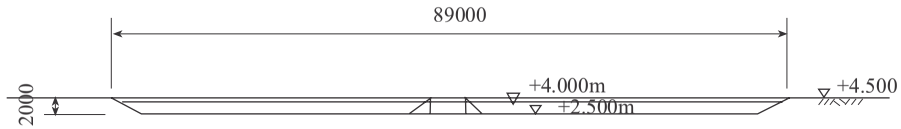


Ø = Pipe diameter in mm
All dimension except elevation is in mm
All elevations are in m
Scale = 1:200

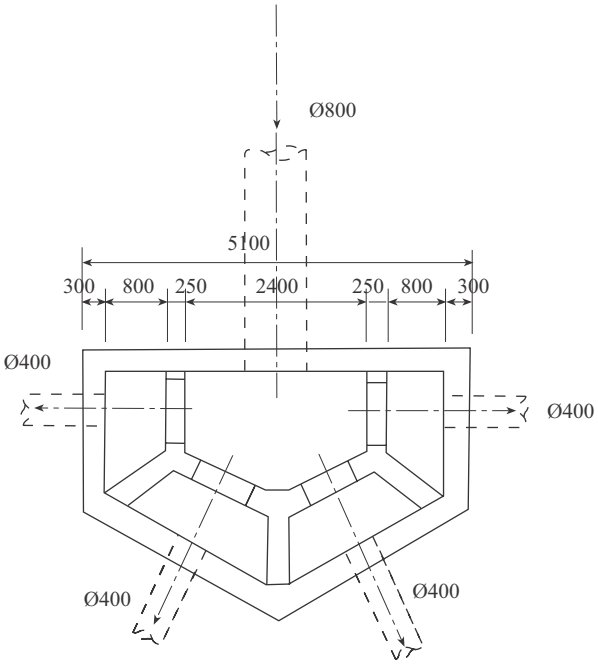
The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.6.4 Pump Station Plan and Section**
Japan International Cooperation Agency	

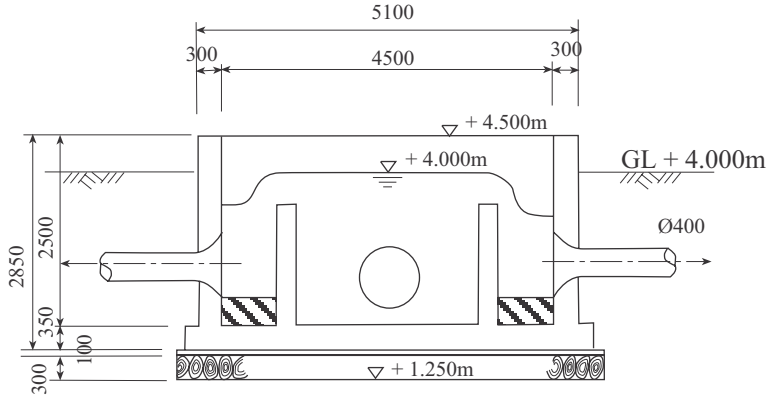


Scale = 1:1000
All dimensions are in mm except elevation



The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.6.5 Stormwater Sedimentation Pond Plan and Section**
Japan International Cooperation Agency	

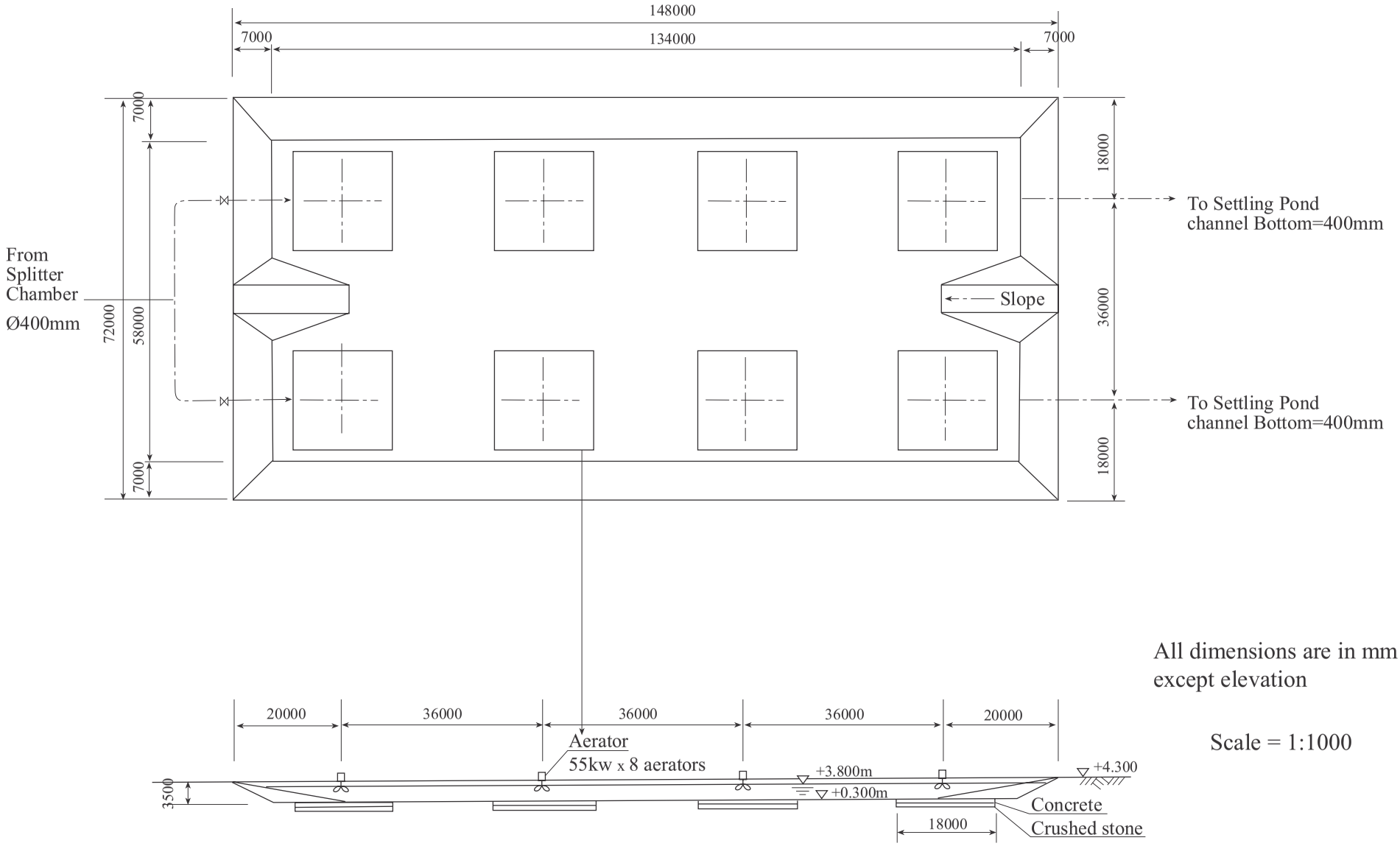




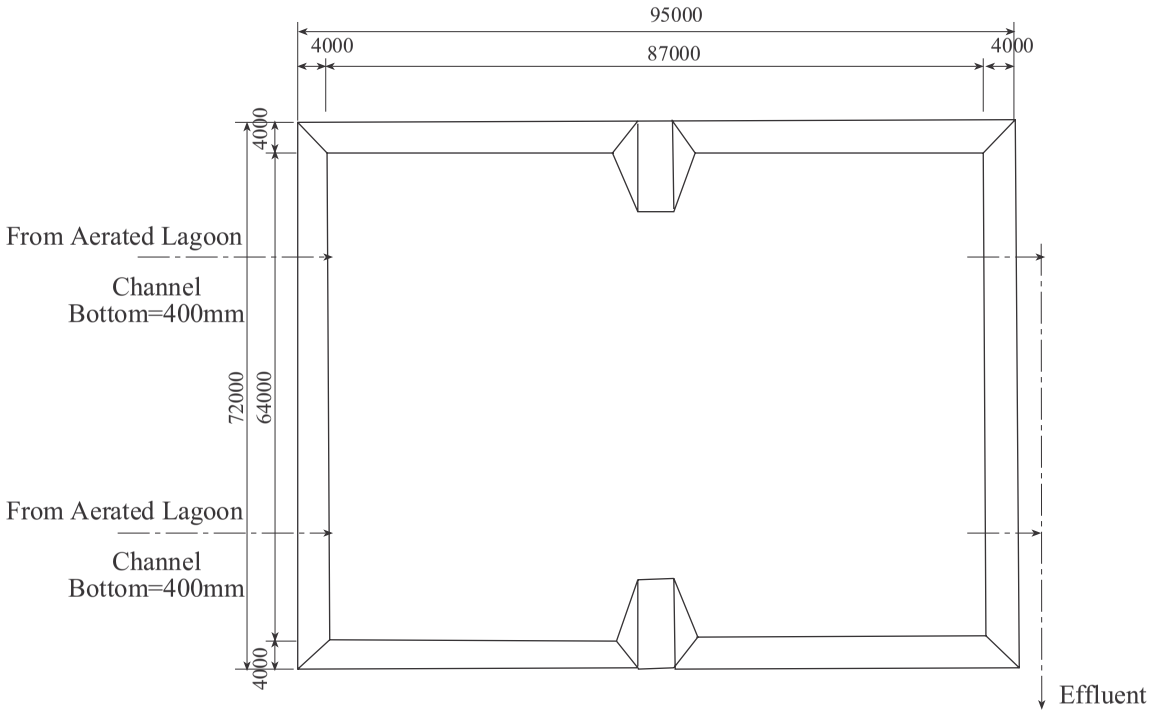
Scale = 1:100

All dimensions are in mm except elevation

The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.6.6 Splitter Chamber Plan and Section**
Japan International Cooperation Agency	

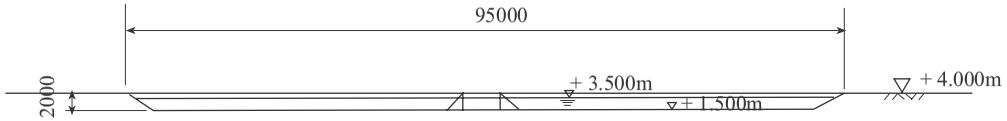


The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.6.7 Aerated Lagoon Plan and Section**
Japan International Cooperation Agency	

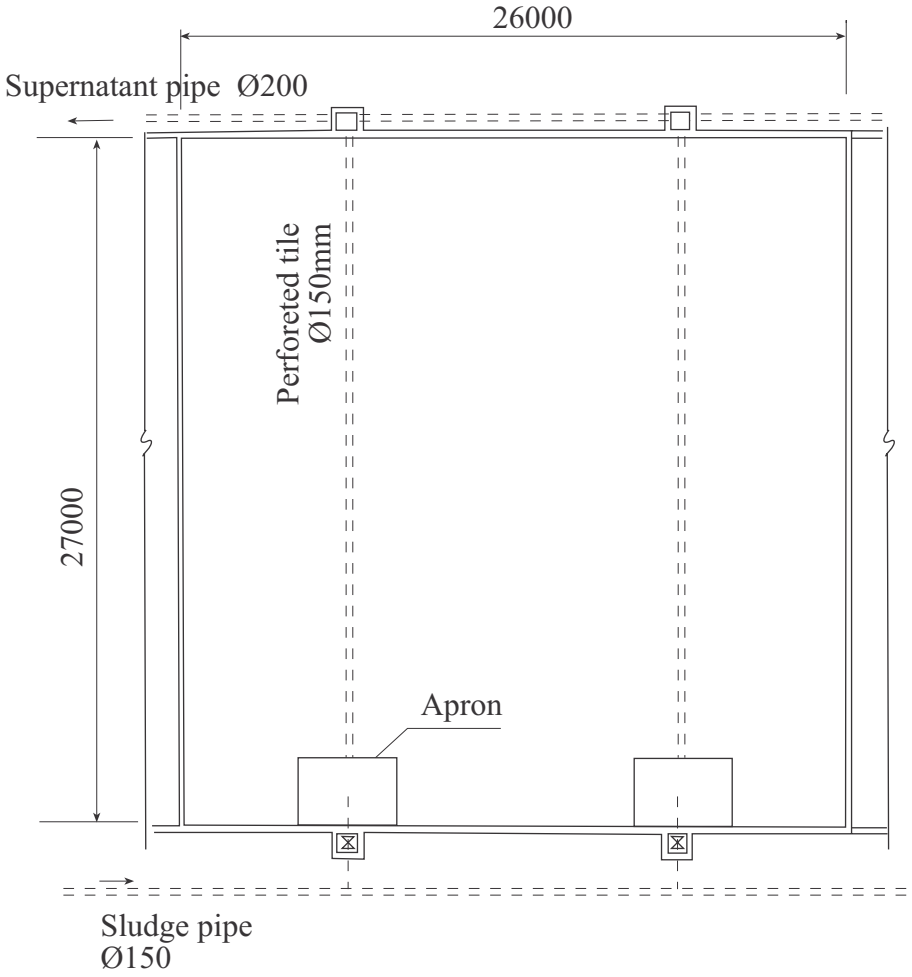


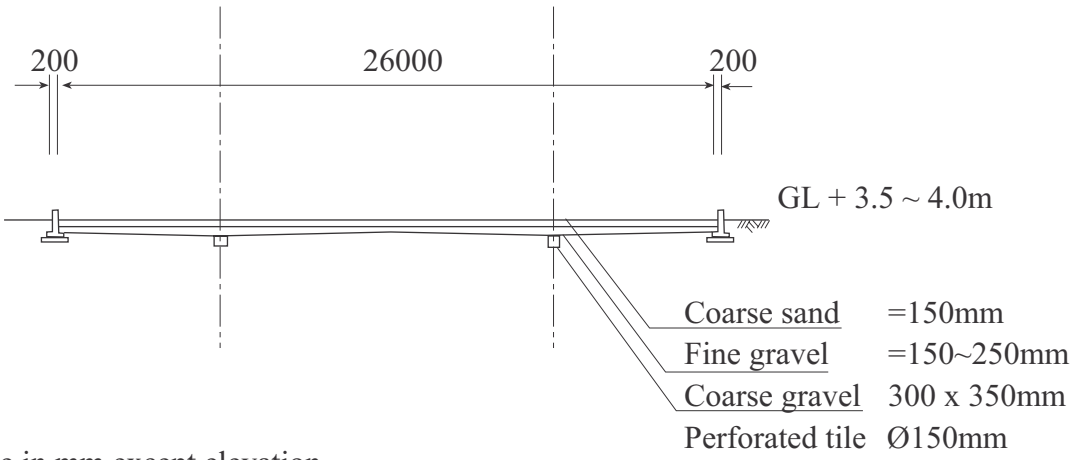
Scale = 1:1000

All dimensions are in mm
except elevation



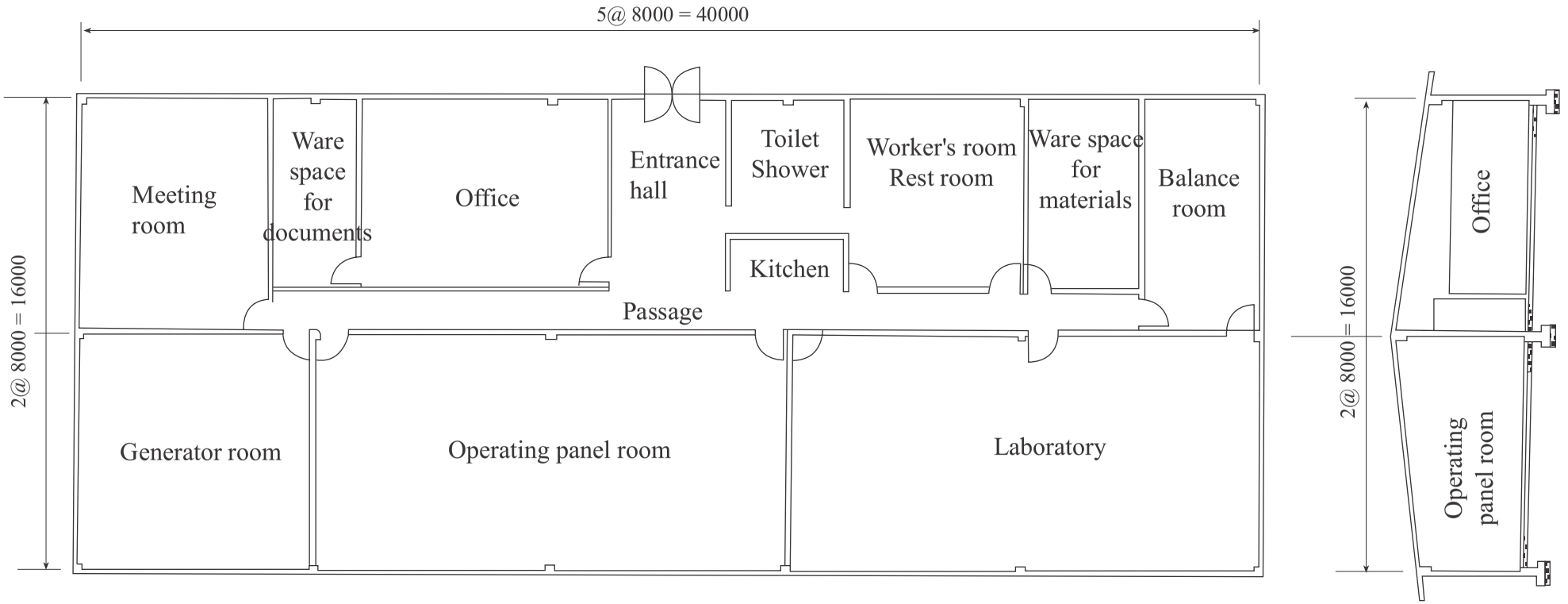
The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.6.8 Settling Pond Plan and Section**
Japan International Cooperation Agency	





Scale = 1:300
All dimensions are in mm except elevation

The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.6.9 Sludge Drying Bed Plan and Section**
Japan International Cooperation Agency	

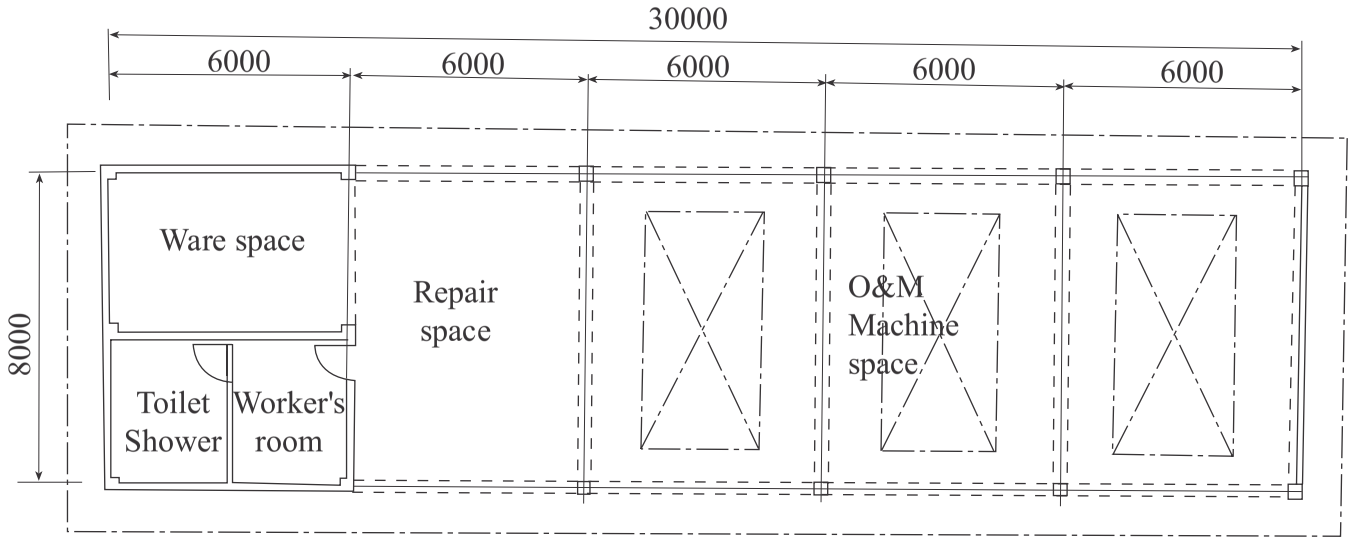


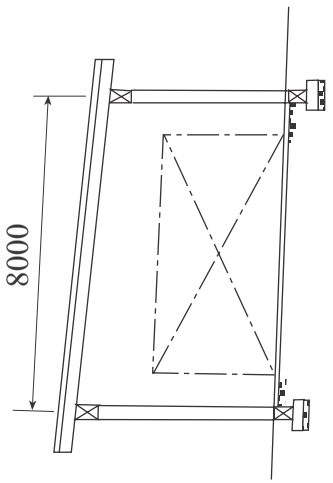
A=40m x 16m = 640m²

All dimensions are in mm except stated otherwise

Scale = 1:200

The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.6.10 Control Building Plan and Section**
Japan International Cooperation Agency	



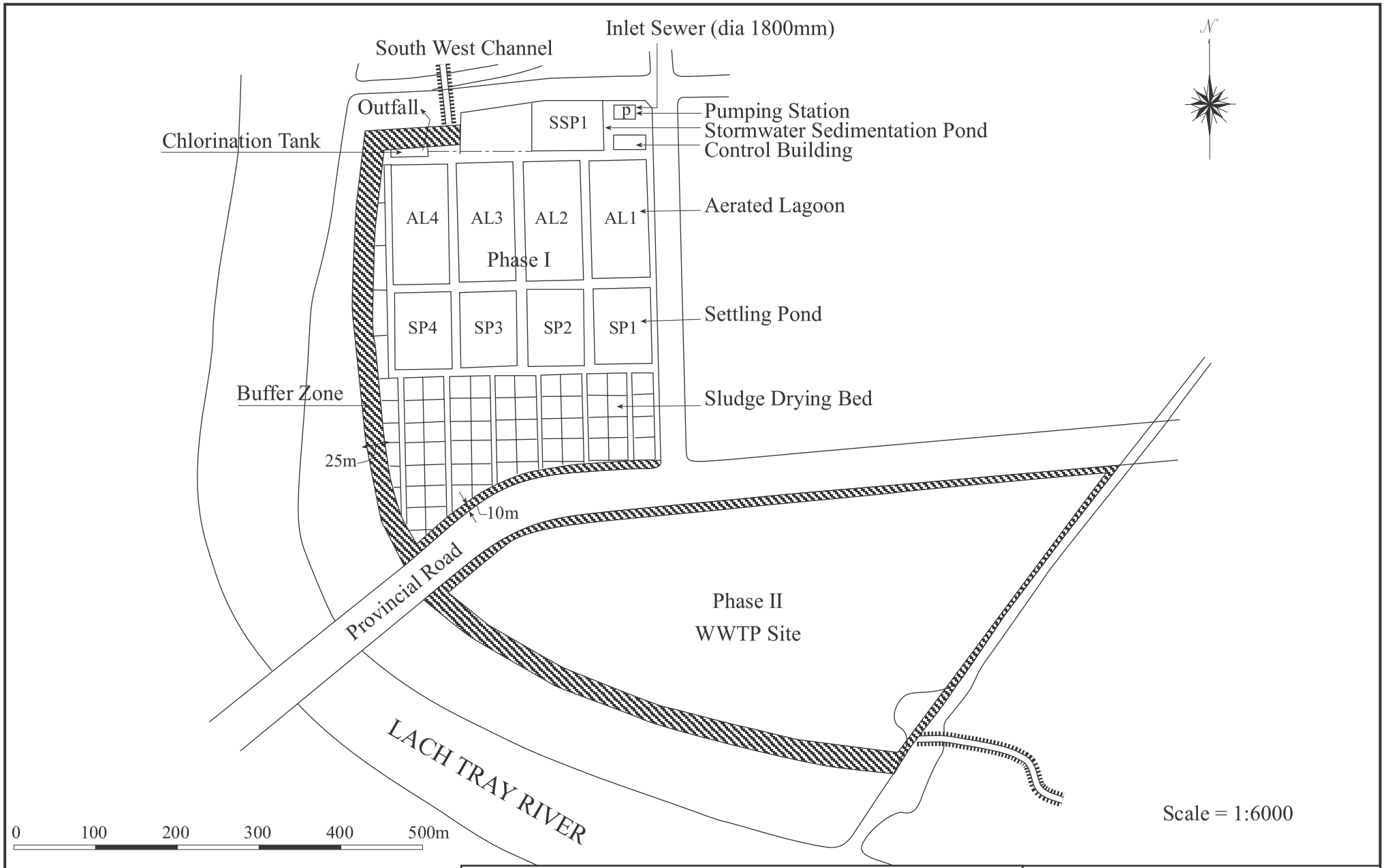


A=40m x 16m = 640m²

All dimensions are in mm except stated otherwise

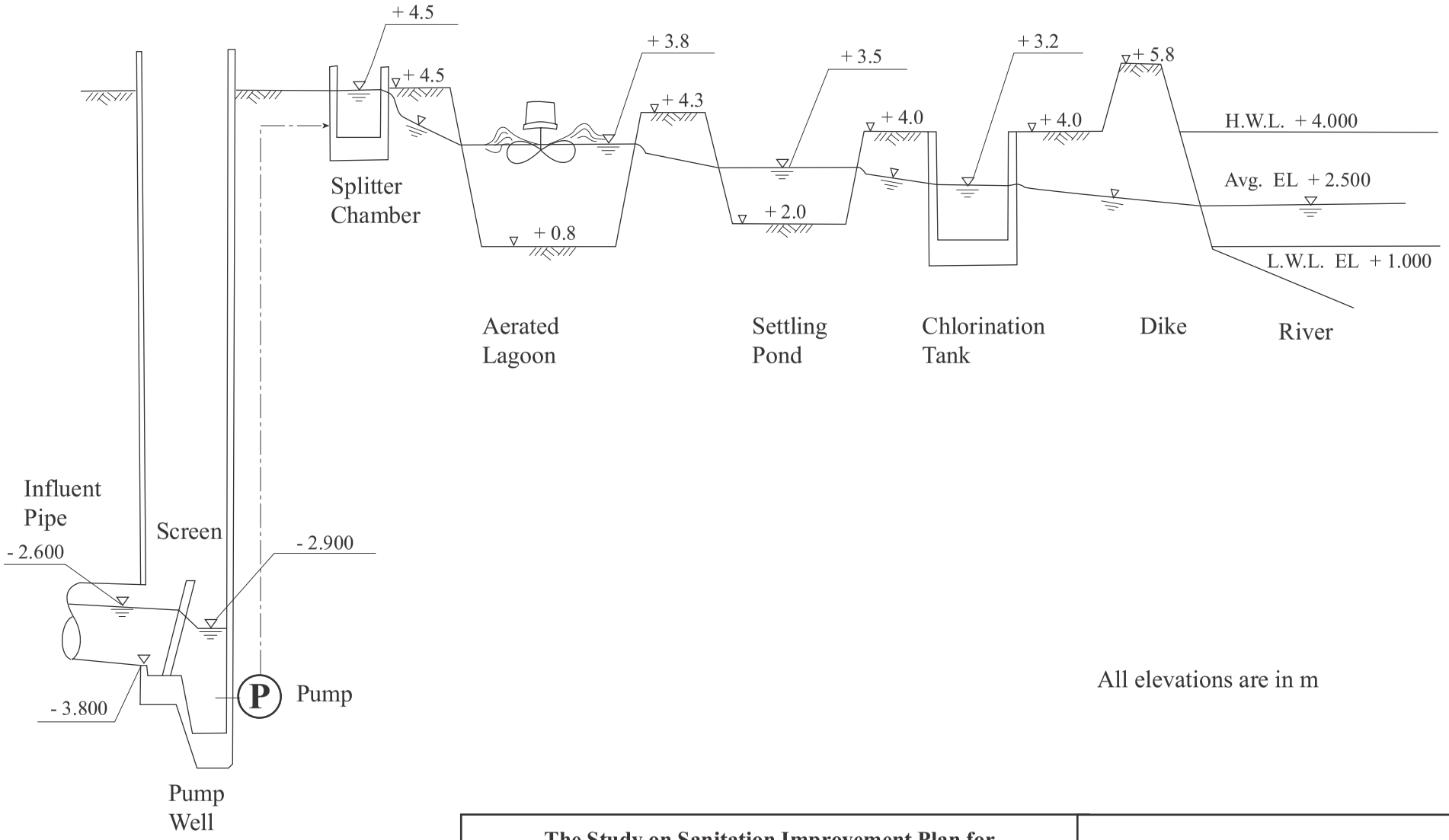
Scale = 1:200

The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.6.11 O&M Machine Building**
Japan International Cooperation Agency	

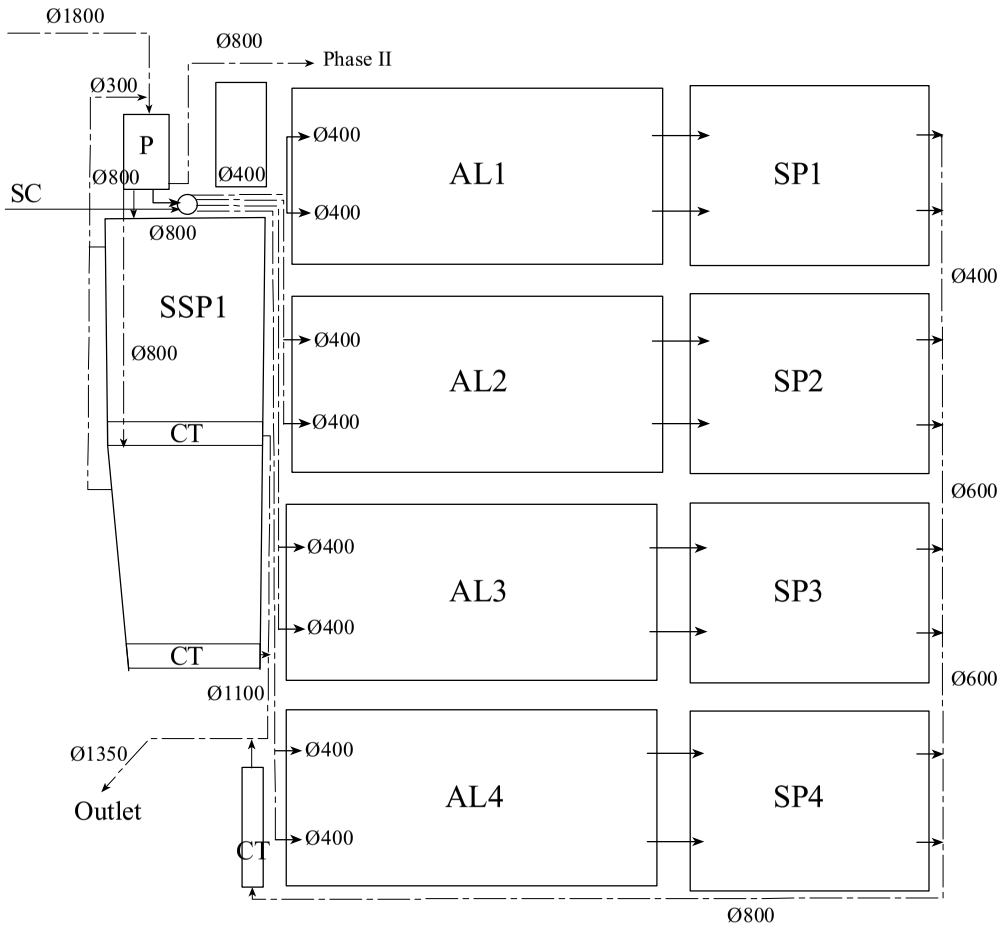


The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.6.12 West Wastewater Treatment Plant Plan**
Japan International Cooperation Agency	

The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.6.13 West WWTP Plan**
Japan International Cooperation Agency	



The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam	**Figure 3.6.14 Hydraulic Longitudinal Profile**
Japan International Cooperation Agency	



Legend

P	=	Pumping Station
AL	=	Aerated Lagoon
SC	=	Splitter Chamber
SP	=	Setting Pond
CT	=	Chlorination Tank
Ø	=	Pipe Diameter

Note: All dimensions are in mm

Scale = 1:3000

The Study on Sanitation Improvement Plan for Haiphong City in The Socialist Republic of Vietnam

Japan International Cooperation Agency

Figure 3.6.15 Internal Pipeline Layout Plan for the Treatment Plan

PART 4 FEASIBILITY STUDY ON THE SOLID WASTE MANAGEMENT PRIORITY PROJECT

CHAPTER 1 ASSESSMENT OF THE EXISTING SITUTATION

1.1 Introduction

1.1.1 Current Situation

The Haiphong City has the following 3 companies that provide solid waste management services:

- Urban Environmental Company (URENCO) responsible for the 3 urban districts, i.e., Hong Bang, Le Chan, and Ngo Quyen
- Kien An Urban Works Company
- Do Son Public Works Company

It is estimated that the 3 companies collect 470 tons of solid waste per day on average, i.e. 75 % of the estimated total amount generated. In terms of population, however, these 3 companies provide waste collection service for about 85 % of the population in their respective areas.

At present, the Haiphong City has two official landfill sites: one in Trang Cat commune of An Hai sub urban district, and the other in Do Son Town. The Trang Cat Landfill site receives solid waste collected by URENCO and Kien An Company, while the Do Son Landfill receives solid waste collected by Do Son Company.

As of 2000, the 3 companies have about 40 waste collection vehicles and 1,300 employees involved in solid waste management. In 2000 annual recurrent expenditures of the 3 companies is estimated to be VND13.5 billion, or about US$0.95 million. Major investments are not included in the budget of respective companies, but are included in the City's investment budget. Annual total investment of the 3 companies is estimated to be VND4 billion or about US$280,000 on average. The total cost including both recurrent and investment expenditure is VND17.5 billion or US$1.23 million per year. Unit cost of solid waste management is estimated to be VND102,000 or US$7.2 per ton including costs of waste collection, landfill, street sweeping, administrative and overhead costs. Number of the beneficiaries of the 3 companies is estimated to be about 410,000 persons. Solid waste management cost per person is VND43,000 or US$3 per person per year.

1.1.2 Major Problems

It is generally observed that the Haiphong City is kept clean and sanitary.

In addition to a normal problem of developing countries of inadequate financial resources, there are number of specific problems in Haiphong City with respect to solid waste management. These are as follows:

- Illegal dumping by citizens and weak enforcement by the City administration
    - Some people dump solid waste into rivers, lakes and the sea
    - People dump significant portion of household waste on the street before handcart workers collect it
    - The Haiphong City Administration's enforcement of regulations against the illegal dumping is very week
- No incentives for industries to construct and operate appropriate waste management facilities
- No independent system for management of hospital waste
- Unsanitary and inefficient waste collection system that also adversely affects traffic
- Unsanitary landfill operation
- Inadequate recovery of solid waste management costs

1.2 Waste Collection and Transport

1.2.1 Current System

Like many other Vietnamese cities, solid waste collection and transport activities in Haiphong typically comprises of two steps; (1) primary collection with handcarts, and (2) transfer of waste from handcarts to a truck, which then transports waste to landfill site.

After collecting waste, handcart operators go to a designated place for transferring waste from handcarts to a waste collection vehicle. Roadsides are used for the waste transfer. Handcart operators empty their handcarts by dumping waste on the roadside. Waste loaders (typically three loaders in a team) manually load waste into a waste collection vehicle with spades. At one transfer point, a waste collection truck receives solid waste from about 10 handcarts. A truck visits several transfer points before going to the landfill site. It typically takes about 40 – 60 minutes for transferring waste into a truck at each transfer point.

1.2.2 Major Problems

The above waste transfer system poses the following problems:

- Road (transfer points) become dirty, unsanitary and eyesore as waste is once dumped on road for waste transfer
- Local residents near by transfer points complain about dirty transfer points and suffer from waste scattering and flowing
- This system affects traffic. Waste collection trucks occupy one side of street for 40 – 60 minutes at each transfer point
- This system imposes hard work on waste loaders who have to manually lift and load waste into a truck that is 2 m high
- This system is not efficient

1.3 Waste Disposal

1.3.1 Overviews of Waste Disposal in Haiphong City

In Haiphong, the main waste disposal method is landfill. There is also good resource recovery system and market by private sector, for example, metals, papers, and kitchen residue recovery. These resource recovery activities are substantially contributing to a reduction of amount of waste landfilled.

(1) Existing Waste Landfill Sites

Two landfill sites are operating now. The three districts in central area and Kien An district are using the Trang Cat landfill site. Do Son district has its own landfill site in the district. Before Kien An district started transporting their waste to Trang Cat landfill site in the mid 1999, they had been using their own landfill site. But it was closed last year. There is also a former landfill site in Hong Bang district, called Thuong Ly, near the URENCO's vehicle garage. But URENCO has not closed Thuong Ly site with appropriate measures yet.

There is not a separate collection of medical waste and ordinary waste yet in Haiphong. Therefore, there is a high risk of exposure of medical waste to landfill workers and scavengers.

(2) Evaluation of Trang Cat Landfill Site from Technical and Sanitary Aspect.

URENCO transports collected wastes to the existing Trang Cat landfill site now. An outline of the site is shown below.

Outline of Trang Cat landfill site

Area of the site	5 ha
Height of filled layer (according to the original plan)	14 m
Volume of waste deposited	Unknown
Date of start of operation	January of 1998
Date of closure (according to the original plan)	middle of 2001
Liners system	Clay liner of 25cm thickness
Leachate collection system	Collection pipes at the bottom
Leachate treatment system	Storage pond & Sedimentation pond
Gas collection & ventilation system	No
Weigh bridge	Not yet *There is a space for weighbridge, but no machine installed because of shortage of budget.
Fence and Gate	Concrete wall of 1.2 m height around the site. The gate has a lock.
Time of operation	24 hours
Numbers of staffs	Management: Filling work:
Heavy vehicles for filling work	2 bulldozers. One bulldozer is almost broken and does not work
Daily cover work	None. Twice partly covers in 2000.
Type of waste disposed of	All kinds of solid waste including industrial, commercial and hospital waste collected, and septage
Amount of incoming waste	427 ton/day on average, of which 367 ton/day by URENCO and 60 ton/day by Kien An Company. On average, URENCO makes 98 trips/day using 25 trucks, while Kien An Company makes 16 trips using 4 trucks.

Major problems of existing Trang Cat landfill site are as follows:

- There is no effective gas collection system. Therefore, filled waste body codition might be anaerobic, i.e. less oxygen. There is also high possibility of methane gas production and biological degradation of organic matters in waste is progressed slowly
- Leachate treatment ponds do not work well. It seems that leachate is discharged without appropriate treatment. A quality of treated water may not satisfy the national standards
- There is no filling work strategy, including a daily cover. Therefore, a shape of filled waste body is very steep and looks very dangerous. URENCO does not have an enough budget to carry out a daily cover

(3) Evaluation of Do Son Landfill Site from Technical and Sanitary Aspect

Do Son Public Works Company collects waste and transports it to the their own landfill site located in Do Son Town. The site is outlined below:

Outline of Do Son landfill site

Area of the site	1 ha
Height of filled layer (in plan)	10 m
Volume of the site	Unknown
Date of start of operation	September of 1998.
Date of closure (in plan)	End of 2001
Liners system	Clay liner of 25cm thickness
Leachate collection system	Gravel & Sand layer and Collection pipes at the bottom
Leachate treatment system	Storage pond & Sedimentation pond
Gas collection & ventilation system	8 vertical pipes of perforated PVC pipes are installed, but has been removed recently
Weigh bridge	No
Fence and Gate	Concrete wall of 1.2 - 1.5m height on the one side of the site. Gate with lock.
Time of operation	24 hours
Numbers of staffs	Management: None for every time Filling work: None
Heavy vehicles for filling work	No bulldozer and no compactor at the site. After the sufficient sedimentation, bulldozer will compact waste according to the plan.
Daily cover work	No
Type of waste disposed of	All kinds of solid waste including industrial, commercial and hospital waste collected, and septage
Amount of incoming waste	Average amount of waste throughout year is 44 ton/day. Do Son Company makes 16 trips/day using 3 dump trucks. In high season from May – September, average waste amount increases to 50 ton/day.

Most of the findings and suggestions are almost same as those for Trang Cat landfill site. But there are a major difference.

- A height of boundary dyke is not enough to prevent the flood and high tide. It looks about 2 m now. It should be higher than 5 m, in order to prevent the flood and high tide. => Higher and stronger dykes are necessary.

The JICA Study Team had found that many gas ventilation pipes were installed at Do Son landfill site on July 2000. But the Team could not found any pipes on January of 2001 unfortunately. It seems that the operator removed the pipes, because they disturb the smooth filling works at site

=> Strategic filling works are necessary.

1.3.2 Plans for Future Landfill Sites

Trang Cat landfill (Phase 2) site is already planned at Trang Cat area. Trang Cat landfill (Phase 3) site is also approved by HPPC. Do Son (Phase 2) landfill site is planned by UPI. UPI has proposed a sites location plan of other future landfill sites for the districts. Existing landfill sites and planned sites are shown in Figure 4.4.1.

1.4 Hospital Waste Management

1.4.1 Current System

At present, URENCO collects solid waste of hospitals and medical centers in Hong Bang, Le Chan and Ngo Quyen.

Infectious waste is not separated from other non-hazardous waste. This means that all the hospital waste might be contaminated by infectious agents. URENCO collects indiscriminately the hospital waste of this nature by scooping with the hand shovels.

In Kien An and Do Son, the Public Works Company of each districts collects the hospital waste from the hospitals and the medical centers in each districts.

1.4.2 Major Problems

Current problems of the hospital waste management are the following three points. These problems can be attributed to lack of a separate and independent system for collection, treatment and disposal of infectious hospital waste.

[1] Remix of the infectious waste with non-infectious waste in the hospitals

[2] Exposure to the dust of the infectious waste during loading them onto the trucks

[3] Contacting to injection needles and syringes possibly infectious during picking up them after disposal.

(1) Remix of the Infectious Waste with Non-infectious Waste in the Hospitals

Vietnamese regulation on hospital waste management issued in 1999 stipulated that the hospital waste should be classified into four categories according to the nature, but actually it has not been respected. Most of the hospitals have only one waste storage in the hospital where all the waste including the infectious one is disposed together and remixed.

(2) Exposure to the Dust of the Infectious Waste

URENCO workers scoop the waste dumped in the waste storage in the hospital by hand shovels. This work diffuses dust of the waste including the infectious one, and the workers are exposed to it. Even the workers may inhale the dust.

(3) Contacting to Injection Needles and Syringes Possibly Infectious

Some scavengers pick up injection needles and syringes to get waste plastics. Consequently they touch the needles and syringes possibly contaminated with infectious viruses. This may be a cause of contagious infection.

CHAPTER 2 WASTE QUANTITY AND QUALITY

2.1 Municipal Waste Quantity

2.1.1 Current Waste Generation and Collection Quantity

Based on the waste collection quantity survey, household waste generation survey and other data obtained, it is estimated that the three companies' average waste collection in the service area are estimated to be 471 ton per day, i.e. 71 % of the estimated generation quantity as shown below.

Estimated Solid Waste Collection and Generation in Haiphong in 2000

Companies	Collection (a)	Generation (b)	Collection Ratio (c)= (a)/(b)
- URENCO	367 ton/day	484 ton/day	76 %
- Kien An Urban Works Company	61 ton/day	80 ton/day	76 %
- Do Son Public Company	44 ton/day	66 ton/day	67 %
- Total	471 ton/day	663 ton/day	71 %

In terms of population, however, it is estimated that 85 % of the population receive waste collection service in the 4 urban districts (Hong Bang, Le Chan and Ngo Quen, and Kien An)

Based on the current JICA Study, the waste collection quantities by waste types are estimated as follows:

Waste Quantity Collected by 3 Companies according to Waste Types in Haiphong in 2000

Type of Waste	Collection	Ratio
- Household waste	218 ton/day	46 %
- Business waste	135 ton/day	29 %
- Street waste	58 ton/day	12 %
- Industrial waste	45 ton/day	10 %
- Hospital waste	5 ton/day	1 %
- Demolition waste	9 ton/day	2 %
- Total	471 ton/day	100 %

Breakdown by the 3 companies is shown in Table 4.2.1.

2.1.2 Projection of Future Waste Generation and Collection Targets

Future waste generation is estimated considering the population projection and economic growth forecast shown in the current report.

Target Solid Waste Collection Quantity and Collection Ratio to Generation in Haiphong

Year	URENCO		Kien An		Do Son		Other Areas (Non-Agriculture Area)		Haiphong Total	
	Collect-ion (t/d)	Collect-ion Ratio	Collect-ion (t/d)	Collect-ion Ratio	Collect-ion (t/d)	Collect-ion Ratio	Collect-ion (t/d)	Collect-ion Ratio*	Collect-ion (t/d)	Collect-ion Ratio
2000	367	76 %	61	76 %	44	67 %	0	0 %	471	72 %
2005	597	85 %	89	85 %	75	81 %	6	20 %	767	82 %
2010	839	95 %	132	95 %	115	91 %	18	45 %	1,104	93 %
2020	1,082	95 %	183	95 %	176	95 %	55	95 %	1,496	95 %

See Tables 4.2.2 for annual quantities during 2000 – 2020.

Annual waste collection targets (ratios of waste collection amounts to generation amounts) are set based on the principles and targets shown in Section 6.1.6. The most important principle is that 100 % of non-agricultural households in Haiphong City will receive household waste collection service in future. This target will be achieved by 2010 in the 4 urban districts; by 2012 in Do Son Company's Area; and by 2020 in all the sub-urban districts.

It would not possible for waste companies to collect 100 % of all kinds of solid waste generated in the service area even if the companies provide waste collection services for 100 % of the non-agricultural population in the service area. Some waste is reused or burned or fed to animals or simply dumped. Maximum possible collection rate in terms of waste quantity is set at 95 %.

2.2 Solid Waste Quality

(1) Analyses Conducted

The JICA Study Team has carried out the waste composition analyses in May and June 2000, during which 3 samples were collected and analyzed with respect to the following:

- Bulk density on wet base
- Physical composition on wet base
- Physical composition on dry base
- Chemical composition, i.e., water, ash and combustible content

Direct results of the survey are shown in Part 1 Section 2.3.9.

(2) Results

The results of the analyses are shown in the tables below.

"Average", "Minimum" and "Maximum" indicated in the tables are those obtained through the analyses of the 3 samplings.

1) Bulk Density

Average bulk density is 0.45, which is similar to those already reported in the other studies.

2) Waste Composition

In the analysis of the current study results, the following two studies were used as reference, i.e. 1) URENCO's survey in 1997 indicated in a report "A Solid Waste Management Strategy for Haiphong Municipality 1998-2020" (referred to as URENCO 1997) and 2) JICA's survey conducted in Hanoi in 1998 (referred to as Hanoi Study). The results of these two studies are shown at the end of this section. The major findings through the current analyses are summarized below:

- Residues of briquette and kitchen waste are the two dominant compositions of Haiphong waste like other cities in Vietnam
  - Share of the kitchen waste, categorized as "garbage" in this study, is about 16 %, much less than the corresponding percentages of 48 % in URENCO 1997 Study, and 42 % of Hanoi Study. There is a possibility that some kitchen waste was sorted as particle>5 mm during the sorting process in the current waste composition study. It is then presumed that actual kitchen waste share is much larger than 16 %
  - Both the particle>5 mm and the particle<5 mm share 54 % in total, and is much greater than those found in other surveys. Majority of them may be ash or residue of the briquette used for cooking. Residue of the briquette after burning is mainly composed of solid laterite. Broken residue may be classified into the particle<5 mm while the solid one into the particle>5 mm. As mentioned above, the particle>5mm may include kitchen waste
- Timber and rags share 6 to 16 % in total while these components are less than 1 % in the URENCO 1997 and the Hanoi survey
- Paper content is still small in Haiphong, while plastic content is higher than expected
- Share of the glass is small because most of glass bottles are not disposed of but are reused

Bulk Density and Physical Composition on Wet Base (%)

No.	Category	Average	Min	Max
	Bulk Density (kg/L)	0.45	0.44	0.47
1	Paper	3.45	2.20	4.88
2	Garbage	16.46	14.82	18.36
3	Weave	0.95	0.36	1.56
4	Timber and rags	12.85	6.48	16.39
5	Plastics	6.10	4.02	8.64
6	Leather and rubber	0.29	0.02	0.82
7	Iron steel	0.41	0.11	0.85
8	Non-ferrous metal	0.03	0.01	0.05
9	Glass	0.29	0.17	0.47
10	Brick and Stone	4.66	2.25	6.52
11	Particle>5mm	41.16	36.85	47.98
12	Particle<5mm	13.35	9.27	17.37
	Total	100.00		

Physical Composition on Dry Base (%)

No.	Category	Average	Min	Max
1	Paper	2.70	1.29	4.13
2	Garbage	8.87	7.93	9.69
3	Weave	0.83	0.45	1.08
4	Timber and rags	9.65	4.92	13.46
5	Plastics	8.89	5.63	12.10
6	Leather and rubber	0.46	0.03	1.33
7	Iron steel	0.67	0.20	1.37
8	Non-ferrous metal	0.05	0.02	0.08
9	Glass	0.49	0.29	0.83
10	Brick and Stone	7.50	3.66	9.72
11	Particle>5mm	42.97	36.43	49.28
12	Particle<5mm	16.92	12.23	21.94
	Total	100.00		

Chemical Composition (%)

	Component	Average	Min	Max
1	Water Content	40.4	38.3	43.1
2	Ash Content	30.2	28.6	32.5
3	Combustible Cont.	29.4	28.8	30.5
	Total	100.0		

Physical Composition in the URENCO 1997 (%)

No.	Category	Percentage
1	Fruit skin and leaves	40.50
2	Paper	6.41
3	Animal bone	5.21
4	Feather	0.39
5	Animal corpse	0.25
6	Night Soil	4.27
7	Debris	2.06
8	Cloth	1.10
9	Nylon	4.21
10	Porcelain	0.47
11	Glass	0.16
12	Metal	0.22
13	Rubber, plastic	0.31
14	Wood, bamboo	0.31
15	Cinder	16.59
16	Grain<10mm	17.54
	Total	100.00

Source: A Solid Waste Management Strategy for Haiphong Municipality, TUPWS and URENCO, 1998

Physical Composition in the Hanoi Survey

Conducted by the JICA Study Team (%)

No.	Category	Percentage
1	Kitchen waste	41.98
2	Paper	5.27
3	Plastics, rubbers	7.19
4	Bricks, stones	6.89
5	Timber, rags	1.75
6	Bones, shells	1.27
7	Metal, tin cans	0.59
8	Glass	1.42
9	Sand and dust	33.67
	Total	100.03

Source: The Study of Environmental Improvement for Hanoi City, JICA, 2000

CHAPTER 3 WASTE COLLECTION AND TRANSPORT PLAN

3.1 Solid Waste Management Policy

The following policy is proposed for the Haiphong City:

- Clearer definitions of solid waste management responsibilities to be shared by HPPC, waste generating enterprises and citizens. Industrial enterprises should have full responsibility for management of industrial waste
- Strengthening of enforcement of regulations and instructions with respect to illegal dumping and waste discharge manner
- Strengthening of the cost recovery
- Strengthening of URENCO as service provider
- Application of sanitary and efficient method for waste collection/transport and disposal
- Establishment of independent system for management of hospital waste
- Recognition of role played by private sector in reuse and recycling. Encouragement of the existing practice of separation of useful materials at sources even with economic growth (Separation of waste after waste collection is not effective)
- Step-by-step improvement in solid waste management system

Detailed discussion is shown in the master plan Section 6.1.

3.2 Target Waste Collection Services

The three solid waste management companies, i.e. URENCO, Kien An Urban Works Company and Do Son Public Works Company will continue to provide solid waste management service. The service area, population and target waste collection amount of each company are planned as shown in the following table.

Service Area, Population and Target Waste Collection Amount of the 3 Solid Waste Management Companies

Company Name	Waste Collection Area in 2005	Population to be Served in the area in 2005 (thousand)	Target Waste Collection Amount in 2005 (ton/day)
1. URENCO	Hong Bang, Le Chan, Ngo Quyen districts, and surrounding areas included in the study area	528	597
2. Kien An Urban Works Company	Kien An district	64	89
3. Do Son Public Works Company	Do Son Town and area along the Route 14	16	75
4. Total		608	761

In total, the three companies will collect 761 ton of waste per day, and serve for 608 thousand people and most enterprises and offices in 2005, which is the year when the 3 companies start using the facilities and equipment provided under the priority project. The following table shows projected number of the service recipients (beneficiaries) during the project life period (2005 0 2014) by company and by year.

Beneficiaries of the Priority Project (Waste Collection and Transport)

Unit: Persons

	Served by URENCO	Served by Kien An Company	Served by Do Son Company	Total
	a	b	c	d = a+b+c
2005	527,810	63,701	16,484	**607,995**
2006	543,705	66,570	19,033	629,308
2007	559,844	69,485	21,765	651,094
2008	576,180	72,445	24,680	673,306
2009	592,737	75,452	27,778	695,967
2010	609,509	78,343	30,985	718,837
2011	620,000	80,473	34,367	734,840
2012	630,491	82,603	37,923	751,018
2013	640,783	84,732	39,671	765,186
2014	650,659	86,862	41,419	778,940

Remark: In 2000, the 3 companies collected 471 ton of waste per day, and provided waste collection service for 409 thousand persons, and most enterprises/offices. The large increases in waste collection quantity and service recipients in 2005 are attributable to expansion of service area of URENCO, and increases in waste generation.

3.3 Proposed Waste Collection System

3.3.1 Criteria for Improvement of Waste Collection and Transport

Two important criteria for improvement of waste collection/transport are:

- Sanitary and hygiene level
- Waste collection efficiency

The current waste collection system is “Open System” where solid waste, once collected by handcarts, is dumped on road for transfer. Waste in transfer process is visible by public. More “Closed System” should be applied. Once waste is collected, it should not be visible by the public. Waste once collected should not contact with road or people.

3.3.2 Proposed Systems

In order to improve the waste collection/transport system, the following two changes would be the most effective:

- Mechanical Lifting (Use of waste collection vehicle equipped with device that mechanically lifts up handcarts) (See Photo 1)
- Gradual application of "Direct Collection System with Use of Fixed Location Bins" (single handling system) instead of the existing handcart collection system (double handling system)

(1) Mechanical Lifting (Use of waste collection vehicle equipped with device that mechanically lifts up handcarts)

Application of waste collection vehicles equipped with a mechanical lifter will make possible to directly transfer waste from handcarts to the vehicle. No waste will be dumped on road during the waste transfer. In August 2000, URENCO introduced one waste collection vehicle equipped with a mechanical lifter, and obtained a good result.

(2) Direct Collection System with Use of Fixed Location Bins (See Photo 2)

The current waste collection (handcart collection) system is very labor intensive. The proposed system is more capital (equipment) intensive system.

For the direct collection system, it is necessary to use and put bins of appropriate capacity at fixed locations nearby waste generators (citizens and enterprises). Generators are requested to put their waste into the bins. Waste collection vehicles visit and empty the bins regularly (once a day normally).

Use of Bins as Means of Waste Storage:

The direct collection system requires use of either bins or plastic bags. In Japan, plastic bags are widely used by individual household persons. In Vietnam, collective use of plastic bins by households and enterprises would be more suitable than plastic bags considering the following situation:

- Plastic bags are easily opened or broken by scavengers or some animals, which leads to waste scattering
- Plastic bags are normally non-degradable at landfill site, which would pose environmental problem if adequate cover soil were not used
- Use of plastic bins bring about higher efficiency of waste loading (into vehicle) than the use of plastic bags does because bins can be mechanically emptied while plastic bags must be manually loaded into vehicle

Photo 1: Recommended Mechanical Lifting

Photo 2: Recommended 660-Liter Bin (This can be used as either fixed location bin or handcart.)

Photo 3: Recommended 240-Liter Bin (used at apartment building in Hochiminh City)

3.3.3 Benefits of the New Systems

(1) Mechanical Lifting

Use of mechanical lifter (to be installed to waste collection vehicle) will bring about the following benefits:

Minimization of adverse impacts by waste transfer activity on

Health of workers
Amenity for the local people
Environment, and
Traffic

Increases in waste collection efficiency

(2) Direct Collection System with Use of Fixed Location Bins

The major benefit deriving from the direct collection system with use of fixed location bins is:

Increases in waste collection efficiency, and resulting cost saving

It is estimated that the direct cost of the proposed direct collection system is about 70 % of that of the double handling system (primary collection with handcarts +

truck transport). In case the salary of collection workers is doubled in future, the former cost will be 50 % of the latter cost. The higher the salary of workers in future, the greater the difference between the two systems will be. Detailed comparison is shown in the Master Plan Tables 6.3.3 and 6.3.4.

Benefit Deriving from Use of Bins:

The citizens and generators are requested to put their waste into the bins placed nearby their houses or offices. Use of the bins will bring the following benefits:

- Convenient for the people

Once people are accustomed to the bin system, they will find the bin convenient because they can put their waste any time of the day irrespective of arrival time of waste collection vehicle.

- More fee revenue for URENCO

Amount of fees for commercial and industrial waste is based on volume of waste discharged by enterprise. According to the JICA study, URENCO's actual fee revenue from commercial and industrial enterprises is only 40 % of the amount that can possibly be charged. A reason for the smaller revenue is that the measurement of the waste volume is not accurate. If enterprises use standard bins (for example 660 liter bin), it is possible for URENCO to accurately, easily and regularly measure waste volume of each enterprise, and use the accurately measured waste volume as base for fee calculation.

3.3.4 Strategy for Introduction of the Direct Collection System

(1) Pilot Project

Unlike the application of the mechanical lifter for the waste transfer; the application of the direct collection system will require the cooperation by the citizens and waste generators. They are requested to put their waste into bins placed nearby the generators.

It is proposed that URENCO will implement a pilot project for the direct collection system at the following places:

- Market
- Large waste generators (enterprises)
- Apartment building

It is considered that it would be easier to introduce the direct collection system in the above types of places than in other places.

The direct collection system should be gradually expanded through the pilot project.

It is proposed that approximately 35 % of waste should be collected by 2005 by the direct collection system.

A proposed plan for the pilot project is shown in the box below.

A Proposed Plan for
Pilot Project for Direct Waste Collection System Using Bins in Haiphong

1. Objective

To confirm the feasibility of the waste direct collection system using bins in terms of:

a. acceptability by the local residents and waste generators
b. URENCO's operational capability

Note: A key factor for success is to organize a system whereby to maintain the bins clean so that the citizens would accept the system. During the pilot period, this system should be established.

2. Implementing Organization: URENCO

3. Schedule

1) Detailed plan: April – May 2001
2) Budget acquisition: June – July 2001
3) Purchase of equipment: August – September 2001
4) Implementation: October 2001 – September 2002

It is expected that the pilot project will continue, and become a regular collection system after the above period..;

Month	2	3	4	5	6	7	8	9	10	11	12	1	2
Planning			━	━									
Budget Acquisition					━	━							
Purchase of equipment							━	━					
Implementation									━	━	━	━	▶

4. Places

a. Market
b. Factory
c. Apartment building

5. Necessary Equipment and Cost

a. 1 compactor truck with mechanical lifter (cost of mechanical liter: VND14 million)
   Note: One of the existing compactor or one of vehicles to be given by Osaka city can be used.
b. 660 liter bins (VND3.4 million/bin x 15 bins = VND51 million))
c. 240 liter bins (VND1.7 million/bin x 10 units = VND17 million)
d. Miscellaneous: VND8 million
e. Total (a + b + c + d =) VND90 million (US$6,200)

(2) Key Factor

It is extremely important to maintain the bins clean. A case in Hochiminh City indicates that the citizens will not put waste into a bin if its cover is dirty. Then, people put their waste around the bin instead of putting it into bin. Then, the place around the bin becomes a small dumping place. And people demand that such bins should be removed.

Through the pilot project, URENCO should find ways to maintain bins clean. Incentive money needs to be paid to person who cleans bins.

(3) Redundant Worker

Application of the direct collection system will make some workers redundant because the system requires no primary collection. It is not necessary for URENCO and other waste management companies to dismiss such redundant workers. It is possible for the companies to absorb redundant workers in other urban areas where waste collection service is newly provided.

Photo 4: Unsuccessful Case in Hochiminh City

(Local residents dump waste outside the bins, as the bins and covers are dirty. Maintaining bins clean is important for success.)

3.4 Equipment Procurement Plan

(1) Users of the Equipment

Haiphong People's Committee (HPPC) will be responsible for procurement of the equipment proposed in the project. The following 3 companies will use the equipment provided through the project:

- Urban Environment Company (URENCO)
- Kien An Urban Works Company
- Do Son Public Works Company

(2) Major Planning Conditions for Equipment Procurement

1) Target Year and Procurement Schedule

Year 2005 is the target year. In the beginning of 2005, the 3 companies will start using the equipment that will be procured through the priority project. The following schedule is proposed:

- Securing financing source by HPPC 2002
- Engineering service (preparation of contract specifications) 2003
- Procurement 2004
- Commencement of use of equipment beginning of 2005

2) Target Waste Collection Amount

Target waste quantities to be collected by the three (3) companies in the beginning of 2005 are set as follows:

- URENCO 597 ton/day on average
- Kien An Urban Works Company 89 ton/day on average
- Do Son Public Works Company 75 ton/day on average
- Total of the 3 Companies 761 ton/day on average

3) Use of Existing and New Equipment

Equipment available in the beginning of the year 2005 can be categorized as follows by timing of procurement:

- The existing equipment of good quality that is currently used by the companies
- New equipment to be procured during 2001 – 2003 by HPPC's own fund
- New equipment to be procured in 2004 under the priority project

Types of Waste Collection Vehicles Available in 2005 by Procurement Timing

	URENCO (a)	Kien An Company (b)	Do Son Company (c)	Total (a+b+c) = (d)
1. Existing vehicles that is still used in 2005	16	1	0	17
2. New vehicles procured during 2001 – 2003	6	2	3	11
3. New vehicles procured in 2004 under the priority project	31	6	6	43
4. Total (1+2+3)	53	9	9	71

Note: As of the beginning of 2001, the 3 companies have about 40 waste collection trucks, of which 17 are expected to be used still in 2005 as shown above.

As for bins and handcarts, it is assumed that 50 % of the equipment used in 2005 will be procured through the priority project in 2004, and the rest is assumed to be procured in 2005 after having assessed level of acceptance of the bin system by the citizens.

4) Capacity of Equipment

Actual waste collection quantity changes every day. It is planned that the total capacity of equipment available in 2005 should have the capacity enough to collect and transport ordinary peak waste amounts. Ordinary peak amounts are assumed to be 15 % larger than the average amounts:

Ordinary Peak Collection Amount
= 115 % of the Average Amount
= Design Capacity of Equipment

- URENCO 687 ton/day
- Kien An Urban Works Company 103 ton/day
- Do Son Public Works Company 87 ton/day
- Total of the 3 Companies 877 ton/day

(3) Types of Equipment

1) Type of Equipment

In order to implement the improvement plan shown in earler section, HPPC should procure the following equipment:

- Waste collection vehicles (compactors in principle) equipped with mechanical lifting device
- Bins to be placed at fixed locations for direct collection
- Handcarts
- Workshop equipment used for maintenance

2) Collection Vehicles

In principle, compactor trucks with capacity 4 – 16 m^3 equipped with mechanical lifting device will be procured. Neither dump truck nor tipper truck will be procured.

3) Bins to be used at Fixed Locations

Considering the experience of Hochiminh City and availability, the following two types of bins will be procured:

- 660 liter bin made of hard plastic with 3 wheels
- 240 liter bin made of hard plastic with 2 wheels

It is planned that the direct collection system with use of fixed location bins will increase in future. In 2005, 25 % of household waste and 60 % of commercial and industrial waste will be collected by the direct collection system. As result, amount of solid waste to be collected by the direct collection system will be about 35 % of the total solid waste collection amount in 2005.

4) Handcarts

The remaining 65 % will be collected by handcarts.

The 660 liter bin (above Item a) can be used also as handcart, and actually perform better than the traditional handcart in terms of efficiency and smoothness of mechanical transfer into vehicle. In 2005, it is planned that 50 % of the waste collected by primary collection will be collected by the new type (660 liter handcart), and the remaining 50 % by the traditional handcart (450 liter).

Photo 5: A Recommended Compactor equipped with mechanical lifting device (Used in Hochiminh City)

5) Workshop Equipment

Each company will be provided with a set of workshop equipment. List of the equipment is shown in the end of this section.

(4) Equipment to be Procured

Quantity of equipment to be procured for the 3 companies in 2004 under the priority project is estimated as follows:

Waste collection vehicles equipped with mechanical lifter	43
Bins including those to be used as handcarts	1,010
Traditional handcarts	224
Workshop equipment	3 sets

Details are shown in the following table.

Equipment to be Procured in 2004 Under the Priority Project

	URENCO	Kien An Company	Do Son Company	Total
a	b	c	d	e=b+c+d
A. Waste Collection Vehicles with Mechanical Lifter				
1 Compactor (4m3; 2ton)	2	0	2	4
2. Compactor (6m3; 3ton)	4	2	1	7
3. Compactor (8m3;4ton)	15	2	1	18
4. Compactor (12m3; 5ton)	2	2	2	6
5. Compactor (16m3; 7ton)	6	0	0	6
6. Hook-lift truck	2	0	0	2
Total	31	6	6	43
B. Bins				
1. 660 liter bin including those used as handcarts	389	58	69	516
2. 240 liter bin	390	56	48	494
3. Traditional Handcart	180	27	17	224
4. Total	959	141	134	1,234
C. Workshop Equipment				
1. Maintenance & repair equipment	1 set	1 set	1 set	3 sets

(5) Major Assumptions Used for Estimation of Equipment Requirement

Based on actual performance of URENCO, typical waste collection performance is assumed as follows:

- Number of round trips to be made by one waste collection vehicle per year

  2 round trips/shift x 2 shifts/day x 274 days/year = 1,096 round trips/year

- Waste load by vehicle
  - Compactor ($4m^3$) 2 ton/trip
  - Compactor ($6m^3$) 3 ton/trip
  - Compactor ($8m^3$) 4 ton/trip
  - Compactor ($12m^3$) 5 ton/trip
  - Compactor ($16m^3$) 7 ton/trip
  - Hook-lift truck 5 ton/trip
- Waste load by bin
  - 660-liter bins used at fixed location 0.264 ton/bin/day
  - 240-liter bins used at fixed location 0.09 ton/bin/day

  Note:
  - It is assumed that the fixed locations bins (either 660 liter or 240 liter) will be emptied once a day

- It is assumed that Bulk density of Haiphong solid waste would be 0.4 ton/m^3 in 2005, while the current bulk density is 0.45

- 660-liter bins used as handcart — 0.79 ton/bin/day (0.264 ton/trip x 3 trips/day)
- Traditional handcart — 0.54 ton/handcart/day (0.18 ton/trip x 3 trips/day)

3.5 Operation and Maintenance Plan

(1) Operation Plan

The 3 companies in Haiphong have a good operation system for waste collection and transport. The Priority Project does not require any change in vehicle operation system.

Procurement plan for the Priority Project is based on the assumption that the 3 companies would apply the current typical vehicle operation plan to the new equipment, which is as follows:

- Number of trips to be made by one vehicle per year

  2 trips/shift x 2 shifts/day x 274 days/year = 1,096 trips/year

- On the base of 365 days per year

  Daily average trips = 1,096 trips/vehicle/ 365 days = 3 trips/day/vehicle

(2) Maintenance Plan

The three (3) solid waste management companies of Haiphong including URENCO have proved that they have an adequate capacity for maintaining and operating waste collection equipment. Most of the waste collection vehicles they use are old, but they still manage to continue to use them.

URENCO has an adequate staffing for vehicle maintenance. However, maintenance equipment they have is not adequate in terms of quantity and quality. Therefore, the Priority Project includes the procurement of some maintenance equipment as listed in previous section.

It is proposed that the 3 companies, with the new maintenance equipment, will carry out the preventive maintenance more on regular base than now.

(3) Organization Plan

The implementation of the Priority Project does not require a new organization or additional staff. Contrary, some waste collection workers and waste loaders will be made redundant as result of the efficiency increases that would be made

possible by introduction of the new waste collection systems, i.e. the direct waste collection system and mechanical loading that are the planning bases for the Priority Project.

The Master Plan proposes that speed of the introduction of the direct collection system should not be too fast so that workers made redundant due to the efficiency increases would be transferred to other areas where waste collection service would be newly provided.

3.6 Cost Estimation

The direct cost of procurement is estimated to be US$3,907,000. Amount by company is shown below:

- URENCO US$2,886,000
- Kien An Company US$522,000
- Do Son Company US$499,000
- Total US$3,907,000

Quantity and cost by type of equipment and by company are summarized in the following table.

Summary of Equipment Procurement Plan – Quantity, Unit Cost and Total Cost

	Quantity (Units)				Unit Price (US$)	Procurement Cost (US$)			
	URENCO	Kien An Com-pany	Do Son Com-pany	Total		URENCO	Kien An Company	Do Son Company	Total
a	b	c	d	e= b+c+d	f	g= b*f	h= c*f	i= d*f	j= g+h+I
A. Waste Collection Vehicles									
1 Compactor (4m3; 2ton)	2	0	2	4	62,000	124,000	0	124,000	248,000
2. Compactor (6m3; 3ton)	4	2	1	7	67,000	268,000	134,000	67,000	469,000
3. Compactor (8m3;4ton)	15	2	1	18	70,000	1,050,000	140,000	70,000	1,260,000
4. Compactor (12m3; 5ton)	2	2	2	6	77,000	154,000	154,000	154,000	462,000
5. Compactor (16m3; 7ton)	6	0	0	6	118,000	708,000	0	0	708,000
6. Hook-lift truck	2	0	0	2	60,000	120,000	0	0	120,000
7. Total	**31**	**6**	**6**	**43**		**2,424,000**	**428,000**	**415,000**	**3,267,000**
B. Bins									
1. 660 liter bin	389	58	69	516	240	93,360	13,920	16,560	123,840
2. 240 liter bin	390	56	48	494	120	46,800	6,720	5,760	59,280
3. Traditional Handcart	180	27	17	224	120	21,600	3,240	2,040	26,880
4. Total	959	141	134	1,234		161,760	23,880	24,360	210,000
5. Rounded Total						**162,000**	**24,000**	**24,000**	**210,000**
C. Workshop Equipment									
1. Maintenance & repair equipment	**1 set**	**1 set**	**1 set**			**300,000**	**70,000**	**60,000**	**430,000**
D. Grand Total (A+B+C)						**2,886,000**	**522,000**	**499,000**	**3,907,000**

Note: The above unit costs are the procurement costs including costs of delivery to Haiphong. These costs do not include administrative cost, engineering costs, and contingency. Further details of procurement plan for each company are shown in Tables 4.3.1-4.3.8.

List of Equipment for Workshop

Unit: VND Million

	Name of Equipment		Quantity				Cost			
		Unit Price Cost (a)	URENCO (b)	Kien An (c)	Do Son (d)	Total (b+c+d =) (e)	URENCO (a) x (b) = (f)	Kien An (a) x (c) = (g)	Do Son (a) x (d) = (h)	Total (f+g+h =) (i)
1	Hydraulic Machines	500	1			1	500		0	500
2	High-Pressure Pump	150	1			1	150		0	150
3	Spraying Needle Adjusting Machine	10	1	1	1	3	10	10	10	30
4	Surface grinding machine	200	1			1	200		0	200
5	Round grinding machine	200	1	1	1	3	200	200	200	600
6	Crank grinding machine	500	1			1	500		0	500
7	Transversal polishing machine	200	1			1	200		0	200
8	Vertical polishing machine	300	1			1	300		0	300
9	Valve grinding machine	50	1	1	1	3	50	50	50	150
10	Engine Rubbing Machine	100	1			1	100		0	100
11	Lathe	50	2	1	1	4	100	50	50	200
12	Shaft drilling machine	50	2	1	1	4	100	50	50	200
13	Cutting and punching machine	50	2	1	1	4	100	50	50	200
14	Table-based drilling machine	30	2	1	1	4	60	30	30	120
15	Fraise	50	1			1	50		0	50
16	Arc welding machine	10	2	1	1	4	20	10	10	40
17	Hand-hold welding machine	20	2			2	40		0	40
18	Air pump (for tires)	10	2	1	1	4	20	10	10	40
19	Tire disassembling machine	10	4	2	1	7	40	20	10	70
20	Mobile electrical pulley set	200	1			1	200	0	0	200
21	4-pillar electrical jack, > 6 ton	100	1	1		2	100	100	0	200
22	hydraulic jack, 5 ton	5	8	4	4	16	40	20	20	80
23	battery charger	20	2		1	3	40	0	20	60
24	Air welding machine	10	2	1	1	4	20	10	10	40
25	paint sprayer	5	1	1		2	5	5	0	10
26	Vehicle washing equipment	300	1	1	1	3	300	300	300	900
27	Forklift truck	500	1			1	500	0	0	500
28	Miscellaneous						277	70	24	371
29	Total		46	19	17	82	4,222	985	844	6,051
30	Total US$ at US$1=VND14,072						300,000	70,000	60,000	430,000

CHAPTER 4 TRANG CAT PHASE 3 LANDFILL PLAN

4.1 Planning Policy and Design Conditions

4.1.1 Planning Policy

For the planning and design of Trang Cat landfill (Phase 3) site, the following concepts are applied.

We will design landfill site facilities from the aspect of BATNEEC (Best Available Technique Not Entailing Excessive Cost), affordability and self-sufficiency, and step-wised improvement.

(1) BATNEEC (Best Available Technology Not Entailing Excessive Cost)

The best available and appropriate technologies are applied, and these are not too expensive for local government and organization.

(2) Step-wise Improvement

There are many tragic projects in developing countries that failed due to high operation cost and high technological requirement that were beyond economic and technological capacity of the project execution agency. Therefore, "Step-wise Improvement" is recommended.

(3) Compliance with Vietnamese Laws and Regulations

It has been confirmed by HPPC through the Steering Committee for the Study that the facilities of the waste landfill must be designed and constructed in compliance with Vietnamese laws and regulations, in particular the Joint Circular No. 01/2001/TTL-BKHCNMT-BXD "Guiding the Regulations on Environmental Protection for the Selection of Location for the Construction and Operation of Solid Waste Landfill Sites" issued on January 18,2001 (Hereafter referred to as the Joint Circular).

The Trang Cat Landfill (Phase 3) was, therefore, planned and designed in the Study in due compliance with the Joint Circular and other relevant regulations.

4.1.2 Design Conditions

(1) Location and Area

Trang Cat Site location is shown in Fig.4.4.1. Phase 3 Site is 32.7 ha, and will occupy the southern part of the land of 60 ha approved by the Prime Minister.

Phase 3 Site is south of a septage treatment (1B Project) site, and shares a border with 1B project site. A total Trang Cat site use plan is shown in Fig. 4.4.2.

There is a space between a west side dike road and a western border of the area approved by the Prime Minister. According to the Dike Management Office, this space can be partly utilized by HPPC. The Study Team suggests that this space will be used for landfill site. However, there should still be a space left between the dike road and the approved area, in order to avoid the damage on the dike road by the load of embankment and filled waste.

(2) Types of Waste to be Accepted

The Phase 3 site will accept a) non-hazardous solid waste collected by URENCO excluding industrial waste, and b) hospital waste incineration residue and leachate treatment sludge. There will be two landfill fields in the Phase 3 site. One (approximately 27 ha) of them will receive the former waste, and the other field (approximately 2 ha) will receive the latter.

There are no disposal plan for sludge from water supply treatment facility and sewage treatment facility, and the residue from restoration work of drainage system. The landfill site for non-hazardous waste will be able to accept these wastes in future. However, there should be strict requirements on the acceptance. The generators should obey the following requirements:

- Water content of waste should be less than 60 %
- Generators should obey the landfill site manager's direction
- Generators should not transport their waste during the period of maintenance work and dike improvement
- Generators should prepare the storage yards for their waste by themselves, and a storage capacity should be more than the amount of two days generation
- Good soil-like materials might be used as cover material, but careful inspection is necessary

(3) Incoming Waste Quantity

Incoming waste quantity is estimated in the next table. The target waste will be generated from 3 urban districts and surrounding areas that will be served by URENCO.

(4) Topographic Conditions

The altitude of area is 2.3 – 2.6 m. The area is very flat and used as aquatic plant ponds. There are two existing dikes.

The east side dike was improved and has height of 5m. This is a national dike and has sufficient height against the high tide.

The west side dike was formerly national dike, but it is a local dike now under the control of "Dike Management Office". This dike is used as a road. But it does not have sufficient width for two-way traffic of vehicles. Therefore, improvement of this dike road is necessary. There is a water pipeline along the road and the south side of existing landfill site.

(5) Geological and Hydro-geological Conditions

There are 4 or 5 strata in the soil of first 30 m in this area. Surface stratum is soil arranged for dike or natural mud. The second stratum is clay of more than 7 m thickness, which has low permeability of 10^{-6} - 10^{-7} cm/s. The third layer contains sands. The forth stratum is also clay. The second layer can serve as natural clay liner for waste landfill site.

These clays are very young and not consolidated well. Therefore, there will be a settlement under the load of embankments and filled waste body. Based on the data of geological survey, total settlement would be more than 1m.

In order to design the embankments for waste filling fields, it is essential to check a stability of the slope of embankments and filled waste.

The Joint Circular requires that ground for waste filling fields should have enough strength of more than 1kg/cm^2. Therefore, reinforcement and improvement of ground soil has been included in the plan.

(6) Other Conditions

For the evaluation of ground condition and stability of filled waste body, it is assumed that bulk density if waste would be 0.8 ton/m^3 after compaction in the landfill site.

4.1.3 Landfill Capacity and Use Period

(1) Planned Conditions are as Follows:

- Lifetime of operation is about 10 years
- Start of operation (receiving solid waste) the beginning of 2005
- Density of the hospital waste incineration residue 1.0 ton/m^3

(2) Amount of Non-hazardous Waste to be Generated during the Period of 2005 - 2014

Total amount of the waste, which will be in the period of 2005-2014, is estimated to be 2,607,305 ton, which is equivalent to 3,259, 132 m^3 as calculated below.

2,607,305[ton] / 0.8[ton/m^3] = 3,259,132 [m^3]

(3) Amount of the Residue from Hospital Waste Incinerator

The capacity of hospital waste incinerator, which is planned by the Study Team, is 1.5 ton/day, and the residue generation rate is 0.5 ton/day.

The yearly amount of residue from hospital waste incinerator is calculated by next equation.

0.5[ton/day] x 365[days/year] = 182.5 [ton/year]

Therefore, the volume of hazardous solid waste is calculated by next equation.

182.5[ton/year] / 1.0[ton/m^3] = 182.5 [m^3/year]

Total amount of the residue is calculated by next equation.

182.5 [m^3/year] x 10[years] = 1,825 [m^3]

(4) Amount of the Sludge from Leachate Treatment Facility

The capacity of leachate treatment facility is 960 m^3/d in this plan. During the removal process of pollutants, most of solid matters and compounds of lime will be precipitated. Assuming removal ratio of 0.5 % of leachate in weight, sludge amount will be 4.8 t/d. Bulk density of sludge is 0.9 - 1.2, and it contains much water. Therefore, volume of sludge will be 4.0 - 5.3 m^3/day.

The sludge is very soft and weak. There should be careful management for filling work, in order to avoid the collapse. Sludge contains much organic matters. Therefore, it is too dangerous to fill the sludge into the normal waste, and it is essential to cover daily for preventing odor and vermin.

It is highly recommended and planned that sludge will be filled in the landfill field for hospital waste incineration residue.

Note:

As shown in Section 4.2.1, it is planned that there will be the following two landfill fields in Trang Cat Phase 3 Landfill Site.

a. Filling field for non-hazardous solid waste (NHSW)

b. Filling field for hospital waste incineration residue (HWIR)

As result of designing each field according to Section 4.2, the final capacity of each field designed is estimated as follows:

a. NHSW: 2,539,093 ton b. HWIR: 36,567 ton

Aggregate capacity of the two fields is 2,575,660 ton, which is slightly less than 2,607,305 ton, estimated waste receiving amount during 10 years from the beginning of 2005 till the end of 2014.

Planned Waste Quantity Received at Trang Cat Phase 3 and 4 Landfill Sites

Year	Annul Collection Exclude Industrial Waste (ton/year)	Cumulative Disposal Quantity at Year End (ton)
2000	120,395	0
2001	125,305	0
2002	129,837	0
2003	146,548	0
2004	152,679	0
2005	196,083	196,083
2006	216,955	413,038
2007	232,402	645,440
2008	246,767	892,207
2009	260,476	1,152,683
2010	275,582	1,428,266
2011	283,092	1,711,358
2012	291,521	2,002,879
2013	298,400	2,301,279
2014	306,027	2,607,305
2015	313,657	2,920,962
2016	322,618	3,243,581
2017	329,955	3,573,536
2018	338,314	3,911,850
2019	346,815	4,258,665
2020	356,435	4,615,100

Note: It is planned that Phase 3 landfill site will be full at the end of 2014. Thereafter, Phase 4 landfill site will receive solid waste.

4.2 Facility Plan and Design

4.2.1 Outline

(1) Main Facilities

The landfill site has the following facilities:

- Filling field for non-hazardous solid waste (NHSW)
- Filling field for hospital waste incineration residue (HWIR)
- Leachate treatment facility
- Site management office and isolation facility
- Workshop for the equipment maintenance and repair

Haiphong city has not practiced daily cover in their landfill sites. However, the daily cover is a very important condition for sanitary landfill. It is highly recommended that a daily cover for HWIR and a weekly cover for NHSW in the first stage. Frequency of cover for NHSW will be upgraded step-by-step.

In order to carry out daily cover at the HWIR filling field and avoid the complicated filling works of two kind of wastes at same area, two separate filling fields system will be applied.

(2) Land use Plan

For the effective land use, the planned site will use a space between the west side dike road and the approved area. In this case, an area of NHSW landfill site is 27.5 ha.

(3) Equipment and Staffing

The site has also the following equipment and human resources:

- Working vehicles for filling of waste and cover soil
- Pumps and pipeline for discharge of treated water
- Workers for filling works
- Facility operation staffs
- Site management staffs

(4) Non-hazardous Solid Waste (NHSW) Filling Field

The NHSW filling field has the following system:

- Area: 27.5 ha
- Total capacity for waste 3.17×10^6 m^3
- Embankments (5 layers) 365.5×10^3 m^3
- Height 17m (5m + 3m + 3m + 3m + 3m)
- Artificial Liner (1.5 mm thick)
- Leachate collection system
- Leachate re-circulation system
- Gas collection system
- Cover (weekly)

(5) Hospital Waste Incineration Residue (HWIR) Filling Field

The HWIR landfill site has almost same system as NHSW site. Major differences are as follows. Hospital waste incineration facility will be renewed at same place. It is convenient that the incineration residue landfill site will be operated for long time near the incinerator at Trang Cat area. It is possible to reduce the risk of ash dispersion through transportation, because of shorter distance for transport:

- Area: 2 ha
- Height: 3 m
- Embankments (1 layers)

This filling field will also accept the sludge from leachate treatment facility.

In this case, total volume of filled waste is 5m^3/d.

Basic description of the landfill sites

	Non-hazardous Waste	Hospital Waste Incineration Residue	Total
a. Area (ha)	27.5	2	29.5
b. Capacity for Filling (m^3) 1)	3,526,518	43,020	3,569,538
c. Volume of Embankment (m^3)	365,537 (209,367m^3 for 2nd-5th layer)	11,796	377,333
d. Cover Soil and Section Dikes (m^3)	352,652 (10 % of item b.)	6,453 (15 % of item b.)	359,105
e. Capacity for Waste (m^3) = b – d	3,173,866	35,567	3,209,433
f. Acceptable Waste (ton)	2,539,093 2)	35,567	2,574,660
g. Operation Period	9.77 years from the beginning of 2005	20.04 years from the beginning of 2005	-

1) "Capacity for filling" calculation is based on the design shown at Figure 6.3.1.

2) Tonnage of waste is calculated with unit density of 0.8 ton/m^3

4.2.2 Embankments

For getting a larger capacity efficiently for waste filling, a landfill site needs higher filling layers and a steep wall.

In order to keep the filled waste layer stable, the embankment should have adequate strength and stable shape. The slope of embankment and dyke is 1:2 outside, and 1:1.5 inside.

There will be 5 layers of waste and each layer need embankment and dykes.

1st layer: 5m height and 5m width at the top

2nd layer: 3m height and 3m width at the top

3rd -5th layer: same as 2nd layer

Every catwalk has a 2 m width.

Stability analysis for a final shape with 17 m height shows that a safety factor is 1.5. It is small but this result is based on the assumption that all construction works will be completed at once. Actually, however, the second layer dike will be constructed 4 years later. The ground soil will be consolidated by the weight of a first layer dike and waste body actually. Therefore, the slope of total dikes must be safer than the estimate in future.

The JICA study team has already surveyed the soil material company site in Phu Luu, An Lao district. There is a sufficient amount of soil. There is another soil material company near Trang Cat area can supply the clay. Therefore, it is capable to construct the strong dikes with soil materials from Phu Luu and clay liner on the inside of the dike.

4.2.3 Reinforcement and Improvement of Ground for Filling Fields

(1) Legal Requirement

The Joint Circular requires that the bearing capacity of the waste filling fields (landfill) should be equal to or exceed 1kg/cm^2. Because the surface soil and mud is very thin in this area, the stratum 1 should satisfy this figure.

However, it is less than 1kg/cm^2 at some selected points of the stratum 1 on the planned site according to the geological survey carried out by the Study Team. Therefore, the Study Team designed a soil reinforcement measure to increase the bearing capacity of ground in full area. There are several measures for the reinforcement and improvement:

- Surcharge with sand bed drainage
- Surcharge with sand pile drainage or paper drainage
- Well point method

The first method has the lowest cost. The others cost several times more than the first one. Therefore, the surcharge with sand bed drainage method is recommended.

(2) Conditions for Surcharge

For designing of the surcharge, the following basic conditions were considered:

- Bearing capacity of the ground surface with the surcharge should exceed 1kg/cm^2 (The geological survey shows that it is 0.82kg/cm^2 for the Stratum 1.)
- Site construction period will be 2 years starting from the beginning of 2004. A part of the site will start receiving solid waste in the beginning of 2005
- Considering applicable surcharge procedure mentioned below and the construction period, surcharge period at one segment of the site should be less than one year

In addition, the following technical conditions were assumed:

- Settlement will occur in first 3 clay strata mainly, excluding surface soil and mud
- The groundwater level is same as the top of stratum 1
- For calculation of consolidation of the first 3 clay strata, we used average values of the strata in terms of soil characters shown in Table 4.4.6

(3) Result

Based on the above conditions, calculations were made for 2 cases as to thickness of surcharge soil: 3m, and 4 m as shown in Table 4.4.7. As result, we consider that 4 m thickness of soil would be needed to be on the safe side. A total of 210,000 m^3 (52,500 m^2 x 4 m) of surcharge soil will be required.

With application of the surcharge with 4-m thick soil, the bearing capacity of the ground will increase to 1.0kg/cm^2 in 8 months (see technical note below). At the end of the period, the permeability of ground will decrease to10^{-7} cm/s or less.

Technical note:

If the ground bearing capacity of 1.0kg/cm^2 was attained, the void ratio of stratum 1 would be 0.942, and then the degree of consolidation (Uv) for the stratum 1 would be 32.2% based on the normal consolidation theory. It is then calculated that 238 days (about 8 months) would be required to attain the above Uv for stratum 1.

However, it is recommended that a more detailed geological survey should be carried out for detailed design, as the current data are not adequate. The surcharge soil height and amount may be reduced depending on results of the future survey.

(4) Surcharge Operation Procedure

Surcharge operation will be carried out as follows. Non-hazardous waste filling field will be divided into 4 segments for surcharge. Surcharge will be carried out at one segment at each time. Area of one segment will be 52,500 m^2.

Surcharge at each segment would take about 8 months. In order to remove water from clay and silt strata smoothly, the sand bed should be placed on the top of soil. The surcharge soil will be filled up on the sand bed layer.

Soil and sand used for the surcharge at the first segment will be reused for 3 other segments too in order to minimize soil purchase costs. After completion of the surcharge at all the 4 segments, the soil used for surcharge will finally be used to make upper level embankments of 2^{nd} – 5^{th} ones. Soil needed for the surcharge will be obtained from a soil deposit in An Lao Suburban District.

4.2.4 Liner

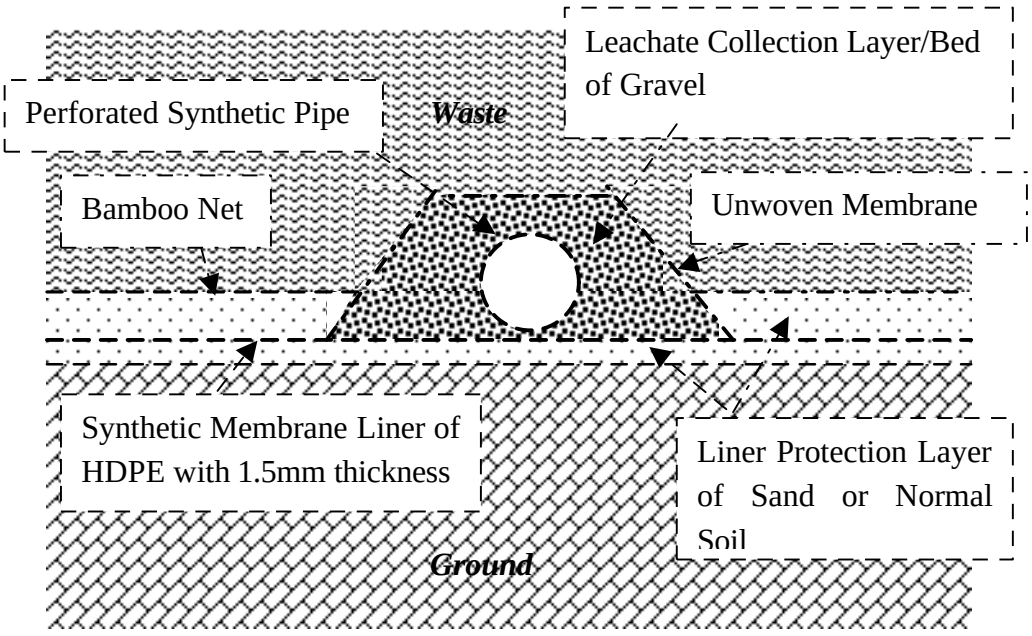
As explained earlier, there are four types of soil stratum in the site area. The third stratum has some sands, and might not prevent the leachate percolation. The second stratum and fourth ones are clay, and have low permeability and thickness, which are adequate for prevention of leachate percolation. Therefore, these clay soil stratums will be used as natural soil liner.

However, the Joint Circular issued by MOSTE and MOC requires the synthetic membrane liner with 1.5mm thickness at least be installed on compacted clay of more than 1m thickness with a permeability of less than 10^{-7} cm/s.

It is estimated that permeability of the site ground with application of synthetic membrane liner will decrease below 10^{-8} cm/s.

For smooth installation of synthetic liner, the ground should be compacted appropriately. There should be both protection layers below and on the synthetic liner. The first protection layer of sand or normal soil with 10 cm thickness will be installed below the synthetic liner, but on the compacted ground, in order to avoid the breakage of liners, and to smooth sheets joint connection work. The second protection layer of 20 cm thickness of sand or soil will be installed on the synthetic liners, in order to protect the synthetic sheets from damages by sharps. The bamboo net will be set on the top of second protection layer to support weight of waste and prevent concentration of stresses. See the figure below.

Design of Liner and Leachate Collection System



The synthetic liners will be also installed at the inner slope of embankments. For the protection of synthetic sheets, sandbags will be put on the synthetic liners.

4.2.5 Leachate Collection System

In order to collect the leachate effectively in a flat place like Trang Cat area, the Ladder type is preferable. We also have to consider the consolidation of clay mud layer of the ground. Total settlement of the ground in long term in this area is estimated to be almost 1m by geological survey reports. It will be difficult to

maintain the collection pipes at original gradient throughout the whole operation period because settlement occurs unevenly at filling area. Therefore, it is preferable to use gravel or broken bricks for leachate collection pipe that is to be installed on the liner protection layer.

Our proposed specification of leachate collection system is as follows:

Basic specifications are as follows:

(i) Basic Structure Perforated Synthetic Pipes + Collection Layer/Bed

(ii) Sizes

- Diameter of Collection Pipes: 0.5 m for main lines & 0.2 m for branch lines
- Thickness of Leachate Collection Layer/Bed: 0.3 - 0.5 m
- Unit space between pipes: 40 m
- A slope of bottom layer is 0.5-1.0 %.

(iii) Materials

Collection Pipes:

- Main pipes: HDPE (High Density Polyethylene) or PVC (Polyvinyl chloride)
- Branch pipes: same as main pipes

Leachate Collection Layer/Beds: gravel of 100 - 200 mm

Liner Protection Layer: to be installed both below and on the synthetic liner. (Bamboo nets will be put on the top of the layer. Sand bags will be used instead of bamboo nets on the inner wall side of embankments.)

Unwoven Membrane will be used as filter for prevention of soil particles invasion into collection beds.

Design of leachate collection system in cross-section is shown in the figure on previous page.

4.2.6 Leachate Treatment System

The JICA Study Team carried out the leachate and groundwater analysis survey at existing Trang Cat landfill area. The survey result shows that collected leachate contains much organic matters in terms of BOD and COD. However, the figures of these indicators are less than 2000 mg/L and are not high enough for anaerobic digestion process.

There would not be big change of quality of leachate in near future. Therefore, we plan the leachate treatment facility based on the result.

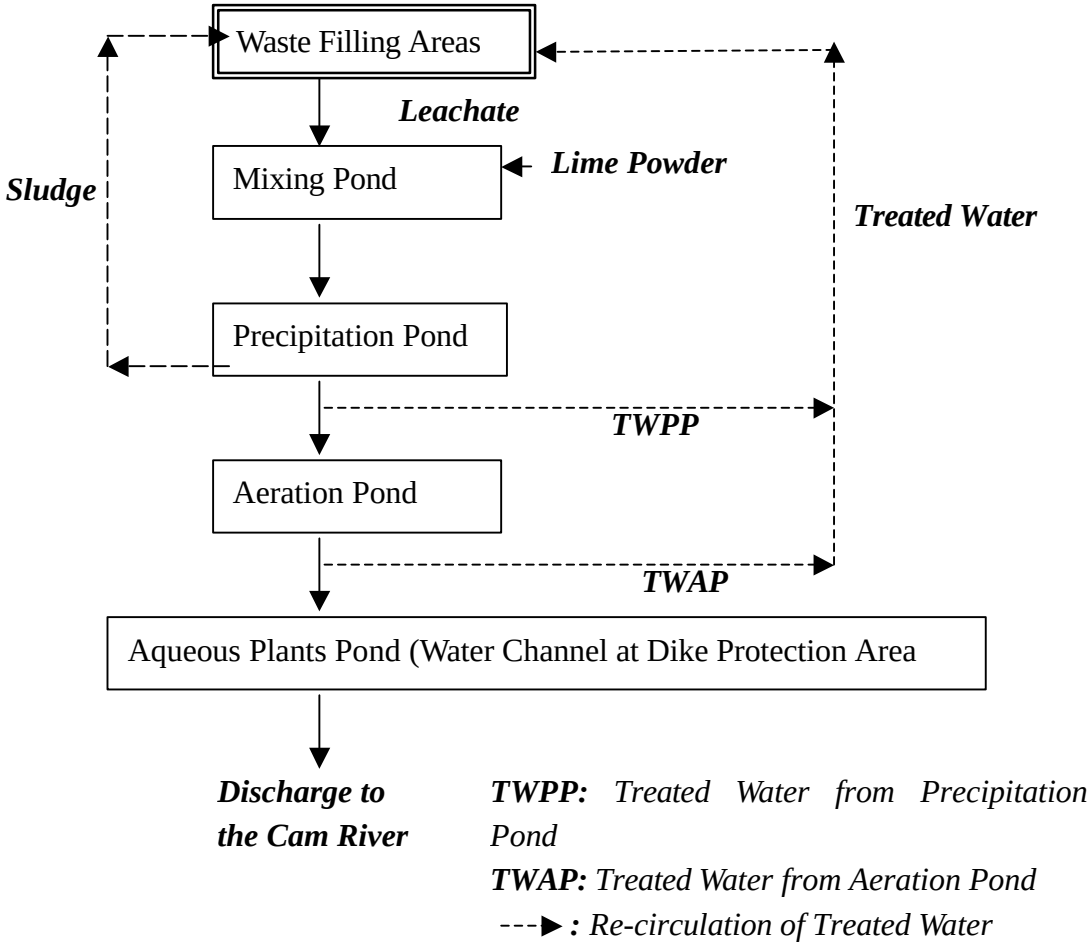
(1) Processes

The process shown in next page is recommended.

The re-circulation of treated water from aeration pond and precipitation pond into the filled waste body is recommended.

Precipitation process with lime powder can remove the pollutants from leachate. However, Treated Water from Precipitation Pond (TWPP) shows high pH (alkaline) in general and cannot be discharged without neutralization.

Therefore, aeration process is necessary after the precipitation. By this aeration, carbon dioxide in the air will be absorbed and then neutralization is processed. If the neutralization will not be promoted, add the acids like acetic acids, hydrochloride, and so on.



(2) Source of Leachate

There are two filling fields in the site. The leachate treatment facility will receive leachate from two filling fields.

The leachate from hospital waste incineration residue filling field will contain less organic matters and more heavy metals than those from Non Hazardous Solid Waste (NHSW) filling field. Therefore, precipitation process with an aid of lime powder is recommended for proper treatment. This process can also remove the organic matters in the leachate generated in the NHSW field.

(3) Capacity of Treatment Ponds

1) Assumption of Calculation

(a) In-Site Storage of Percolated Water

In rainy season, the site will be able to store the rainfall and percolated water for 3 days.

(b) Rate of Percolation of Rainfall

Covered area: 0.5 Uncovered area: 1.0

(c) Maximum Uncovered Rate

The Non-hazardous Solid Waste (NHSW) filling area will be divided into two major parts. Therefore, the maximum uncovered rate is 50 %. In that time, rainfall in covered area will be collected by the surface drainage and discharged into the river without treatment.

2) Maximum amount of Percolation

(a) Comprehensive Percolation Rate in full Area

$(0.5 \times 0.5) + (1.0 \times 0.5) = 0.75$

(b) Annual amount of Percolated Water

Because of the area of 50 ha and rainfall of 1800 mm/y, the total amount of percolated water is;

$0.75 \times 1800 / 10^3 \times 50 \times 10^4 = 675 \times 10^3$ m^3/y

For the references, the table of leachate at in-situ storage will be estimated.

$675 \times 10^3 / (50 \times 10^4 \times 1/2 \times 0.5) = 5.4 > 5.0$ m (height of dyke)

This means that height of table of leachate will be 2.7 m, if the site would store the rainfall for a year by the half of filling area with a porosity of 0.5.

(c) Averaged Daily amount of Percolated Water

Because there are 365 days in a year, daily averaged amount is;

$675 \times 10^3 / 365 = 1850$ m^3/d

Therefore, hourly rate is;

$1850 / 24 = 77$ m^3/h

3) Quantity of Leachate Treatment

80 m^3/h will be applied.

Necessary capacity for leachate treatment process is shown as follows.

Retention Pond: 6400m^3 (40 m x 80 m x 2 m)

The filling area, which will not be filled yet at the operation period, will be used as a retention pond in the case of heavy rainfall.

Flocculation & Precipitation Ponds: 40 m^3 (4 m x 4 m x 2.5 m) x 4
Aeration Pond: 2400 m^3 (40 m x 40 m x 1.5 m)

(4) Discharge of Treated Water

Treated water will be discharged directly from the site to the Com River through the water gate.

Treated water will be discharged into the Cam River.

According to the city development master plan, Cam River between main land and Dinh Vu Island will be closed as a lake or pond. If this happens, this discharge point will have to be moved in order to prevent the eutrophication and another pollution in a newly formed lake.

(5) Leachate re-circulation System

In order to promote the degradation of filled waste and minimize the space for leachate retention pond, collected leachate will be re-circulated into the waste body by the pump or tank vehicle.

(6) Sludge Disposal at Hospital Waste Incineration Residue Filling Field

Sludge will be generated from the leachate treatment facility everyday. The sludge should be disposed at an isolated place, because it contains some hazardous substances and has fluidity and softness.

There are two options for sludge disposal places, NHSW field and HWIR field. However, a co-disposal of sludge and NHSW at same place may cause a risk of collapse of filled body. In this case, it is very difficult to maintain a filling place properly and safe, because sludge has not enough strength to support another waste. But a co-disposal of sludge and incineration residue is easy to maintain filling field properly, because the amount of waste is small and a speed of filling is slow. There is enough time for sludge to be dewatered at the field and turn to be stronger. Therefore, the sludge disposal at incineration residue landfill field is highly recommended.

4.2.7 Gas Collection System

We plan to install gas ventilation pipes (in vertical) and gas collection bed of gravel or broken bricks (in lateral). For the promotion of degradation of waste and prevention of casual fires, we recommend the following system:

- A vertical pipe in every square of 40 m x 40 m
- Lateral gas collection beds at the top of every layer of waste

4.2.8 Access road and On-site Road

(1) Access Road

There is a dike road at the western side of area approved by Prime Minister. This road will be used as the access road for Phase 3 site.

This road will be improved for SADCO's 1B project (sewage sludge treatment) and URENCO's Phase 2 landfill site. However, these improvements will not reach the Phase 3 site. Therefore, the further improvement work is needed.

(2) On-site Road

In order to smoothen the traffic of waste transport vehicles, there should be on site road with sufficient strength and good surface. This road is temporary facility. Soil material should be recovered from the road after the out of use. The requirements for on-site road are as follows.

- Width: 5 m
- Slope of road 1:3.0 at least, 1:3.5 is recommended
- Vehicle exchange space one at least

4.2.9 Environmental Monitoring Facility

For the environmental monitoring, some facilities and equipment are necessary.

(1) Groundwater Pollution

3 units of background wells should be provided for water sampling.

The JICA Study Team carried out the geological survey at the Trang Cat area. For the survey, the Study Team installed two wells. These wells should be preserved and used to collect water samples. In addition to these two wells, one more well should be provided.

(2) Leachate Treatment Quality

For the inspection of treated water quality, the aeration pond should have an access step. Other ponds also should have steps for daily operation monitoring. See Section 4.3.4 for details.

4.2.10 Other Facilities

(1) Office

There should be rooms for management staffs, a rest room, a shower room and room for guards. The office should be close to the entrance gate, and have a weight-bridge control room in front of weigh-bridge.

(2) Weigh-bridge

In order to accurately measure the weight of incoming waste, an electric weighbridge will be installed.

(3) Fences

Fence of 2 m heights will be installed on the border of site, in order to isolate the site and control the illegal entry. The fence will also protect the scattering of waste.

(4) Fire Fighting Equipment

There should be a water storage tank, pumps and other fire fighting equipment.

(5) Storage Yard for Cover Soil

For the proper cover works, a storage yard for soil should be provided. The area, which is not filled with waste, can be used as storage yard.

4.2.11 Heavy Equipment

In order to carry out the effective and sanitary filling works, the following heavy vehicles are necessary.

Heavy Vehicles for Filling Works

Equipment	Function and Role	Requirements
Bulldozer (Crawler dozer) (3 units)	To spread and compact waste unloaded from collection vehicles. To construct the embankments of 2^{nd} – 5^{th} layer.	15 ton weight
Crawler Front Loader (2 units)	To load cover soil from storage yard to dump trucks. To construct the embankments of 2^{nd} – 5^{th} layer.	Bucket of $1m^3$
Backhoe (1 unit)	To construct the dike and arrange the shape and surface. To excavate soil and waste for installation of gas collection system and so on.	Shovel of $0.6m^3$
Water Tank Truck (1 unit)	To pour water on the filled area, for prevention of dust dispersion in dry season.	Tank of $4m^3$
Vacuum Tank Truck (1 unit)	To pour treated water/leachate on the waste body for re-circulation.	

4.3 Landfill Operation and Management

4.3.1 Landfill Work Plan and Record Keeping

There should be a weekly filling work plan, because the cover work will be carried out weekly at the Phase 3 site. This plan should cover the following aspects:

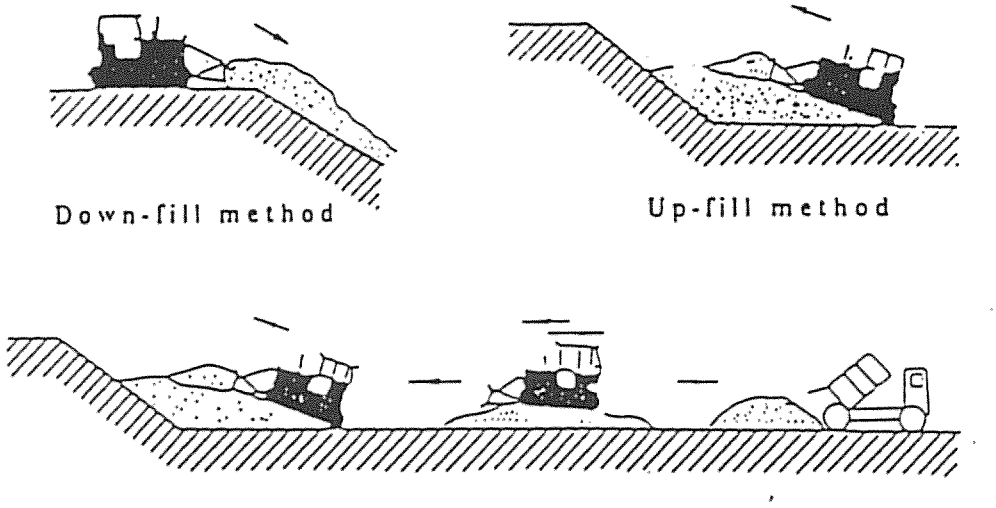
- Location of filling area
- Location of section dike
- Amount of soil to be used as cover
- Location of the area to be filled in next week

4.3.2 Landfill Method

Daily cover should be applied for HWIR landfill, and weekly cover, at least, for NHSW.

(1) Filling Work

Effective filling work plan/strategy must be established at first. "Push-up" method is recommended.



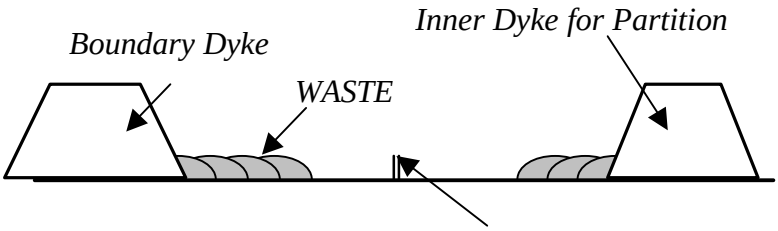
"Push Up" Method

Two bulldozers of 15 will be used. Daily cover is recommended. A ratio of cover soil to filled waste will be 10 cm / 1 m - 10 cm / 1.5 m of thickness. According to URENCO, cover soil material is available from Kien An District.

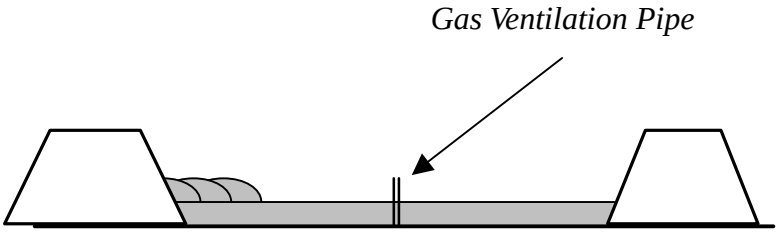
(2) Harmonization of Filling Work and Gas Collection/Ventilation

The gas collection system comprises of gas collection beds and vertical ventilation. A gas collection bed is a layer of gravel. It is preferable to install a perforated synthetic pipe. Vertical ventilation system is a perforated pipe with gravel placed around it.

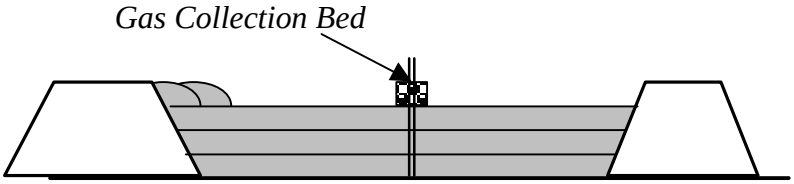
Gas collection beds will be installed at every level of dikes heads. The beds will be located within a space of 40 m at the top of every filling layer. The beds will be made perpendicular to the previous layer's bed as shown in Step 5 in the following figure.



Step 1: *Waste will be filled by the "Cell Methods", from the edge of filling area toward the center.*

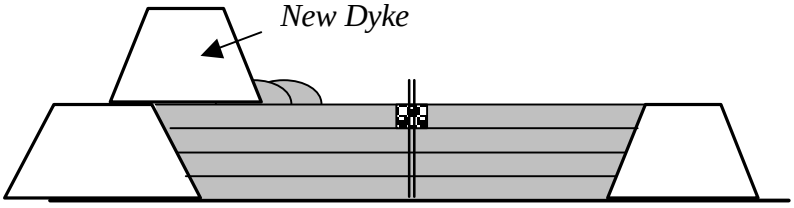


Step 2: *After the completion of 1st layer filling of waste, 2nd waste layer filling will be carried out in the same way as step1. Gas ventilation pipe will be also extended.*

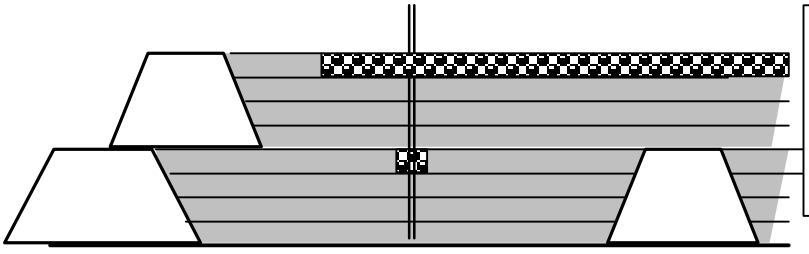


Step 3: *After the completion of waste filling in several layers, gas collection bed will be installed.*

The waste will be filled to the head of 2nd level dyke at the same way as ***Step 1 - 3****.*



Step 4: *When a height of waste will reach at dyke's head, 2nd level dyke should be constructed.*

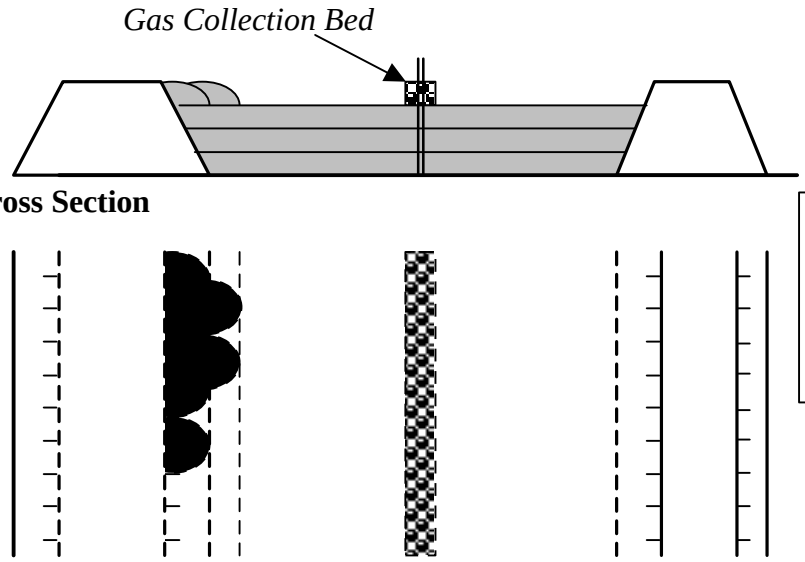


Step 5: *When a height of waste reaches 2nd level dyke's head, gas collection bed will be installed.*

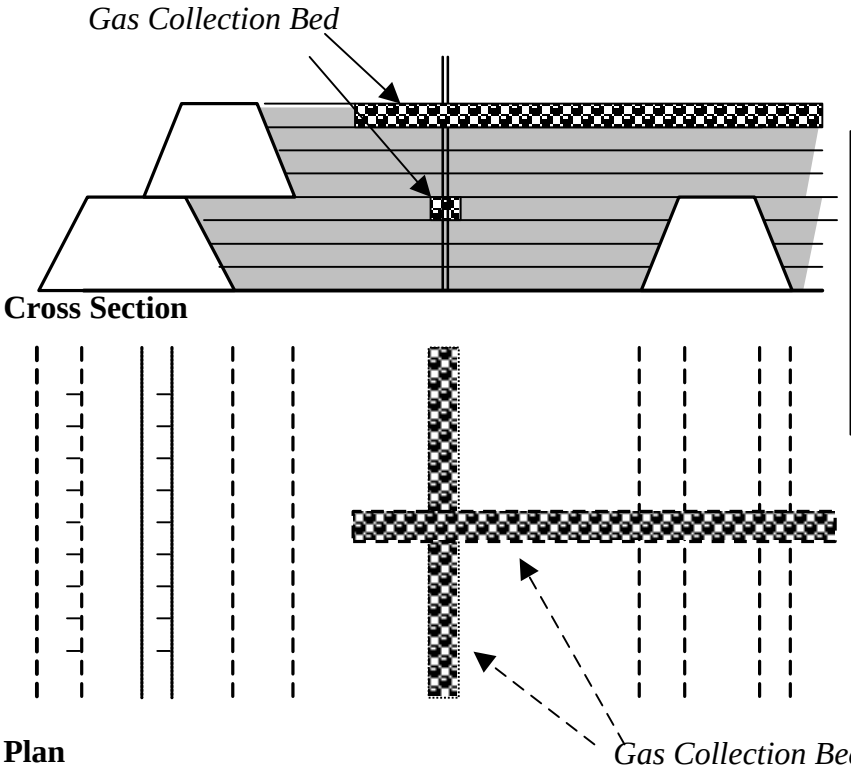
Note: Figures above are not shown in correct scale and shape.

Appropriate Process of Waste Filling Works Shown in Cross-section

Cross Sections & Plans for Several Steps of Filling Works



Step 3: *After the completion of waste filling in several layers, gas collection bed will be installed.*



Step 5: *When a height of waste reaches 2nd level dyke's head, gas collection bed will be installed perpendicular to the first layer gas collection bed.*

Appropriate Process of Waste Filling Works Shown in Plan

4.3.3 Operation of Major Facilities

(1) Leachate Collection and Treatment

In order to treat the leachate adequately, there should be adequate monitoring/inspection work and capable operators. There should be one person who has knowledge of chemistry at least. URENCO has already several mechanical engineers, and some of them will work for operation of the leachate treatment facility and maintenance of heavy equipment.

1) Daily Monitoring/Inspection

The operators should inspect the flow rate of collected leachate and check the collection pipes on the surface. A height of water table of leachate in the filling area should be measured occasionally.

The operators should check the following basic parameters of leachate and effluent by themselves:

- pH
- Electric conductivity
- Color

2) Periodical Inspection

Manager should order an external institute to analyze the leachate and discharge water periodically. Quarterly inspection is recommended. However, yearly inspection is sufficient for the first 3years.

3) Precipitation with Lime Addition

Haiphong area is very rich with lime stone. It is very easy to procure the lime powder at low cost. There are two types of lime powder, quick lime powder (CaO) and normal lime powder ($CaCO_3$). Quick lime powder should be used as a promoter of precipitation.

Lime powder sold at road markets is made by cracking natural limestone, and is a mixture of quick lime powder and normal one. Quick lime is very easy to be aged by chemical reaction with carbon dioxide (CO_2) in air. $CaCO_3$ does not act as a promoter of precipitation in water and it is insoluble in water. If quick lime powder was aged, and turned into normal lime powder, it should be baked for making it into quick lime power. It is easy to do so.

(2) Gas Control and Fire Control

Landfill gas contains flammable gas like methane and bad smell gas like hydrosulphide, and so on.

Special care is necessary to avoid methane gas explosion. Smoking or other works that use fires are strictly prohibited near the gas collection pipes.

(3) Liners Installation

The Phase 3 landfill site is so designed that the first embankment layer will be constructed during the initial site construction, but 2^{nd} – 5^{th} embankment layers will be constructed after commencement of the landfill operation according to the progress of waste filling. The synthetic membrane liners for the first embankment layer will be installed during the initial construction, but they should be installed at the inner slope of 2^{nd} –5^{th} layer embankments upon construction of these embankments.

4.3.4 Environmental Monitoring Plan

Monitoring plan for Phase 3 site is as follows. There are two types of monitoring:

- Inspection by external organization
- Self monitoring by URENCO

(1) Inspection by External Organization

Frequency once a year for the first 3 years, and quarterly thereafter.
Indicators Items shown in water quality control regulation

(2) Self-monitoring by URENCO

1) Daily Monitoring
   - pH, Temperature, EC(Electric Conductivity), Colour, Smell at each pond and discharge point (3 times a day)
   - Flow rate of discharge, Water table height at each pond (daily)
   - Consumption rate of lime (total amount in a day) (daily)
   - Generation rate of sludge (total amount in a day) (daily)

2) Weekly Monitoring
   - Filled waste amount in a week at both filling fields
   - Checking drains at cat walks
   - Checking the surface of cover and embankments (cracks, erosion, etc.)

3) Monthly Monitoring
   - Height of top of filled waste and covered area (Settlement)

(3) Equipment for Self-monitoring by URENCO

The equipment needed for on-site monitoring is as follows:

1) For Leachate Quality and Quantity Measurement
   - Potable pH meter, Thermometer, EC (Electric Conductivity) meter, Grass cylinder tube
   - Buckets, Stop-watch
2) For Landfill Gas Measurement
   - Potable gas detector, Test paper for pH, Test tubes

4.3.5 Organizational Arrangement (Staffing and Training)

(1) Staffing Plan

For the appropriate management of Phase 3 site, required staffing is as follows.

Staffs for Trang Cat Landfill site (Phase 3) management

Title	Content of Work	Numbers
Manager	To manage the site. To attend the meetings related to Trang Cat area as the representative of site.	1
Deputy Manager	To assist the manager. It is preferable that one has knowledge of engineering or science at least.	2
Secretary	To carry out the business related the management.	1
Chief Engineer	To manage the site from the engineering aspect, and instruct the operators. To make the filling work plans. To carry out on-site monitoring	1
Truck Scale Engineer	To operate and maintain the electric scale system.	1
Truck Scale Operator	To record the weight of incoming waste.	3 (1 x 3 shifts)
Leachate Control Engineer	To manage the leachate treatment facility and instruct the operators.	1
Chief Landfill Operator	To instruct the operators in collaboration with chief engineer.	2 (1 x 2 shifts)
Equipment Operator	To operate the heavy vehicles for landfilling work. To operate the leachate treatment facility	15 (3 x 4 shifts) (1 x 3 shifts)

(2) Training

In principle, most of staffs working at existing landfill site will continue working after the training. A chemical engineer or skilled waste treatment facility operator should be recruited in 2005. If there is no appropriate person, a skilled engineer who works at water treatment facility of the water supply company may be acceptable.

It is preferable for filling operators to have training by a skilled operator from oversea countries. The training period will be more than 3 months. 6 months would be sufficient for the training. During the operation of bulldozers, an operator could easily damage such facilities as gas collection pipes, joint works of new pipes for extensions, installations of gas collection beds and re-circulation

bed for leachate. The training should include careful bulldozer operation near these facilities.

4.3.6 Post-closure Management

After the final acceptance of waste, the filled area should be covered by normal soil, clay is preferable for cover soil to prevent a percolation of rainfall into the waste body. There should be a settlement of the waste body. It will cause the cracks on the cover because of large settlement, and the cracks will become larger by erosion of rainfall. Therefore, periodical maintenance and checking is necessary. It is common that aftercare works will be carried out several years after a first final cover.

There should be vegetation on the surface of final cover. It is essential to plant small trees on the final cover that should be thicker than 1 m. Sometimes, vegetation will be a good indicator for gas leakage through cracks of cover soil and affection on the flora.

4.4 Cost Estimation

4.4.1 Procurement and Operation Costs (include Unit Cost)

(1) Investment Cost

Total investment cost for Trang Cat (Phase 3) landfill site is summarized in the following table.

Investment Cost for Trang Cat (Phase 3) landfill site (US$ in 2000 Price)

	Non-hazardous Waste Filling Field and Leachate Treatment Facility	Hospital Waste Incineration Residue Filling Field	Total
(1) Construction Works	6,121,040	477,430	6,598,470
(2) Procurement of heavy equipment	1,411,800	0	1,411,800
(3) Land Acquisition & Compensation	601,680	0	601,680
(4) Engineering Services	682,694	47,743	730,437
Sub total	8,817,214	525,173	9,342,387
(5) Administration Cost (3 % of the above costs)	264,516	15,755	280,272
(6) Physical Contingency (10 % of the above costs)	908,173	54,093	962,266
(7) Total Cost (US$)	9,989,903	595,021	10,584,924
(8) Total waste received	2,539,093 ton (filled in 9.77 years)	36,567 ton (filled in 20.04 years)	2,575,660 ton
(9) Unit Cost per Tonnage of Filled Waste = (7)/(8) (US$/ton)	3.93 (US$5.73/ton including operation and maintenance cost)	16.27* (US$18.21/ton including operation and maintenance cost)	4.11 (US$5.91/ton including operation and maintenance cost)

* Unit cost for original hospital waste is estimated to be one third of the above cost as the hospital waste incineration residue amount is about one third of the original hospital waste amount.

(2) Operation and Maintenance Cost

Total operation and maintenance cost is summarized at next table.

Operation and Maintenance Cost for Trang Cat (Phase 3) Landfill Site (US$ in 2000 Price)

	Non-hazardous Waste Filling Field & Leachate Treatment Facility (Operation period: 9.77 years)	Hospital Waste Incineration Residue Filling Field (Operation period: 20.04 years)	Total
(1) Total Cost during whole operation period	US$4,577,458	US$70,820	US$4,648,278
(2) Annual average cost	US$468,522/year	US$3,535/year	US$472,057/year
(3) Total amount of waste received	2,539,093 ton	36,567 ton	2,575,660 ton
(4) Unit OM Cost per ton of waste (US$/ton)	US$1.80/ton	US$1.94/ton	US$1.80/ton

* Unit cost for original hospital waste is estimated to be one third of the above cost as the hospital waste incineration residue amount is about one third of the original hospital waste amount.

(3) Total Unit Cost (including Investment & O/M)

Total unit cost is summarized at next table.

Unit Cost for Trang Cat (Phase 3) landfill site Unit: (US$/ton)

	Non-hazardous Waste Filling Field and Leachate Treatment Facility	Hospital Waste Incineration Residue Filling Field*	Grand Average
(1) Investment	3.93	16.27	4.11
(2) Operation & Maintenance	1.80	1.94	1.80
(3) Total Unit Cost	5.73	18.21	5.91

* Unit cost for original hospital waste is estimated to be one third of the above cost as the hospital waste incineration residue amount is about one third of the original hospital waste amount.

4.4.2 Major Assumptions Used for Cost Estimation

The following assumptions are applied for cost estimation:

- Priority project excludes the construction works for 2nd - 5th layer dikes. But total construction cost was taken into account, in order to evaluate the cost evaluation
- NHSW filling field will be used for about 10 years, but leachate will be generated after closure of NHSW field. HWIR field will be used until the end of a year of 2020. In order to calculate "Operation & Maintenance Cost", leachate treatment facility will be operated until the end of a year of 2020. Unit Cost of O&M for leachate treatment is calculated for amount of NHSW only, for simplification
- Staffs' salary is based on the discussion with URENCO

CHAPTER 5 HOSPITAL WASTE MANAGEMENT PLAN

5.1 Planning Objective, Policy and Design Conditions

5.1.1 Objectives

Safe collection and disposal of infectious waste out of solid waste generated from hospitals in order to avoid risk of infectious diseases such as AIDS/HIV, hepatitis B, etc. is an objective of this plan.

Final purpose is to secure safe work condition for waste collectors of URENCO and then to prevent prevalence of infectious diseases among URENCO's workers, their families, their neighbours and so on. It can contribute to all the Haiphong citizens to avoid the risk of infectious diseases.

5.1.2 Planning Policy

The following three policies are emphasized in this plan:

- Cost effectiveness
- Compliance with Vietnamese Laws and Regulation
- Locally Manageable Technology

5.1.3 Planning Conditions

(1) Responsible Organizations

1) URENCO

URENCO is a main actor of hospital waste management. It should be a collector of the infectious waste as well as an operator of the incinerator. A centralized incinerator of hospital waste is proposed in the plan. URENCO is a most suitable entity which operates the incinerator because of its manpower and scale of organization. In a centralized system, URENCO collects the infectious waste from hospitals in Kien An and Do Son as well as those in three urban districts.

2) Hospitals and Medical Centers

Hospitals and medical centers are the generators of the hospital waste and are primarily responsible for hospital waste management. The National Regulation on Hospital Waste Management, issued by the Ministry of Health in 1999, requires the health-care facilities to manage hospital waste properly in its article 3 and also requires them to build or upgrade, operate and maintain the waste treatment facilities. It allows them to contract out the

waste collection, transportation, treatment and disposal to the other environmental service entities.

3) Department of Health

Department of Health is responsible to administer hospitals and medical centers under its control. 6 hospitals out of 9 hospitals in Haiphong are under the Department of Health. The National Regulation on Hospital Waste Management stipulates that the Department of Health is responsible for monitoring and inspection of implementation of the proper hospital waste management.

4) Other Ministries

Ministry of Defense, Ministry of Labor, War-invalid and Social Affairs, and Ministry of Communication and Transport have their hospitals in Haiphong. In case of these hospitals, these ministries should provide financial support to the hospitals to develop the hospital waste management system.

(2) Beneficiaries

There are 9 hospitals, 13 district medical centers and 4 specialized medical centers in Haiphong. Hospitals and medical centers subject to this plan are the following, as is shown in the table below:

- 9 hospitals (= all hospitals in Haiphong)
- 5 district medical centers (= in the three central districts, Kien An and Do Son)
- 4 specialized medical centers

Total number of beds subjected to the plan is 2,765 beds out of 3,730 beds in total. This accounts for 74 % of the total number of beds.

Hospitals and Medical Centers to be subjected

No.	Type	Name	Meaning in English	Location	Beds
1	HL	Quan y vien 7	Army Hospital No. 7	Hon Bang	70
2	HL	Phu San	Obstetrics	Hon Bang	350
3	HL	Hoc Co Truyen	Traditional	Le Chan	200
4	HL	Viet Tiep	Viet-Czech	Le Chan	700
5	HL	Giao thong Van Tai mien Duyen Hai	Communication and Transportation Industry	Ngo Quyen	75
6	HL	Tam Than	Psychiatrics	Ngo Quyen	200
7	HL	Kien An		Kien An	300
8	HL	Lao	Tuberculosis	Kien An	200
9	HL	Tre Em	Pediatrics	Kien An	300
10	MC	Ching Hinh Va Phuc Hoi	Orthopedics	Kien An	80
11	MC	Kien An		Kien An	30
12	MC	Hong Bang		Hon Bang	50
13	MC	Cap Cuu	Emergency	Le Chan	0
14	MC	Le Chan		Le Chan	50
15	MC	Mat	Ophthalmology	Le Chan	0
16	MC	Da Lieu TP	Skin and Venereal Disease	Ngo Quyen	0
17	MC	Ngo Quyen		Ngo Quyen	100
18	MC	Do Son		Do Son	60
				Total Beds	2,765

Note: HL = Hospital, MC = Medical center, "Beds" means the number of beds

(3) Incoming Waste Quality and Quantity

1) Waste Quality

Hospital waste contains plastics, rubbers, cottons, metals, glasses and others. Plastics and cottons are the main contents among them. Estimated composition of the hospital waste based on site observation is shown in the table below. Typical articles contained in each categories are also indicated.

Calorific value of the waste is estimated to be 3,500 to 4,000 kcal/kg. It is fairly high due to the high content of plastic and rubbers.

The waste may possibly be infectious if they are contaminated with human blood or body fluids. Note that all the waste which may possibly be contaminated with infectious agents should be treated as the infectious waste. On the contrary, non-infectious waste should be excluded from the infectious waste.

Main Content of the Infectious Waste

Category	Typical articles	Estimated Composition (%)
Plastic	Syringes, injection needles with plastic connectors, infusion tubes with injection needles, infusion bags, blood testing plates	40
Rubber	Rubber gloves	5
Cotton	Bandage, gauze and cottons	30
Metal	Injection needles, blades of operation knives	10
Glass	Glass slide, test tube	5
Others	Papers, strings, other organic substances	10

2) Waste Quantity

Currently (in 1999) amount of the infectious waste generated in the hospitals and medical centers subject to the plan is estimated to be 0.968 ton/day on average. It is considered that factors to increase the infectious waste are population growth and economic growth which leads an increase of visiting and staying patients, while factors to decrease are improvement of sanitary condition, health condition and enhancement of people's awareness to the preventive health. To simplify the estimation, only population growth is taken account to predict the future quantity of the infectious waste generated at the hospitals.

The table below shows the projection of the infectious waste generation quantities based on the population growth. Number of all Haiphong citizens is cnsidered for the projection, as the hospitals accepts citizens living in the rural area as well as those in urban area.

Future Quantity of the Infectious Waste

Year	Population	Population Index	Daily Quantity (ton/day)	Annual Quantity (ton/year)
1999	1,677,465	100.0	0.968	353
2000	1,697,478	101.2	0.980	358
2001	1,717,491	102.4	0.991	362
2002	1,737,504	103.6	1.003	366
2003	1,757,516	104.8	1.014	370
2004	1,777,529	106.0	1.026	374
2005	1,797,542	107.2	1.038	379
2006	1,819,898	108.5	1.050	383
2007	1,842,254	109.8	1.063	388
2008	1,864,610	111.2	1.076	393
2009	1,886,966	112.5	1.089	397
2010	1,909,322	113.8	1.102	402
2011	1,930,587	115.1	1.114	407
2012	1,951,853	116.4	1.127	411
2013	1,973,118	117.6	1.138	415
2014	1,994,384	118.9	1.151	420
2015	2,015,649	120.2	1.164	425
2016	2,036,658	121.4	1.175	429
2017	2,057,666	122.7	1.188	434
2018	2,078,675	123.9	1.199	438
2019	2,099,683	125.2	1.212	442
2020	2,120,692	126.4	1.224	447

5.2 Proposed System of Hospital Waste Management

5.2.1 Outline

Hospital Waste Management is composed of the following four stages:

- In-hospital Management
- Collection and Transport
- Treatment
- Final disposal

Incineration is strongly recommended for the treatment method, as it is easy to confirm disinfection and cost-effective. A centralized incinerator is proposed in view of the economic efficiency.

5.2.2 In-hospital Management

(1) Objective:

Isolation of infectious waste from other non-infectious waste.

Safe transportation of infectious waste from waste generation sources to waste storage room in each hospital.

(2) Actor

Doctors, nurses and other hospital staff in charge of waste handling. It is most effective that doctors and nurses separate the infectious waste from others because they know well how and why the waste is contaminated with infectious agents.

(3) Facilities

- Carton boxes and plastic bags of yellow-color with bio-hazard marks. URENCO supplies them to the hospitals as a part of service on contract
- Waste storage rooms with roof and locked-door, exclusively for storage of infectious waste

(4) Operation

Doctors and nurses put the infectious waste into carton boxes and plastic bags designed for the infectious waste. They are yellow-colored ones with Bio-Hazard mark as shown below. Once the infectious waste is put into the boxes and bags, thy should never be opened again.

The nurses or waste handlers bring the boxes and bags to the storage room exclusive for hospital waste.

Infectious waste to be collected is listed below. They are defined as clinical waste in the article 8 of the Regulations on Hospital Waste Management issued by the DOH in 1999.

Infectious Waste to be collected

Sub-category	Description
Group A: Infectious waste	Materials absorbed with blood, human body liquid, and other excreta from patients such as bandages, cotton, gloves, plaster cast, cloth materials, artificial anal sacs, blood transfusion ducts, fistulas, strings, and bags for drained liquids.
Group B: Sharps and pointed articles	Syringes and injection needles, blades and handles of operation knives, operation nails, saws, shards of glass, and every material that can cut or pierce, infectious or not infectious.
Group C: Highly infectious waste from laboratories	Gloves, glass slides, test tubes, post-biopsy/test/cultivated human removed organs, blood containing bags, etc.
Group D: Pharmaceutical waste	i) Pharmaceutical products that are outdated, infectious, overturned, or out of need. ii) Pharmaceutical products that poison cells.
Group E: Human and animal tissues and organs	All tissues of the body (infectious or not); organs, limbs, placenta, fetus, animal corpse.

5.2.3 Collection and Transport

(1) Objective

Safe collection and transportation of the infectious waste from the hospitals to an incinerator

(2) Actor

URENCO should establish Hospital Waste Management Unit within URENCO.

(3) Facilities

URENCO procures two (2) vehicles that are used exclusively for collection and transport of the hospital waste.

Type: A truck with a load cabin to keep the waste isolated. The cabin should have a lock.

(4) Operation

2 teams (one team is composed of one driver and one waste loader for each vehicle) visit the hospitals and the medical centers and collect the infectious waste which is readily packed in the carton boxes and plastic bags everyday.

URENCO collectors should have keys of the doors of the waste storage rooms in the hospitals. They unlock the door, bring out the boxes and the bags containing the infectious waste and lock it again.

URENCO provides the hospitals with collection services on contract base. When entering the contract, URENCO provides necessary boxes and bags to collect the waste.

5.2.4 Treatment

(1) Objective

Disinfection of the infectious waste by incineration. This means killing bacteria and viruses by heat.

(2) Actor

URENCO operates the incinerator. URENCO should establish Hospital Waste Management Unit within URENCO.

(3) Facility

HPPC procure a hospital waste incinerator. The incinerator with housing will be installed at the existing gate of Trang Cat Landfill Site.

Dual-chambered incinerator with a capacity or 1.5 tons/day. Specification of the incinerator is described in the section 5.3.

(4) Operation

Before starting the daily operation, the operators collect incineration residue of a previous day from an outlet for ash discharge of the incinerator.

Operators put boxes and bags containing the infectious waste into the incineration chamber and then start to incinerate. The incinerator automatically works by feeding back the temperature of the chambers as it is readily programmed. The details of the operation method are described in the section 5.4.

5.2.5 Disposal

(1) Objective

Safe disposal of incineration residue (ash) by means of the sanitary landfill.

(2) Actor

URENCO should establish Hospital Waste Management Unit within URENCO.

(3) Facilities

It is planned that Trang Cat Phase 3 Landfill site include a Hazardous Waste Landfill Site (HWLS). Incineration ash will be disposed of at HWLS.

(4) Operation

The residue is carried into HWLS by a cart that is exclusively used for the residue transportation. The residue should be covered by soil everyday after being landfilled.

Leachate stemmed from the residue is collected together with that of municipal solid waste and should be treated properly.

5.3 Facility Specification

5.3.1 Incinerator

(1) Incinerator

1) Proposed Site

A vacant area behind the existing entrance gate of Trang Cat landfill site is a proposed site for the incinerator with a building. Approximately 240 m^2 of area is required for the building that would house the incinerator.

2) Specifications

The capacity of the incinerator should be 1.5 ton/day. Current amount of infectious waste to be incinerated is about 1 ton/day and it may increase to 1.15 tons after 8 years when the service life of the incinerator ends. Therefore, the capacity of 1.5 ton/day seems enough. 8 hours operation per day is assumed to incinerate 1.5 tons of the waste. Daily operation hours depend on quantity and quality of the waste. Corresponding to the capacity of 1.5 ton/day, physical capacity of the first chamber should be 5 m^3 to accept the waste for a day.

The Incinerator is composed of two chambers. The secondary chamber contributes to prevents dioxin generation by complete combustion. In this sense, the secondary chamber is also called a recombustion chamber. Temperature in the secondary chamber should be kept at more than 800 °C during incineration, otherwise dioxin may be generated. When starting incineration, a supplementary burner is ignited to raise the temperature inside of the secondary chamber, then the waste is ignited when temperature has reached 800 °C. There are possibility to chose heavy oil, kerosene or gas as fuel of the burner, but heavy oil or kerosene is recommendable from an economic point of view. This burner is used for pre-heating of the recombustion chamber as well as an after burner to incinerate gaseous matters.

Incineration by a batch is recommended to keep the temperature high enough to prevent dioxin generation.

Thermometers to monitor the temperature in the primary and recombustion chamber should be equipped.

Blower to control the air supply necessary for complete combustion in the recombustion chamber should be equipped.

For pollution prevention, dust collector such as cyclone type dust collector or a bag filter should be equipped.

Dioxin concentration in smoke from stack should be limited less than 5 ng-TEQ/Nm^3 which is a standard value defined in Japanese law for dioxin control. It is desirable that the dioxin concentration is limited less than 1 ng-TEQ/Nm^3.

The emission gas of the incinerator should comply with the Vietnamese Standard with respect to the other conventional air pollutants.

Service life of the incinerator is assumed to be 8 years in this plan, but the longer life can be expected if it is operated in a proper manner. Longer the life of the incinerator, less cost per tonnage of the waste. Therefore it is strongly recommended to elongate the service life by proper operation condition.

Major Specifications of the Incinerator

Item	Specification	Purpose or Condition
Capacity	1.5 ton/day = 187.5 kg/h	8 hours operation/day
Waste Loading Method	Batch type incinerator	with a recombustion chamber
Structure of chambers	Dual-chamber	Primary chamber to incinerate solid matters Secondary chamber to incinerate gaseous matters to prevent dioxin generation
Secondary Chamber	Recombustion chamber	The temperature should be more than 800 °C during incineration
Supplementary burner	Necessary to heat the recombustion chamber	Fuel can be heavy oil, kerosene or gas
Thermo-sensor	Thermo-sensor in each chamber	To monitor the temperature in each chamber
Blower	Necessary	To control air supply for the recombustion chamber
Dust Collector	Cyclone type or a bag filter	To collect dust from the stack smoke

Components and Functions of Incinerator Required

Component	Function
Primary incineration chamber	Incineration of solid waste
Secondary incineration chamber	Incineration of combustible gas
Supplementary burner	Raising temperature of the secondary chamber
Blower	Air supply control
Dust collector	Collecting dust in the smoke
Smoke stack	Smoke emission into the atmosphere
Controller Board	Controller for operation

3) Quality of Emission Gas

Quality of emission gas shall comply with the industrial emission standards for air quality in Vietnam, that is, Standard TCVN 5939-1995 and TCVN 5940-1995. The former regulates 19 kinds of inorganic substances while the latter regulates 109 kinds of organic ones. However, no dioxin standard is established in Vietnam. According to the Japanese standard, dioxin concentration in the emission gas is regulated according to the capacity of the incinerators. More stringent standard is applied to larger incinerator as shown below. This standard does not refer to the incinerator with a capacity of 1.5 ton/day or less. At present an incinerator of which dioxin concentration in the emission gas is 0.5 ng-TEQ/Nm^3 or less is available. Such an incinerator with low dioxin generation is strongly recommended.

Dioxin Emission Standard in Japan

Standard (ng-TEQ/Nm^3)	Capacity	Capacity for 8 hrs
0.1	More than 4 ton/hr	More than 32 tons
1	2 to 4 ton/hr	16 to 32 tons
5	0.2 to 2 ton/hr	1.6 to 16 tons

Note: TEQ stands for Toxic Equivalent as converted to the toxicity of 2,4,7,8-para-dibenzodioxin

5.3.2 Collection Vehicles

Type: Trucks with a load cabin on their back to keep the waste inside. The chamber should have a lock.

Capacity: 1.5 ton/truck

Number of vehicles: 2 vehicles

5.3.3 Waste Storage Room in Hospitals

Area:15 m^2

Specification: A room closed with wall to keep out rodents and insects. Door with lock.

Cost: US$4,500

5.3.4 Other Equipment

A cart is needed to transport the ash after incineration to the designated segment in the landfill site (HWLS). Capacity of the cart should be more than 0.5 m^3 to accept abut 0.5 ton of ash.

5.4 Operation and Maintenance Plan for Hospital Incinerator

5.4.1 Procedure of Operation and Maintenance

(1) Operation

Before starting the operation, residue after incineration (ash) of the previous day should be removed from the primary chamber. The ash is loaded on a cart for transportation and is carried to the landfill site. Wearing masks is strongly recommended to prevent inhaling the ash dust.

Put the box and bags containing waste into the primary chamber of the incinerator. Then, ignite the supplementary burner to heat the recombustion chamber. Ignite the waste in the primary chamber after the temperature in the recombustion chamber reached to more than 800 ℃. Wearing the gloves during loading of the waste in case of spilling out of hazardous liquid. Operators of incinerator should take shower after work

(2) Maintenance

Brick wall of the furnace degrades gradually and will be worn out. It is necessary to feed firebricks to repair the brick wall.

Duration of shut down for maintenance will be less than 3 days a year for the first three years and gradually increases after that depending on scale of damages.

Major maintenance parts are listed in the following table with its service life.

Major Maintenance Parts

Parts	Service life (year)
Thermo-sensor	1
Seal of the door	1
Door	5
Supplementary Burner	2.5
Motor of the Blower	4
Other blowers	6
Relay and Magnet Switch	4
Recording Paper	Consumable

5.4.2 Organizational Arrangement

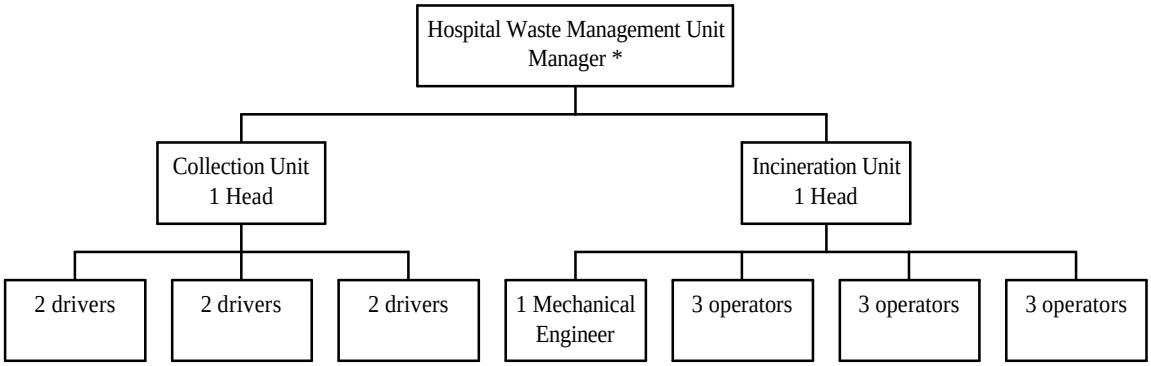
(1) URENCO

URENCO will be responsible for hospital waste collection, transport, treatment (incineration) and final disposal of incineration residue.

URENCO should create Hospital Waste Management Unit that has the following two sub units:

- Hospital waste collection unit, composed of 1 head and 6 drivers and collectors

- Hospital waste incineration unit, composed of 1 head and 10 operators or workers



* Head of Incineration Unit will serve as manager of Hospital Waste Management Unit

URENCO also should have some persons in charge of managing contracts with the hospitals and collecting fees.

(2) Hospitals and Medical Centers

It is recommended that each hospital and medical center establish infectious waste management system within the hospital. Standard Operation Procedure should be developed with the DOH's assistance. Good practice should be promoted through the training for doctors, nurses and the waste handlers in the hospital.

(3) DOH

Hospital Waste Treatment Steering Board shall be established in accordance with the article 28 of Regulation on Hospital Waste Management issued by the Ministry of Health in 1999. The Board will be chaired by the director of the DOH Haiphong, and composed members from the management section of relevant hospitals and medical centers. DOH should help hospitals and medical centers develop the Standard Operation Procedure on infectious waste management. It may be better that the DOH organizes the training for doctors, nurses and waste handlers. Budget preparation might be charged on the DOH.

(4) DOSTE

DOSTE is responsible for inspection of the incinerator. It is strongly recommended that the DOSTE periodically requires the URENCO to report quality of emission gas from the incinerator. 19 inorganic and 109 organic pollutants as defined in the industrial emission standard should comply the standard in a legal sense, and dioxin also should be controlled, as it is not yet regulated by the national law and the determination costs high.

5.4.3 Training and Maintenance Contract

(1) Training

Operators of the incinerator should receive adequate training with respect to operation and maintenance. It is practical that such training should be provided by a supplier of the incinerator during commissioning period.

(2) Maintenance Contract

It is advisable that URENCO should have a maintenance contract with the supplier for at least 3 years after commencement of the operation.

5.5 Cost Estimation

Investment and O&M cost of the priority project for the first 8 years are shown below.

(1) Investment Cost

Total investment cost is estimated to be US$426,662.

Initial Investment Cost

Equipment	Cost (US$)	Service Life
Incinerator	262,938	8 years
Building for incinerator	87,360	More than 16 years
Collection vehicle (2 units)	76,364	8 years
Total	426,662	

(2) Operation/maintenance Cost

Average operation/maintenance cost is estimated to be US$45,860 per year, or US$126 per day as shown below.

Operation/maintenance Cost

Equipment	Cost (US$/year)	Cost (US$/day)	Purpose
Fuel for burner	12,045	33	Incinerator's burners
Electricity	365	1	Incinerator's fan
Repair parts	4,745	13	Incinerator parts
Gasoline for vehicle	1,095	3	Collection truck
Maintenance of vehicle	6,570	18	Collection truck
Carton boxes	3,285	9	Infections waste
Plastic bags	3,285	9	Infections waste
Others	5,110	14	
Salary of workers	9,360	26	
Total	45,860	126	

5.6 Fee Collection

Infectious waste collection and incineration should be implemented on full-cost recovery base by collecting the fee from the hospital. This is based on the "Polluter Pay Principle".

Unit cost of the infectious waste treatment will be US$245.3/ton. URERNCO should assign the fee collection unit to collect the fee from the hospitals. Breakdown of the cost is shown below.

Cost breakdown of the infectious waste treatment

	Collection & Transport (a)	Incineration (b)	Landfill of Incineration Residue (c)	Total (d =a+b+c)
1. Investment	24.2	97.0	5.4	126.6
2. O & M	58.8	59.2	0.7	118.7
3. Total (1+2)	83.0	156.2	6.1	245.3

It should be recommended that the hospitals themselves pay the fee. This way gives the hospitals an incentive to reduce the amount of infectious waste by separating precisely from other non-hazardous waste, because the fee increases as the amount of infectious waste increases.

In case of Ho Chi Minh City, CITENCO (City Environment Management Company) is responsible for collection and treatment of infectious waste. The fee rate of collection was VND4 million/ton (US$276/ton) at the beginning and is now raised to VND7 million/ton, equivalent to US$483/ton. The government and the People's Committee pay for the governmental hospitals and the People's Committee's hospitals, respectively.

In case of Hanoi, current fee rate is VND3 million/ton (US$206/ton) but this can not cover the incineration cost. URENCO Hanoi is considering to raise the fee rate to VND5 million/ton (US$344/ton).

CHAPTER 6 COST ESTIMATION

6.1 Construction and Procurement

6.1.1 Summary

Total investment cost of the priority project in solid waste management sector is estimated to be US$15.8 million approximately, and comprises of the following items:

- Construction and procurement
- Engineering service (5 % of the procurement cost and 10 % of construction cost)
- Land acquisition
- Administration (3 % of the sum of the above items a, b and c.)
- Physical Contingency (10 % of the sum of the above items a, b, c and d)

Investment costs by items are estimated as follows:

Investment Cost of Solid Waste Management Priority Project

Cost Items	Amount (US$1,000)
a. Construction and procurement	12,343
b. Engineering service	968
c. Land acquisition	602
c. Administrative cost	417
d. Physical Contingency	1,434
e. Total (a+b+c+d)	15,764

6.1.2 Investment Cost by Project Components

The solid waste management priority project cost is comprised of the following three components:

- Waste collection and transport equipment (vehicles, containers and handcarts)
- Trang Cast Phase 3 Landfill Site (site construction and heavy equipment)
- Hospital waste incinerator and hospital waste collection vehicles

The estimated investment costs by components are shown below.

Investment Cost of Solid Waste Management Priority Project by Components

Cost Items	Amount (US$1,000)
a. Waste collection and transport equipment	4,648
b. Trang Cast Phase 3 Landfill Site	10,585
c. Hospital waste incinerator and hospital waste collection vehicles	531
e. Total (a+b+c)	15,764

Investment costs by items and by project components are shown in the following table.

Solid Waste Management Priority Project Investment Cost (Unit: US$1,000)

	Construction & Procurement				Engineer-ing Cost	Land Acquisi-tion Cost	Total E+f+g	Administ-Ration Cost	Total including Admi. Cost	Contin-gency	Grand Total including Contin- gency
	URENCO	Kien An Company	Do Son Company	Total							
a	b	d	d	e = b+c+d	f	g	h	i = h* 3%	j = h+i	k= j*10%	l = j+k
1. Waste Collection and Transport Equipment	2,886	522	499	3,907	195	0	4,102	123	4,225	423	4,648
2. Trang Cat Phase 3 Landfill	8,010	0	0	8,010	730	602	9,342	280	9,622	963	10,585
3. Hospital Waste Management Facilities	426	0	0	426	43	0	469	14	483	48	531
4. Total (1+2+3)	11,322	522	499	12,343	968	602	13,913	417	14,330	1,434	15,764

6.1.3 Investment Cost by Recipient Companies

There are three (3) companies as shown below that actually use equipment and facilities provided through the priority project:

- Urban Environment Company (URENCO) that provide services in Hong Bang, Le Chan and Ngo Quen Urban Districts
- Kien An Urban Works Company that provides service for Kien An Urban District
- Do Son Public Works Company that provides service for Do Son Town and area along Route 14 linking Do Son and Haiphong City center

Investment costs by companies are as follows:

Investment Cost of Solid Waste Management Priority Project by Companies

Cost Items	Amount (US$1,000)
a. URENCO	14,549
b. Kien An Company	621
c. Do Son Company	594
e. Total (a+b+c)	15,764

6.2 Operation and Maintenance Costs

It is planed that the operation of all the facilities and equipment provided under the priority project will start in the beginning of 2005. It is estimated that the total operation and maintenance cost in 2005 will be US$2.147 million.

Estimated Operation and Maintenance Costs of the Priority Project

	US$1,000
a. Waste collection and transport including administrative employees	1,744
b. Trang Cat Phase 3 Landfill Site	356
c. Hospital waste management (collection and incineration)	47
d. Total	2,147

Note: Waste collection and transport cost is the sum of the costs of the 3 companies, i.e. URENCO, Kien An Company and Do Son Company.

Detailed operation and maintenance costs as well as detailed investment costs by year and by companies are shown in Tables 4.6.1- 4.6.4.

CHAPTER 7 PROJECT IMPLEMENTATION PLAN

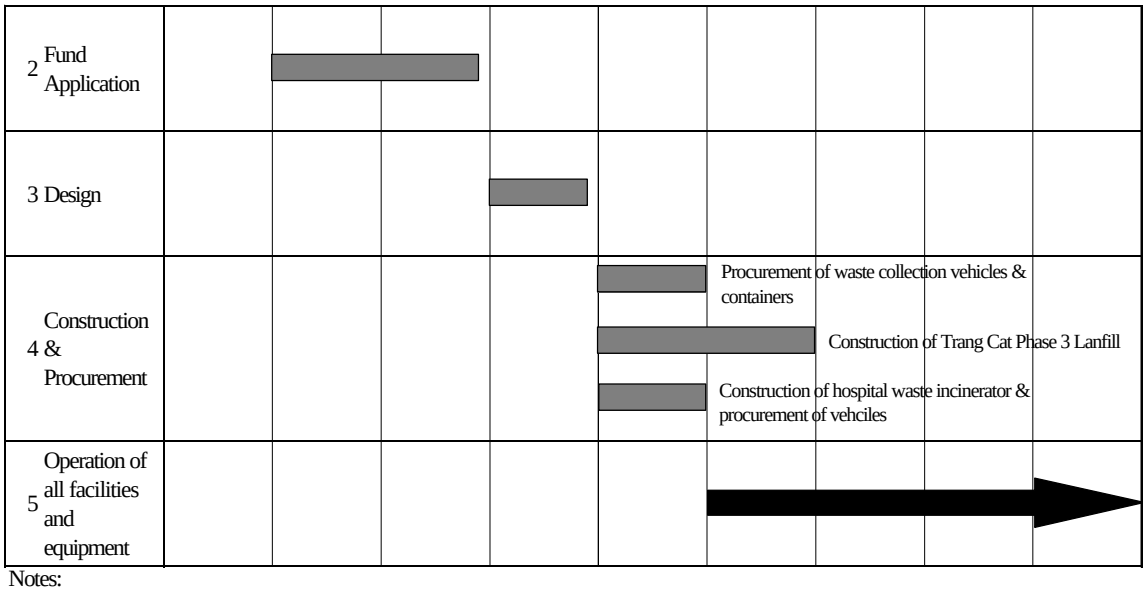
7.1 Implementation Schedule

The implementation schedule for the priority project in the field of solid waste management is proposed as follows:

- Securing financial sources for implementation: 2001 – 2002
- Engineering services: 2003 – 2005

Note: Engineering services will include 1) project preparation of contact specifications and design as well as 2) the construction supervision. The former service will be provided and completed in 2003.

- Procurement and construction: 2004 – 2005
- Commencement of Operation: Beginning of 2005



Notes:
1. Design and Construction/ Procurement include tendering process.

Proposed Schedule for Implementation of the Priority Project for Improvement of Solid Waste Management

Notes:

1. Design and construction/procurement include tendering process.
2. Construction of the first part of Trang Cat Phase 3 Landfill Site will be completed by the end of 2004 so that it may be used from the beginning of 2005. Construction of the remaining part of Trang Cat Phase 3 Landfill will be completed in 2005.

7.2 Organization Plan for Project Implementation and Management

7.2.1 General

There will be the following 3 distinctive stages with respect to the implementation of the priority project:

- 1st Stage from now till the acquisition of an ODA fund (2001 – 2002)
- 2nd Stage for the procurement and construction including tendering process (2003 – 2005)
- 3rd Stage for operation (2005 – 2014)

Key organizations and major tasks for each stage are as follows:

Key Organizations and Major Tasks for the Project Implementation

Stages	Key Organizations	Major Task
1st Stage from now till acquisition of ODA fund	Department of Planning and Investment DPI), TUPWS and other relevant departments of HPPC	1. To obtain the prime minister's approval for the feasibility study, and 2. Acquisition of an ODA fund (loan)
2nd Stage during the construction and procurement including tendering	Project Management Unit (PMU) to be formulated under the leadership of TUPWS PMU members will include representatives from relevant departments and the URENCO	1. Detailed project preparation, 2. Tendering and selection of consultants and contractors, 3. Land acquisition, and 4. Administration and supervision of the whole process.
3rd Stage for operation	URENCO, Kien An Company and Do Son Company	Operation of the proposed waste management system using the facilities and equipment provided through the project

7.2.2 First Stage (Pre-ODA Fund Acquisition Stage)

DPI should take a lead in the first stage. DPI should organize a Project Management Unit at this stage if necessary. The major tasks of the first stage are 1) to obtain the Prime Minister's approval for the project, and 2) acquisition of ODA fund for implementation.

There are three priority projects (drainage, sewage and solid waste management projects) that need ODA fund for implementation. It is would be advisable that HPPC will consider these 3 projects as 3 components of one project in terms of promotion of acquisition of ODA funds.

7.2.3 Second Stage (Construction Stage)

Under the leadership of TUPWS, HPPC should organize a Project Management Unit. PMU's major tasks are 1) project preparation, 2) tendering and selection of consultants and contractors, 3) land acquisition, and 4) administration and supervision of the procurement and construction.

Each task would take longer time than initially planned if not managed well. It is extremely important to prepare a realistic time schedule and follow it.

Head of the PMU should be either director or deputy director of TUPWS. PMU members should include representatives of:

- TUPWS
- DPI
- DOSTE
- Department of Health
- URENCO
- Kien An Urban Works Company
- Do Son Public Works Company

7.2.4 Third Stage (Operation Stage)

(1) Management and Operation of Trang Cat Phase 3 Landfill Site and Hospital Waste Incinerator

As has been proposed and discussed in the master plan, the JICA Study Team proposes that HPPC should establish a new municipal company – Trang Cat Site Management Company - TCSMC that will be responsible for all activities in Trang Cat Site, i.e.:

- Management and operation of solid waste landfill sites
- Management and operation of hospital waste incinerator (to be located in Trang Cat Site)
- Management and operation of septage treatment facilities provided under 1B project

Major advantages of this arrangement include the following:

- Better coordination between septage management and solid waste landfill in terms of site allocation and use, as well as production of compost manufactured from both dried septage and some solid waste
- In the event that environmental pollution problems occur and local residents complain, it is clear, under the proposed arrangement, who has responsibility for the pollution, and for taking necessary measures. If two organizations (URENCO and SADCO) manage the Site, it may not be clear as to which organization is responsible for the pollution
- Reduction in total site management cost can be expected by avoiding duplication of costs of common expenses such as salary of manager, engineers, technicians, guard men who can work for both septage treatment and solid waste landfill

(2) Organization and Training Required for Management and Operation of Hospital Waste Incinerator

1) Organization

Hospital waste incineration is a new practice to Haiphong. Regardless of whether the hospital waste incinerator would be managed by the proposed new company (TCSMC) or URENCO, it is necessary to establish a new organization for management and operation of the incineration facility. A proposed organization is shown in Section 5.4. 18 staff will be needed.

2) Training

Adequate training should be provided for management and operation of the hospital waste incinerator during the commissioning period by supplier (contractor) of the incineration facility. This training requirement should be clearly included in the contract to be made between HPPC and the contractor. It is also advisable that the contract should include a maintenance contract.

As for the in-hospital waste management, both Department of Health and URENCO that is responsible for collection of hospital waste should give necessary instructions and guidance to the hospitals.

(3) Training for Operation of Trang Cat Phase 3 Landfill Site

Trang Cat Phase 3 Landfill is the sanitary landfill that has not been practiced in Haiphong so far. The proposed landfill operation method such as push-up method is very different from the one that URENCO has been applying. Because such landfill operation is also new to all other cities of Vietnam, it is advisable that HPPC will arrange on-site training for operators of sanitary landfill by inviting a foreign expert for about 6 to 12 months.

The leachate treatment system proposed for Trang Cat Phase 3 is different from the existing system. It is advisable that an engineer specialized in the waste water treatment be recruited for operation of the leachate treatment facility.

(4) Pilot Project for the New Waste Collection and Transport System

The waste collection system (direct collection system with use of bins) proposed by the JICA Study Team will require serious cooperation on the part of the citizens and enterprises. For the successful implementation of the new system, the most important thing is that URENCO should execute a pilot project for the new collection system in the manner proposed in Section 3.3.3. Through execution of the pilot project, URENCO will find ways to make the system sustainable and acceptable to the citizens and enterprises.

The 3 solid waste management companies of Haiphong have high level of capacity in maintaining old vehicles at reasonably good conditions. Therefore there won't be any particular needs to provide training for operation and maintenance of vehicles.

CHAPTER 8 PROJECT EVALUATION

8.1 Objective Achievement

8.1.1 Project Objective

The objective of the project is the improvement of urban sanitation and public health of Haiphong city through establishment of the sanitary, environmentally sound and cost effective solid waste management system. Ultimate objective (Project goal) is to improve the citizens' health, amenity and economic level.

Project Aim

Establishment of **Sanitary, Environmentally-Sound, and Cost Effective Solid Waste Management System Comprising of:**
• Sanitary and cost effective waste collection and transport system with mechanical waste loading and direct collection using bins and compactors • Sanitary and cost effective waste disposal system at Trang Cat Phase 3 Landfill Site • Sanitary and cost effective hospital waste management system (in-hospital storage of infectious waste, exclusive collection system for infectious waste, and treatment through incineration, and sanitary landfill disposal of incineration ash)

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Project Objective

Improvement of Urban Sanitation and Public Health

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Project Goal

Improvement in People's Health, Amenity and Economic Standard

8.1.2 Evaluation in Terms of Objective Achievement

Each of the three components of the Project is evaluated as follows:

(1) Proposed Waste Collection and Transport System

Target area of the Priority Project in the field of waste collection and transport is the 4 urban districts, Do Son Town and the areas adjacent to the existing urban districts, which are considered to be urbanized by 2005. Total population of the

above-mentioned target area excluding agricultural population who do not need waste collection service is estimated to be 528,000 in 2005. With the project, the waste collection capacity will increase by 62 %. Waste collection amount will increase to 761 ton/day in 2005 when Haiphong City starts using equipment provided through the priority project) from the current 467 ton/day in 2000. Population with waste collection service will increase to 608,000 persons in 2005 from the current 409,000 in 2000. See the table below

Key Indicators concerning Waste Collection Service

Indicators	Before the Project (2000)	After the Project (2005)
1. Population served with waste collection service	409,000 persons (100 %)	608,000 persons (149 %)
2. Average waste collection amount	471 ton/day (100 %)	761 ton/day (162 %)
3. Collection service ratio (population served with collection service/total non-agricultural population in the target area)	85 %	94 %
4. Collection ratio (collection amount/generation amount)	75 %	85 %

Comparison of Waste Collection/Transport Systems Before and After the Project

	Before the Project	After the Project
- System of waste loading into vehicles	Open and manual system*1	Closed and mechanical system*2
- Efficiency	Poor	High
Type of Adverse Impacts		
1. Adverse impact on health of workers and residents near by waste transfer points	Much	Very small
2. Adverse impacts on the cleanliness and appearance of roads	Much	Very small
3. Adverse impacts on the traffic	Much (one hours for loading into vehicle)	Small (a few minutes for loading)
4. Cost-effectiveness (unit cost) at present level of workers' salary*3	US$6.65/ton (100 %)	US$4.76/ton (72 %)
5. Cost-effectiveness in future when salary of workers are doubled*3	US$10.44/ton (100 %)	US$5.33/ton (51 %)

Notes:
*1: Under the current system, waste is collected by handcarts, and dumped on road for loading into vehicles.
*2: The proposed system is such that waste is discharged into bins by generators. Bins will be mechanically lifted, and waste is loaded into vehicle.
*3 Costs indicated are the direct costs excluding overhead costs.

Conclusion:

It is judged that the stated aim (establishment of sanitary and cost-effective waste collection/transport system) will be attained through the implementation of Project based on the above-shown comparison.

(2) Proposed Sanitary Landfill System (Trang Cat Phase 3 Landfill Site)

Waste disposal system proposed by the JICA Study Team is the sanitary landfill. The sanitary landfill system is the most economical among different waste disposal options including incineration.

The planned landfill site has the capacity of receiving 2.6 million ton of solid waste approximately that will be collected from URENCO service area, i.e., Hong Bang, Le Chan, and Ngo Quyen urban districts during 10 years starting from the beginning of 2005. Beneficiaries of the planned landfill site will be the whole non-agricultural population of the 3 central urban districts and Trang Cat commune, which is estimated to be 528,000 in 2005. The planned site has a segment that will receive hospital waste incineration residue.

At present, Haiphong City virtually applies the open dumping system. The proposed sanitary landfill system is more advantageous than the existing open dumping system in terms of minimization of risks of environmental pollution and health risks as shown below.

Comparison of Waste Disposal System Before and After the Project

	Before the Project (Existing Trang Cat Landfill Site)	After the Project (Trang Cat Phase 3 Landfill Site)
Landfill system	Open dumping	Sanitary landfill with cover soil and leachate treatment

Type of Risks		
1. Risk of open water pollution with leachate	Already open water is being polluted.	Very low because of installation of artificial liner, & leachate collection/ treatment system
2. Adverse impacts on workers, local residents, and surrounding environment by waste deposited (Risk of generation of fire, smoke, rodents, dusts and waste scattering)	High	Low because of periodical (weekly) application of cover soil
4. Risk of explosion and accidental fires with gases	Some	Very low because of gas collection and exhaust system
5. Risk of collapse of waste layers	High	No Because of dyke and improved filling method
6. Generation of greenhouse (methane) gas contributing to global warming	Some	Low Can be reduced to about one third by properly applying the proposed semi-aerobic method instead of the current anaerobic method.

Conclusion:

It is judged that the stated aim (establishment of sanitary, environmentally sound and cost-effective waste disposal system) will be attained through the implementation of Project based on the above-shown comparison.

(3) Proposed Hospital Waste Management System with Incinerator

At present, Haiphong City has no independent management system for hospital waste. We have proposed an independent system with separation at sources (hospitals) and treatment (disinfections) by incinerator.

The Priority Project will cover 18 health care organizations (9 hospitals and 9 medical centers, located in the 4 urban districts and Do Son Town) with 2,765 beds in total, which corresponds to 74 % of the total number beds (3,730 bends) of all health care organizations in Haiphong city. Whole population of the above areas, which is estimated to be 704 thousand in 2005, will benefit from the Priority Project either directly or indirectly.

The proposed system will ensure the elimination of risks that people get infected through waste handling or indirect way. Conditions before and after the introduction of the proposed system are compared in the following table.

Comparison of Hospital Waste Management System Before and After the Project

	Before the Project (No Independent Management System for Hospital Waste)	After the Project (Independent Management System with Incinerator)
- Separation at sources (hospitals)	No separation at hospitals	Separation and isolated storage at hospitals
- Treatment of infectious waste	No treatment	Complete disinfections through incineration

Type of Risks		
1. Risk that waste collection workers and scavengers get infected through contacting infectious waste	High	No
2. Risks of transmission of infectious diseases from workers or scavengers to their family members or neighbors.	Some	No
3. Risk that people get infected through rodents and flies that touch infectious waste	Some	No

Conclusion:

It is judged that the stated objective (establishment of sanitary and cost-effective hospital waste management system) will be attained through the implementation of Project based on the above-shown comparison.

8.1.3 Conclusion

It is judged that the aim of the Solid Waste Management Project, i.e., establishment of the sanitary and cost-effective solid waste management system will be attained through the implementation of the Project based on the above-shown evaluation.

Through the attainment of the project aim, it is considered that the project objective, i.e. the improvement of urban sanitation and public health will achieved, and finally the project goal, i.e. improvement of People's Health, Amenity and Economic Standard will be realized.

8.2 Economic Evaluation

8.2.1 General Principles

The priority project, as described earlier, is designed to provide basic sanitary services to improve the general living environment and amenity, and to protect public health. The project will improve the system of waste collection for existing beneficiaries of the solid waste service, and extend this service to others, so that the number of beneficiaries increases from the present number of about 424,000 to about 608,000 in 2005 and 780,000 in 2015.

The solid waste project, in contrast to the drainage and sewerage projects, corresponds to the whole solid waste program of Haiphong City over the relevant period.

Ideally, project evaluation would be carried out by (a) determining the least cost

solution and then (b) comparing economic benefits and costs, when both are measured in financial terms. In practice, however, epidemiological and other data do not allow adequate measurement of the public health and amenity benefits of solid waste management services in financial terms.

As an alternative, project evaluation consists of (a) determination that a cost-effective solution has been selected, including qualitative judgment about the need and appropriate level of the services provided, and (b) financial feasibility, in terms primarily of the affordability of the program. Even if a theoretically more desirable cost benefit calculation cannot be done, if these two tests are satisfied, there can be confidence that the system expansion program is justifiable, given the importance of the basic services provided.

8.2.2 Least-Cost Solution

The Priority Project for solid waste management comprises the three (3) aspects, i.e. 1) waste collection and transport, 2) disposal (landfill), and 3) hospital waste management. In each aspect, the least cost option has been selected as explained below.

(1) Waste Collection and Transport System

In Haiphong the dominant waste collection system is the double handling collection system using handcarts. First, a worker collects solid waste from sources with a handcart and carries the handcart to a place for waste transfer. Waste is dumped from the handcart on the ground, and then loaded into vehicle by loading workers. The main system proposed by the JICA Study Team is the single handling system, i.e., the direct collection system using bins (to be placed on fixed locations) and compactors equipped with lifting device.

As result of the cost comparison of the two systems, it has been found that the proposed single handling system is much lower in cost than the existing double handling system. It is estimated that direct unit cost of the proposed system is US$4.76/ton, which corresponds to 72 % of the unit cost of the existing system, US$6.65/ton. In future the cost difference will be greater as salaries of workers increase. Based on the proposed waste collection system, equipment has been selected. Therefore, the least-cost criterion is satisfied.

(2) Disposal (Tran Cat Phase 3 Landfill Site)

There are a few options for waste disposal. Major ones are open dumping, sanitary landfill, composting and incineration.

Evaluation of Solid Waste Disposal Options

Disposal System Options	In terms of Environ-mental Soundness	Unit Cost
Open dumping	Not Acceptable	US$0.5 – 1.0/ton
Sanitary landfill planned by JICA Study Team	Acceptable	US$5.9 /ton
Composting + Sanitary landfill of compost rejects	Acceptable	US$4.6 – 18.6/ton
Incineration + landfill of incineration ash	Acceptable	US$58/ton at minimum
Incineration + power generation + landfill of incineration ash	Acceptable	US$64/ton at minimum

In terms of cost, the open dumping is of the lowest cost. However, it does not satisfy the environmental criteria. The open dumping causes environmental pollution, and affects the environment and health of site workers and local residents living near the site.

As can be seen from the above table, the sanitary landfill planned by the JICA Study Team requires the least cost among options that are environmentally acceptable.

Therefore, the proposed Sanitary Landfill (Trang Cat Phase 3 Landfill Site) satisfies the least cost criterion.

(3) Hospital Waste Management

The JICA Study Team has proposed incineration as means of treatment of infectious waste among a few treatment options including autoclave (high pressurized steam sterilization) and chemical treatment. In terms of cost, chemical treatment is of the least cost. However, it is not possible to verify completion of disinfections under the chemical treatment system. The incineration system is more economical than the autoclave, and more effective for disinfections under normal operation conditions. Therefore, the JICA Study Team has selected the incineration as treatment system, which satisfies the least cost criteria.

(4) Solid Waste Management System as a Whole

As result of selection of the least cost sub-systems in the 3 aspects, the solid waste management system as a whole satisfies the least cost criterion.

8.2.3 Justification of the Solid Waste Project

Justification of the solid waste project – or of the future solid waste program as a whole for Haiphong City – rests mainly upon the qualitative improvement in the living conditions of residents in the areas who will receive better collection of solid waste from their homes and neighborhoods. Other important beneficiaries are those who live close to illegal dumping sites as well as those who will benefit from the higher standards of landfill disposal contained in the proposed project. The project will also help to protect groundwater and offshore water quality.

The component of the project that disposes of hospital waste in an environmentally effective manner will also be beneficial for people living within a wide area, not simply local residents.

The number of people who receive improved collection services (referred to here as direct beneficiaries) is thus a conservative estimate of the total number of beneficiaries from the project, but this number is used as an indicator of the project's impact.

Direct beneficiaries are initially located in the relatively densely populated areas of the four Urban Districts and Do Son Town. Subsequently the collection area and number of direct beneficiaries, and therefore recurrent costs, will increase significantly over the lifetime of the project. In this regard the solid waste project service differs from the drainage and sewerage projects in which benefits are expected to grow rapidly over time, but recurrent costs will not do so.

8.3 Financial Evaluation and Affordability

8.3.1 Affordability: General Principles

In contrast to the drainage and sewerage projects, the proposed project represents most of the total investment program for solid waste management for at least the period 2003-2010. However, as in the case of drainage and sewerage, consideration of the solid waste program as a whole is the best indicator of the affordability of the specific project now under consideration.

8.3.2 Affordability of Solid Waste Program

Solid waste program costs are compared with GRP, disposable income, and HPPC expenditures in order to assess affordability. The costs and number of people benefiting from the solid waste program are shown in the following table:

Solid Waste Program Costs and Direct Beneficiaries, 2000-2020

Costs in 2000 prices

Year	Investment Cash Costs (US$'000)	Amort. Val of (1) (US$'000)	Cumulative Val of (2) (US$'000)	Recurrent Costs (US$'000)	Total Costs (US$'000)	Number of Beneficiaries	Cost Per Beneficiary (US$)
2001	206	15	18	1,206	1,224	423,628	2.89
2002	633	45	63	1,303	1,366	436,754	3.13
2003	2,714	193	255	1,524	1,780	484,446	3.67
2004	12,538	890	1,145	1,638	2,783	500,491	5.56
2005	4,569	324	1,469	2,227	3,697	607,995	6.08
2006	1,025	73	1,542	2,477	4,019	629,308	6.39
2007	1,113	79	1,621	2,682	4,303	651,094	6.61
2008	745	53	1,674	2,883	4,557	673,306	6.77
2009	1,430	101	1,775	3,084	4,859	695,967	6.98
2010	993	70	1,846	3,270	5,115	718,837	7.12
2011	1,266	90	1,935	3,412	5,348	734,840	7.28
2012	1,146	81	2,017	3,550	5,566	751,018	7.41
2013	4,804	341	2,358	3,672	6,030	765,186	7.88
2014	7,911	561	2,919	3,806	6,724	778,940	8.63
2015	1,667	118	3,037	3,993	7,031	792,220	8.87
2016	2,365	168	3,205	4,234	7,439	805,690	9.23
2017	1,468	104	3,309	4,501	7,810	819,160	9.53
2018	1,588	113	3,422	4,779	8,201	832,630	9.85
2019	2,878	204	3,626	5,076	8,702	846,101	10.28
2020	1,579	112	3,738	5,332	9,070	859,424	10.55

This figure includes amortization of some investments prior to 2003. However, in general it understates the accounting costs of existing assets. For this reason, as in the case of drainage and sewerage, affordability indicators for years after

2005 are more representative. The same condition (25 years, 5 % interest rate) is used for calculation of the amortized costs of the solid waste investments.

Affordability of the proposed program can be assessed in light of the information contained in the following table:

Affordability of Solid Waste Program 2001-20:

Costs as Percentage of Key Indicators

values in 2000 prices

Year	Total Cost as % of Benefici-aries GRP (%)	Total Cost as % of Haiphong GRP (%)	Total Cost as % of HPPC Exp. (%)	Cost as % of Benefi-Ciaries Disp. Inc. (%)	Cost per Capita of Benefi-Ciaries (US$)
2001	0.38	0.17	1.93	0.76	2.89
2002	0.38	0.18	2.01	0.77	3.13
2003	0.42	0.22	2.45	0.85	3.67
2004	0.61	0.32	3.60	1.21	5.56
2005	0.63	0.41	4.52	1.26	6.08
2006	0.59	0.40	4.42	1.17	6.39
2007	0.55	0.39	4.30	1.10	6.61
2008	0.51	0.38	4.17	1.03	6.77
2009	0.49	0.37	4.10	0.98	6.98
2010	0.46	0.36	4.00	0.92	7.12
2011	0.45	0.35	3.94	0.90	7.28
2012	0.44	0.35	3.87	0.87	7.41
2013	0.44	0.36	3.97	0.89	7.88
2014	0.47	0.38	4.20	0.93	8.63
2015	0.46	0.38	4.18	0.92	8.87
2016	0.46	0.38	4.22	0.93	9.23
2017	0.46	0.38	4.24	0.92	9.53
2018	0.46	0.38	4.27	0.92	9.85
2019	0.47	0.39	4.35	0.94	10.28
2020	0.47	0.39	4.35	0.93	10.55

Notes: Total cost = investment cost on amortization base + recurring cost.

The above table shows that the program meets affordability criteria under the base case scenario. Measured as a proportion of GRP of direct beneficiaries, these costs are low by developing country standards, as they tend to be constantly less than 0.5 % annually over the lifetime of the program. Recovery of O and M costs alone for solid waste (assuming disposable incomes remain as the same proportion of GRP) would require only 0.6 % of disposable incomes in 2010, the target date (referred to in Volume 1, Ch. 7.4) for full recovery of O and M costs in the form of user charges.

The program would also place a minor burden on the budget of HPPC., as it will amount to between three and 4 % of its annual expenditures under the Average Growth scenario. Even this overstates the relative importance of solid waste in the HPPC budget, as already 20 % of the costs of solid waste management are recovered directly from beneficiaries in the form of user charges. If the cost recovery reforms proposed by the Study Team materialize (i.e. full cost recovery

by 2020), the burden on the HPPC budget will gradually decrease over the period to zero.

Results of sensitivity testing, assuming half the estimated economic growth rate and cost increases of 20 %, are presented in Table 4.8.1. Under these conditions, rate of the cost to the beneficiaries' GRP would exceed 1 % in and after 2005. 1 % is considered the maximum rate in normal conditions in most developing countries. However, when economic growth is slow down, rate of increase in waste generation would decrease, which leads to slower increases in solid waste management costs.

8.3.3 Funding Requirements and Financing Plan

It is proposed that external assistance should be obtained for the priority project, as in the case of the drainage and sewerage projects. It is similarly assumed that funding will be available on the following terms:

Interest rate for construction and procurement 1.3 %, and for engineering 0.75 %.

Funding available for 85 % of project costs, repayable over 30 years after a 10-year grace period, during which time interest only is paid.

Table 4.8.2 shows the repayment schedule and total financial burden under these conditions. The Average Growth Scenario and base case project costs (in current prices) are assumed.

It is also assumed that the responsibility for repayment of loans for the selected priority projects ultimately rests with HPPC. Table 4.8.2 shows the percentage of HPPC expenditure that would be required to repay the loan, plus the associated recurrent costs of the projects. In addition, HPPC would have to fund the 15 % of project costs not financed by the external lender.

The table shows that year 2005 is the year in which HPPC has the peak burden in terms of ratio of project cash expenditure to HPPC's total expenditure. Such ratios will be 3.3 % in 2005, 2.6 % in 2006, and decrease thereafter. Considering these level of ratios, the priority project is considered feasible for HPPC in terms of cash payment burden.

8.4 Technical Evaluation

Technical evaluation section comprises 3 sub sections corresponding to the following 3 project components:

- Waste collection and transport
- Trang Cat Phase 3 Landfill Site
- Hospital Waste Management

8.4.1 Waste Collection and Transport Project

The Priority Project proposes:

- Mechanization of waste transfer from handcarts to a waste collection vehicle by introducing mechanical lifter (to be attached at rear end of vehicles)
- Direct waste collection (Generators put waste directly into bins, and waste collection trucks visit bins, and empty them. No handcarts will be used.)
- Provision of equipment, i,e, waste collection vehicles, waste bins, handcarts and workshop equipment that is required to implement the above system

The above system has been proposed and planned with the objective to improve the waste collection efficiency and to minimize adverse impacts of waste collection/transport activities on the health and environment.

In the system planning and selection of equipment, the following technical and other aspects were considered:

- Whether or not the system can be technically manageable and operational by URENCO as well as Kien An and Do Son Environmental companies
- Whether or not the system can be accepted by waste generators (the citizens and enterprises)
- Whether or not the equipment can be maintained at reasonably good conditions
- Whether or not spare parts can be locally available
- Whether or not the proposed system has been implemented and proven to be successful by some other cities in Vietnam

Among the two systems that the JICA Study Team proposed (a and b above), URENCO has already tried a test mechanization of waste transfer by installing a lifting device to one compactor. It has been successful. URENCO intends to install the lifting devices to a few more compactors in near future. Mechanization of the waste loading is very much generalized in both Hanoi and Hochiminh City, and therefore, it is considered that the proposed mechanization should have no problem.

The direct collection system will be more difficult to apply than the mechanization because the direct collection system will require the close cooperation on the part of generators (the citizens and enterprises).

In some districts of Hochiminh City, the direct collection system has been already implemented. There are both successful cases and unsuccessful cases. Based on the experiences of Hochiminh City, the JICA Study Team proposed the following strategy:

- Implement a pilot project of the direct collection system on small scale at places where it is easy to apply, such as markets and factories at first, then apartment buildings
- Through the implementation of such pilot project, URENCO should closely monitor the citizens' reaction, and communicate with them as often as necessary
- Develop a system in which waste bins can be maintained clean because this is the most important factor affecting the citizens' acceptance of the system.
- Expand the application area gradually

As for the operation and maintenance of equipment, it is judged that URENCO as well as Kien An and Do Son Environmental Companies have a high level of capacity. They manage to use even very old vehicles by maintaining and repairing them. URENCO has a long history of provision of waste collection service.

The equipment including proposed for the Priority Project as well as necessary spare parts are all available in Vietnam.

As conclusion, the proposed priority project of waste collection and transport is considered technically feasible provided that URENCO will implement the pilot project in a manner proposed by the JICA Study Team.

8.4.2 Trang Cat Phase 3 Landfill Project

The disposal system that is proposed as a component of the Priority Project is the sanitary landfill equipped with waste retaining structure, artificial liner, leachate collection and treatment system, and gas ventilation, etc. Application of regular soil cover is also planned.

The proposed sanitary landfill is planned and designed with the objective of disposing solid waste in sanitary, environmentally sound and economical manner. In general, the following technical and other conditions are considered as base for designing and planning a landfill site:

- Topographical and geological conditions of the site

- Relevant Vietnamese laws and regulations with respect to environmental pollution control
- Safe structure of landfill
- System that can be locally manageable and operational
- System that has been widely applied in other Asian countries, and proved to be successful
- Local availability of cover soil

As explained in Chapter 4, the proposed system is designed and planned to satisfy or be compatible with all the above aspects.

Because URENCO has no experience in operating a sanitary landfill of the type planned, it is very important for URENCO to arrange that operators (engineers and technicians) of the landfill site will receive training in the landfill operation, especially, filling methods including cell method, push up method, which are recommended by the JICA Study Team. It is also necessary for URENCO to recruit a specialist in operation of wastewater (leachate) treatment system.

It is considered that the planned sanitary landfill will be technically feasible provided that the above training and staff needs are satisfied.

8.5 Environmental Impact Assessment

8.5.1 Environmental Impacts of Solid Waste Management Project

The main impacts of the proposed project are described for the design phase, the construction phase and the operation phase. Alternative without the project implementation has also been described.

The proposed solid waste project is expected to bring the following positive impacts: (i) reduction of uncollected solid waste in the city, (ii) improvement of health condition, (iii) environmentally-sound disposal of collected waste, and (iv) safe management and disposal of medical waste.

The anticipated negative environmental impacts of the project are: (i) change from fishponds to landfill, (ii) noise and odor nuisance along the access road, (iii) odor and pollution from landfill, (iv) increase of pollution load to the Cam River, and (v) risk of groundwater pollution.

The overall impacts during construction of Trang Cat Landfill Phase 3 will be reasonably small, local and temporary. The impacts on air quality will be insignificant. Excavation of bottom works will be above upper aquifer and no groundwater pollution is expected. Impacts on the Cam River during emptying of fishponds will be insignificant and short-term.

Special attention should be paid to minimize the adverse impacts from operation of the Trang Cat Phase 3 landfill. The most critical impacts will be the offensive odor from the landfill and discharge of treated leachate to the Cam River. Solid waste collection and transportation will have minor impacts, which can be minimized with proper working methods. Actually proposed improvements to from double handling system to single handling system will decrease remarkably environmental and health impacts. With single handling system it is much easier to keep the streets clean. The more detailed information is presented in Tables 4.8.3.

The positive aspects of the project exceed the negative ones. Although there are long-term negative impacts those can be minimized with mitigation measures and good solid waste management and proper operation of the landfill.

The major environmental impacts for Trang Cat Landfill Phase 3 are presented more in detail in Table 4.8.3.

In any case solid waste collection and disposal have to be arranged, other wise the streets and vacant lands would be full of garbage in short time. This kind of uncontrolled solid waste disposal would increase the environmental pollution much more than controlled solid waste treatment in proper landfill.

8.5.2 Mitigation Measures for Solid Waste Management Project

(1) General Instructions

Mitigation measures are given separately for design phase, construction phase and operation phase.

Environmental matters have to be carefully integrated in all the design work and the planning of the project. Mechanisms to monitor environmental impacts, and to feed back monitoring results to the operation should be developed.

(2) Mitigation Measures during Design Phase

The design of the landfill has to be done minimizing adverse impacts including transportation, filling method, height of filling, gas collection, leachate collection and treatment, and covering.

1) Landfill Design Instructions

Detailed design should be done according to the principles presented in the facility plan and preliminary design in the Feasibility Study. The design should include:

- Outline design including: Design of main facilities, Land use plan, and Equipment and staffing
- Embankment design
- Liner design
- Design of leachate collection system
- Design of leachate treatment system
- Design of leachate re-circulation system
- Design of Gas collection system
- Design of Access road and on-site road
- Design of Environmental monitoring facility
- Design of other possible facilities

The following matters should be considered in the design:

(a) Protection Zones

The dyke separating Quyet Thang pond and Cam River belongs to the category national dyke and according to regulation, there must be at least 20 m wide protection zone between dyke and construction.

There are no households inside the project site, which have to be resettled, but to minimize the adverse impacts on the villages nearby trees should be planted between the landfill and villages. The width of the protection zone must be at least 20 m.

The landfill area has to be surrounded by fence to prevent encroachment of the area and outsiders to come to the area.

(b) Leachate Treatment and Discharge

A treatment system including mixing pond, precipitation pond, aeration pond and aquatic plant pond has been proposed for treatment method. Due to the possible heavy metals in leachate aquatic plants are not recommended to be used for feeding animals, but should be harvested and returned to the landfill.

Discharging point has to be selected so that the adverse impacts on the water quality of the Cam River can be minimized. Attention should be paid to the possible erosion of the river banks.

(c) Health and Safety

Location of supporting facilities as office, dining rooms and social rooms should be designed so that they are upwards from the prevailing wind to prevent odor, dust and noise.

(d) Public Relations and Compensation

Although resettlement is not anticipated, compensation for the aquaculture business will be needed. Good co-operation between local authorities, project affected people and employer are essential for the successful implementation of the project. There should be also public awareness campaigns to introduce proper solid waste management system.

(3) Mitigation Measures during Construction Phase

The general instructions concerning working conditions, prevention of noise, odor, litter and dust during works, protection of water and sediment, health and safety, and public relations mentioned in the project documents have to be followed. The content of the project and construction schedule should be informed to the people living in the vicinity of Trang Cat Landfill Phase 3.

(4) Mitigation Measures during Operation Phase

Long-term mitigation measures will be needed during operation phase to minimize the adverse impacts from the landfill. Buffer zone with trees should be established around the area to prevent dispersion of offensive odor and gases, and to improve the landscape. Leachate collection and treatment process should be controlled frequently to guarantee the quality of treated leachate to be discharged to the Cam River.

Instructions and regulations concerning the following activities should be included in the operation and management of landfill:

- Landfill activities
- Operation and Management
- Environmental Protection
- Health and Safety

(5) Mitigation Measures during Closing-down Phase

The following mitigation measures are proposed for the landfill in post-operation phase:

- Before covering the top layer of waste must be leveled with a proper slope
- Proper cover layers have to be established: gas drainage layer, impermeable layer and top layer
- Gas and surface run-off system must be in operation
- Leachate collection and treatment system must be in operation
- Landscaping has to be arranged

(6) Summary of Mitigation Measures for Sewerage Project

Phase	Main mitigation measures	Responsible organization
Design	International and Vietnamese design criteria and standards to be used. Outline of preliminary design has to be followed. Works designed to implemented during dry season.	Design Consultant
Construction	Minimize dust, odor, litter, noise and traffic emissions by good operation management and site supervision. Appropriate working methods have to be followed. Surface water and groundwater contamination has to be prevented during construction. Sites have to be kept clean and safe during and after the work. Safety and health regulations has to be strictly followed. Protective clothing and operational training for workers is essential. Transportation has to be minimized and routes selected to avoid public nuisance. Transportation during rush hours and night has to be avoided Construction sites and time has to be informed to the local people in advance.	Contractor
O&M	Operation and Management regulations have to be followed including filling, gas and leachate collection and treatment. Minimize odor, litter and noise emissions by good operation management and site supervision. Appropriate working methods have to be followed. Sites have to be kept clean and safe during and after the work. Safety and health regulations have to be strictly followed. Protective clothing and operational training for workers is essential.	URENCO

8.5.3 Evaluation of the Impacts with the Counter-Measures

Impacts of the project will be monitored in every phase according to the monitoring program. Monitoring is concentrating especially on operation phase.

Environmental impacts caused by operation of Trang Cat Landfill Phase 3 can be minimized to the acceptable levels with good landfill management and using proper working methods.

8.6 Organizational Capability of the Project Implementation and Administration Bodies

8.6.1 Solid Waste Management Companies – Project Implementation Bodies

There are three (3) companies that will implement the Priority Project of solid waste management, i.e. Urban Environmental Company (URENCO), Kien An Urban Works Company, and Do Son Public Works Company. They have a long history of providing solid waste management service in the past. They also have experienced expansion of the service area.

Considering the scope and technical requirement of the Priority Project, we have proposed the following institutional, organizational and training arrangements:

- Creation of hospital waste management section, within URENCO, which should be responsible for collection/transport and treatment of infectious waste
- Training of landfill engineers and operators particularly in waste filling work, and cover soil application, and operation of leachate treatment system. It is proposed that a foreign expert in landfill operation be invited for provision of this training
- Training of operators of a hospital waste incinerator (Training requirement should be included in the contract with a supplier of incinerator.)
- Creation of Trang Cat Site Management Company (TCSMC) for the management of all activities in Trang Cat Site (This is an option recommended in the Master Plan.)

Though the Priority Project proposes new technical systems and methods in waste collection/transport, landfill, and hospital waste management, it does not require new management skill or additional management capacity. Therefore, it is considered that the existing management capacity of the three companies, in principle, is adequate for the implementation of the Priority Project provided that the above-mentioned training and organizational arrangements be made.

8.6.2 Project Administration

Prior to the commencement of operation of new systems and facilities provided through the Priority Project, there are the following two stages:

- Pre-construction stage: Main task is to prepare projects and secure funds
- Tendering and construction stage: Main task is administration of tendering and construction

In the pre-construction stage, HPPC must play an important role to obtain an approval from the central government, and secure funds for the project implementation. During the tendering and construction stage, a Project Management Unit should be formed within HPPC as has been proposed in the institutional chapter.

In view of the experience of HPPC in forming similar organizations (PMUs), it is considered that HPPC is capable of forming such PMU for the proposed Priority Project, and managing the whole administrative procedure including land acquisition.

As conclusion, it is considered, that HPPC and the three (3) solid waste management companies have adequate capacity in administering and implementing the Priority Project provided that they will implement the organizational and training arrangements earlier mentioned.

8.7 Overall Project Evaluation

The preceding sections have evaluated the Priority Project for Improvement of Solid Waste Management in terms of the following:

- Objective achievement
- Economic evaluation
- Financial evaluation
- Technical evaluation
- Environmental Impact Assessment
- Organizational capability of the implementing and managing bodies

As result, it is judged that the Priority Project is feasible provided that it is implemented as planned.

Table 4.2.1 Estimated Waste Collection and Generation in 2000 by Type of Waste (ton/day)

	COLLECTION				GENERATION				COLLECTION RATIO			
	3 Urban Districts	Kien An	Do Son	Total	3 Urban Districts	Kien An	Do Son	Total	3 Urban Districts	Kien An	Do Son	Total
	a	b	c	d	e	f	g	h	i = a/e	j = b/f	k = c/g	l = d/h
1. Household	186.4	30.8	1.2	218.4	219.3	36.3	9.0	264.5	85%	85%	13%	83%
2. Business waste	85.7	13.0	36.1	134.8	95.2	14.4	40.1	149.8	90%	90%	90%	90%
3. Street wasate	45.3	7.5	5.4	58.2	53.3	8.8	10.9	73.0	85%	85%	50%	80%
4. Industrial waste	38.9	6.4	0.0	45.3	43.2	7.1	0.1	50.5	90%	90%	0%	90%
5. Hospital waste	3.2	1.7	0.1	5.0	3.2	1.7	0.1	5.0	100%	100%	100%	100%
6. Demolition waste	7.0	1.2	1.2	9.3	70.0	11.6	5.8	87.4	10%	10%	20%	11%
7. Total	366.5	60.6	44.0	471.1	484.2	79.9	66.0	630.1	76%	76%	67%	75%
Population in 2000	419,813	74,600	30,995	525,408	419,813	74,600	30,995	525,408				
Unit Rate (kg/capita/day)	0.873	0.812	1.420	0.897	1.153	1.071	2.129	1.199				

Table 4.2.2 Projected Waste Generation and Target Collection Amount by Company (ton/day)

	3 Urban Districts			Kien An			Do Son			Haiphong Total		
Year	Genera-tion	Collection Rate	Collection (ton/day)	Genera-tion	Collection Rate	Collection (ton/day)	Genera-tion	Collection Rate	Collection (ton/day)	Genera-tion	Collection Rate	Collection (ton/day)
a	b	c	d = bxc	b	c	d = bxc	b	c	d = bxc	b	c	d = bxc
2000	484	76%	367	80	76%	61	66	67%	44	630	75%	471
2001	495	77%	381	84	77%	65	75	73%	55	655	77%	501
2002	507	78%	395	89	78%	69	80	75%	60	675	78%	524
2003	565	79%	446	93	79%	74	84	77%	64	742	79%	584
2004	579	80%	464	98	80%	78	88	79%	70	765	80%	611
2005	702	85%	597	104	85%	89	93	81%	75	899	85%	761
2006	734	90%	660	110	90%	99	99	83%	82	943	89%	842
2007	769	92%	707	117	92%	108	105	85%	89	991	91%	904
2008	806	93%	749	124	93%	115	112	87%	97	1,042	92%	962
2009	844	94%	793	131	94%	123	119	89%	106	1,094	93%	1,022
2010	883	95%	839	139	95%	132	127	91%	115	1,148	95%	1,086
2011	907	95%	862	144	95%	137	133	93%	124	1,184	95%	1,122
2012	932	95%	885	149	95%	142	138	95%	132	1,219	95%	1,158
2013	956	95%	908	154	95%	147	144	95%	137	1,254	95%	1,192
2014	981	95%	932	160	95%	152	149	95%	142	1,290	95%	1,225
2015	1,005	95%	955	165	95%	157	155	95%	147	1,325	95%	1,259
2016	1,031	95%	979	170	95%	162	161	95%	153	1,362	95%	1,294
2017	1,057	95%	1,004	176	95%	167	167	95%	158	1,400	95%	1,330
2018	1,084	95%	1,030	181	95%	172	173	95%	164	1,438	95%	1,366
2019	1,111	95%	1,056	187	95%	178	179	95%	170	1,477	95%	1,403
2020	1,139	95%	1,082	193	95%	183	185	95%	176	1,517	95%	1,441

Table 4.3.1 URENCO Waste Collection Vehicle Procurement Plan

Target Collection Amount in 2005 **687ton/day (597t/d x 1.15)**

	Capacity (m4)	Capacity (ton)	ton/trip	Trips/ shift	Shift/ day	Days/ Year	Annual Collection /vehicle (ton/vehicle/year)	Daily Average/vehicle (ton/vehicle/day)	(Units)	Daily Collection (ton/day)		
a	b	c	d	e	f	g	h = (d*e*f*g)	i = h/365	j	k = i*j		
A.. Existing Vehicles that will be still used in 2005												
1 Compactor	4	2	2.0	2.0	2.0	274	2,192	6.0	1	6		
2. Compactor	6	3	3.0	2.0	2.0	274	3,288	9.0	1	9		
3. Compactor	8	4	4.0	2.0	2.0	274	4,384	12.0	2	24		
4. Compactor	12	5	5.0	2.0	2.0	274	5,480	15.0	2	30		
5. Compactor	16	7	7.0	2.0	2.0	274	7,672	21.0	0	0		
6. Hooklift truck			5.0	3.0	2.0	274	8,220	22.5	4	90		
7. IFA Tipper			3.0	2.0	2.0	274	3,288	9.0	6	54		
Total									16	213		
B. Vehicles with mechanical lifter to be Procured during 2001-2003 by HPPC's Own Fund											Unit Price ($/vehicle)	Total Cost
1 Compactor	4	2	2.0	2.0	2.0	274	2,192	6.0	3	18	35,000	105,000
2. Compactor	6	3	3.0	2.0	2.0	274	3,288	9.0	3	27	40,000	120,000
3. Compactor	8	4	4.0	2.0	2.0	274	4,384	12.0	0	0	45,000	0
4. Compactor	12	5	5.0	2.0	2.0	274	5,480	15.0	0	0	50,000	0
5. Compactor	16	7	7.0	2.0	2.0	274	7,672	21.0	0	0	71,000	0
6. Hooklift truck			5.0	3.0	2.0	274	8,220	22.5	0	0	52,000	0
Total									6	45		225,000
C. New Vehicles with mechanical lifter Purchased in 2004											Unit Price ($/vehicle)	Total Cost
1 Compactor	4	2	2.0	2.0	2.0	274	2,192	6.0	**2**	12	62,000	124,000
2. Compactor	6	3	3.0	2.0	2.0	274	3,288	9.0	**4**	36	67,000	268,000
3. Compactor	8	4	4.0	2.0	2.0	274	4,384	12.0	**15**	180	70,000	1,050,000
4. Compactor	12	5	5.0	2.0	2.0	274	5,480	15.0	**2**	30	77,000	154,000
5. Compactor	16	7	7.0	2.0	2.0	274	7,672	21.0	**6**	126	118,000	708,000
6. Hook-lift truck			5.0	3.0	2.0	274	8,220	22.5	**2**	45	60,000	120,000
Total									**31**	429		2,424,000
D. Grand Total (A+B+C)									53	688		

Table 4.3.2 URENCO Target Waste Collection Quantity by Collection Method

Unit: ton/day

Collection Method			Household Waste	Industrial, commercial and hospital waste	Demolition waste	Street Waste	Total
			1	2	3	4	5=1+2+3+4
A. Total Waste to be Collected by URENCO		a	304	208	11	74	597
B. Waste Collected by Direct Collection System Using Fixed Location Bins	Target Ratio	b	25%	60%	0%	10%	35%
	Target Quantity	c = a*b	76	125	0	7	208
	by 660 liter Bins (% out of c)	d	50%	80%	0%	0%	
	by 240 liter Bins (% out of c)	e	50%	20%	0%	100%	
	by 660 liter Bins (ton/day)	f = c*d	38	100	0	0	138
	by 240 liter Bins (ton/day)	g = c*e	38	25	0	7	70
C. Waste Collected with Primary Collection System (Double handling system)	Target Quantity	h = a-c	228	83	11	66	389
	by 660 liter Bin Cart (% out of h)	I	50%	50%	50%	50%	50%
	by traditional handcart (% out of h)	j	50%	50%	50%	50%	50%
	by 660 liter Bins (ton/day)	k = h*I	114	42	6	33	194
	by Traditional Handcart (t/d)	l = h*j	114	42	6	33	194

Table 4.3.2b URENCO Bin Procurement Plan

	Units of bins						
	Bins to be Used as of 2005						
	To be Used at fixed location for Direct Collection	To be Used for Primary Collection	Total	**To be Procured in 2004**	To be Procured in 2005	Unit Price ($/unit)	Purchase Cost ($)
	a	b	c = a+b	d	e = c-d	f	g = d*f
bin	531	247	778	**389**	389	240	93,360
bin	781	0	781	**390**	391	120	46,800
3. Traditional Handcart	0	361	361	**180**	181	120	21,600
4. Total	1,312	608	1,920	**959**	961		161,760

Note: Assumptions used for estimation of bin requirement

	Capacity		Number of Times Emptied	Quantity collected per bin per day
	liter/trip/bin	bin	times/ day	ton/bin/day
a	b	c	d	e = c*d
1. 660 liter bin used for primary collection				
	660	0.264	3	0.79
2. 660 liter bin used at fixed location				
	660	0.264	1	0.26
3. 240 liter bin used at fixed location				
	240	0.096	1	0.09
4. Traditional Handcart used for primary collection				
	450	0.18	3	0.54

Table 4.3.3 Kien An Company Waste Collection Vehicle Procurement Plan

Target Collection Amount in 2005 103ton/day (89t/d x 1.15)

	Capacity (m4)	Capacity (ton)	ton/trip	Trips/day	Shift/day	Days/Year	Annual Collection /vehicle (ton/vehicle/year)	Daily Average/vehicle (ton/vehicle/day)	(Units)	Daily Collection (ton/day)		
a	b	c	d	e	f	g	h = (d*e*f*g)	i = h/365	j	k = i*j		
A.. Existing Vehicles that will be still used in 2005												
1 Compactor	4	2	2.0	2.0	2.0	274	2,192	6.0	0	0		
2. Compactor	6	3	3.0	2.0	2.0	274	3,288	9.0	0	0		
3. Compactor	8	4	4.0	2.0	2.0	274	4,384	12.0	0	0		
4. Compactor	12	5	5.0	2.0	2.0	274	5,480	15.0	0	0		
5. Compactor	16	7	7.0	2.0	2.0	274	7,672	21.0	0	0		
6. Hooklift truck			5.0	3.0	2.0	274	8,220	22.5	0	0		
7. IFA Tipper			3.5	2.0	2.0	274	3,836	10.5	1	11		
Total									1	11		
B. Vehicles with mechanical lifter to be Procured during 2001-2003 by HPPC's Own Fund											Unit Price ($/vehicle)	Total Cost
1 Compactor	4	2	2.0	2.0	2.0	274	2,192	6.0	0	0	35,000	0
2. Compactor	6	3	3.0	2.0	2.0	274	3,288	9.0	1	9	40,000	40,000
3. Compactor	8	4	4.0	2.0	2.0	274	4,384	12.0	1	12	45,000	45,000
4. Compactor	12	5	5.0	2.0	2.0	274	5,480	15.0	0	0	50,000	0
5. Compactor	16	7	7.0	2.0	2.0	274	7,672	21.0	0	0	71,000	0
6. Hooklift truck			5.0	3.0	2.0	274	8,220	22.5	0	0	52,000	0
Total									2	21		85,000
C. New Vehicles with mechanical lifter Purchased in 2004 xxx											Unit Price ($/vehicle)	Total Cost
1 Compactor	4	2	2.0	2.0	2.0	274	2,192	6.0	**0**	0	62,000	0
2. Compactor	6	3	3.0	2.0	2.0	274	3,288	9.0	**2**	18	67,000	134,000
3. Compactor	8	4	4.0	2.0	2.0	274	4,384	12.0	**2**	24	70,000	140,000
4. Compactor	12	5	5.0	2.0	2.0	274	5,480	15.0	**2**	30	77,000	154,000
5. Compactor	16	7	7.0	2.0	2.0	274	7,672	21.0	**0**	0	118,000	0
6. Hooklift truck			5.0	3.0	2.0	274	8,220	22.5	**0**	0	60,000	0
Total									**6**	72		428,000
Grand Total (A+B)									9	104		

Table 4.3.4 Kien An Company Target Waste Collection Quantity by Collection Method

Unit: ton/day

Collection Method			Household Waste	Industrial, commercial and hospital waste	Demolition waste	Street Waste	Total
			1	2	3	4	5=1+2+3+4
A. Total Waste to be Collected by URENCO		a	45	31	2	11	89
B. Waste Collected by Direct Collection System Using Fixed Location Bins	Target Ratio	b	25%	60%	0%	10%	35%
	Target Quantity	c = a*b	11	19	0	1	31
	by 660 liter Bins (% out of c)	d	50%	80%	0%	0%	
	by 240 liter Bins (% out of c)	e	50%	20%	0%	100%	
	by 660 liter Bins (ton/day)	f = c*d	6	15	0	0	21
	by 240 liter Bins (ton/day)	g = c*e	5	4	0	1	10
C. Waste Collected with Primary Collection System (Double handling system)	Target Quantity	h = a-c	34	12	2	10	58
	by 660 liter Bin Cart (% out of h)	I	50%	50%	50%	50%	50%
	by traditional handcart (% out of h)	j	50%	50%	50%	50%	50%
	by 660 liter Bins (ton/day)	k = h*I	17	6	1	5	29
	by Traditional Handcart (t/d)	l = h*j	17	6	1	5	29

Table 4.3.4b Kien An Company Bin Procurement Plan

	Units of bins						
	Bins to be Used as of 2005						
	To be Used at fixed location for Direct Collection	To be Used for Primary Collection	Total	**To be Procured in 2004**	To be Procured in 2005	Unit Price ($/unit)	Purchase Cost ($)
	a	b	c = a+b	**d**	e = c-d	f	g = d*f
bin	81	37	118	**58**	60	240	13,920
bin	112	0	112	**56**	56	120	6,720
3. Traditional Handcart	0	54	54	**27**	27	120	3,240
4. Total	193	91	284	**141**	143		23,880

Note: Assumptions used for estimation of bin requirement

	Capacity		Number of Times Emptied	Quantity collected per bin per day
	liter/trip/bin	bin	times/ day	ton/bin/day
a	b	c	d	e = c*d
1. 660 liter bin used for primary collection				
	660	0.264	3	0.79
2. 660 liter bin used at fixed location				
	660	0.264	1	0.26
3. 240 liter bin used at fixed location				
	240	0.096	1	0.09
4. Traditional Handcart used for primary collection				
	450	0.18	3	0.54

Table 4.3.5 Do Son Company Waste Collection Vehicle Procurement Plan

Target Collection Amount in 2005 **87ton/day (75t/d x 1.15)**

	Capacity (m4)	Capacity (ton)	ton/trip	Trips/day	Shift/day	Days/Year	Annual Collection /vehicle (ton/vehicle/year)	Daily Average/vehicle (ton/vehicle/day)	(Units)	Daily Collection (ton/day)		
a	b	c	d	e	f	g	h = (d*e*f*g)	i = h/365	j	k = i*j		
A.. Existing Vehicles that will be still used in 2005												
1 Compactor	4	2	2.0	2.0	2.0	274	2,192	6.0	0	0		
2. Compactor	6	3	3.0	2.0	2.0	274	3,288	9.0	0	0		
3. Compactor	8	4	4.0	2.0	2.0	274	4,384	12.0	0	0		
4. Compactor	12	5	5.0	2.0	2.0	274	5,480	15.0	0	0		
5. Compactor	16	7	7.0	2.0	2.0	274	7,672	21.0	0	0		
6. Hooklift truck			5.0	3.0	2.0	274	8,220	22.5	0	0		
7. IFA Tipper			3.5	2.0	2.0	274	3,836	10.5	0	0		
Total									0	0		
B. Vehicles with mechanical lifter to be Procured during 2001-2003 by HPPC's Own Fund											Unit Price ($/vehicle)	Total Cost
1 Compactor	4	2	2.0	2.0	2.0	274	2,192	6.0	2	12	35,000	70,000
2. Compactor	6	3	3.0	2.0	2.0	274	3,288	9.0	0	0	40,000	0
3. Compactor	8	4	4.0	2.0	2.0	274	4,384	12.0	1	12	45,000	45,000
4. Compactor	12	5	5.0	2.0	2.0	274	5,480	15.0	0	0	50,000	0
5. Compactor	16	7	7.0	2.0	2.0	274	7,672	21.0	0	0	71,000	0
6. Hooklift truck			5.0	3.0	2.0	274	8,220	22.5	0	0	52,000	0
Total									3	24		115,000
C. New Vehicles with mechanical lifter Purchased in 2004											Unit Price ($/vehicle)	Total Cost
1 Compactor	4	2	2.0	2.0	2.0	274	2,192	6.0	**2**	12	62,000	124,000
2. Compactor	6	3	3.0	2.0	2.0	274	3,288	9.0	**1**	9	67,000	67,000
3. Compactor	8	4	4.0	2.0	2.0	274	4,384	12.0	**1**	12	70,000	70,000
4. Compactor	12	5	5.0	2.0	2.0	274	5,480	15.0	**2**	30	77,000	154,000
5. Compactor	16	7	7.0	2.0	2.0	274	7,672	21.0	**0**	0	118,000	0
6. Hooklift truck			5.0	3.0	2.0	274	8,220	22.5	**0**	0	60,000	0
Total									**6**	63		415,000
Grand Total (A+B)									9	87		

Table 4.3.6 Do Son Company Target Waste Collection Quantity by Collection Method

Unit: ton/day

Collection Method			Household Waste	Industrial, commercial and hospital waste	Demolition waste	Street Waste	Total
			1	2	3	4	5=1+2+3+4
A. Total Waste to be Collected by URENCO		a	2	62	2	9	75
B. Waste Collected by Direct Collection System Using Fixed Location Bins	Target Ratio	b	25%	60%	0%	10%	51%
	Target Quantity	c = a*b	1	37	0	1	38
	by 660 liter Bins (% out of c)	d	50%	80%	0%	0%	
	by 240 liter Bins (% out of c)	e	50%	20%	0%	100%	
	by 660 liter Bins (ton/day)	f = c*d	0	30	0	0	30
	by 240 liter Bins (ton/day)	g = c*e	0	7	0	1	9
C. Waste Collected with Primary Collection System (Double handling system)	Target Quantity	h = a-c	2	25	2	8	37
	by 660 liter Bin Cart (% out of h)	I	50%	50%	50%	50%	50%
	by traditional handcart (% out of h)	j	50%	50%	50%	50%	50%
	by 660 liter Bins (ton/day)	k = h*I	1	12	1	4	18
	by Traditional Handcart (t/d)	l = h*j	1	12	1	4	18

Table 4.3.6b Do Son Company Bin Procurement Plan

	Units of bins						
	Bins to be Used as of 2005						
	To be Used at fixed location for Direct Collection	To be Used for Primary Collection	Total	**To be Procured in 2004**	To be Procured in 2005	Unit Price ($/unit)	Purchase Cost ($)
	a	b	c = a+b	**d**	e = c-d	f	g = d*f
bin	115	24	139	**69**	70	240	16,560
bin	96	0	96	**48**	48	120	5,760
3. Traditional Handcart	0	34	34	**17**	17	120	2,040
4. Total	211	58	269	**134**	135		24,360

Note: Assumptions used for estimation of bin requirement

	Capacity		Number of Times Emptied	Quantity collected per bin per day
	liter/trip/bin	bin	times/ day	ton/bin/day
a	b	c	d	e = c*d
1. 660 liter bin used for primary collection				
	660	0.264	3	0.79
2. 660 liter bin used at fixed location				
	660	0.264	1	0.26
3. 240 liter bin used at fixed location				
	240	0.096	1	0.09
4. Traditional Handcart used for primary collection				
	450	0.18	3	0.54

Table 4.3.7 Aggregate Waste Collection Vehicles Procurement Plan for the 3 Companies

Target Collection Amount in 2005 875ton/day (761t/d x 1.15)

	Capacity (m4)	Capacity (ton)	ton/trip	Trips/day	Shift/day	Days/Year	Annual Collection /vehicle (ton/vehicle/year)	Daily Average/vehicle (ton/vehicle/day)	(Units)	Daily Collection (ton/day)		
a	b	c	d	e	f	g	h = (d*e*f*g)	i = h/365	j	k = i*j		
A.. Existing Vehicles that will be still used in 2005												
1 Compactor	4	2	2.0	2.0	2.0	274	2,192	6.0	1	6		
2. Compactor	6	3	3.0	2.0	2.0	274	3,288	9.0	1	9		
3. Compactor	8	4	4.0	2.0	2.0	274	4,384	12.0	2	24		
4. Compactor	12	5	5.0	2.0	2.0	274	5,480	15.0	2	30		
5. Compactor	16	7	7.0	2.0	2.0	274	7,672	21.0	0	0		
6. Hooklift truck			5.0	3.0	2.0	274	8,220	22.5	4	90		
7. IFA Tipper			3.5	2.0	2.0	274	3,836	10.5	7	74		
Total									17	233		
B. Vehicles with mechanical lifter to be Procured during 2001-2003 by HPPC's Own Fund											Unit Price ($/vehicle)	Total Cost
1 Compactor			2.0	2.0	2.0	274	2,192	6.0	5	30	35,000	175,000
2. Compactor			3.0	2.0	2.0	274	3,288	9.0	4	36	40,000	160,000
3. Compactor			4.0	2.0	2.0	274	4,384	12.0	2	24	40,000	80,000
4. Compactor			5.0	2.0	2.0	274	5,480	15.0	0	0	50,000	0
5. Compactor			7.0	2.0	2.0	274	7,672	21.0	0	0	71,000	0
6. Hooklift truck			5.0	3.0	2.0	274	8,220	22.5	0	0	52,000	0
Total									11	90		425,000
C. New Vehicles with mechanical lifter Purchased in 2004											Unit Price ($/vehicle)	Total Cost
1 Compactor	4	2	2.0	2.0	2.0	274	2,192	6.0	**4**	24	62,000	248,000
2. Compactor	6	3	3.0	2.0	2.0	274	3,288	9.0	**7**	63	67,000	469,000
3. Compactor	8	4	4.0	2.0	2.0	274	4,384	12.0	**18**	216	70,000	1,260,000
4. Compactor	12	5	5.0	2.0	2.0	274	5,480	15.0	**6**	90	77,000	462,000
5. Compactor	16	7	7.0	2.0	2.0	274	7,672	21.0	**6**	126	118,000	708,000
6. Hooklift truck			5.0	3.0	2.0	274	8,220	22.5	**2**	45	60,000	120,000
Total									**43**	565		3,267,000
Grand Total (A+B)									71	887		

Table 4.3.8 The 3 Companies Aggregate Target Waste Collection Quantity by Collection Method

Unit: ton/day

Collection Method			Household Waste	Industrial, commercial and hospital waste	Demolition waste	Street Waste	Total
			1	2	3	4	5=1+2+3+4
A. Total Waste to be Collected by URENCO		a	351	301	15	94	761
B. Waste Collected by Direct Collection System Using Fixed Location Bins	Target Ratio	b	25%	60%	0%	10%	36%
	Target Quantity	c = a*b	88	181	0	9	278
	by 660 liter Bins (% out of c)	d	50%	80%	0%	0%	
	by 240 liter Bins (% out of c)	e	50%	20%	0%	100%	
	by 660 liter Bins (ton/day)	f = c*d	44	145	0	0	189
	by 240 liter Bins (ton/day)	g = c*e	44	36	0	9	89
C. Waste Collected with Primary Collection System (Double handling system)	Target Quantity	h = a-c	263	120	15	85	483
	by 660 liter Bin Cart (% out of h)	I	50%	50%	50%	50%	50%
	by traditional handcart (% out of h)	j	50%	50%	50%	50%	50%
	by 660 liter Bins (ton/day)	k = h*I	132	60	8	42	242
	by Traditional Handcart (t/d)	l = h*j	132	60	8	42	242

Table 4.3.8b The 3 Companies Aggregate Bin Procurement Plan

	Units of bins						
	Bins to be Used as of 2005						
	To be Used at fixed location for Direct Collection	To be Used for Primary Collection	Total	**To be Procured in 2004**	To be Procured in 2005	Unit Price ($/unit)	Purchase Cost ($)
	a	b	c = a+b	**d**	e = c-d	f	g = d*f
bin	727	308	1035	**516**	519	240	123,840
bin	989	0	989	**494**	495	120	59,280
3. Traditional Handcart	0	449	449	**224**	225	120	26,880
4. Total	1,716	757	2,473	**1,234**	1,239		210,000

Note: Assumptions used for estimation of bin requirement

	Capacity		Number of Times Emptied	Quantity collected per bin per day
	liter/trip/bin	bin	times/ day	ton/bin/day
a	b	c	d	e = c*d
1. 660 liter bin used for primary collection				
	660	0.264	3	0.79
2. 660 liter bin used at fixed location				
	660	0.264	1	0.26
3. 240 liter bin used at fixed location				
	240	0.096	1	0.09
4. Traditional Handcart used for primary collection				
	450	0.18	3	0.54

Table 4.4.1 (1/2) Investment Cost for Trang Cat Phase 3 Landfill Site [Non-Hazardous Landfill Field and Leachate Treatment]

Amount of Waste: 2,539,093 tonns for 9.77 years from the beginning of 2005

Item No.	Item	Unit cost (US$/unit)	unit	Site Quantity	Cost (US$)	Remark
A. Construction cost						
1	**Surrounding Embankment for 1st Layer**					
	Material	2.20	m3	0	0	
	Embankment	4.50	m3	156,442	0	incl. Materials cost
	Penetration clay covering	5.00	m3	0	0	
	Road Surface	5.00	m2	10,000	50,000	
	Surface adjustment	1.50	m2	60,000	90,000	
	Sub total				**140,000**	
2	**Section Embankment**					5% of Surrounding embankment
	Material	2.13	m3	0	0	30,000 Dong/m3
	Embankment	3.55	m3	7,822	27,768	Dong/m3
	Penetration clay covering	1.00	m3	0	0	0.1m thick
	Road Surface	5.00	m2	500	2,500	
	Surface adjustment	1.50	m2	3,000	4,500	
	Sub total				**34,768**	
3	**On-site road crossing the dykes**					
	Material	2.20	m3	0	0	
	Embankment	3.55	m3	1,500	5,325	Dong/m3
	Road Surface	5.00	m2	500	2,500	
	Sub total				**7,825**	
4	**Surcharge for Landfill Areas Geodynamic Improvement**					This soil will be used for 2nd-5th layer embnakments, after preloading completion.
	Preload Material	2.20	m3	210,000	462,000	52500m2 x 4m height
	Sand for Drainage layer	5.00	m3	1,050	5,250	52500m2 x 0.02m/m2
	Filling Work	1.30	m3	844,200	1,097,460	(211,050 + 1050) x 4 times
	Sub total				**1,564,710**	
5	**Leachate collection facility**					
	PVC Pipe (D=600mm)	11.09	m	2,185	24,232	156000 Dong/m
	(D=400mm)	7.82	m	1,115	8,719	110000 Dong/m
	(D=200mm)	5.69	m	4,087	23,255	80000 Dong/m
	Excavation for D600	2.84	m3	360	1,022	40000 Dong/m
	for D400	2.84	m3	0	0	40000 Dong/m
	For D200	2.84	m3	0	0	40000 Dong/m
	Gravel (50-150mm) for D600	4.62	m3	2,185	10,095	65,000 Dong/m3; 1m3/m
	for D400	4.62	m3	781	3,606	65,000 Dong/m3; 0.7m3/m
	For D200	4.62	m3	2,452	11,329	65,000 Dong/m3; 0.6m3/m
	Protection Membrane for D 600	0.40	m2	8,740	3,496	Width 4m
	for D 400	0.40	m2	3,568	1,427	Width 3.2m
	for D 200	0.40	m2	10,218	4,087	Width 2.5m
	Sub total				**91,268**	
6	**Surface water collction facility**					
	U type drainage ditch (450*450)	12.50	m	8,690	108,625	
	Excavation	2.84	m3	1,760	4,998	40,000 Dong/m3
	Gravel (50-150mm)	4.62	m3	196	903	65,000 Dong/m3
	Sub total				**114,526**	
7	**Liner facilities**					
	Geomembrane for 1st layer (material cost only)	5.00	m2	268,831	1,344,155	HDPE thickness: 1.5mm Overlap: 10%, (for bottom & walls)
	only)	2.00	m2	268,831	537,662	(for bottom & walls)
	Geomembrane for 2nd-5th layers (material cost only)	5.00	m2	44,988	224,940	HDPE thickness: 1.5mm Overlap: 10%, (for walls only)
	Bamboo net	1.50	m2	268,831	403,247	
	Protection layer on liner(150mm)	5.00	m3	40,325	201,623	Sand or Normal soil is applicable
	Protection layer below liner(100mm)	5.00	m3	26,883	134,416	Sand or Normal soil is applicable
	Sub total				**2,846,042**	
8	**Leachate treatment facility**					
	Precipitation + Aeration + Re-circulation	300,000.00	station	1	300,000	(960m3/d)
	Sub total				**300,000**	
9	**Leachate pumping**					
	Pump (60 m3/hr)	2,580.00	station	4	10,320	
	Electric cable	39.00	m	800	31,200	
	Delivery pipe	55.00	m	2,000	110,000	
	Sub total				**151,520**	
10	**Leachate regulating pond**				(4000m3/d x 2)	

Table 4.4.1 (2/2) Investment Cost for Trang Cat Phase 3 Landfill Site [Non-Hazardous Landfill Field and Leachate Treatment]

Item No.	Item	Unit cost (US$/unit)	unit	Site Quantity	Cost (US$)	Remark
	Excavation	2.00	m3	20,000	40,000	
	Embankment	4.50	m3	10,000	45,000	
	Surface adjustment	1.50	m2	2,000	3,000	
	Sub total				**88,000**	
11	**Passive gas vents:**					
	Vertical gas vents (D150 pipe + section timber)	24.00	No	70	1,680	
	Sub total				**1,680**	
12	**Fencing :**					
	2m security , cranked tops (Surrounding area)	12.80	m	4,253	54,438	
	(transfer type for compartment)	9.00	m	800	7,200	
	Sign (notice) board	24.50	unit	4	98	
	Sign (guide) board in site	24.50	unit	4	98	
	Sub total				**61,834**	
13	**Lighting system**	4,800.00	Set	1	4,800	
	Sub total				**4,800**	
14	**Landscape planting:**					
	Standard trees (5m pitch * 2km)	8.00	unit	350	2,800	
	Hedges	5.00	m	400	2,000	
	Grass seeding:	0.66	m2	30,000	19,800	
	Sub total				**24,600**	
15	**Groundwater monitoring boreholes**	12.20	m	40	488	D=100mm, 20 m deep x 2 holes
	Sub total				**488**	
16	**Fuel stores/ garages/workshops**	142.12	m2	80	11,370	
	Sub total				**11,370**	
17	**Site services :**					
	Water	1,550.00	unit	1	1,550	
	Electricity	1,800.00	unit	1	1,800	
	Telephone	400.00	unit	2	800	
	Sub total				**4,150**	
18	**Access road improvement**					15m(W) x 4m(H) x 650m(L)
	Material	1.00	m3	39,000	39,000	
	Embankment	1.00	m3	39,000	39,000	
	Road Surface	5.00	m2	7,800	39,000	
	Sub total				**117,000**	
(A)	**Total cost of Item 1-18**				**5,564,582**	
19	**Temporary Works and others**				**556,458**	Total cost for Items 1-18 (A) x 10%
					6,121,040	Total cost for Items 1-19
B. Procurement cost						
1	**Heavy equipment**					
	Buldozer (total weight: 15t)	219,750.00	unit	4	879,000	
	Dumptruck (loading capacity: 11t)	92,500.00	unit	2	185,000	
	Pick-up truck	20,000.00	unit	1	20,000	
	Backhoe(0.6m3)	128,300.00	unit	1	128,300	
	Front Loader(1m3)	110,000.00	unit	1	110,000	
	Vacuum Tank Truck	89,500.00	unit	1	89,500	
	Sub total				**1,411,800**	
C. Land Acquisition Cost & Compensation						
	Acquisition Cost	1.70	m2	327,000	555,900	
	Compensation for fishery activities for 2004	0.14	m2	327,000	45,780	
	Sub total				**601,680**	
D. Engineering (Detailed design & supervision)						
1	For construction works (10%)				612,104	
2	For equipment procurement (5%)				70,590	
3	**Total**				**682,694**	
E.	**Grand Total**				**8,817,214**	

Total quantity of waste disposed of during 9.77 years from the beginning of 2005	**2,539,093 ton**
Unit Cost (total cost/total cumulative waste quantity disposed during use period of Trang Cat Phase 3 Site	**3.47**

Table 4.4.2 Annual Costs of Operation & Maintenance of Trang Cat Phase 3 Landfill Site [Non-hazardous Waste Landfill Filed]

Waste received: 259,887 ton/year (average)

Item No.	Item	Unit cost (US$/unit/year)	unit	Site Quantity	Yearly Cost (US$/year)	Remark
1	**Wages and salaries**					VND/month
	Manager	1,241.38	employee	1	1,241	1,500,000
	Deputy manager	993.10	employee	2	1,986	1,200,000
	Secretary	662.07	employee	1	662	800,000
	Chief engineer	993.10	employee	2	1,986	1,200,000
	Truck scale engineer	827.59	employee	1	828	1,000,000
	Truck scale operator	662.07	employee	3	1,986	800,000
	Leachate control engineer	993.10	employee	1	993	1,200,000
	Chief operator	662.07	employee	2	1,324	800,000
	Operator	620.69	employee	12	7,448	750,000
	Additional operator in 2008	620.69	employee	0.69	430	750,000
	Additional operator in 2011	620.69	employee	0.39	240	750,000
	Guardman	620.69	employee	4.00	2,483	750,000
	Sub total				**21,608**	
2	**Machine repair and maintenance:**					
	Buldozer (total weight: 15t)	21,975.00	unit	4	87,900	10% of purchase cost/year
	Dumptruck (loading capacity: 11t)	9,250.00	unit	2	18,500	10% of purchase cost/year
		2,000.00	unit	1	2,000	10% of purchase cost/year
	Backhoe(0.6m3)	12,830.00	unit	1	12,830	10% of purchase cost/year
	Front Loader(1m3)	11,000.00	unit	1	11,000	10% of purchase cost/year
	Vacuum Tank Truck	8,950.00	unit	1	8,950	10% of purchase cost/year
	Sub total				**141,180**	
3	**Fuel**	0.50	ton of waste	30,000	15,000	
	Sub total				**15,000**	
4	**Soil for cover and section dike**					352,652m3/9.77years
	Daily cover:	1.00	m3	36,095	36,095	
	Sub total				**36,095**	
5	**Mounting UP of 2nd-5th layer**					209,439m3/9.777years
	Embankment for mounting up (2005 - 2014)	1.00	m3	21,437	21,437	Exclude the soil material cost
	Geomembrane Liner Installation	2.00	m2	44,988	89,976	
	Sub total				**111,413**	
6	**Site maintenance(roads, grass, cutting,**	55,645.82	site	1	55,646	1% of total construction cost (A)
	Sub total				**55,646**	
7	**Environmental control (pests, wind, etc.)**	10,000.00	site	1	10,000	
	Sub total				**10,000**	
8	**Environmental monitoring**					
	Leachate and treated water	500.00	time/year	12	6,000	
	Ground water	250.00	time/year	12	3,000	
	Gas	100.00	time/year	12	1,200	
	Settlement	1,200.00	time/year	4	4,800	
	Odor	50.00	time/year	1	50	
	Sub total				**15,050**	
9	**Electricity**					
	for leachate removal pump	10.00	kWh	4,000	40,000	
	for lighting system	10.00	kWh	150	1,500	
	for water supply station	10.00	kWh	160	1,600	
	for administration office	10.00	kWh	500	5,000	
	Sub total				**48,100**	
10	**Others**				**14,430**	Telephone, etc.
	Total annual operating cost				**468,522**	
	Cumulative O/M cost during 9.77 years from the beginning of 2005				**4,577,458**	9.77

Total quantity of waste disposed of during 9.77 years from the beginning of 2005	**2,539,093 ton**
Unit O/M cost per ton	**1.80**
Unit Construction Cost per Ton	**3.47**
Total Unit Cost Per Ton	**5.27**

Table 4.4.3 (4/2) Investment Costs of Trang Cat Phase 3 Landfill Site [Hospital Waste Incineration Residue Landfill Site]

Amount of Waste: 36,567 tonns for 20.04 years from the beginning of 2005

Item No.	Item	Unit cost (US$/unit)	unit	Site Quantity	Cost (US$)	Remark
A. Construction cost						
1	**Surrounding Embankment**					
	Material	2.20	m3	0	0	
	Embankment	4.50	m3	11,796	53,082	incl. Materials cost
	Penetration clay covering	5.00	m3	4,000	20,000	
	Road Surface	5.00	m2	0	0	
	Surface adjustment	1.50	m2	0	0	
	Sub total				**73,082**	
2	**Section Embankment**					5% of Surrounding embankment
	Material	2.13	m3	0	0	30,000 Dong/m3
	Embankment	3.55	m3	590	2,094	Materials 30,000 Dong/m3 + Labor 20,000
	Penetration clay covering	1.00	m3	200	200	0.1m thick
	Road Surface	5.00	m2	0	0	
	Surface adjustment	1.50	m2	0	0	
	Sub total				**2,294**	
3	**On-site road crossing the dykes**					
	Material	2.20	m3	0	0	
	Embankment	3.55	m3	1,500	5,325	Materials 30,000 Dong/m3 + Labor 20,000
	Road Surface	5.00	m2	0	0	
	Sub total				**5,325**	
4	**Landfill area excavation**	1.50	m3	0	0	This soil will be used for 2nd-5th layer embnakments, after preloading completion.
						52500m2 x 4m height
						52500m2 x 0.02m/m2
	Sub total				**0**	
5	**Leachate collection facility**					
	PVC Pipe (D=600mm)	11.09	m	500	5,545	156000 Dong/m
	(D=400mm)	7.82	m	200	1,564	110000 Dong/m
	(D=200mm)	5.69	m	200	1,138	80000 Dong/m
	Excavation for D600	2.84	m3	360	1,022	40000 Dong/m
	for D400	2.84	m3	0	0	40000 Dong/m
	For D200	2.84	m3	0	0	40000 Dong/m
	Gravel (50-150mm) for D600	4.62	m3	500	2,310	65,000 Dong/m3; 1m3/m
	for D400	4.62	m3	140	647	65,000 Dong/m3; 0.7m3/m
	For D200	4.62	m3	120	554	65,000 Dong/m3; 0.6m3/m
	Protection Membrane for D 600	0.40	m2	0	0	Width 4m
	for D 400	0.40	m2	0	0	Width 3.2m
	for D 200	0.40	m2	0	0	Width 2.5m
	Sub total				**12,781**	
6	**Surface water collction facility**					
	U type drainage ditch (450*450)	12.50	m	1,600	20,000	
	Excavation	2.84	m3	324	920	40,000 Dong/m3
	Gravel (50-150mm)	4.62	m3	36	166	65,000 Dong/m3
	Sub total				**21,086**	
7	**Liner facilities**					
	Geomembrane (material cost only)	5.00	m2	16,563	82,815	HDPE thickness: 1.5mm Overlap: 10%, (for bottom & walls)
	Geomembrane (installation cost only)	2.00	m2	16,563	33,126	(for bottom & walls)
	Bamboo net	1.50	m2	16,563	24,845	
	Protection layer on liner(150mm)	5.00	m3	2,484	12,422	Sand or Normal soil is applicable
	Protection layer below liner(100mm)	5.00	m3	1,656	8,282	Sand or Normal soil is applicable
	Sub total				**161,489**	
8	**Leachate treatment facility**					
	Precipitation + Aeration + Re-circulation	300,000.00	station	0	0	(960m3/d)
	Sub total				**0**	
9	**Leachate pumping**					
	Pump (60 m3/hr)	2,580.00	station	2	5,160	
	Electric cable	39.00	m	800	31,200	
	Delivery pipe	55.00	m	2,000	110,000	
	Sub total				**146,360**	
10	**Leachate regulating pond**				(4000m3/d x 2)	
	Excavation	2.00	m3	0	0	
	Embankment	4.50	m3	0	0	
	Surface adjustment	1.50	m2	0	0	
	Sub total				**0**	

Table 4.4.3 (5/2) Investment Costs of Trang Cat Phase 3 Landfill Site [Hospital Waste Incineration Residue Landfill Site]

Item No.	Item	Unit cost (US$/unit)	unit	Site Quantity	Cost (US$)	Remark
11	**Passive gas vents:**					
	Vertical gas vents (D150 pipe + section timber	24.00	No	10	240	
	Sub total				**240**	
12	**Fencing :**					
	2m security , cranked tops (Surrounding area)	12.80	m	0	0	
	(transfer type for compartment)	9.00	m	0	0	
	Sign (notice) board	24.50	unit	0	0	
	Sign (guide) board in site	24.50	unit	0	0	
	Sub total				**0**	
13	**Lighting system**	4,800.00	Set	0	0	
	Sub total				**0**	
14	**Landscape planting:**					
	Standard trees (5m pitch * 2km)	8.00	unit	0	0	
	Hedges	5.00	m	0	0	
				0		
	Grass seeding:	0.66	m2	0	0	
	Sub total				**0**	
15	**Groundwater monitoring boreholes**	12.20	m	0	0	D=100mm, 20 m deep x 2 holes
	Sub total				**0**	
16	**Fuel stores/ garages/workshops**	142.12	m2	80	11,370	
	Sub total				**11,370**	
17	**Site services :**					
	Water	1,550.00	unit	0	0	
	Electricity	1,800.00	unit	0	0	
	Telephone	400.00	unit	0	0	
	Sub total				**0**	
18	**Access road improvement**					15m(W) x 4m(H) x 650m(L)
	Material	1.00	m3	0	0	
	Embankment	1.00	m3	0	0	
	Road Surface	5.00	m2	0	0	
	Sub total				**0**	
(A)	**Total cost of Item 1-18**				**434,027**	
20	**Temporary Works and others**				**43,403**	Total cost for Items 1-18 (A) x 10%
					477,430	Total cost for Items 1-19
B. Procurement cost						
1	**Heavy equipment**					
	Buldozer (total weight: 15t)	219,750.00	unit	0	0	
	Dumptruck loading capacity (11t)	92,500.00	unit	0	0	
	Pick-up truck	20,000.00	unit	0	0	
	Backhoe(0.6m3)	128,300.00	unit	0	0	
	Front Loader(1m3)	110,000.00	unit	0	0	
	Vacuum Tank Truck	89,500.00	unit	0	0	
	Sub total				**0**	
C. Land Acquisition Cost					**0**	
D. Engineering (Detailed design & supervision)						
1	For construction works (10%)				47,743	
2	For equipment procurement (5%)				0	
3	**Total**				**47,743**	
E.	**Grand Total**				**525,173**	

Total quantity of waste disposed of during the period	**36,567 ton**
Unit Cost (total cost/total cumulative waste quantity disposed during use period of Trang Cat Phase 3 Site	**14.36**

Table 4.4.4 Annual Costs of Operation & Maintenance of Trang Cat Phase 3 Landfill Site [Incineration Residue Landfill Field]

Waste received: 1,825 ton/year (average)

Item No.	Item	Unit cost (US$/unit/year)	unit	Site Quantity	Yearly Cost (US$/year)	Remark
1	**Wages and salaries**					VND/month
	Manager	1,241.38	employee	0	0	1,500,000
	Deputy manager	993.10	employee	0	0	1,200,000
	Secretary	662.07	employee	0	0	800,000
	Chief engineer	993.10	employee	0	0	1,200,000
	Truck scale engineer	827.59	employee	0	0	1,000,000
	Truck scale operator	662.07	employee	0	0	800,000
	Leachate control engineer	993.10	employee	0	0	1,200,000
	Chief operator	662.07	employee	0	0	800,000
	Operator	620.69	employee	0	0	750,000
	Additional operator in 2008	620.69	employee	0	0	750,000
	Additional operator in 2011	620.69	employee	0	0	750,000
	Guardman	620.69	employee	0	0	750,000
	Sub total				**0**	
2	**Machine repair and maintenance:**					
	Buldozer (total weight: 15t)	21,975.00	unit	0	0	10% of purchase cost/year
	Dumptruck (loading capacity: 11t)	9,250.00	unit	0	0	10% of purchase 0ost/year
		2,000.00	unit	0	0	10% of purchase cost/year
	Backhoe(0.6m3)	12,830.00	unit	0	0	10% of purchase cost/year
	Front Loader(1m3)	11,000.00	unit	0	0	10% of purchase cost/year
	Vacuum Tank Truck	8,950.00	unit	0	0	10% of purchase cost/year
	Sub total				**0**	
3	**Fuel**	0.50	ton of waste	1,825	913	
	Sub total				**913**	
4	**Soil for cover and section dike**					6453m3/20.04years
	Daily cover:	1.00	m3	322	322	
	Sub total				**322**	
5	**Embankment**					
	Embankment for mounting up	1.00	m3	0	0	
	Sub total				**0**	
6	**Site maintenance(roads, grass, cutting, drainage)**	2,170.13	site	1	2,170	0.5% of total construction cost (A
	Sub total				**2,170**	
7	**Environmental control (pests, wind, etc.)**	10,000.00	site	1	0	
	Sub total				**0**	
8	**Environmental monitoring**					
	Leachate and treated water	500.00	time/year	0	0	
	Ground water	250.00	time/year	0	0	
	Gas	100.00	time/year	0	0	
	Settlement	1,200.00	time/year	0	0	
	Odor	50.00	time/year	0	0	
	Sub total				**0**	
9	**Electricity**					
	for leachate removal pump	10.00	kWh	10	100	
	for lighting system	10.00	kWh	0	0	
	for water supply station	10.00	kWh	0	0	
	for administration office	10.00	kWh	0	0	
	Sub total				**100**	
10	**Others**				**30**	
	Total annual operating cost				**3,535**	
	Cumulative O/M cost during 20.04 years from the beginning of 2005				**70,820**	20.04

Total quantity of waste disposed of during 20.04 years from the beginning of 2005	**36,567 ton**
Unit O/M cost per ton	**1.94**
Unit Construction Cost per Ton	**14.36**
Total Unit Cost Per Ton	**16.30**

Table 4.4.5 Cost Summary of Trang Cat Phase 3 Landfill Site

Unit: US$ in 2000 price

	Non-Hazardous Waste Landfill + Leachate Treatment	Hospital Waste Incineration Residue Landfill	Total
	a	b	c
A. Investment			
1. Construction	6,121,040	477,430	6,598,470
2. Heavy Equipment	1,411,800	0	1,411,800
3. Land acquisition	601,680	0	601,680
4. Engineering (10% of 1 + 5% of 2)	682,694	47,743	730,437
5. Sub-total (1+2+3+4)	8,817,214	525,173	9,342,387
6. Administration cost	264,516	15,755	280,272
7. Sub-total (5+6)	9,081,730	540,928	9,622,658
8. Contingency (10% of 7)	908,173	54,093	962,266
9. Total (8+9)	9,989,903	595,021	10,584,924
B. Operation & Maintenance for 10 years	4,577,458	70,820	4,648,277
	(9.77 years)	(20.04 years)	
C. Total (A + B)	14,567,361	665,840	15,233,201
D. Total Waste Received (ton)	2,539,093	36,567	2,575,660
		(as the residue)	
E Unit Cost per ton ($/ton)			
1. Investment cost	3.93	16.27	4.11
2. Operation & Maitenance	1.80	1.94	1.80
c. Total (1+2)	5.73	18.21	5.91
F Unit Cost per ton of medical waste ($/ton) (See Note below.)			
1. Investment cost		5.42	
2. Operation & Maitenance		0.65	
c. Total (1+2)		6.07	

Note: Amount (weight) of Incineration reisidues is one third of that of original medical waste.

Table 4.4.6 Summary of Soil Characters in 4 Strata in Trang Cat Site

Stratum Number		1	2	3	4
Classification		Sandy Lean Clay	Plastic Silt	Plastic Silt	Lean Clay
Color		Grey	Grey	Yellowish Grey	Red-Brown, Yellow
Hardness		Very Soft	Soft to Very Soft	Soft to Very Soft	Stiff
The Numbers of Samples		4	4	2	1
Averaged Thickness (m)		7.24	5.17	7.34	6.20
Moisture content ***w***(%)		29.1	59.3	53.6	37.2
Wet density γ_w(g/cm^3)		1.8	1.69	1.74	1.84
Dry density γ_d(g/cm^3)		1.34	1.09	1.16	1.34
Specific gravity Gs (g/cm^3)		2.62	2.64	2.66	2.66
Void ratio ***e***		0.951	1.444	1.28	0.983
Porosity **n** (%)		48.85	58.82	56.23	49.62
Degree of saturation S (%)		83.48	102.37	102.89	100.66
Liquid limit LL(%)		30.53	60.13	51.10	46.80
Plastic Limit PL (%)		20.93	34.63	31.50	26.20
Plasticity index PI (%)		9.60	25.50	19.60	20.60
Liquidity index LI(%)		0.83	1.09	0.93	0.53
Shear test	Angle of internal friction ϕ (degree)	24°28'	4°28'	2°59'	7°19'
	Cohesion C (kg/cm2)	0.16	0.09	0.12	0.42
Consolidation Test	Preconsolidation pressure P0 (kg/cm2)	0.82	0.51	0.88	-
	Coefficient of consolidation Cv (x 10^{-3}cm^2/s)	0.74	0.84	0.54	-
	Coefficient of permeability K (x 10^{-7}cm/s)	0.128	0.496	0.240	-
	Compression Index Cc	0.104	0.447	0.307	-
	Swell Index Cs	0.019	0.047	0.030	-
Compression ratio a_{1-2} (cm^2/kg)		-	0.096	-	0.041
Triaxial Test	Angle of internal friction ϕ (degree)	6°42'	7°45'	5°16'	-
	Cohesion C (kg/cm2)	0.076	0.123	0.090	-
Permeability K (x 10^{-7}cm/sec)		3.170	0.775	0.059	0.094
Resilient Modulus E (kg/cm2)		-	31.80	-	72.00
Chemical test result	Cation Exchage Capacity (meq/100g soil)	5.25	20.50	22.20	15.75
	Ignition Loss (%)	6.91	13.29	11.97	11.59
	Organic Content (%)	5.12	9.78	8.69	8.42

Table 4.4.7 Consolidation of Stratum 1 by Surcharge Soil of 4m (and 3m) Height

Improvement Case		**1**	**2**	**3**	**4**
Targets of Bearing Capacity at the Surface: P_G (kg/cm2)		1.0	1.1	1.2	1.5
Thickness of Stratum: H (m)		7.24 (Average Value of Geological Survey)			
Wet Density: γ_w (g/cm^3)		1.75 (Average Value of Geological Survey)			
Preconsolidation Pressure: P_0 (kg/cm2)		0.82 (Result of Geological Survey)			
Coefficient of Consolidation: Cv (x 10^{-3}cm^2/s)		0.74 (Result of Geological Survey)			
Compression Index: C_c (kg/cm2)		0.104 (Result of Geological Survey)			
Void Ratio (at the present): $\boldsymbol{e}_1$ (-)		0.951 (Result of Geological Survey)			
Wet Density of Surcharge Soil: γ_{ss} (g/cm^3)		1.6 (Assumption)			
Height of Surcharge Soil: h (m)		4 or 3			
Pressure at the bottom of Stratum 1 at the present $P_1 = P_0 + H \times 100 \times (\gamma_w - 1)/1000$		1.363			
Pressure at the bottom of Stratum 1 with surcharge: $P' = P_1 + h \times 100 \times \gamma_{ss}/1000$		2.003 (h = 4m) / 1.843 (h = 3m)			
Void Ratio (P = P'): $\boldsymbol{e}' = \boldsymbol{e}_1 - (Cc \times \log (P'/P_1))$		0.934 (h = 4m) / 0.937 (h = 3m)			
Bearing Stress at the bottom of Stratum 1, when the Surface's bearing capacity will reach to the target value level $P = P_G + H \times 100 \times (\gamma_w - 1)/1000$		1.543	1.643	1.743	2.043
Void Ratio ($P = P_G + H \times (\gamma_w - 1)/1000$): $\boldsymbol{e}_G = \boldsymbol{e}_1 - (Cc \times \log (P_G/P_1))$		0.942	0.934	0.924	0.911
h=4	Degree of Consolidation at the target level Uv (%) = $(\boldsymbol{e}_1-\boldsymbol{e}_G)/(\boldsymbol{e}_1-\boldsymbol{e}')$	32.2	48.5	63.9	105.1
	Tv (Uv) from the consolidation chart	0.029	0.082	0.2	-
	t (days) = H x H x Tv / Cv	238	672	1640	-
h=3	Degree of Consolidation at the target level Uv (%) = $(\boldsymbol{e}_1-\boldsymbol{e}_G)/(\boldsymbol{e}_1-\boldsymbol{e}')$	41.1	61.9	81.5	134.1
	Tv (Uv) from the consolidation chart	0.05	0.114	0.46	-
	t (days) = H x H x Tv / Cv	410	935	3771	-

Table 4.6.1 Solid Waste Management Priority Project Cost (1) URENCO

Unit: $1,000

Cost Items	2000	2001	2002	2003	2004	2005	Sub-total 2000-2005	2006	2007	2008	2009	2010	Sub-total 2006-2010	Sub-total 2000 - 2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Sub-total 2011-2020	Total 2000-2020
A. INVESTMENT																										
1. Waste collection & transport																										
1.1 Equipment (Vehicle, Container, Workshop equipment)	0	0	0	0	2,886	0	2,886	0	0	0	0	0	0	2,886	0	0	0	0	0	0	0	0	0	0	0	2,886
1.2 Engineering service (5% of Item 1.1)	0	0	0	144	0	0	144	0	0	0	0	0	0	144	0	0	0	0	0	0	0	0	0	0	0	144
1.3 Total (1.1+1.2)	0	0	0	144	2,886	0	3,030	0	0	0	0	0	0	3,030	0	0	0	0	0	0	0	0	0	0	0	3,030
2. Landfill							0																			
2.1 Site construction (mainly civil works	0	0	0	0	3,299	3,299	6,598	0	0	0	0	0	0	6,598	0	0	0	0	0	0	0	0	0	0	0	6,598
2.2 Heavy equipment (bulldozers)	0	0	0	0	1,412	0	1,412	0	0	0	0	0	0	1,412	0	0	0	0	0	0	0	0	0	0	0	1,412
2.3 Land acquisition	0	0	0	602	0	0	602	0	0	0	0	0	0	602	0	0	0	0	0	0	0	0	0	0	0	602
2.4 Total (2.1+2. + 2.3)	0	0	0	602	4,711	3,299	8,612	0	0	0	0	0	0	8,612	0	0	0	0	0	0	0	0	0	0	0	8,612
2.5 Closure of the former and existing sites	0	0		0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.6 Engineering service (10% of 2.1 & 2.5 plus 5% of 2.2)	0	0	0	400	330	0	730	0	0	0	0	0	0	730	0	0	0	0	0	0	0	0	0	0	0	730
2.7 Total (2.4+2.5 + 2.6)	0	0	0	1,002	5,041	3,299	9,342	0	0	0	0	0	0	9,342	0	0	0	0	0	0	0	0	0	0	0	9,342
3. Hospital waste treatment							0																			
3.1 Incineration plant (equipment & facility)	0	0	0	0	263	0	263	0	0	0	0	0	0	263	0	0	0	0	0	0	0	0	0	0	0	263
3.2 Incineration plant (site preparation & building)	0	0	0	0	87	0	87	0	0	0	0	0	0	87	0	0	0	0	0	0	0	0	0	0	0	87
3.3 Collection vehicle	0	0	0	0	76	0	76	0	0	0	0	0	0	76	0	0	0	0	0	0	0	0	0	0	0	76
3.4 Waste storage room in hospital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5 Engineering Service (10% of the above)	0	0	0	43	0	0	43	0	0	0	0	0	0	43	0	0	0	0	0	0	0	0	0	0	0	43
3.6 Pilot project	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.7 Total (3.1+3.2+3.3 + 3.4+3.5+3.6)	0	0	0	43	426	0	469	0	0	0	0	0	0	469	0	0	0	0	0	0	0	0	0	0	0	469
4 Total																										
4.1 Sub total of Construction (2.1+2.5+3.2+3.4)	0	0	0	0	3,386	3,299	6,685	0	0	0	0	0	0	6,685	0	0	0	0	0	0	0	0	0	0	0	6,685
4.2 Sub total of equipment (1.1+2.2+3.1+3.3)	0	0	0	0	4,637	0	4,637	0	0	0	0	0	0	4,637	0	0	0	0	0	0	0	0	0	0	0	4,637
4.3 Sub total of land acquisition	0	0	0	602	0	0	602	0	0	0	0	0	0	602	0	0	0	0	0	0	0	0	0	0	0	602
4.4 Sub total of Engineering Services (1.2+2.6+3.5+3.6)	0	0	0	587	330	0	917	0	0	0	0	0	0	917	0	0	0	0	0	0	0	0	0	0	0	917
4.5 Sub total (4.1+4.2+4.3+4.4)	0	0	0	1,189	8,353	3,299	12,841	0	0	0	0	0	0	12,841	0	0	0	0	0	0	0	0	0	0	0	12,841
4.6 Administration Cost (3% of 4.5)	0	0	0	36	251	99	385	0	0	0	0	0	0	385	0	0	0	0	0		0	0	0	0	0	385
4.7 Sub total including administration cost (4.5+4.6)	0	0	0	1,225	8,604	3,398	13,227	0	0	0	0	0	0	13,227	0	0	0	0	0	0	0	0	0	0	0	13,227
4.8 Contingency (10% of 4.7)	0	0	0	123	860	340	1,323	0	0	0	0	0	0	1,323	0	0	0	0	0	0	0	0	0	0	0	1,323
4.9 Total (4.7+4.8)	**0**	**0**	**0**	**1,348**	**9,464**	**3,738**	**14,549**	**0**	**0**	**0**	**0**	**0**	**0**	**14,549**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**14,549**
B. OPERATION							0																			
1. Collection & transport	0	0	0	0	0	1,368	1,368	1,368	1,368	1,368	1,368	1,368	6,842	8,211	1,368	1,368	1,368	1,368	0	0	0	0	0	0	5,474	13,684
2. Landfill	0	0	0	0	0	356	356	394	422	448	472	500	2,236	2,592	513	528	541	554	0	0	0	0	0	0	2,136	4,729
3. Hospital waste treatment						47	47	47	47	47	47	47	235	282	47	47									94	376
4. Total (1+2+3)	**0**	**0**	**0**	**0**	**0**	**1,771**	**1,771**	**1,809**	**1,837**	**1,863**	**1,887**	**1,915**	**9,313**	**11,085**	**1,928**	**1,943**	**1,909**	**1,922**	**0**	**0**	**0**	**0**	**0**	**0**	**7,704**	**18,788**
C. Grand Total (A + B)	**0**	**0**	**0**	**1,348**	**9,464**	**5,509**	**16,321**	**1,809**	**1,837**	**1,863**	**1,887**	**1,915**	**9,313**	**25,634**	**1,928**	**1,943**	**1,909**	**1,922**	**0**	**0**	**0**	**0**	**0**	**0**	**7,704**	**33,338**

Table 4.6.2 Solid Waste Management Priority Project Cost (2) Kien An Company

Unit: $1,000

Cost Items	2000	2001	2002	2003	2004	2005	Sub-total 2000-2005	2006	2007	2008	2009	2010	Sub-total 2006-2010	Sub-total 2000 - 2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Sub-total 2011-2020	Total 2000-2020
A. INVESTMENT																										
1. Waste collection & transport																										
1.1 Equipment (Vehicle, Container, Workshop equipment)	0	0	0	0	522	0	522	0	0	0	0	0	0	522	0	0	0	0	0	0	0	0	0	0	0	522
1.2 Engineering service (5% of Item 1.1)	0	0	0	26	0	0	26	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	26
1.3 Total (1.1+1.2)	0	0	0	26	522	0	548	0	0	0	0	0	0	548	0	0	0	0	0	0	0	0	0	0	0	548
2. Landfill							0																			
2.1 Site construction (mainly civil works	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2 Heavy equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.3 Land acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.4 Total (2.1+2. + 2.3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5 Closure of the former and existing sites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.6 Engineering service (10% of 2.1 & 2.5 plus 5% of 2.2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.7 Total (2.4+2.5 + 2.6)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Hospital waste treatment							0																			
3.1 Incineration plant (equipment & facility)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.2 Incineration plant (site preparation & building)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.3 Collection vehicle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.4 Waste storage room in	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5 Engineering Service (10% of the above)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.6 Pilot project	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.7 Total (3.1+3.2+3.3 + 3.4+3.5+3.6)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Total																										
4.1 Sub total of Construction (2.1+2.5+3.2+3.4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.2 Sub total of equipment (1.1+2.2+3.1+3.3)	0	0	0	0	522	0	522	0	0	0	0	0	0	522	0	0	0	0	0	0	0	0	0	0	0	522
4.3 Sub total of land acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.4 Sub total of Engineering Services (1.2+2.6+3.5+3.6)	0	0	0	26	0	0	26	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	26
4.5 Sub total (4.1+4.2+4.3+4.4)	0	0	0	26	522	0	548	0	0	0	0	0	0	548	0	0	0	0	0	0	0	0	0	0	0	548
4.6 Administration Cost (3% of 4.5)	0	0	0	1	16	0	16	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	16
4.7 Sub total including administration cost (4.5+4.6)	0	0	0	27	538	0	565	0	0	0	0	0	0	565	0	0	0	0	0	0	0	0	0	0	0	565
4.8 Contingency (10% of 4.7)	0	0	0	3	54	0	56	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0	0	0	56
4.9 Total (4.7+4.8)	**0**	**0**	**0**	**30**	**591**	**0**	**621**	**0**	**0**	**0**	**0**	**0**	**0**	**621**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**621**
B. OPERATION							0																			
1. Collection & transport	0	0	0	0	0	204	204	204	204	204	204	204	1,020	1,224	204	204	204	204	0	0	0	0	0	0	816	2,040
2. Landfill							0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Hospital waste treatment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Total (1+2+3)	**0**	**0**	**0**	**0**	**0**	**204**	**204**	**204**	**204**	**204**	**204**	**204**	**1,020**	**1,224**	**204**	**204**	**204**	**204**	**0**	**0**	**0**	**0**	**0**	**0**	**816**	**2,040**
C. Grand Total (A + B)	**0**	**0**	**0**	**30**	**591**	**204**	**825**	**204**	**204**	**204**	**204**	**204**	**1,020**	**1,845**	**204**	**204**	**204**	**204**	**0**	**0**	**0**	**0**	**0**	**0**	**816**	**2,661**

Table 4.6.3 Solid Waste Management Priority Project Cost (3) Do Son Company

Unit: $1,000

Cost Items	2000	2001	2002	2003	2004	2005	Sub-total 2000-2005	2006	2007	2008	2009	2010	Sub-total 2006-2010	Sub-total 2000 - 2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Sub-total 2011-2020	Total 2000-2020
A. INVESTMENT																										
1. Waste collection & transport																										
1.1 Equipment (Vehicle, Container, Workshop equipment)	0	0	0	0	499	0	499	0	0	0	0	0	0	499	0	0	0	0	0	0	0	0	0	0	0	499
1.2 Engineering service (5% of Item 1.1)	0	0	0	25	0	0	25	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	25
1.3 Total (1.1+1.2)	0	0	0	25	499	0	524	0	0	0	0	0	0	524	0	0	0	0	0	0	0	0	0	0	0	524
2. Landfill							0																			
2.1 Site construction (mainly civil works	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.2 Heavy equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.3 Land acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.4 Total (2.1+2. + 2.3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5 Closure of the former and existing sites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.6 Engineering service (10% of 2.1 & 2.5 plus 5% of 2.2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.7 Total (2.4+2.5 + 2.6)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Hospital waste treatment							0																			
3.1 Incineration plant (equipment & facility)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.2 Incineration plant (site preparation & building)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.3 Collection vehicle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.4 Waste storage room in	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5 Engineering Service (10% of the above)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.6 Pilot project	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.7 Total (3.1+3.2+3.3 + 3.4+3.5+3.6)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Total																										
4.1 Sub total of Construction (2.1+2.5+3.2+3.4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.2 Sub total of equipment (1.1+2.2+3.1+3.3)	0	0	0	0	499	0	499	0	0	0	0	0	0	499	0	0	0	0	0	0	0	0	0	0	0	499
4.3 Sub total of land acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.4 Sub total of Engineering Services (1.2+2.6+3.5+3.6)	0	0	0	25	0	0	25	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	25
4.5 Sub total (4.1+4.2+4.3+4.4)	0	0	0	25	499	0	524	0	0	0	0	0	0	524	0	0	0	0	0	0	0	0	0	0	0	524
4.6 Administration Cost (3% of 4.5)	0	0	0	1	15	0	16	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	16
4.7 Sub total including administration cost (4.5+4.6)	0	0	0	26	514	0	540	0	0	0	0	0	0	540	0	0	0	0	0	0	0	0	0	0	0	540
4.8 Contingency (10% of 4.7)	0	0	0	3	51	0	54	0	0	0	0	0	0	54	0	0	0	0	0	0	0	0	0	0	0	54
4.9 Total (4.7+4.8)	**0**	**0**	**0**	**28**	**565**	**0**	**594**	**0**	**0**	**0**	**0**	**0**	**0**	**594**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**594**
B. OPERATION							0																			
1. Collection & transport	0	0	0	0	0	172	172	172	172	172	172	172	860	1,031	172	172	172	172	0	0	0	0	0	0	688	1,719
2. Landfill				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Hospital waste treatment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Total (1+2+3)	**0**	**0**	**0**	**0**	**0**	**172**	**172**	**172**	**172**	**172**	**172**	**172**	**860**	**1,031**	**172**	**172**	**172**	**172**	**0**	**0**	**0**	**0**	**0**	**0**	**688**	**1,719**
C. Grand Total (A + B)	**0**	**0**	**0**	**28**	**565**	**172**	**766**	**172**	**172**	**172**	**172**	**172**	**860**	**1,625**	**172**	**172**	**172**	**172**	**0**	**0**	**0**	**0**	**0**	**0**	**688**	**2,313**

Table 4.6.4 Solid Waste Management Priority Project Cost (4) The 3 Companies Total

Unit: $1,000

Cost Items	2000	2001	2002	2003	2004	2005	Sub-total 2000-2005	2006	2007	2008	2009	2010	Sub-total 2006-2010	Sub-total 2000 - 2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Sub-total 2011-2020	Total 2000-2020
A. INVESTMENT																										
1. Waste collection & transport																										
1.1 Equipment (Vehicle, Container, Workshop equipment)	0	0	0	0	3,907	0	3,907	0	0	0	0	0	0	3,907	0	0	0	0	0	0	0	0	0	0	0	3,907
1.2 Engineering service (5% of Item 1.1)	0	0	0	195	0	0	195	0	0	0	0	0	0	195	0	0	0	0	0	0	0	0	0	0	0	195
1.3 Total (1.1+1.2)	0	0	0	195	3,907	0	4,102	0	0	0	0	0	0	4,102	0	0	0	0	0	0	0	0	0	0	0	4,102
2. Landfill																										
2.1 Site construction (mainly civil works	0	0	0	0	3,299	3,299	6,598	0	0	0	0	0	0	6,598	0	0	0	0	0	0	0	0	0	0	0	6,598
2.2 Heavy equipment	0	0	0	0	1,412	0	1,412	0	0	0	0	0	0	1,412	0	0	0	0	0	0	0	0	0	0	0	1,412
2.3 Land acquisition	0	0	0	602	0	0	602	0	0	0	0	0	0	602	0	0	0	0	0	0	0	0	0	0	0	602
2.4 Total (2.1+2. + 2.3)	0	0	0	602	4,711	3,299	8,612	0	0	0	0	0	0	8,612	0	0	0	0	0	0	0	0	0	0	0	8,612
2.5 Closure of the former and existing sites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.6 Engineering service (10% of 2.1 & 2.5 plus 5% of 2.2)	0	0	0	400	330	0	730	0	0	0	0	0	0	730	0	0	0	0	0	0	0	0	0	0	0	730
2.7 Total (2.4+2.5 + 2.6)	0	0	0	1,002	5,041	3,299	9,342	0	0	0	0	0	0	9,342	0	0	0	0	0	0	0	0	0	0	0	9,342
3. Hospital waste treatment																										
3.1 Incineration plant (equipment & facility)	0	0	0	0	263	0	263	0	0	0	0	0	0	263	0	0	0	0	0	0	0	0	0	0	0	263
3.2 Incineration plant (site preparation & building)	0	0	0	0	87	0	87	0	0	0	0	0	0	87	0	0	0	0	0	0	0	0	0	0	0	87
3.3 Collection vehicle	0	0	0	0	76	0	76	0	0	0	0	0	0	76	0	0	0	0	0	0	0	0	0	0	0	76
3.4 Waste storage room in	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5 Engineering Service (10% of the above)	0	0	0	43	0	0	43	0	0	0	0	0	0	43	0	0	0	0	0	0	0	0	0	0	0	43
3.6 Pilot project	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.7 Total (3.1+3.2+3.3 + 3.4+3.5+3.6)	0	0	0	43	426	0	469	0	0	0	0	0	0	469	0	0	0	0	0	0	0	0	0	0	0	469
4 Total																										
4.1 Sub total of Construction (2.1+2.5+3.2+3.4)	0	0	0	0	3,386	3,299	6,685	0	0	0	0	0	0	6,685	0	0	0	0	0	0	0	0	0	0	0	6,685
4.2 Sub total of equipment (1.1+2.2+3.1+3.3)	0	0	0	0	5,658	0	5,658	0	0	0	0	0	0	5,658	0	0	0	0	0	0	0	0	0	0	0	5,658
4.3 Sub total of land acquisition	0	0	0	602	0	0	602	0	0	0	0	0	0	602	0	0	0	0	0	0	0	0	0	0	0	602
4.4 Sub total of Engineering Services (1.2+2.6+3.5+3.6)	0	0	0	638	330	0	968	0	0	0	0	0	0	968	0	0	0	0	0	0	0	0	0	0	0	968
4.5 Sub total (4.1+4.2+4.3+4.4)	0	0	0	1,240	9,374	3,299	13,914	0	0	0	0	0	0	13,914	0	0	0	0	0	0	0	0	0	0	0	13,914
4.6 Administration Cost (3% of 4.5)	0	0	0	37	281	99	417	0	0	0	0	0	0	417	0	0	0	0	0	0	0	0	0	0	0	417
4.7 Sub total including administration cost (4.5+4.6)	0	0	0	1,278	9,655	3,398	14,331	0	0	0	0	0	0	14,331	0	0	0	0	0	0	0	0	0	0	0	14,331
4.8 Contingency (10% of 4.7)	0	0	0	128	966	340	1,433	0	0	0	0	0	0	1,433	0	0	0	0	0	0	0	0	0	0	0	1,433
4.9 Total (4.7+4.8)	**0**	**0**	**0**	**1,405**	**10,621**	**3,738**	**15,764**	**0**	**0**	**0**	**0**	**0**	**0**	**15,764**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**15,764**
B. OPERATION																										
1. Collection & transport	0	0	0	0	0	1,744	1,744	1,744	1,744	1,744	1,744	1,744	8,722	10,466	1,744	1,744	1,744	1,744	0	0	0	0	0	0	6,977	17,444
2. Landfill						356	356	394	422	448	472	500	2,236	2,592	513	528	541	554	0	0	0	0	0	0	2,136	4,729
3. Hospital waste treatment	0	0	0	0	0	47	47	47	47	47	47	47	235	282	47	47	0	0	0	0	0	0	0	0	94	376
4. Total (1+2+3)	**0**	**0**	**0**	**0**	**0**	**2,147**	**2,147**	**2,185**	**2,213**	**2,239**	**2,263**	**2,291**	**11,193**	**13,340**	**2,304**	**2,319**	**2,285**	**2,298**	**0**	**0**	**0**	**0**	**0**	**0**	**9,207**	**22,548**
C. Grand Total (A + B)	**0**	**0**	**0**	**1,405**	**10,621**	**5,885**	**17,911**	**2,185**	**2,213**	**2,239**	**2,263**	**2,291**	**11,193**	**29,104**	**2,304**	**2,319**	**2,285**	**2,298**	**0**	**0**	**0**	**0**	**0**	**0**	**9,207**	**38,312**

Table 4.8.1 Solid Waste Program Costs in Relation to Key Indicators: Sensitivity to Key Assumptions

(20% increase in estimated costs, half the predicted economic growth rate)

values in 2000 prices

Year	Total Cost ($US'000)	Cost as % of Benefic-iaries' GRP (%)	Cost as % Of GRP in Haiphong (%)	Cost as % of HPPC Exp. (%)	Cost as % Of Benefic-Iaries' Disp. Inc. (%)	Cost per Capita of Benefic-iaries ($)
2001	1,468	0.46%	0.21%	2.31%	0.91%	3.47
2002	1,639	0.48%	0.23%	2.53%	0.97%	3.75
2003	2,136	0.58%	0.30%	3.34%	1.16%	4.41
2004	3,339	0.86%	0.46%	5.13%	1.72%	6.67
2005	4,436	1.00%	0.65%	7.23%	2.01%	7.30
2006	4,823	1.01%	0.68%	7.60%	2.02%	7.66
2007	5,163	1.01%	0.71%	7.89%	2.02%	7.93
2008	5,468	1.00%	0.73%	8.13%	2.00%	8.12
2009	5,831	1.01%	0.76%	8.45%	2.01%	8.38
2010	6,138	1.00%	0.78%	8.69%	2.01%	8.54
2011	6,417	1.01%	0.80%	8.86%	2.02%	8.73
2012	6,680	1.02%	0.81%	9.00%	2.03%	8.89
2013	7,235	1.07%	0.86%	9.52%	2.13%	9.46
2014	8,069	1.15%	0.94%	10.39%	2.31%	10.36
2015	8,437	1.17%	0.96%	10.63%	2.35%	10.65
2016	8,927	1.21%	0.99%	11.02%	2.42%	11.08
2017	9,373	1.24%	1.02%	11.34%	2.47%	11.44
2018	9,841	1.27%	1.05%	11.69%	2.53%	11.82
2019	10,442	1.31%	1.10%	12.19%	2.62%	12.34
2020	10,884	1.34%	1.13%	12.49%	2.67%	12.66

Table 4.8.2 Solid Waste Management Priority Project: Loan Repayment Schedule and Costs as Percentage of HPPC's Expenditure

Unit: 1,000 dollar in current price

	Borrowing (85% of Total Investment)												
	Const-ruction & Procure-ment (1.3%/year)	Engi-neering (0.75%/ year)	Total	Repay-ment of Principal	Payment of Interest	Total Repay-ment	15% of Total Invest-ment (Not Covered by Loan)	Recurring Cost	Total Project Cash Expendi-ture	HPPC's Expenditur e	Raito of Re-payment to HPPC Exp.	Ratio of Sum of the 15% & Recurring Cost to HPPC	Ratio of Total Project Expenditure to HPPC Exp.
a	b	c	d = b+c	e	f	g = e+f	h	I	j = g+h+I	k	l =g/k	m = (h+I)/k	n = j/k
2003	0	735	735	0	0	0	746	0	746	77,066	0.0%	1.0%	1.0%
2004	9,767	274	10,041	0	6	6	1,327	0	1,333	83,548	0.0%	1.6%	1.6%
2005	3,634	140	3,774	0	135	135	494	2,370	2,999	90,259	0.1%	3.2%	3.3%
2006	0	0	0	0	183	183	0	2,461	2,643	102,432	0.2%	2.4%	2.6%
2007	0	0	0	0	183	183	0	2,542	2,725	115,057	0.2%	2.2%	2.4%
2008	0	0	0	0	183	183	0	2,623	2,806	128,146	0.1%	2.0%	2.2%
2009	0	0	0	0	183	183	0	2,676	2,859	141,712	0.1%	1.9%	2.0%
2010	0	0	0	0	183	183	0	2,759	2,941	155,770	0.1%	1.8%	1.9%
2011	0	0	0	0	183	183	0	2,849	3,031	168,894	0.1%	1.7%	1.8%
2012	0	0	0	0	183	183	0	2,922	3,105	182,482	0.1%	1.6%	1.7%
2013	0	0	0	708	183	891	0	3,000	3,891	196,545	0.5%	1.5%	2.0%
2014	0	0	0	708	174	882	0	3,015	3,897	211,098	0.4%	1.4%	1.8%
2015	0	0	0	708	165	873	0	0	873	226,154	0.4%	0.0%	0.4%
2016	0	0	0	708	156	864	0	0	864	241,728	0.4%	0.0%	0.4%
2017	0	0	0	708	147	855	0	0	855	257,834	0.3%	0.0%	0.3%
2018	0	0	0	708	138	846	0	0	846	274,488	0.3%	0.0%	0.3%
2019	0	0	0	708	129	837	0	0	837	291,705	0.3%	0.0%	0.3%
2020	0	0	0	708	120	828	0	0	828	309,501	0.3%	0.0%	0.3%
2021	0	0	0	708	111	819	0	0	819	328,319	0.2%	0.0%	0.2%
2022	0	0	0	708	102	810	0	0	810	348,281	0.2%	0.0%	0.2%
2023	0	0	0	708	93	801	0	0	801	369,456	0.2%	0.0%	0.2%
2024	0	0	0	708	84	792	0	0	792	391,919	0.2%	0.0%	0.2%
2025	0	0	0	708	75	783	0	0	783	415,748	0.2%	0.0%	0.2%
2026	0	0	0	708	66	774	0	0	774	441,025	0.2%	0.0%	0.2%
2027	0	0	0	708	57	765	0	0	765	467,840	0.2%	0.0%	0.2%
2028	0	0	0	708	48	756	0	0	756	496,284	0.2%	0.0%	0.2%
2029	0	0	0	708	39	747	0	0	747	526,458	0.1%	0.0%	0.1%
2030	0	0	0	708	30	738	0	0	738	558,467	0.1%	0.0%	0.1%
2031	0	0	0	708	21	729	0	0	729	592,422	0.1%	0.0%	0.1%
2032	0	0	0	708	12	720	0	0	720	628,441	0.1%	0.0%	0.1%
2033	0	0	0	38	3	41	0	0	41	666,650	0.0%	0.0%	0.0%
2034	0	0	0	38	3	41	0	0	41	707,183	0.0%	0.0%	0.0%
2035	0	0	0	38	2	41	0	0	41	750,179	0.0%	0.0%	0.0%
2036	0	0	0	38	2	40	0	0	40	795,790	0.0%	0.0%	0.0%
2037	0	0	0	38	2	40	0	0	40	844,174	0.0%	0.0%	0.0%
2038	0	0	0	38	1	40	0	0	40	895,500	0.0%	0.0%	0.0%
2039	0	0	0	38	1	39	0	0	39	949,947	0.0%	0.0%	0.0%
2040	0	0	0	38	1	39	0	0	39	1,007,703	0.0%	0.0%	0.0%
2041	0	0	0	38	1	39	0	0	39	1,068,972	0.0%	0.0%	0.0%
2042	0	0	0	38	0	39	0	0	39	1,133,965	0.0%	0.0%	0.0%
Total	13,400	1,149	14,550	14,550	3,383	17,932	2,568	27,216	47,716	9,917,709	0.2%	0.3%	0.5%

Note: A 2% annual inflation in terms of dollar is assumed.

Table 4.8.3 Summary of the Major Impacts and Mitigation Measures of Solid Waste Management Project

Issue	Location	Major Impacts	Mitigation Measures	Net Effects	Monitoring
Pre-Construction					
Land acquisition and Compensation	Trang Cat	Area is already reserved for landfill. No need for land acquisition or resettlement. Change from fish ponds to landfill needs excavation and bottom works.	Compensation for fishing co-operative for the ponds.	Long-tern permanent impacts	Monitoring of compensation
Operation					
Access to landfill and transportation	Villages nearby	Traffic through the nearby villages is increasing. Possible spills from trucks, noise, offensive odor problems.	Garbage trucks have to be covered or be container type to avoid spills. Construction of internal roads according to the design. Minimize night traffic.	Long-term temporary impacts	Supervision of loading and transportation Monitoring or air quality and noise
Offensive odor and emission of air pollutants	Trang Cat	CO, CO_2, H_2S, NO_2 and especially CH_4 and offensive odor, generated from landfill process will have local, long-term impacts on air environment in Trang Cat area.	Burning and exploding methane has to be prevented with gas collection system. Weekly covering decreases odor.	Long-term impacts	Monitoring of air quality
Hazardous solid waste	Trang Cat	Among domestic solid waste there might be also industrial waste or hazardous waste.	Origin of solid waste should be known. Hazardous waste should be separated.	Occasional impacts	Monitoring content of solid waste
Leachate	Cam River	Leachate from landfill, groundwater pollution by leachate	Leachate will be collected and treated in treatment system before discharging to Cam River. Groundwater contamination is prevented with proper lining.	Long-term permanent impacts	Monitoring of treated leachate and Cam River water quality
Closing-down	Trang Cat	Landfill will have impacts decades after closing.	Landfill has to be covered properly. It is recommended plant trees and other vegetation on closed areas. Gas collection and leacheate collection and treatment has to be in operation	Long-term impacts	Monitoring of air, surface water, groundwater and leachate quality

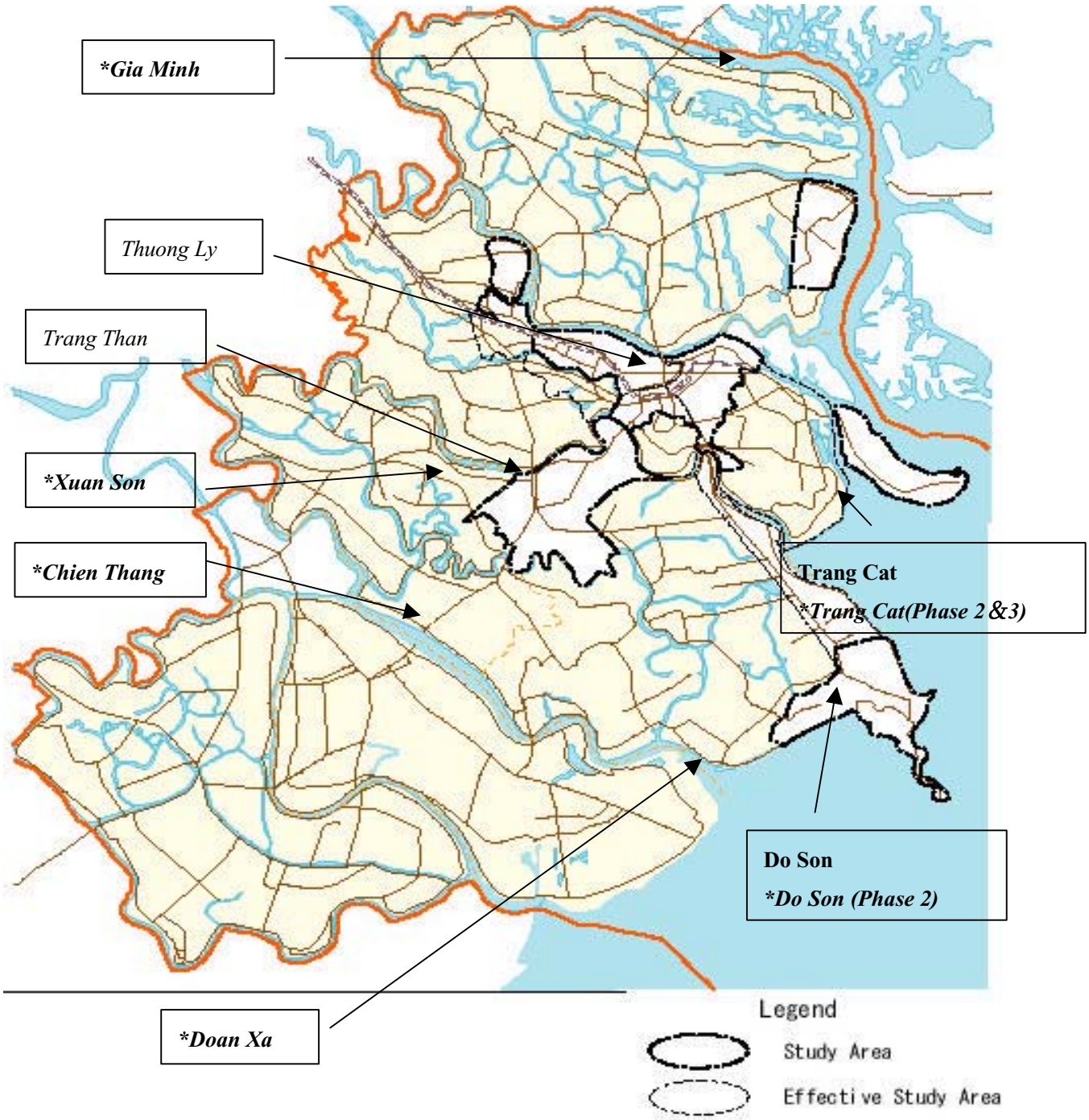

Figure 4.4.1 Location of Waste Landfill Sites in Haiphong City

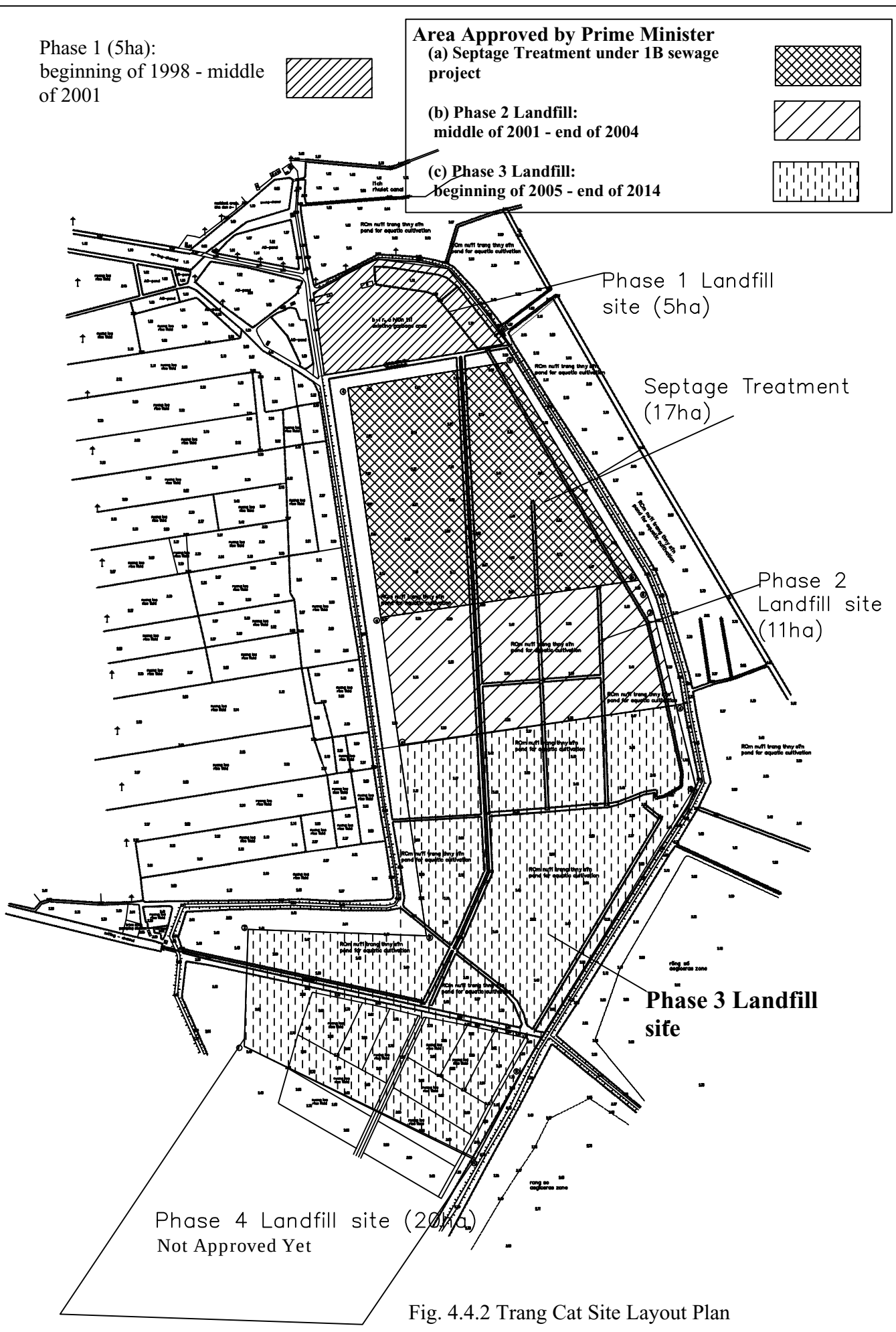

Fig. 4.4.2 Trang Cat Site Layout Plan

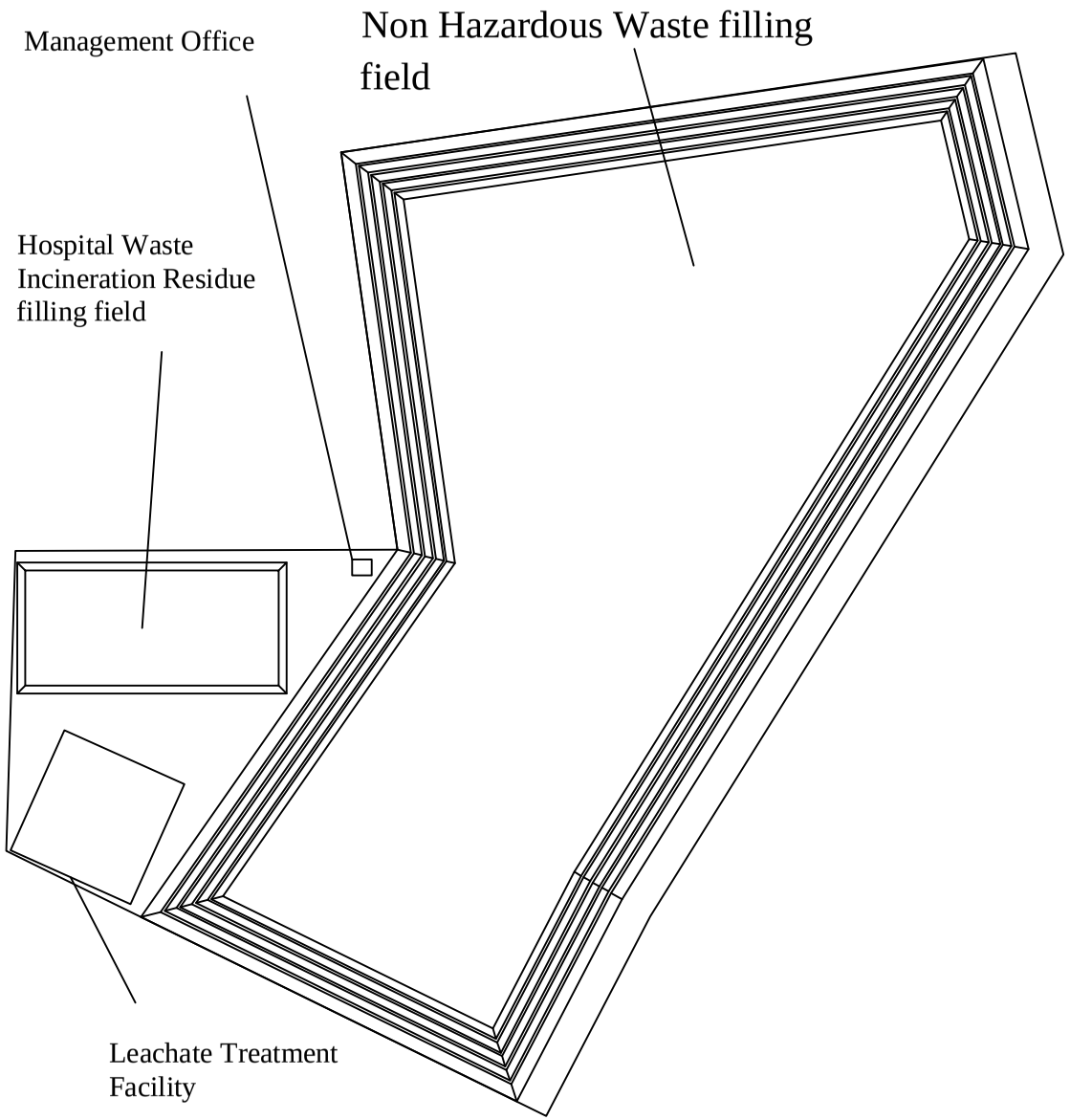

Fig. 4.4.3 Layout Plan of Trang Cat Phase 3 Landfill site

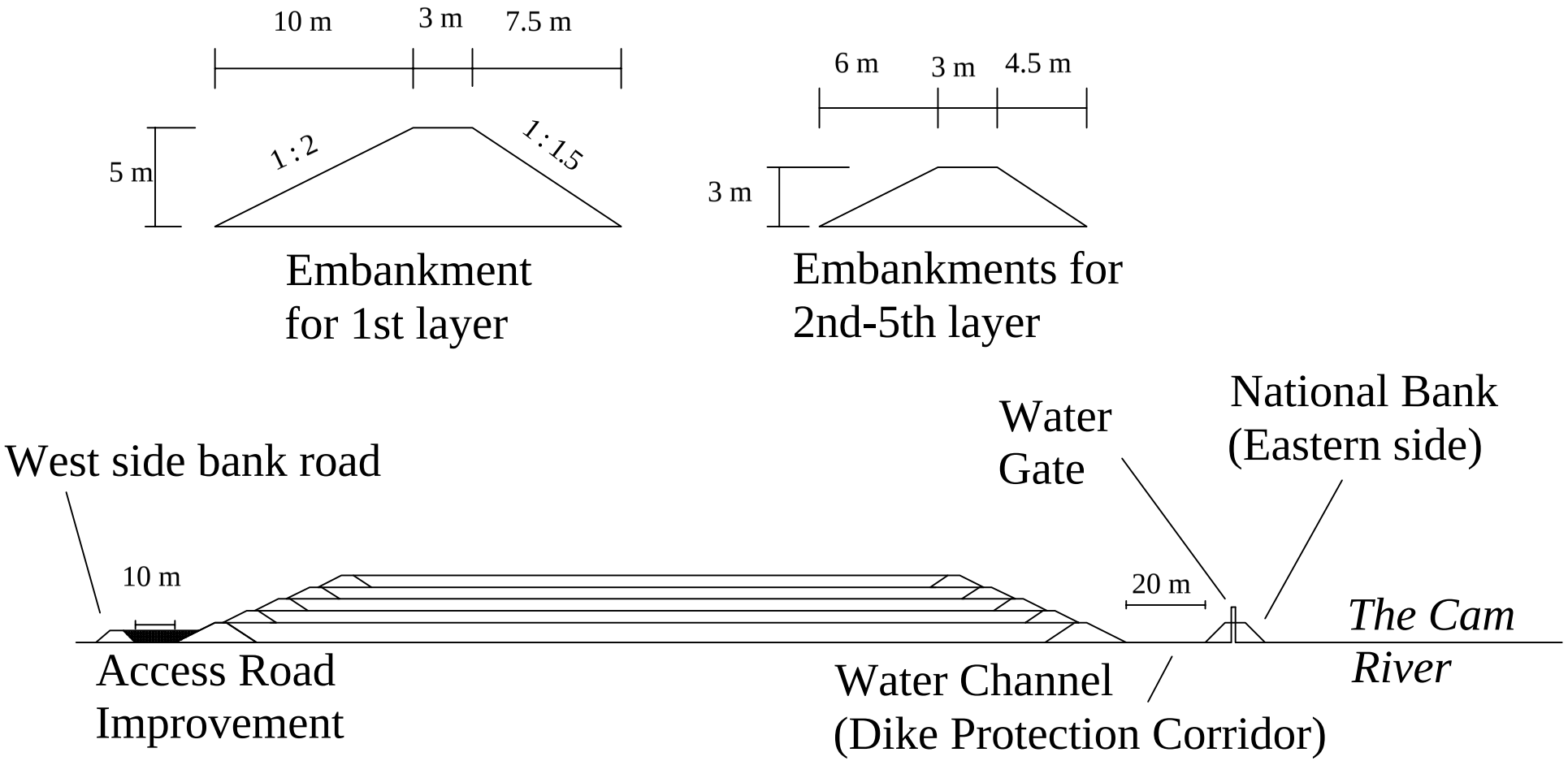

Figure 4.4.4 Cross-section of Landfill site at Final Stage

PART 5 OVERALL FEASIBILITY OF THE PRIORITY PROJECTS

CHAPTER 1 ECONOMIC AND FINANCIAL FEASIBILITY OF THE COMBINED PROJECT OF DRAINAGE AND SEWERAGE

1.1 Economic Feasibility

In the previous Parts of Drainage and Sewage, the economic feasibility was checked by evaluating switching values, i.e. percentage increases in the property value and GRP required to economically justify the project. This exercise is not done for solid waste management project because benefits are not quantified for the solid waste project.

This chapter evaluates the drainage and sewerage projects taken together by assessing the switching values obtained by aggregating those of the drainage project and sewerage project.

Costs of Drainage and Sewerage Projects as Percentage of Property Values and Productivity in the Project Area, and Sensitivity to Cost Estimates

Unit: Percentage

	Base Case	Costs + 10 %	Costs + 20 %
Project Cost Ratio to Property value – under No Growth case	9.4	10.3	11.3
Project Cost Ratio to Property value - under Average Growth case	4.5	4.9	5.4
Project Cost Ratio to Project Area GRP value – under No Growth case	6.3	6.9	7.6
Project Cost Ratio to Project Area GRP value – under Average Growth case	2.7	3.0	3.2

The present value of the drainage and sewage project together is estimated to be US$78.3 million.

The above table indicates that the property values, on base case, would have to increase by 4.5 % to economically justify the combined project, i.e. to realize the situation where the project benefit exceeds the project cost. The table also shows that the Project Area GRP would have to increase by 2.7 % to demonstrate economic justification. In terms of these percentage increases required, the two Priority Projects taken together seem to be economically feasible.

The corresponding percentages get higher under the no growth case with 10 % or 20 % project cost increases. However, considering that 1) no growth scenario is unlikely to happen, and 2) the estimated Priority Project costs already include 10 % physical contingency, the scenario of no growth with 20 % cost increase is unlikely.

1.2 Financial Evaluation and Affordability

Affordability of the combined priority projects of drainage and sewage is evaluated using the two sectors program costs that include the priority projects costs.

In terms of their GRP and disposal income in the study area as well as HPPC's expenditure, the following table suggests that the combined program of drainage and sewage is likely to be affordable for Haiphong City residents, direct beneficiaries and HPPC under the base case scenario. In 2010, ratios of the combined project cost (amortized investment cost + operation/maintenance cost) is 1.5 % of the Study Area GRP, 3 % of the Study Area disposal income, 11.3 % of HPPC expenditure. The corresponding percentages in 2020 are 2.5 %, 5 % and 18.7 % respectively.

As a sensitivity analysis, Table 5.1.1 shows a case where economic growth is halved, and the project cost increases by 20 %. Naturally the above percentage figures are higher under this scenario, and the situation would be less favorable. However, considering that 1) the economic growth rate assumed as a base case is an average growth scenario, and 2) the Priority Project costs already include 10 % physical contingency, the above scenario (economic growth is halved, and the cost increase by 20 %) is unlikely.

Affordability of the Drainage and Sewerage Program 2001-2020
Costs as Percentage of Key Indicators

(Value in 2000 Price)

Year	Cumula-tive Amortized Capital costs	O and M Cost	Total Cost	Total Cost as % of Study Area GRP	Total Cost as % of Haiphong GRP	Total Cost as % of HPPC Exp.	Total Cost as % of Study Area Disposal Inc.	Annual per Capita Cost in. Haiphong
	($US'000)	($US'000)	($US'000)	(%)	(%)	(%)	(%)	(US$)
2001	11	208	219	0.05	0.03	0.34	0.10	0.13
2002	1,063	208	1,271	0.27	0.17	1.87	0.54	0.73
2003	2,448	208	2,656	0.53	0.33	3.66	1.06	1.51
2004	4,525	299	4,824	0.90	0.56	6.25	1.79	2.71
2005	6,300	308	6,608	1.15	0.73	8.08	2.30	3.68
2006	8,229	318	8,547	1.31	0.85	9.40	2.62	4.70
2007	10,003	637	10,640	1.46	0.96	10.62	2.92	5.78
2008	11,492	772	12,264	1.52	1.01	11.21	3.04	6.58
2009	12,772	909	13,681	1.54	1.04	11.54	3.09	7.25
2010	**13,545**	**923**	**14,468**	**1.50**	**1.02**	**11.32**	**3.00**	**7.58**
2011	16,293	966	17,259	1.68	1.14	12.71	3.37	8.94
2012	19,653	1,062	20,715	1.91	1.30	14.40	3.82	10.61
2013	22,863	1,350	24,213	2.11	1.44	15.94	4.23	12.27
2014	24,856	1,636	26,492	2.20	1.49	16.56	4.40	13.28
2015	26,848	1,712	28,560	2.26	1.53	17.00	4.51	14.17
2016	28,841	1,790	30,631	2.31	1.57	17.40	4.62	15.04
2017	30,834	1,868	32,702	2.36	1.60	17.76	4.72	15.89
2018	32,827	1,944	34,771	2.40	1.63	18.09	4.81	16.73
2019	34,820	2,021	36,841	2.44	1.66	18.40	4.89	17.55
2020	36,812	2,097	38,909	2.48	1.68	18.68	4.96	18.35

1.3 Funding Requirements and Financing Plan

Funding requirement was estimated based on the following conditions:

- 85 % of the total project investment cost will be financed by a soft ODA loan
- HPPC will be the borrower
- The remaining 15 % and all recurring costs will be borne by HPPC
- Two percent annual inflation in terms of US dollar is assumed
- Conditions of the loans are as follows
    - For the engineering services, a very soft loan with a 0.75 % interest with loan repayment period of 40 years, of which the first 10 years is a grace period during which only interest will be paid
    - For the procurement and construction, a soft loan with a 1.3 % interest with loan repayment period of 30 years, of which the first 10 years is a grace period during which only interest will be paid

During the period, maximum ratio of total cash requirement (repayment + counterpart fund + OM cost) to HPPC's projected total expenditure will be 5.6 % that will take place in 2004.

CHAPTER 2 ECONOMIC AND FINANCIAL FEASIBILITY OF THE THREE PROJECTS AS PACKAGE

2.1 Aggregate Project Cost

Cost of the individual priority projects and aggregate cost of the three projects combined together are shown in the table below.

Table: Drainage, Sewerage and Solid Waste Project Costs
(Cash Investment + Recurring Cost))2003-2023

(Cash Costs) in 2000 prices

Year	Drainage (US$'000)	Sewerage (US$'000)	Solid Waste (US$'000)	Total (US$'000)
2003	2,734	1,970	1,405	6,109
2004	6,408	7,157	10,621	24,185
2005	7,156	13,197	5,885	26,238
2006	7,722	13,197	2,185	23,104
2007	8,296	10,741	2,213	21,251
2008	10,299	7,975	2,239	20,513
2009	6,502	8,092	2,263	16,857
2010	21	4,595	2,291	6,908
2011	23	426	2,304	2,753
2012	25	426	2,319	2,770
2013	26	426	2,285	2,738
2014	30	426	2,298	2,754
2015	33	426	0	459
2016	38	426	0	464
2017	43	426	0	469
2018	49	426	0	475
2019	54	426	0	480
2020	59	426	0	485
2021	64	426	0	490
2022	69	426	0	495
2023	74	426	0	500
Total	49,724	72,462	38,312	160,498

Total cost of the three priority projects is estimated to be US$160.5 million in 2000 price. A more detailed cost with distinction of investments and recurring costs are shown in Table 5.2.1.

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2.2 Financial Affordability

Financial affordability of the 3 combined priority projects is evaluate using the 3 sectors program costs that include the priority projects costs. The affordability is assessed in terms of ratio of the project costs to key indicators including the Study Area GRP, Haiphong GRP, HPPC expenditures, and Study Area disposal income. The table below summarizes these ratios in percentages.

The table suggests that the program consisting of the three sub-sectors, drainage, sewerage and solid waste, is likely to be affordable for Haiphong City residents and direct beneficiaries in terms of their GRP under the base case scenario.

While in 2010 the program appears to be affordable in terms of GRP, it will increasingly put pressure upon the HPPC budget, accounting for about 15 % of HPPC expenditures by 2010 and 23 % by 2020.

Also, prospects for full cost recovery from direct beneficiaries through user charges will also be hampered unless general economic reforms, including increasing the proportion of disposable incomes to GRP, are carried out.

However, affordability will be greatly dependent upon the rate of economic growth. Under the most conservative assumptions as shown in Table 5.2.2 (economic growth rate being halved, and 20 % cost increase), in 2010 the costs of the total program would be about 7.2 % of disposable incomes, while the corresponding percentage, under base case, is 4.1 % in 2010.

Thus while individual sub-sector programs (drainage, sewerage, and solid waste) all appear to meet affordability criteria in isolation, they may not do so under an undesirable situation (lower economic growth and rising of the project cost) if they are combined together.

The financial viability of the package depends heavily upon economic growth; if it does materialize as predicted, the package is viable, but if it does not, the project would have to be modified or phased over a longer period.

It is therefore imperative to continue to monitor macroeconomic parameters closely and to adjust the sanitation program accordingly if required.

Affordability of the Drainage, Sewage and Solid Waste Program 2010 – 2020 Costs as Percentage of Key Indicators (Value in 2000 Price)

Year	Cumulative Amortized Capital Cost (US$'000)	O and M Cost (US$'000)	Total Cost (US 1,000)	Total Cost as % of Study Area GRP (%)	Total Cost as % of Haiphong GRP (%)	Total Cost as % of HPPC Exp. (%)	Total Cost as % of Study Area Disposal Income (%)	Annual per Capita Cost in Haiphong (US$)
2001	25	1,414	1,439	0.33%	0.20%	2.27%	0.67%	0.84
2002	1,122	1,511	2,633	0.56%	0.35%	3.87%	1.13%	1.52
2003	2,700	1,732	4,432	0.88%	0.55%	6.10%	1.76%	2.52
2004	5,666	1,937	7,603	1.41%	0.89%	9.85%	2.82%	4.28
2005	7,765	2,535	10,300	1.79%	1.13%	12.60%	3.59%	5.73
2006	9,768	2,795	12,563	1.93%	1.24%	13.81%	3.85%	6.90
2007	11,620	3,319	14,939	2.05%	1.34%	14.91%	4.09%	8.11
2008	13,162	3,655	16,817	2.08%	1.39%	15.38%	4.16%	9.02
2009	14,543	3,993	18,536	2.09%	1.41%	15.63%	4.18%	9.82
2010	**15,387**	**4,193**	**19,580**	**2.03%**	**1.38%**	**15.32%**	**4.06%**	**10.26**
2011	18,225	4,378	22,603	2.21%	1.50%	16.64%	4.41%	11.71
2012	21,666	4,612	26,278	2.42%	1.65%	18.26%	4.85%	13.46
2013	25,217	5,022	30,239	2.64%	1.79%	19.90%	5.28%	15.33
2014	27,771	5,442	33,213	2.76%	1.87%	20.76%	5.51%	16.65
2015	29,882	5,705	35,587	2.81%	1.91%	21.18%	5.62%	17.66
2016	32,042	6,024	38,066	2.87%	1.95%	21.62%	5.74%	18.69
2017	34,139	6,369	40,508	2.92%	1.98%	22.00%	5.84%	19.69
2018	36,245	6,723	42,968	2.97%	2.01%	22.36%	5.94%	20.67
2019	38,441	7,097	45,538	3.02%	2.05%	22.74%	6.04%	21.69
2020	40,546	7,429	47,975	3.06%	2.07%	23.03%	6.12%	22.62

2.3 Funding Requirements and Financing Plan

Table 5.2.3 shows funding requirements of the package based on the same conditions as for the combined project of drainage and sewerage.

The table shows that the total counterpart fund that has to be financed by HPPC will amount to 2.2 million in total for the implementation of the priority project during 2003 – 2010. During the same period, ratios of total cash requirement (repayment + counterpart fund + OM cost) to HPPC's projected total expenditure will range from 3 – 7 %. Maximum ratio will be 7.2 % that will take place in 2004. The percentages will then decline gradually. In 2013, the year when the repayment of loan starts, the corresponding percentage will be 5.7 %. Thereafter, the percentages will decrease.

The table indicates that securing of the local fund (15 % of the project investment cost) is a crucial to materialize the financial plan shown in the table.

Table 5.1.1 Drainage and Sewerage Program Costs in Relation to Key Indicators: Sensitivity to Key Assumptions

(20% increase in estimated costs, half the predicted economic growth rate)

(Values in 2000 Price)

Year	Total Cost (Amortized Investment + Recurring Cost) ($US'000)	Cost as % of GRP in Study Area (%)	Cost as % of GRP in Haiphong (%)	Cost as % of HPPC Exp. (%)	Cost as % of Disp. Inc. Study Area (%)	Per Capita Cost in Haiphong Area ($)
2001	263	0.06	0.04	0.41	0.12	0.46
2002	1,525	0.34	0.21	2.31	0.68	2.66
2003	3,187	0.68	0.42	4.65	1.37	5.49
2004	5,789	1.2	0.73	8.15	2.4	9.87
2005	7,930	1.59	0.97	10.81	3.18	13.38
2006	10,258	1.92	1.18	13.09	3.85	17.12
2007	12,767	2.26	1.38	15.37	4.52	21.07
2008	14,717	2.47	1.52	16.82	4.94	24.02
2009	16,417	2.63	1.61	17.9	5.26	26.51
2010	**17,362**	**2.67**	**1.63**	**18.14**	**5.33**	**27.74**
2011	20,711	3.08	1.89	20.98	6.17	32.74
2012	24,858	3.59	2.2	24.46	7.19	38.89
2013	29,054	4.09	2.5	27.81	8.17	44.99
2014	31,789	4.36	2.67	29.65	8.71	48.73
2015	34,272	4.58	2.81	31.18	9.16	52.01
2016	36,757	4.8	2.94	32.66	9.6	55.23
2017	39,242	5.01	3.07	34.1	10.02	58.38
2018	41,724	5.21	3.2	35.48	10.43	61.47
2019	44,208	5.41	3.32	36.82	10.82	64.5
2020	46,691	5.6	3.43	38.13	11.21	67.48

Table 5.2.1 Haiphong Sanitation Priority Project Costs

Unit: US$ 1000 in 2000 Price

	Drainage			Sewage			Solid Waste			3 Project Total		
Year	a.Investment	b. Recurrin	c.Total (a+b)	a.Investment	b. Recurrin	c.Total (a+b)	a.Investment	b. Recurrin	c.Total (a+b)	a.Investment	b. Recurrin	c.Total (a+b)
2,000	0	0	0	0	0	0	0	0	0	0	0	0
2,001	0	0	0	0	0	0	0	0	0	0	0	0
2,002	0	0	0	0	0	0	0	0	0	0	0	0
2,003	2,734	0	2,734	1,970	0	1,970	1,405	0	1,405	6,109	0	6,109
2,004	6,408	0	6,408	7,157	0	7,157	10,621	0	10,621	24,185	0	24,185
2,005	7,156	0	7,156	13,197	0	13,197	3,738	2,147	5,885	24,091	2,147	26,238
2,006	7,722	0	7,722	13,197	0	13,197	0	2,185	2,185	20,918	2,185	23,104
2,007	8,280	16	8,297	10,432	309	10,741	0	2,213	2,213	18,712	2,539	21,251
2,008	10,281	18	10,299	7,666	309	7,975	0	2,239	2,239	17,947	2,566	20,513
2,009	6,482	20	6,502	7,666	426	8,092	0	2,263	2,263	14,148	2,709	16,857
2,010	0	21	21	4,169	426	4,595	0	2,291	2,291	4,169	2,739	6,908
2,011	0	23	23	0	426	426	0	2,304	2,304	0	2,753	2,753
2,012	0	25	25	0	426	426	0	2,319	2,319	0	2,770	2,770
2,013	0	26	26	0	426	426	0	2,285	2,285	0	2,738	2,738
2,014	0	30	30	0	426	426	0	2,298	2,298	0	2,754	2,754
2,015	0	33	33	0	426	426	0	0	0	0	459	459
2,016	0	38	38	0	426	426	0	0	0	0	464	464
2,017	0	43	43	0	426	426	0	0	0	0	469	469
2,018	0	49	49	0	426	426	0	0	0	0	475	475
2,019	0	54	54	0	426	426	0	0	0	0	480	480
2,020	0	59	59	0	426	426	0	0	0	0	485	485
2,021	0	64	64	0	426	426	0		0	0	490	490
2,022	0	69	69	0	426	426	0		0	0	495	495
2,023	0	74	74	0	426	426	0		0	0	500	500
Total	49,063	661	49,724	65,454	7,008	72,462	15,764	22,548	38,312	130,281	30,217	160,498

Table 5.2.2 Drainage, Sewerage and Solid Waste Program Costs in Relation to Key Indicators: Sensitivity to Key Assumptions

(20% increase in estimated costs, half the predicted economic growth rate)

(Value in 2000 Price)

Year	Total Cost ($US'000)	Cost as % of GRP in Study Area (%)	Cost as % of GRP in Haiphong (%)	Cost as % of HPPC Exp. (%)	Cost as % of Disp. Inc. Study Area (%)	Per Capita Cost in Study Area ($)
2001	1,727	0.39	0.26	2.69	0.79	3.02
2002	3,160	0.70	0.44	4.79	1.41	5.51
2003	5,318	1.13	0.70	7.76	2.29	9.16
2004	9,124	1.89	1.15	12.84	3.78	15.56
2005	12,360	2.48	1.51	16.85	4.96	20.85
2006	15,076	2.82	1.73	19.24	5.66	25.16
2007	17,927	3.17	1.94	21.58	6.35	29.59
2008	20,180	3.39	2.08	23.06	6.77	32.94
2009	22,243	3.56	2.18	24.25	7.13	35.92
2010	**23,496**	**3.61**	**2.21**	**24.55**	**7.21**	**37.54**
2011	27,124	4.03	2.48	27.48	8.08	42.88
2012	31,534	4.55	2.79	31.03	9.12	49.33
2013	36,287	5.11	3.12	34.73	10.20	56.19
2014	39,856	5.47	3.35	37.17	10.92	61.10
2015	42,704	5.71	3.50	38.85	11.41	64.81
2016	45,679	5.97	3.65	40.59	11.93	68.64
2017	48,610	6.21	3.80	42.24	12.41	72.32
2018	51,562	6.44	3.95	43.85	12.89	75.96
2019	54,646	6.69	4.10	45.51	13.37	79.73
2020	57,570	6.90	4.23	47.01	13.82	83.20

Table 5.2.3 Priority Projects: Loan Repayment Schedule and Costs as Percentage of HPPC's Expenditure

Unit: 1,000 dollar in current price

	Borrowing (85% of Total Investment)												
	Const-ruction & Procure-ment (1.3%/year)	Engi-neering (0.75%/ year)	Total	Repay-ment of Principal	Payment of Interest	Total Repay-ment	15% of Total Invest-ment (Not Covered by Loan)	Recurring Cost	Total Project Cash Expendi-ture	HPPC's Expenditure	Raito of Re-payment to HPPC Exp.	Ratio of Sum of the 15% & Recurring Cost to HPPC Exp.	Ratio of Total Project Expenditure to HPPC Exp.
a	b	c	d = b+c	e	f	g = e+f	h	I	j = g+h+I	k	l =g/k	m = (h+l)/k	n = j/k
2003	0	2,159	2,159	0	0	0	4,314	0	4,314	77,066	0.0%	5.6%	5.6%
2004	18,317	1,726	20,043	0	16	16	6,007	0	6,024	83,548	0.0%	7.2%	7.2%
2005	22,237	1,621	23,858	0	267	267	2,881	2,370	5,519	90,259	0.3%	5.8%	6.1%
2006	19,561	1,511	21,071	0	568	568	2,486	2,461	5,515	102,432	0.6%	4.8%	5.4%
2007	17,774	1,541	19,314	0	834	834	2,180	2,916	5,930	115,057	0.7%	4.4%	5.2%
2008	17,459	1,572	19,031	0	1,077	1,077	1,997	3,006	6,080	128,146	0.8%	3.9%	4.7%
2009	13,639	1,598	15,237	0	1,315	1,315	1,672	3,207	6,195	141,712	0.9%	3.4%	4.4%
2010	3,640	880	4,520	0	1,505	1,505	562	3,302	5,369	155,770	1.0%	2.5%	3.4%
2011	0	0	0	0	1,505	1,505	0	3,405	4,909	168,894	0.9%	2.0%	2.9%
2012	0	0	0	0	1,505	1,505	0	3,491	4,995	182,482	0.8%	1.9%	2.7%
2013	0	0	0	6,052	1,559	7,610	0	3,581	11,192	196,545	3.9%	1.8%	5.7%
2014	0	0	0	6,052	1,482	7,534	0	3,611	11,145	211,098	3.6%	1.7%	5.3%
2015	0	0	0	6,052	1,406	7,458	0	611	8,069	226,154	3.3%	0.3%	3.6%
2016	0	0	0	6,052	1,330	7,381	0	629	8,010	241,728	3.1%	0.3%	3.3%
2017	0	0	0	6,052	1,253	7,305	0	646	7,951	257,834	2.8%	0.3%	3.1%
2018	0	0	0	6,052	1,177	7,228	0	664	7,893	274,488	2.6%	0.2%	2.9%
2019	0	0	0	6,052	1,101	7,152	0	682	7,834	291,705	2.5%	0.2%	2.7%
2020	0	0	0	6,052	1,024	7,076	0	700	7,776	309,501	2.3%	0.2%	2.5%
2021	0	0	0	6,052	948	6,999	0	719	7,718	328,319	2.1%	0.2%	2.4%
2022	0	0	0	6,052	871	6,923	0	738	7,661	348,281	2.0%	0.2%	2.2%
2023	0	0	0	6,052	795	6,847	0	757	7,603	369,456	1.9%	0.2%	2.1%
2024	0	0	0	6,052	719	6,770	0	776	7,547	391,919	1.7%	0.2%	1.9%
2025	0	0	0	6,052	642	6,694	0	797	7,491	415,748	1.6%	0.2%	1.8%
2026	0	0	0	6,052	566	6,618	0	818	7,436	441,025	1.5%	0.2%	1.7%
2027	0	0	0	6,052	490	6,541	0	840	7,381	467,840	1.4%	0.2%	1.6%
2028	0	0	0	6,052	413	6,465	0	863	7,328	496,284	1.3%	0.2%	1.5%
2029	0	0	0	6,052	337	6,389	0	887	7,276	526,458	1.2%	0.2%	1.4%
2030	0	0	0	6,052	261	6,312	0	912	7,224	558,467	1.1%	0.2%	1.3%
2031	0	0	0	6,052	184	6,236	0	938	7,173	592,422	1.1%	0.2%	1.2%
2032	0	0	0	6,052	108	6,159	0	964	7,124	628,441	1.0%	0.2%	1.1%
2033	0	0	0	420	32	452	0	992	1,444	666,650	0.1%	0.1%	0.2%
2034	0	0	0	420	28	449	0	1,022	1,470	707,183	0.1%	0.1%	0.2%
2035	0	0	0	420	25	445	0	1,052	1,498	750,179	0.1%	0.1%	0.2%
2036	0	0	0	420	22	442	0	1,084	1,526	795,790	0.1%	0.1%	0.2%
2037	0	0	0	420	19	439	0	1,117	1,557	844,174	0.1%	0.1%	0.2%
2038	0	0	0	420	16	436	0	1,152	1,588	895,500	0.0%	0.1%	0.2%
2039	0	0	0	420	13	433	0	1,189	1,621	949,947	0.0%	0.1%	0.2%
2040	0	0	0	420	9	430	0	1,227	1,656	1,007,703	0.0%	0.1%	0.2%
2041	0	0	0	420	6	427	0	1,267	1,693	1,068,972	0.0%	0.1%	0.2%
2042	0	0	0	420	3	423	0	1,309	1,732	1,133,965	0.0%	0.1%	0.2%
Total	112,627	12,607	125,234	125,234	25,432	150,665	22,100	56,704	229,470	9,917,709	1.5%	0.8%	2.3%

Note: A 2% annual inflation in terms of dollar is assumed.