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MUNICIPALITY OF PHNOM PENH  
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NO.

# THE STUDY ON SOLID WASTE MANAGEMENT IN THE MUNICIPALITY OF PHNOM PENH IN THE KINGDOM OF CAMBODIA

## Final Report Supporting Report



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# Annex 1

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*Waste Amount and  
Composition Survey  
(Rainy and Dry Season)*

# Annex 1 Waste Amount and Composition Survey

The Waste Amount and Composition Survey (WACS) consists of two parts:

- The Waste Amount Survey
- The Waste Composition Survey.

The objectives, methodologies and results are separately described in each part and findings are discussed together in the subsequent section.

## 1.1 Waste Amount Survey

### 1.1.1 Objective

The objective of the Waste Amount Survey is to know the current waste generation rates of households, restaurants, shops, markets, schools, streets, hotels, offices and collection vehicles in the Study Area. Knowledge of the waste generation rate is essential for the development and design of integrated solid waste management systems.

The data on waste generation rates obtained in this survey is then applied to elaborate the waste stream, which is used to comprehend the current flow of waste and to make future projections in the Study Area.

### 1.1.2 Methodology

#### a. Wastes Targeted

The survey covers households, restaurants, shops, markets, schools, streets, hotels, offices and collection vehicles. The waste generation sources were selected through consultation with the counterparts in order to reflect the present situation of the Study Area in the survey.

#### b. Questionnaire Survey

A questionnaire survey was also conducted to know the number of residents in houses, the number of tables in restaurants, the number of stalls in markets, the number of the students in schools and the number of rooms in hotels.

#### c. Survey Schedule

The survey was conducted in the dry season, in March 2003, and in the rainy season, in October 2003. The first day of the survey was used as a trial run. The sources had a chance to discharge waste accumulated before the survey started, and the sources and surveyors could get used to the survey. Plastic bags were distributed to sampling points before the survey, except markets that had their waste collected by truck.

#### d. Waste Generation Sources

Table 1-1 shows the categories, the number of waste generation sources, the number of survey days and the total number of samples in each category. There were 11 categories, 90 waste generation sources, and the total number of sampling plans was 630 in the each season.

Table 1-1: Generation Source and Number of Sampling plans

Generation Source		Samples Per Day	Survey Days	Total Samples
Residential (by income)	High	20	7	140
	Middle	20	7	140
	Low	20	7	140
Commercial	Restaurant	5	7	35
	Other Shop	5	7	35
Market		2	7	14
School		2	7	14
Street		8	7	56
Hotel		2	7	14
Office		5	7	35
Collection Vehicle		1	7	7
Total		90	---	630

Households were categorized into three groups according to income level, i.e. high, middle, and low income, in order to reflect the living conditions in the Study Area. Classification of income level was not based on actual income. It was based on the observation of houses and areas where sources are located. Other categories are selected in consideration of the situation in Cambodia.

### 1.1.3 Results

#### a. Household Waste Generation Rate

For households, 140 samples for each income level, 420 samples in total, were obtained for seven days in the both season. The results of the survey are shown in the table below.

Table 1-2: Household Waste Generation Ratio in the Target area

Item	High Income		Middle Income		Low Income	
	Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season
Average value (g/person/day)	668.5	646.2	545.3	501.4	445.9	435.2
Maximum value (g/person/day)	2021	1216	1280	923	1300	900
Minimum value (g/person/day)	255	250	167	196	87	104

#### b. Households and Other wastes

The following table shows the daily waste generation rates of households, restaurants, shops, markets, schools, streets, hotels and offices.

Table 1-3: Daily Waste Generation Amount in Dry Season (2003)

Item	Average monthly income (Riel)	Population by Income Level	Generation Ratio (g/person/day)	
			Dry season	Rainy season
High Income Household	3,708,000	10%	668.5	646.2
Middle Income Household	1,291,000	30%	545.3	501.4
Low Income Household	636,000	60%	445.9	435.2
Weight Average	---	---	498.0	476.1

Table 1-4: Generation Ratio of Other Types of Waste

Item		Unit	Discharge Ratio	
			Dry season	Rainy season
Commercial	Restaurant	g/table/day	1,940	1,387
	Other shop	g/shop/day	4,566	4,437
Market waste		g/stall/day	1,700	1,945
School		g/student/day	18	21
Street Sweeping Waste		g/km/day	47,235	59,510
Hotel		g/room/day	199	263
Office		g/office/day	2,946	4,174

Table 1-5: Daily Waste Generation Amount (2003)

Generation Source	Unit	Number of Generation Source	Generation Ratio			Daily Generation Amount (ton/day)		
			Dry season	Rainy season	Average	Dry season	Rainy season	Average
Household Waste	g/person/day	1,199,414	498	476	487	597.3	570.9	584.1
Commercial Waste (Restaurant)	g/table/day	27,808	1,940	1,387	1,664	54.0	38.6	46.3
Commercial Waste (Other Shop)	g/shop/day	33,524	4,566	4,437	4,502	153.1	148.8	151.0
Market Waste	g/stall/day	51,766	1,700	1,945	1,823	88.0	100.7	94.4
School Waste	g/student/day	385,013	18	21	20	6.9	8.1	7.5
Street Sweeping Waste	g/km/day	56	47,235	59,510	53,373	2.6	3.3	3.0
Hotel Waste	g/room/day	13,385	199	263	231	2.7	3.5	3.1
Office Waste	g/office/day	368	2,946	4,174	3,560	1.1	1.5	1.3
Total						905.7	875.4	890.6

Note: Data sources are as follows:

Restaurant: Statistics of Tourism Industry in 2002 published by Department of Phnom Penh Tourism of the municipality of PP

Other shop: Based on interviews with the Department of Commerce of MPP (in 2002)

Market: Based on Interviews with the Department of Commerce in the Khan office, the cabinet of Khan, the market committee, which is in charge of managing the market ( i.e. security, daily operation, etc.), and by counting the number of shops in the market by ourselves (in 2002-2003)

School: Based on Interviews with to the Department of Education in MPP (in 2002) and the Department of Higher Education in the Ministry of Education (in 2003)

Street Sweeping: Based on the contract between MPP and CINTRI

Hotel: Statistics of Tourism Industry in 2002 published by Department of Phnom Penh Tourism of the municipality of PP

Office: Based on interviews with the Social Service Section in the Khan office (in 2001)

## 1.2 Waste Composition Survey

### 1.2.1 Objectives

The objective of the Waste Composition Survey is to obtain data on the physical and chemical properties of wastes generated in the Study Area. The study focused on determining the following:

- a) Specific gravity
- b) Physical composition (wet base)
- c) Water content
- d) Three contents (combustible matter, water and ash)
- e) Chemical analysis (carbon and nitrogen)

### 1.2.2 Methodology

#### a. Waste Targeted

Twelve types of wastes were targeted for specific gravity, physical composition, water content, and three contents, and three types of wastes were targeted for chemical analyses. Table 1-6 and Table 1-7 show the waste targeted and the number of sampling plans.

Table 1-6: Number of sampling plans for Waste Composition Survey in Dry Season

Generation Source		Samples Per Day	Survey Days	Specific gravity	Physical composition	Three contents	Chemical analysis
Residential (by income)	High	1	7	7	7	7	0
	Middle	1	7	7	7	7	14
	Low	1	7	7	7	7	0
	(Uncollected areYYa)	1	7	7	7	7	0
Commercial	Restaurant	1	7	7	7	7	14
	Other Shop	1	7	7	7	4	0
Market		1	7	7	7	7	14
School		1	7	7	7	3	0
Street		1	7	7	7	4	0
Hotel		1	7	7	7	3	0
Office		1	7	7	7	3	0
Collection Vehicle		1	7	7	7	4	0
Total			---	84	84	63	42

Table 1-7: Number of sampling plans for Waste Composition Survey in Rainy Season

Generation Source		Samples Per Day	Survey Days	Specific gravity	Physical composition	Three contents	Chemical analysis
Residential (by income)	High	1	7	7	7	7	0
	Middle	1	7	7	7	7	14
	Low	1	7	7	7	7	0
Commercial	Restaurant	1	7	7	7	7	14
	Other Shop	1	7	7	7	4	0
Market		1	7	7	7	7	14
School		1	7	7	7	3	0
Street		1	7	7	7	4	0
Hotel		1	7	7	7	3	0
Office		1	7	7	7	3	0
Collection Vehicle		1	7	7	7	4	0
Total			---	77	77	63	42

#### b. Sampling

The wastes used in the Waste Amount Survey were used for the Waste Composition Survey. Wastes from each source were gathered and mixed by category and one sample was extracted from each category using the waste reduction method.

#### c. Specific gravity

The specific gravity of the waste sample was calculated with the following formula.

$$\text{Specific gravity} = \text{Net weight of waste} / \text{Volume of waste}$$

#### d. Physical Composition (wet base)

The physical composition was measured on a “wet basis” (as discarded, before the waste had a chance to dry). The samples were divided into the following ten components, and the weight of each was measured.

- paper
- rubber and leather
- grass and wood
- metals

- kitchen waste
- textiles
- plastics
- bottles and glass
- soil and stone
- others

**e. Three contents (water content)**

First, the samples were weighed before drying. After drying out for two hours in a dryer set at 110 degrees, the samples were weighed again, and the water content was calculated by the following formula.

$$\text{Water Content(\%)} = \frac{\text{Original Weight} - \text{Dry Weight}}{\text{Original Weight}} \times 100$$

**f. Three contents (combustible matter, ash)**

After weighing the dried wastes, the samples were mixed and crushed, and then dried out again for five hours in a dryer set at 550 degrees to measure combustible matter and ash.

$$\text{Ash (\%)} = \text{sample weight after drying at 550 degrees} / \text{original sample weight} \times 100$$

$$\text{Combustible matter (\%)} = 100 - \text{water content (\%)} - \text{ash (\%)}$$

**g. Chemical analysis**

The method of carbon is the Walkly and Black Method (1934). The method of total nitrogen is the Kjeldahl Method (1965).

**1.2.3 Result**

**a. Specific gravity and physical composition**

From Table 1-8 to Table 1-10 show the results of the specific gravity and physical composition of the waste.

**b. Three contents and chemical analysis**

Table 1-11 and Table 1-12 show the results of the three contents and chemical analysis of the wastes.

Table 1-8: Result of Waste Composition Survey (1/3)

Classification			Household												Commercial						
			High Income			Middle Income			Low Income			Weight average			Restaurant			Other Shop			
			Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	
Physical Composition (Wet Base)	Apparent Specific Gravity (ASG)		Kg/l	0.22	0.29	0.26	0.26	0.25	0.26	0.23	0.22	0.23	0.24	0.25	0.25	0.37	0.26	0.32	0.31	0.23	0.27
	Combustible Wastes	Paper	(%)	6.8	5.6	6.2	5.5	6.0	5.8	3.6	3.6	3.6	4.5	4.6	4.6	18.6	25.1	21.9	6.5	7.8	7.2
		Rubber and Leather	(%)	0.2	0.0	0.1	0.0	0.4	0.2	0.0	0.2	0.1	0.0	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0
		Kitchen Waste	(%)	57.1	55.9	56.2	63.6	54.9	59.0	67.0	68.9	67.7	65.0	62.8	63.6	54.2	41.8	47.6	77.8	58.2	67.8
		Textile	(%)	2.3	1.6	2.0	2.0	5.0	3.5	2.2	2.0	2.1	2.1	2.9	2.5	0.0	0.8	0.4	4.7	4.0	4.4
		Plastic	(%)	16.0	14.8	15.4	23.9	18.2	21.1	19.2	14.3	16.8	20.3	15.6	18.0	10.7	9.4	10.1	9.2	9.8	9.5
		Grass and Wood	(%)	14.1	16.8	15.5	2.2	9.0	5.6	2.3	6.2	4.3	3.4	8.5	6.0	1.1	5.8	3.5	0.6	19.1	9.9
	Sub-total		(%)	96.5	94.7	95.4	97.1	93.5	95.2	94.3	95.2	94.6	95.4	94.6	94.8	84.5	83.0	83.6	98.9	98.9	98.8
	Incombustible Wastes	Metal	(%)	0.4	0.7	0.6	0.5	1.2	0.9	0.0	1.1	0.6	0.2	1.1	0.7	1.7	1.6	1.7	0.6	0.6	0.6
		Bottle and Glass	(%)	1.7	1.8	1.8	1.0	0.8	0.9	0.0	0.1	0.1	0.5	0.6	0.6	12.6	10.3	11.5	0.0	0.0	0.0
Ceramic and Stone		(%)	1.0	0.9	1.0	1.0	0.7	0.9	3.2	0.9	2.1	2.4	0.8	1.6	1.1	1.6	1.4	0.6	0.0	0.3	
Others		(%)	0.4	1.9	1.2	0.3	3.8	2.1	2.5	2.7	2.6	1.6	2.9	2.3	0.0	3.5	1.8	0.0	0.5	0.3	
Sub-total		(%)	3.5	5.3	4.6	2.9	6.5	4.8	5.7	4.8	5.4	4.6	5.4	5.2	15.5	17.0	16.4	1.1	1.1	1.2	
Total			(%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 1-9: Result of Waste Composition Survey (2/3)

Classification			Market			School			Street Sweeping			Hotel			Office			Collection Vehicle			
			Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	
Physical Composition (Wet Base)	Apparent Specific Gravity (ASG)		Kg/l	0.15	0.17	0.16	0.10	0.16	0.13	0.16	0.22	0.19	0.18	0.19	0.19	0.11	0.10	0.11	0.24	0.23	0.24
	Combustible Wastes	Paper	(%)	9.3	6.6	8.0	23.4	21.9	22.7	4.8	3.1	4.0	5.9	8.6	7.3	25.7	33.3	29.5	12.0	9.5	10.8
		Rubber and Leather	(%)	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.4	0.2	0.0	0.6	0.3	0.0	0.0	0.0	0.2	0.5	0.4
		Kitchen Waste	(%)	63.9	69.3	66.4	16.9	1.8	9.4	5.8	1.4	3.6	35.9	44.4	40.0	41.0	27.0	33.8	56.1	46.8	51.1
		Textile	(%)	0.8	0.9	0.9	0.5	0.6	0.6	1.4	1.1	1.3	0.0	2.9	1.5	0.0	2.4	1.2	4.5	6.2	5.4
		Plastic	(%)	12.7	10.5	11.6	28.8	24.3	26.3	6.5	4.8	5.7	9.0	9.6	9.3	14.1	9.8	12	15.2	12.9	14.1
		Grass and Wood	(%)	2.9	10.0	6.5	14.0	33.2	23.6	28.5	21.6	25.1	43.2	17.9	30.6	8.2	13.2	10.7	2.4	10.7	6.6
	Sub-total		(%)	89.6	97.5	93.5	83.6	81.8	82.6	47.0	32.4	39.9	94.0	84.0	89.0	89.0	85.7	87.2	90.4	86.6	88.4
	Incombustible Wastes	Metal	(%)	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.1	0.1	0.0	0.2	0.1	0.0	1.1	0.6	1.0	0.7	0.9
		Bottle and Glass	(%)	2.1	1.9	2.0	0.0	0.0	0.0	1.2	1.0	1.1	1.0	1.4	1.2	0.3	0.8	0.6	1.0	1.4	1.2
Ceramic and Stone		(%)	1.9	0.5	1.2	7.2	9.0	8.1	51.8	64.7	58.0	4.5	6.1	5.3	8.0	6.0	7.0	1.8	2.2	2.0	
Others		(%)	6.4	0.1	3.3	9.2	8.9	9.1	0.0	1.8	0.9	0.5	8.3	4.4	2.7	6.4	4.6	5.8	9.1	7.5	
Sub-total		(%)	10.4	2.5	6.5	16.4	18.2	17.4	53.0	67.6	60.1	6.0	16.0	11.0	11.0	14.3	12.8	9.6	13.4	11.6	
Total			(%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 1-10: Result of Waste Composition Survey (3/3)

Classification			Total			
			Dry season	Rainy season	Average	
Physical Composition (Wet Base)	Apparent Specific Gravity (ASG)		Kg/l	0.25	0.24	0.25
	Combustible Wastes	Paper	(%)	6.3	6.5	6.4
		Rubber and Leather	(%)	0.0	0.1	0.1
		Kitchen Waste	(%)	65.8	61.2	63.3
		Textile	(%)	2.3	2.7	2.5
		Plastic	(%)	17.1	13.8	15.5
		Grass and Wood	(%)	3.0	10.5	6.8
	Sub-total		(%)	94.5	94.8	94.6
	Incombustible Wastes	Metal	(%)	0.3	0.9	0.6
		Bottle and Glass	(%)	1.3	1.1	1.2
Ceramic and Stone		(%)	2.1	0.9	1.5	
Others		(%)	1.8	2.3	2.1	
Sub-total		(%)	5.5	5.2	5.4	
Total			(%)	100.0	100.0	100.0

Table 1-11: Result of Three contents and Chemical analysis (1/2)

Classification			Household											Commercial							
			High Income			Middle Income			Low Income			Weight average		Restaurant			Other Shop				
			Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	
Three contents	Water contents		(%)	67.8	72.4	70.0	66.6	70.1	68.3	65.0	70.8	67.9	65.8	70.5	68.2	67.7	66.9	67.3	76.5	67.8	72.1
	Combustible		(%)	23.6	24.7	24.2	26.7	25.9	26.3	25.2	26.4	25.8	25.5	26.0	25.7	25.7	30.5	28.1	18.3	27.3	22.8
	Ash		(%)	8.6	2.9	5.8	6.7	4.0	5.4	9.8	2.8	6.3	8.7	3.5	6.1	6.6	2.6	4.6	5.2	4.9	5.1
Total			(%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Chemical analysis	Kitchen waste	Carbon	(%)				28.5	30.4	29.5							31.5	27.5	29.5			
		Nitrogen	(%)				1.6	1.6	1.6							1.8	2.0	1.9			
		C/N	(%)				17.5	19.0	18.3							17.8	13.8	15.8			
	Grass/wood	Carbon	(%)				30.8	31.1	31.0							33.7	31.2	32.5			
		Nitrogen	(%)				1.2	1.4	1.3							1.1	1.7	1.4			
		C/N	(%)				26.7	22.2	24.5							30.2	18.4	24.3			



Table 1-12: Result of Three contents and Chemical analysis (2/2)

Classification			Market			School			Street Sweeping			Hotel			Office			Collection Vehicle			
			Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	Dry season	Rainy season	Average	
Three contents	Water contents	(%)	60.2	68.7	64.4	41.7	46.9	44.2	18.1	20.2	19.1	57.3	58.6	57.8	60.1	54.0	57.0	61.8	58.8	60.3	
	Combustible	(%)	27.9	25.1	26.5	46.8	34.9	40.9	61.7	37.6	49.7	37.1	35.2	36.2	31.7	40.2	36.0	30.0	37.0	33.5	
	Ash	(%)	11.9	6.2	9.1	11.5	18.2	14.9	20.2	42.2	31.2	5.6	6.3	6.0	8.2	5.8	7.0	8.2	4.2	6.2	
	Total	(%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
Chemical analysis	Kitchen waste	Carbon	(%)	28.3	25.9	27.1															
		Nitrogen	(%)	2.0	1.5	1.8															
		C/N	(%)	14.4	17.3	15.9															
	Grass/wood	Carbon	(%)	30.0	28.4	29.2															
		Nitrogen	(%)	0.8	1.5	1.2															
		C/N	(%)	39.5	18.9	29.2															

## 1.3 Findings

### 1.3.1 Waste amount survey

#### a. Waste generation rate

The average household waste generation ratio of 487 g/person/day is similar to other developing countries such as Sri Lanka (450-650 g/person/day in 2002) and the municipality of Panama (440-898 g/person/day in 2002). As for the household waste discharge ratio by income level, for high income households it is 668.5 g/person/day in the dry season and 646.2 g/person/day in the rainy season; for middle income households it is 545.3 g/person/day in the dry season and 501.4 g/person/day in the rainy season; and for low income households it is 445.9 g/person/day in the dry season and 435.2 g/person/day in the rainy season. The increase in the generation ratio by level is proportionate to the household income level.

It is notable that most of the daily generation amount is household waste (65.6%) followed by shop (other than restaurant) waste (17.0%)

### 1.3.2 Waste composition survey

#### a. General

The content of recyclable waste, including metal, paper, glass and plastics, is 23.7% in total. It is notable that plastic waste accounts for 15.5% of this 23.7%, which is very high. In Phnom Penh, it is thought that the use of PET bottles and plastic bags have spread rapidly, and are consumed at the same level as developed countries. From the viewpoint of proper management of the final disposal site, plastic waste will be an obstacle. Therefore, countermeasure should be considered.

#### b. Household waste

Kitchen waste is the most dominant constituent, which accounts for 63.3% of the composition in total waste. It seems to be natural that the use of ready-made food is not so popular in Cambodia. Therefore, waste from the kitchen for food preparation accounts for much more than other types of waste. As for the household income level, the percentage of kitchen waste decreases as the household income level increases. This is because high income households generate other types of wastes than kitchen waste more than middle and low income households. The most significant waste is "grass and wood" because, in general, only

high income households can generate garden waste. The increase in paper waste also indicates the difference in lifestyle.

**c. Other waste**

- Restaurants generate the highest percentage of bottle and glass waste at approximately 11.5% in total, followed by market waste, which generates only 2.0% in total.
- Office and school wastes contain high percentage of paper waste accounting for 29.5% and 22.7% in total, respectively.
- Street sweeping waste contains 58.0 % of ceramic and stone waste, and 25.1% of grass and wood waste in total respectively.
- Table 1-11 and Table 1-12 show the established C/N ratio, the ratio of carbon and nitrogen contained in the waste of households, restaurants and markets. These results indicate the condition of these wastes is suitable for composting. The results show a C/N ratio of 15.8% to 18.3% for kitchen waste, and 24.3% to 29.2% for grass and wood waste. It can be said that the kitchen waste and grass and wood waste show typical C/N values, and are suitable for composting.

# Annex 2

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*Time and Motion Survey  
(Rainy and Dry Season)*

## Annex 2 Time and Motion Survey

### 2.1 Background

#### 2.1.1 Objective

The objective of this study was to obtain information about the collection and haulage system of solid waste management (SWM) in Phnom Penh. This information will be used to obtain a better understanding of the current situation in terms of SWM. Selected information will also be used in calculating equipment and workforce needs for future SWM in the Phnom Penh.

Specific objectives of the study were:

- To understand the present situation of waste collection in Phnom Penh.
- To verify collection efficiencies for the different vehicle types and collection systems used.
- To detail labor inputs required for each task.

This information will be used in the preparation of the Master Plan for Solid Waste Management for Phnom Penh.

#### 2.1.2 Collection area characteristics

The Municipality of Phnom Penh is located on a flat alluvial plain at the confluence of the Mekong, Sap and Bascac rivers. Administratively, the city is divided into 7 Khans or districts. Of these, 4 districts are mainly urban (Daum Penh, Chamcarmon, Toul Kork, 7 Makara) in nature with a total area of 27.19<sup>1</sup> km<sup>2</sup> and a population of 628,322<sup>2</sup>. The majority of government and administrative buildings are located here, especially in Daum Penh and Chamcarmon districts. The remaining 3 districts are mainly rural or peri-urban in nature with a total area of 348.3 km<sup>2</sup> and population of 571,092. The housing stock in high-density downtown areas mainly consists of older 3 to 6 buildings constructed in the colonial period, typically with a “Chinese shop house” configuration at the street level and walk-up flats on the upper floors. Flats are mostly accessed by stairways in the rear of the buildings that commonly connect to small alleyways. Housing in medium density areas is mainly 2-3 story shop houses and detached or semi-detached buildings from the postcolonial periods. A number of unplanned settlements (squatter areas) also located in the medium density areas. Low density, peri-urban and rural areas contain the widest range of housing types with rural style wooden houses, shop houses, detached and semi-detached all represented.

Solid waste collect service is mainly limited to the urban areas and some nearby peri-urban areas. The urban population served is estimated at 587,481 or about 93.5% of the total, while coverage in the rural and peri-urban areas is estimated at 234,148, or about 41% of the total. Overall the coverage is estimated at 68.5%.

#### 2.1.3 Service Providers

A Canadian company called CINTEC has created a local subsidiary with the name of

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<sup>1</sup> BUA, July 2003

<sup>2</sup> Baseline projection from Population Census 1998






CINTRI. This local subsidiary purchased the solid waste collection rights from the previous contract holder called PSBK Company in March 2002 and started providing service in August 2002. CINTRI is the sixth service provider since waste collection was privatized in 1994.



Although CINTRI's contract gives it exclusive rights to collect and treat municipal solid waste in the territory of the municipality of Phnom Penh, there are several small collection systems operating within the service area under special agreements. This survey also collected data from the largest of these schemes, which is in a special collection zone known as the Neighborhood Improvement Project area or NIP. The NIP was set-up in Sangkats (wards) Boueng Keng Kang 2 and 3 as a demonstration project under a NORAD (Norway) funded program that ended in 2001. Waste collection service continues to be provided to the approximately 20,000 residents in the NIP area by the municipal solid waste authority called Phnom Penh Waste Management (PPWM), in cooperation with the non-governmental group called Community Sanitation and Recycling Organization (CSARO) and Waste Picker Self-help Groups (SHG).

#### a. Collection Equipment

CINTRI operates a fleet of some 51 waste collection vehicles of various ages, makes and models (see table 1.1 below for details). All vehicles are between 8 and 25 years old and generally in very poor condition. All vehicles were acquired from the previous contract holder and were originally imported into the country as used equipment.

PPWM operates a single 1993 Daewoo 11 ton (18m<sup>3</sup>) compactor vehicle to service the secondary collection needs of the NIP area and a 1994 Boxer 4.5 (4m<sup>3</sup>) ton for collection activities in other areas.

Vehicle Type	Number of vehicles	Vehicle ID numbers	Remarks	Photo
Titan 2.5 ton	8 vehicles	57, 58, 72, 75, 76, 77, 74, 92	3 m <sup>3</sup> capacity with mechanical compaction, 5-6 trips per day (day-time operation only)	
Boxer 3.5 ton	9 vehicles	09, 47, 62, 65, 67, 68, 69, 71, 99	3 m <sup>3</sup> capacity, short frame, mechanical and hydraulic compaction units, 4-5 trips per day (day-time operation only)	
Boxer 4.5 ton	11 vehicles	11, 12, 23, 24, 41, 42, 48, 49, 50, 66, 98	4 m <sup>3</sup> capacity, long frame, 4-5 trips per day (day-time operation only)	
Isuzu 4.5 ton	2 vehicles	21, 22	4 m <sup>3</sup> capacity, roll-top box, 4-5 trips per day (day-time operation only)	
Dealus 6 ton	1 vehicle	53	4 m <sup>3</sup> capacity open top dump truck, 4 trips per day	
Dealus 7 ton	1 vehicle	28	6 m <sup>3</sup> capacity compactor truck, 4 trips per day	
Amaz 9 ton	1 vehicle	59	6 m <sup>3</sup> capacity, 3-4 trips per day	

Daewoo 11 ton	14 vehicles	13, 14, 15, 16, 25, 26, 27, 43, 45, 54, 79, 80, 81, 89,	18 m3 capacity, 4-5 trips per day (24 hr. per day operation)	
Kama 11 ton	4 vehicles	52, 59, 61, 93	20 m3 capacity, 2 trips per day, side load arm, compaction not working	

### 2.1.4 Waste Collection Systems

CINTRI collection methods range from daily curbside collection and bell collection in most of Daum Penh and 7 Makakra districts, to 3 times weekly in much of Toul Kork and Chamcarmon districts and irregular collection from communal collection points and some bell collection in many of the peri-urban areas in Dangkor, Mean Chey and Russey Kao districts.

PPWM with CSARO and the SHGs provide a daily manual collection service in the NIP area using pushcarts. Waste is brought to a collection center where it is sorted and recyclables and compostables are removed. The remaining waste is loaded into the PPWM vehicle for transport to the final disposal site. This is called a “Primary/Secondary” collection system.

## 2.2 Survey Approach

### 2.2.1 Survey Composition

*Dry Season field survey*, which took place over a 10 day period (March 24 to April 6, 2003) and included data collection of 40 vehicle cycles (one cycle is defined as a single trip starting with vehicle preparation, travel time to collection area, waste loading time, travel time to disposal site, and disposal time). This study looked at the range of vehicles and collection methods used in Phnom Penh.

*Wet season field survey* was carried out intermittently over a two-month period from October 10 to December 8, 2003. This study looked at seasonal changes to the working efficiencies of the larger vehicles (18 m3 Daewoo compactor and 20 m3 Kamaz trucks) currently used in Phnom Penh. Data was also collected on the operating efficiencies of the single “medium” sized collection vehicle (8 m3 Dealus) currently in operation in Phnom Penh (which was not studied during the previous period).

To obtain an accurate picture of the existing solid waste collection system it was decided to collect data on at least 40 collection trips (a trip was defined as one cycle of a collection vehicle including travel time, waste loading and discharge at the final disposal site) and including various waste collection methods, vehicle types and collection areas.

After developing a study plan and data collection methodology, the transportation and collection specialist from JICA Study Team met with CINTRI management to obtain the company’s cooperation and to request access to the company truck garage/parking depot. Information was also collected on the number and types of vehicles operated by the company and the organization of the collection routes.

Data collection forms were prepared and tested and a database set-up. An initial list of collection routes was selected for survey based on the selection criteria. For this survey, waste collection methods were defined as follows:

- *Curbside and Bell collection.* These are actually two different collection methods, but as they are practiced interchangeably in Phnom Penh they have been treated together in this study. The activity consists of vehicle and crew slowly driving through the collection area and sounding the vehicle horn to announce their arrival. Residents who store their waste in the home bring their waste to the vehicle, while the crews load waste that has been deposited along the curbside.
- *Heap collection.* This collection method consists of the manual loading of waste from the ground at communal collection points.
- *Container collection.* This is mainly the mechanical loading of waste containers (0.6 – 2.5 m<sup>3</sup>), but also includes some data on the manual loading of smaller public bins (100 liter).
- *Primary/Secondary collection.* This is actually a combination of manual collection of waste (mostly curbside and heap) with pushcarts, and then transferring the waste into trucks for secondary transport to the disposal site. In Phnom Penh there are several such schemes. In the NIP area the transfer is by container, other areas use heap method for transfer, or so called “meeting points” where waste is transferred directly from the pushcarts used in manual collection to the secondary collection vehicle at a designated road side location. This survey only looked at the secondary portion of the NIP collection, so this data has been treated as container collection.

### 2.2.2 Data collection

Three research teams were organized consisting of one researcher and one assistant each. The teams supplied their own means of transportation during data collection. They were issued stopwatches, clipboards and data collection forms. The teams received training on the survey methodology and use of the data collection forms. After field-testing, some minor revisions were made to the data collection forms.

Where possible the selected collection vehicle was monitored from the time the driver and crew arrived at the truck garage until the completion of the collection and discharge work. Vehicle and crew activities were broken down as shown in the figure below.

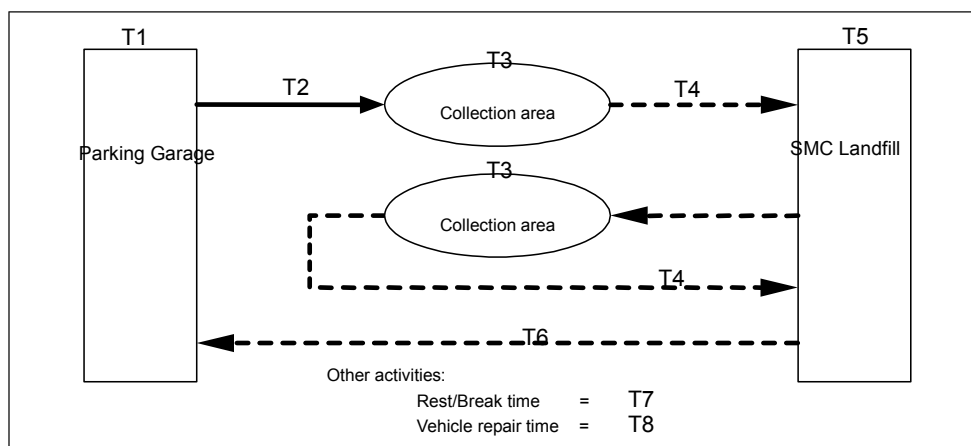


Figure 2-1: Breakdown of vehicle and crew activities

Data codes were used to organize the information collected with specific data collected as shown below.

Table 2-1: Data codes and definitions

Data Code	Specific data collected
T1	Vehicle preparation at truck garage (checking condition, loading equipment, vehicle starting and warm-up, fueling, etc..)
T1 <sup>1</sup>	Wait time at a “meeting point” where vehicles and crews gather to receive the daily work assignments
T2	Travel time from truck garage to collection area
D2	Distance from the truck garage to the collection area
T3	Collection time
D3	Collection distance (used for rolling collection such as curbside and bell collection)
C3	Collection volume
T4	Travel time to and from the dumpsite
D4	Travel distance to and from the dumpsite
T5	Discharge time (including time spent in queue if applicable)
D5	Distance traveled for discharge activity
T6	Travel time from dumpsite to truck garage (for final trip of the shift)
D6	Distance from dumpsite to truck garage
T7	Break time (rest or lunch break)
T8	Vehicle down time because of mechanical problems

The team planned to survey a complete work shift (vehicle departure from garage to vehicle return to garage) for each vehicle selected on three consecutive days working the same route, however, because many of the vehicles and crews work double, split or even 24 hour shifts, it was not possible to collect all data points on all vehicles surveyed. Frequent vehicle breakdowns, vehicle changes and route changes also complicated data collection. Equipment changes and shifting of crews also made it difficult to collect data on break time (rest or lunch break) and vehicle down time. Lunch break was often taken at the same time as discharge waiting time. In the event that the study subject vehicle had mechanical problems during the data collection, the researchers had to decide whether to stay with the disabled vehicle or proceed with the replacement vehicle. The break and down-time data collected was not sufficient to include in this report.

### 2.2.3 Data compilation and analysis

Counterpart staff from PPWM were trained in use of the computer database program and assisted to enter the data received from the research teams on a daily basis. The database was manually queried for totals, averages and means in each data field as well as secondary correlations.

## 2.3 Survey Findings

### 2.3.1 Study Sample

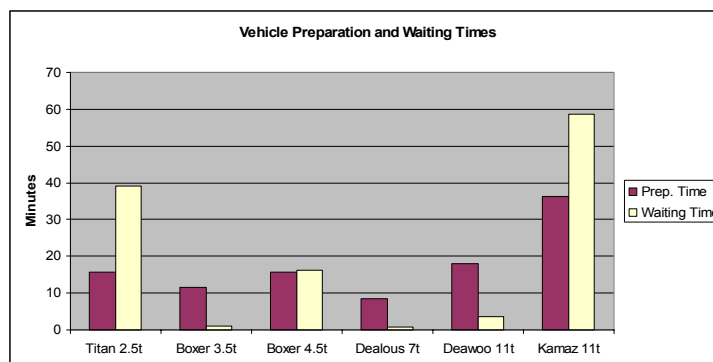
This survey collected data on a total of 69 completed vehicle shifts (data sets) during two data collection periods (wet season and dry season) for a total of approximately 6 weeks of survey time. A breakdown of vehicles surveyed is shown below.



Vehicle type	Total Vehicles in Operation (Cintri + PPWM)	Data Sets Collected		
		Dry Season	Wet Season	Total
Titan 2.5t	8	7		7
Boxer 3.5t	9	8		8
Boxer 4.5t	12	17		17
Isuzu 6t	2	1		1
Daelus 6 ton	1	0		0
Daelus 7 ton	1	0	5	5
Amaz 9 ton	1	0		0
Deawoo 11t	15	13	20	33
Kamaz 11t	4	5	12	17
Total	53	51	37	88

### 2.3.2 Preparation time

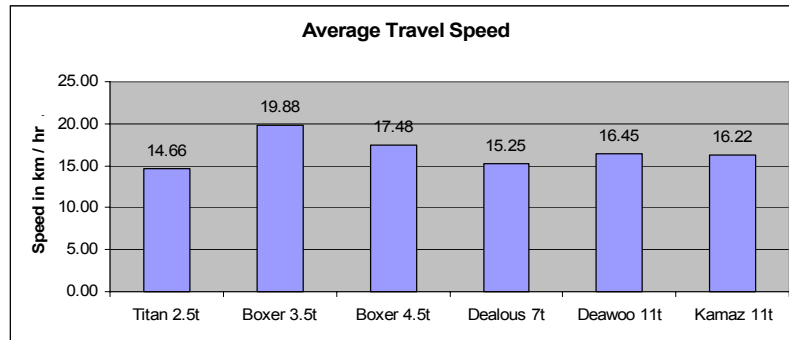
Time spent on vehicle preparation (checking fluid levels, tires, etc.), waiting for crew members to arrive, filling fuel and collection of equipment varied widely between vehicles. Data indicated preparation times from 0 to 100 minutes, with average time at about 20 minutes. In addition to preparation time, during the dry season survey it was found that vehicles working in the Chamcarmon and Toul Kork districts spent an average of 27 minutes at the so called “meeting points” which are roadside locations where the vehicles group and wait for the crews to assemble and supervisors give work assignments. Researchers noted some confusion among drivers and crews relating to collection routes, probably because the route assignments are continually changing due to vehicle breakdowns and the entire group work alternate days in Chamcarmon and Toul Kork districts. Average times for each of the vehicle types are indicated in the figure below. The oldest vehicles seem to have the longest preparations because of their poor condition. Similarly, the Kamaz and Titan vehicles seem to have the longest waiting time at meeting points because of their poor condition and low reliability requires frequent changes of work schedule.



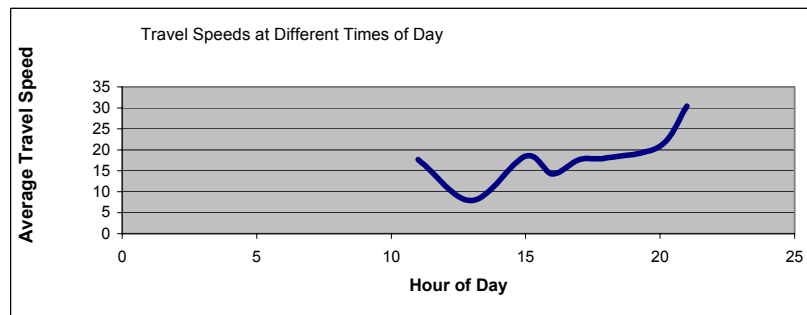
### 2.3.3 Travel Times and Travel Speeds

Travel times varied widely depending on traffic condition, driver ability and vehicle type. Overall average travel speed was 16.6 km/hr. Some variation was noted between wet and dry season averages (wet season average was 17.5 km/hr, dry season average was 16.1 km/hr), however the difference in travel speed was probably not due to weather conditions but the fact that the wet season survey focused on the larger vehicles only. In general, the smaller collection vehicles are more maneuverable and can travel more quickly in traffic than the larger vehicles, however this advantage is apparently off-set by the fact that the smaller vehicles operate mainly in the daytime when traffic is most congested. Larger vehicles

generally work day and also night times when the roads are much less crowded and traffic speeds are higher. Average travel speeds are shown in figure below.



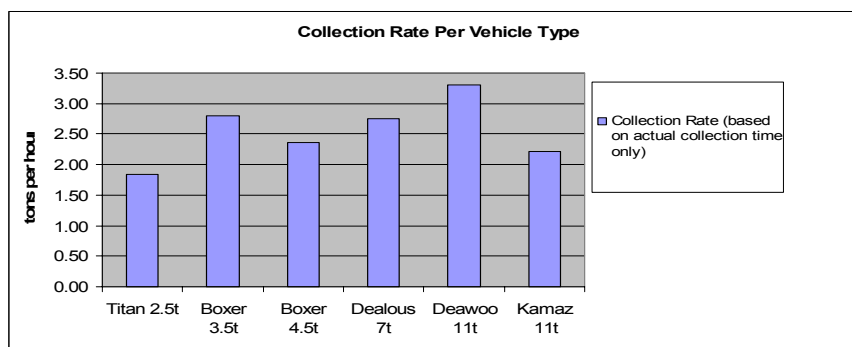
The impact of traffic conditions can be clearly seen in the figure below where time of day travel speeds are illustrated.



### 2.3.4 Waste Collection Data

Collection time and collection rate (ton/hour) varied considerably depending on the type of vehicle, condition of the vehicle and the collection method used. In the interim report an effort was made to breakdown collection rates by type of collection method. However this breakdown was difficult to calculate because almost all collection routes studied involved several collection methods (example: some curbside collection mixed with heap collection or container collection), which made it difficult to estimate volumes and collection times for each. Also during the dry season data collection it was not possible to collect data on the exact amount of waste contained in each vehicle because the weighbridge was not yet installed at the dumpsite. All waste amount data from this period was estimated in cubic volume and then converted to weight using average density figures.

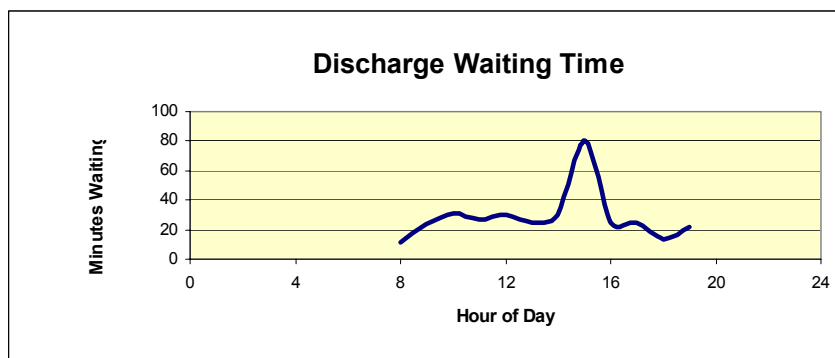
From available data it is possible to establish average collection rates for each vehicle type using a mix of collection methods as shown in the figure below.



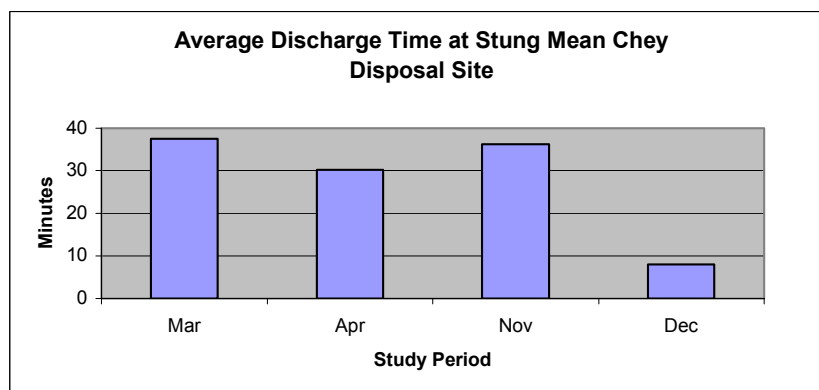
In addition to the above, it was possible to make some general observation of the efficiency of the various collection methods. Researchers noted that collection of waste heaps and scattered waste was considerable slower than other methods of waste collection. Not only did it appear that waste heaps require more time to collect, but the results were also inferior with considerable amount of waste remaining on the ground after collection crews had passed. By contrast, collection of waste in bins, baskets or containers was observed to be the most efficient and sanitary. Collection of bags of waste placed at curb side was judged to be almost as efficient as bins, baskets or containers except where bags were overloaded, split or had been opened by animals or waste scavengers resulting in scattering.

### 2.3.5 Discharge time

Once collection vehicles arrive at the disposal site they often must queue to discharge the waste. During the dry season survey period the average discharge waiting time was found to be 34 minutes, but some vehicles were waiting longer than 100 minutes. The amount of waiting time varied considerably according to the time of day as can be seen in the figure below.

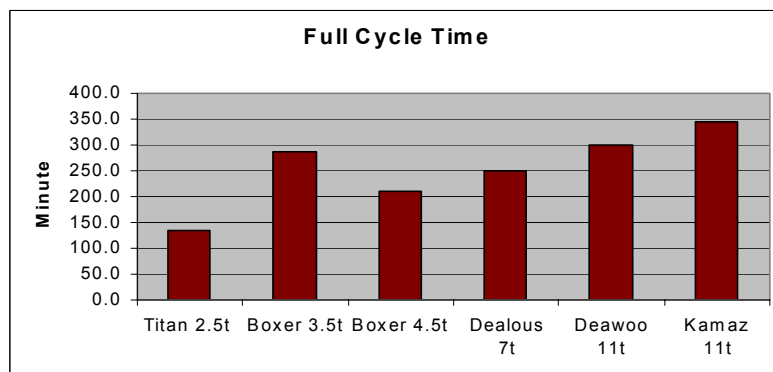


Infrastructure and management improvements at the Stung Mean Chey disposal site were started in November 2003 under the JICA sponsored pilot project to improve conditions and extend the working life of the facility. These improvements resulted in a considerable reduction in waiting time by December 2003 (even with the additional process of vehicle weigh-in at the new weighbridge which started operation in August 2003) as shown in the figure below.

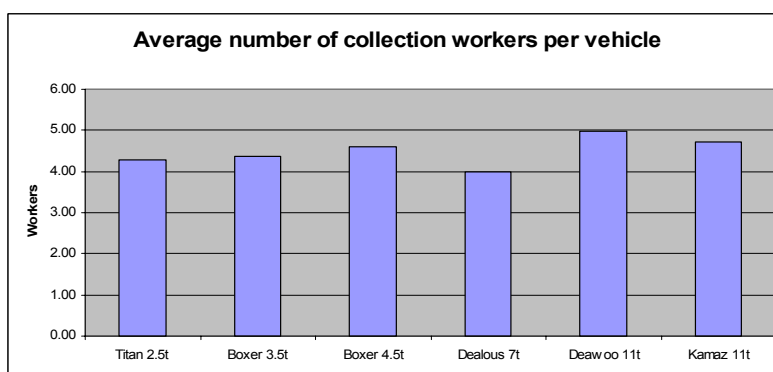


### 2.3.6 Overall Cycle Efficiency

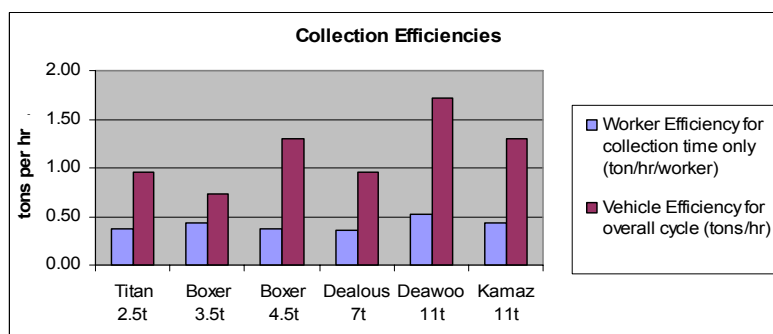
When collection amounts are compared with overall collection cycle time and number of collection workers it is possible to understand the overall cycle efficiency. The average time for a complete collection trip or cycle (including preparation time, the various travel times, collection time and discharge time) was 268 minutes, however when broken down by vehicle type some variation as can be seen in the figure below.



When vehicle capacities and number of workers are entered into the calculation the overall cycle efficiencies can be seen. The number of workers per vehicle seemed to vary between days or trips. Average number of workers is shown in the figure below.



Worker efficiency is measured as tons of waste loaded per worker per hours of collection time. Overall vehicle efficiency is measured as tons of waste transported per hour. Figure 1.10 below shows the worker and vehicle efficiencies broken down by vehicle type.



## 2.4 Conclusions

The key findings from the Time and Motion Survey can be summarized as follows:

- The present fleet of collection vehicles used by CINTRI for municipal solid waste management is very old and in poor condition. Vehicle breakdowns are common, making collection management difficult and resulting in unreliable service.
- In many cases the vehicles and equipment being used for waste collection are mismatched. Researchers observed a number of cases where waste in containers was dumped on the ground and then manually shovelled into compactor vehicles because container-loading vehicles were unavailable.
- Where containers were used (0.6 m<sup>3</sup> size), it was common to find waste overflowing the container and scattered on the ground, apparently because container volume is too small or the collection frequency is not enough. This waste on the ground creates conditions similar to waste heaps (see below).
- Waste heaps are a common method for waste collection in many parts of Phnom Penh. This type of waste collection allows waste to be washed into the drains by rain or scattered by wind or animals. Waste entering the drainage system causes blockages. Scattered waste also creates unsanitary and unhygienic conditions in the area around the heap. Flies and bad odors affect residents and businesses nearby. The manual loading of waste from heaps is labor intensive and inefficient, not only because it requires a lot of worker time, but also because it ties up the vehicle which could be doing other collection work.
- Improper discharge habits by residents and other waste generators (such as street vendors and construction projects) were also noted as a major contributor to inefficient waste collection. Researcher observed many cases where loose waste was discharged along the road instead of placed in bags. This habit slows down the collection process. Waste was also placed along the curbside after the vehicle had already passed through the area. In areas lacking adequate collection service, waste is commonly burned, buried or dumped on vacant land and in waterways causing health and environmental problems.
- A major reduction (almost 74%) in discharge time (defined as the time required for a vehicle to enter the disposal site, discharge waste and depart from the site) was noted between dry season and wet season data. This was despite the fact that the weighbridge was installed and new weigh-in procedures added during the interval between the two data collection periods. This change was attributed to improved management at the discharge site and major improvements in on-site infrastructure as a result of the dumpsite improvement pilot project.

# Annex 3

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*Public Opinion Survey*

## **Annex 3 Public Opinion Survey**

### **3.1 Method of the Survey**

#### **3.1.1 Design of Survey**

The survey is divided into two parts: the household survey and the business establishment survey. The household survey has two different targets: those who enjoy the waste collection service at present in the urban area and those who do not receive the collection service in the rural area.

In the total, there were 500 samples, and 400 of the samples were allocated to the household survey and 100 to the business establishment survey. The 400 samples for the household survey were further divided into 300 samples from the four urban Khans with the collection service and 100 samples from the three rural Khans without the collection service. All the samples of the business establishment survey were selected from the urban area with the collection service. The method and outline of survey is shown as follows.

1. Method of Survey: interview
2. Target of Survey: (1) household - all the people of 18 years old and over in the urban area with the collection service and rural area without the collection service  
(2) business establishment - all the business establishments in the urban area including shops, restaurants, hotels, offices, and markets.
3. Number of samples: (1) household - 400 valid samples  
(300 samples were allocated to the urban area and 100 to the rural area without the collection service)  
(2) business establishment – 100 valid samples
4. Target area: Municipality of Phnom Penh
5. Number of questions: about 50 questions related to the objectives of the survey.
6. Subjects of questions: (1) generation and recycling of waste at the source  
(2) the way of storing and discharging waste  
(3) awareness of SWM

The waste generated from households is strongly correlated to socioeconomic factors such as the household income and expenditure, but it is very difficult to know the real household income level from the interview survey in Cambodia. The team used the Socio-Economic Status (SES), a socio-economic classification system that estimates socio-economic classes based on a list of possessed durable goods, as the main socio-economic indicator of the target households.

#### **3.1.2 Preparation of Questionnaire and Show Card**

##### **a. Questionnaire**

The questionnaire is divided into six sections: (1) general environmental issues, (2) problems caused by solid waste, (3) generation of waste and its management, (4) reuse/recycling of waste, (5) public cooperation, and (6) about the interviewee. The purpose and content of each

section are summarized below. The contents and expressions were modified based on the result of the pilot test. The questionnaire used in the survey is shown in Annex C.

**a.1 About interviewee**

This section tried to gather personal information such as age, sex, income and SES to examine explanatory factors for the in-depth analysis.

In addition, the results were used to examine how selected samples represent the population, by comparing the distribution of samples in terms of sex, age, and SES to other data such as the national census data and the SES data that the local subcontractor updates regularly.

**a.2 General Questions**

The main purpose of this section is to know people's priorities in their daily lives and the degree of environmental awareness in general.

**a.3 Problems caused by solid waste**

This section tries to reveal how much people are aware of current problems caused by improper management of solid waste.

**a.4 Generation of waste and its management**

In this section, the target is divided into two groups: (1) households and business establishments that receive the waste collection service at present in the urban area and (2) households that do not receive the collection service in the rural area. Interviewees were asked different questions depending on the existence of the collection service and the type of collection service.

This section tried to reveal people's methods of managing their waste. In addition, the former group was asked their opinion about the current collection service, while the latter group was asked how much they needed the collection service and how much they were willing to pay for it.

**a.5 Reuse/recycling of waste**

The reduction of waste is a key element for sound waste management. One effective measure for reducing the volume of waste is the reuse and recycling of waste. It is important to know how much people reuse or recycle their waste in their daily lives at present and how aware people are of the importance of the reuse/recycling of waste.

As baseline data for Pilot Project "Development of the Urban Waste Compost Market and Promotion" mentioned in Chapter 7, several questions about compost were also asked.

**a.6 Public Cooperation**

It is almost impossible for the government to implement sound SWM without the understanding and cooperation of local residents. The purpose of this section is to know how much people are willing to cooperate with SWM and to find an appropriate approach for the government to develop cooperation with local residents.

**b. Show Card**

For the interview survey, a collection of answer lists, called a show card, was prepared along with the questionnaire sheet. On the show card are the lists of answers to each question, and at the time of interview, each interviewer showed the list of answers to the interviewee, while reading aloud questions slowly, so that the interviewee could ponder each question before choosing the most appropriate answer.



### 3.1.3 Sampling

#### a. Sampling Methods

Sampling was one of the most crucial parts of the survey procedure. The team aimed to achieve an interval estimation of 5% with a confidence level of 90%. However, in general it is difficult to achieve this target in developing countries, since there are not enough data such as a list that covers the entire population in the study area. In addition, the number of samples in this survey is limited, 300 samples in the urban area and 100 samples in the rural areas without the waste collection service, and this made it even more difficult to keep the precision of the survey.

In consultation with the local subcontractor, Indochina Research Ltd. (IRL), the team decided to adopt the following sampling method.

#### a.1 Household survey

- (1) In the urban area with the waste collection service (four urban Khans): 300 samples
  - Allocate samples in each Sangkat of the four urban districts on a proportional basis according to the relative size of the population.
  - Select city blocks randomly in each Sangkat, as well as the starting points of these, with a sampling interval of four successful households per block.
  - Select an appropriate interviewee in each household at the time of the interview survey. Interviewers try to select the person who is the most familiar with waste management issues from members of the selected household.
- (2) In the rural area without the waste collection service (three rural Khans)
  - Eliminate collection service areas from the three rural districts, and allocate samples to the rest of the area of each Sangkat in the rural study area according to its population size.
  - Select city blocks randomly in each Sangkat, as well as the starting points of these, with a sampling interval of four successful households per block.
  - Select an appropriate interviewee in each household at the time of the interview survey. Interviewers try to select the person who is the most familiar with waste management issues from members of the selected household.

Table 3-1: Allocation of samples in each District

#### Urban Area

District Name	District Pop.	Target Pop.	Target Pop. %	No. of Target Sangkat	No. of Samples
Daun Penh	131,913	131,913	23.14%	11	69
Chamkar Mon	187,082	187,082	32.81%	12	98
Prampir Makara	96,192	96,192	16.87%	8	51
Tuol Kork	154,968	154,968	27.18%	10	82
	<b>570,155</b>	<b>570,155</b>	<b>100%</b>	<b>41</b>	<b>300</b>

#### Rural Area

District Name	District Pop.	Target Pop.	Target Pop. %	No. of Target Sangkat	No. of Samples
Dang kor	92,461	57,340	18%	5	18
Mean Chey	157,112	122,507	38%	8	38
Russei keo	180,076	141,909	44%	9	44
	<b>429,649</b>	<b>321,756</b>	<b>100%</b>	<b>22</b>	<b>100</b>

## **a.2 Business establishment survey**

Businesses selected were representative of almost all the types of businesses in Phnom Penh and included small, medium and large enterprises. For the selection of samples, the IRL 2002 Business Census in MPP was used.

- Modify the categories of the business establishment list for each type of business such as shops, restaurants, hotels, offices and markets, and allocate 20 samples to these categories according to the number of business establishments, as shown in Table 3-2.
- Select samples randomly in each category.

Interviews were conducted with the business owner, office manager or facility supervisor.

Table 3-2: Allocation of Samples for the Business Establishment Survey

Type	Category		Total No.	%	Allocation of samples.	Number of Samples	Remarks
Shops	Grocery	Minimart	8			0	
		Supermarket	10			1	
	Convenience	Neighborhood Store*	2056	0.28	6	3	
		Convenience Store	946			2	
	Other retail	Pharmacy	552	0.05	1	1	
		Mobile Drug Kiosk	20			0	
		Audio/Visual/Electronics	265	0.06	1	0	
		Phone Shop	316			1	
		Computer	62			0	
		Internet Café	88	0.09	4	1	
		Photography	197			1	
		Beauty/Hair care/Cosmetics	666			2	
		Book/Library/Stationary/News Stand	251	0.05	1	1	
		Clothing/Footwear/Textile	312			1	1 extra copy
		Home Furniture/Appliances	133	0.04	1	1	
		Optical	48			0	
Jewelry	225	1	1 extra copy				
Other retail (Bakery, watch, art)	1957	0.18	3	3			
Other service (Shoe repair...)	2785	0.26	3	3			
	Total	10897		20	22		
Restaurants	Bar	40	0.19	4	1		
	Nightclub	1			0		
	Coffee Shop	400			2		
	Roadside Café	102	0.30	6	1		
	Restaurant	845			6		
	Street Stall/Eating Place	1443	0.51	10	10		
	Total	2831		20	20		
Hotel	Local Hotel		0.46	9	8	Throughout 4 districts in urban area	
	International Hotel				3		
	Guest house	87			9		
	Total	190		20	20		
Government institution/ Offices	Government institution offices				5	Throughout 4 districts in urban area	
	NGO offices				5		
	Company offices				10		
	Total			20	20		
Market	Central Market	Grocery			2	2	
		Clothes/Footwear/Bag			2	2	
		Others			1	1	
		sub total			5		
	Old Market	Grocery				2	2
		Clothes/Footwear/Bag				2	2
		Others				1	1
		sub total			5		
	Olympic Market	Grocery				2	2
		Clothes/Footwear/Bag				2	2
		Others				1	1
		sub total			5		
	Market in the suburb (Steung meanchey market)	Grocery				2	2
		Clothes/Footwear/Bag				2	2
		Others				1	1
		sub total			5		
	Total			20	20		
	<b>Total</b>				<b>102</b>		

Note: Neighborhood store is a micro-scale and family-owned store.

### 3.1.4 Execution of Survey

#### a. Recruitment of Interviewers

Fourteen interviewers were arranged by IRL from its list of interviewers. A briefing was arranged to provide instruction to interviewers.

## b. Sample Survey

The research was carried out as follows:

- **Mobilization** - Prior to beginning fieldwork, the team arranged a meeting with IRL to make sure of the research scope and design of the survey. In addition, the management of IRL conducted a project briefing to ensure that the survey objectives, methodology and quality standards were fully understood by the management team responsible for this project.
- **Research Team** - All interview staff who worked on this project were experienced with similar types of quantitative studies that addressed public opinion. All staff underwent training and a briefing session to ensure that they met certain quality standards and understood the objectives of the research project. Pilot interviews were then conducted to test the interview flow and interview performance of each interviewer. A re-briefing was then conducted to clarify any interview points and re-emphasize the objectives and methodology of the study.
- **Quality Control** - experienced supervisors managing the fieldwork will carry out quality control of the survey results. These staff members are experienced in a range of survey methodologies, quality control and procedural aspects of such research projects and will work closely with IRL management, to monitor the performance of interviewers. The specific roles of the supervisors are summarized as follows:
  - Collect the incoming completed survey forms and check for incomplete, omitted or otherwise erroneous data recording practices
  - Conduct random post-checking of 30% of completed surveys

Fieldwork was conducted from the 21<sup>st</sup> of April to the 5<sup>th</sup> of May 2003.

## 3.2 Result of the Survey

At first, the samples of the household survey were checked to see how much they represented the whole population. Since actual interviewees were selected by interviewers at the time of the interview survey based on their familiarity with waste management issues, interviewees tended to be older and the share of female respondents was higher than that of the population. The team used SES as the main indicator to evaluate how much the samples represent the population.

Then, the results of the household survey were analyzed based on the type of collection service and the location of residence (urban/rural). The results were further analyzed based on age, sex, educational background, and SES.

In general, people with a higher educational background tend to be more aware of environmental issues and stricter in evaluating the current environmental situation, but the result of the survey in Phnom Penh did not show significant differences in the level of awareness.

### 3.2.1 About Interviewees

The numbers of valid respondents of the households survey in the urban and rural area were 294 and 106 respectively. The 294 samples from the urban area were further classified according to the type of collection service, as shown in Table 3-3.

Table 3-3: Sample Number of Household Survey

Urban Area		Urban area total	Rural Area	Total
Type of collection service			Non-Collection service Area	
Block/CurbSide/Com munal Collection	Door to Door Collection			
279	15	294	106	400

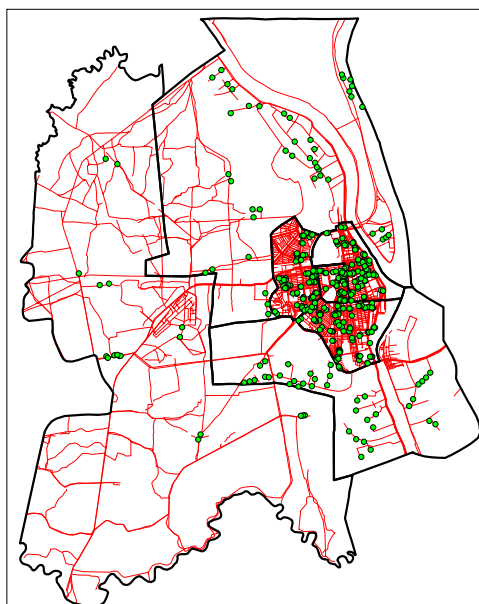


Figure 3-1: Location of Households Interviewed - All Areas

The number of valid respondents of the business establishment survey was 102. The breakdown of samples is shown in Table 3-4.

Table 3-4: Number of Business Establishment Samples

<b>Shop</b>			
Supermarket		1	
Neighborhood store		3	
Convenience store		2	
Pharmacy		1	
Phone Shop		1	
Internet Café		1	
Photography		1	
Beauty/Hair Care/News stand		2	
Book/Library/Stationary/Textile		1	
Home Furniture/Appliances		1	
Jewelry		1	
Other retail (Bakery, watch, art)		4	
Other service (Shoe repair...)		3	
<b>Sub-total</b>		<b>22</b>	
<b>Office</b>			
Government office/institution/		5	
NGO/ Company Office		15	
<b>Sub-total</b>		<b>20</b>	
<b>Restaurant</b>			
Bar		1	
Coffee Shop		2	
Roadside Café		1	
Restaurant		6	
Street Stall/Eating Place		10	
<b>Sub-total</b>		<b>20</b>	
<b>Hotel</b>			
Local Hotel		8	
International Hotel		3	
Guest house		9	
<b>Sub-total</b>		<b>20</b>	
<b>Market</b>			
Grocery		7	
Clothes/Footwear/Bag		9	
Others		4	
<b>Sub-total</b>		<b>20</b>	
<b>TOTAL</b>		<b>102</b>	

Most of the target shops/offices are small scale. More than 40% of the respondents replied that the number of person who worked at the shop/office was three or less.

Table 3-5: Number of persons who work at the shop/office

Number of persons working at the shop/office	Count
1	10
2	23
3	11
4-10	32
11-20	13
21-40	6
41-100	3
more than 100	4
Total	102

### Evaluation of samples

In order to evaluate how much the samples of the household survey represented the population, the distribution of these samples in terms of Socio-Economic Status (SES) was compared to the SES data in Phnom Penh acquired by IRL in 2002, as shown in Table 3-6. In addition, the distribution of respondents by sex and age was also compared to the National Census data in 1988, as shown in Table 3-7. As mentioned before, since people who were more familiar with waste management issues were arbitrarily selected, the age distribution of respondents was off to the older strata.

Table 3-6: SES Distribution of respondents and the Phnom Penh people

SES	SES Distribution JICA Study - Urban	SES Distribution Phnom Penh Urban	SES Distribution JICA Study - Rural	SES Distribution Phnom Penh Rural
E (US\$0-100)	19%	22%	35%	37%
D (US\$101-200)	30%	33%	42%	44%
C (US\$201-300)	25%	21%	6%	6%
B (US\$301-400)	10%	11%	1%	2%
A (US\$400+)	6%	4%	0%	0%
Don't Know/Refused	11%	9%	16%	11%

SES Distribution Figures for Phnom Penh Urban and Rural are based on a nationwide General Consumer Study conducted by IRL in 2002. All SES data was collected from a random selection of households in Phnom Penh: Total samples sizes for this study were Urban n=2010 random households & Rural n=402 random households.

Table 3-7: Distribution of Respondents of the Household Survey and National Census in Phnom Penh (Age and Sex)

	Respondents			National Census in 1998		
	Male	Female	Total	Male	Female	Total
18 - 24 years	8.0%	6.5%	14.5%	11.2%	13.1%	24.4%
25 - 29 years	2.3%	4.5%	6.8%	8.3%	8.3%	16.6%
30 - 34 years	5.8%	8.0%	13.8%	6.9%	6.8%	13.7%
35 - 39 years	5.5%	7.5%	13.0%	5.9%	6.1%	12.0%
40 - 44 years	4.3%	6.8%	11.0%	4.1%	5.3%	9.4%
45 - 49 years	3.8%	6.8%	10.5%	3.4%	4.0%	7.5%
50 - 54 years	2.8%	6.0%	8.8%	2.3%	2.9%	5.2%
55 - 59 years	3.8%	5.0%	8.8%	1.6%	2.0%	3.6%
60 - 64 years	5.0%	4.0%	9.0%	1.1%	1.6%	2.8%
Over 65+ years	3.0%	1.0%	4.0%	1.8%	3.1%	4.9%
<b>Total (%)</b>	<b>44.0%</b>	<b>56.0%</b>	<b>100.0%</b>	<b>46.8%</b>	<b>53.2%</b>	<b>100.0%</b>
<b>Total Number</b>	<b>176</b>	<b>224</b>	<b>400</b>	<b>272,082</b>	<b>309,797</b>	<b>581,879</b>

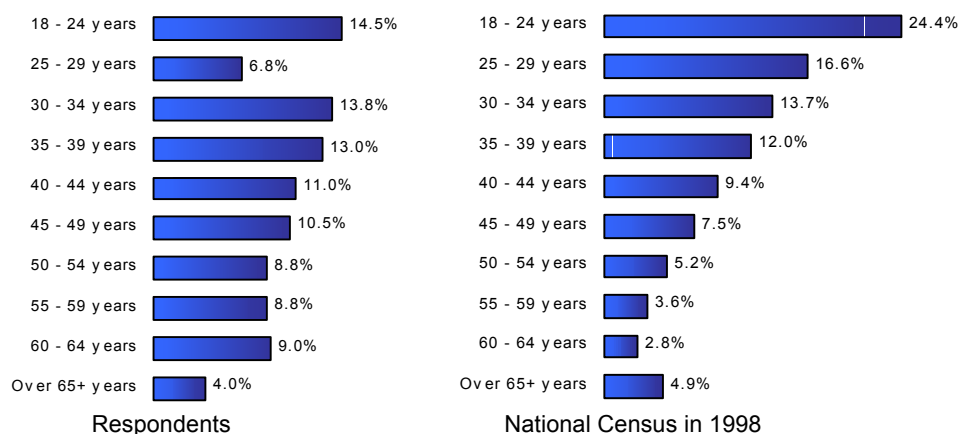


Figure 3-2: Age Distribution of Respondents and National Census in Phnom Penh

Table 3-8: Educational Background of Respondents and Educational Level and Stratum in Phnom Penh (Socio-Economic Survey in 1999)

Respondents of the survey

No formal education	Some primary school	Completed primary school	Some secondary school	Completed secondary school	Higher than secondary school	Refused
5.7%	17.0%	22.8%	30.3%	11.8%	12.0%	0.5%

Educational level and stratum in Phnom Penh (Socio-Economic Survey in 1999)

No Schooling	Primary/ Grade 1-6	Secondary/ Grade 7-9	High school/ 10-13	Technical/ Vocational	Undergraduate/ Graduate	Others
16.8%	32.1%	26.9%	18.0%	1.7%	4.0%	0.3%

93.5% of the respondents replied that they were literate, but referring to other surveys such as the National Literacy Survey mentioned in Chapter 1, it seems that this figure was too high. More than 97% of respondents stated they were Khmer.

As a source of daily news, TV was the most popular media for respondents as shown in Table 3-9. According to the question about possession of durable goods to estimate SES, more than 95% of respondents had one or more TV sets

Table 3-9: Frequency of access to news by type of media

Frequency	Newspaper	Magazine	Radio	TV
Never	37.5%	53.5%	13.0%	2.3%
Rarely	12.0%	12.0%	4.8%	0.8%
Once or twice per week	33.8%	30.8%	26.3%	6.5%
Everyday	16.8%	3.8%	56.0%	90.5%

Base: All

### 3.2.2 General Question

First of all, all the interviewees were asked to choose one answer from the list as the most serious problem at present in Phnom Penh. Then, respondents were asked to choose all the problems that they agreed as the second most serious.

For the respondents of the household survey, pollution was the primary problem along with poverty. Cross-sectional analysis by the location of residence showed that the drug problem was considered a serious problem in the urban area, while inadequate supply of safe water was the most serious problem along with pollution in the rural area.

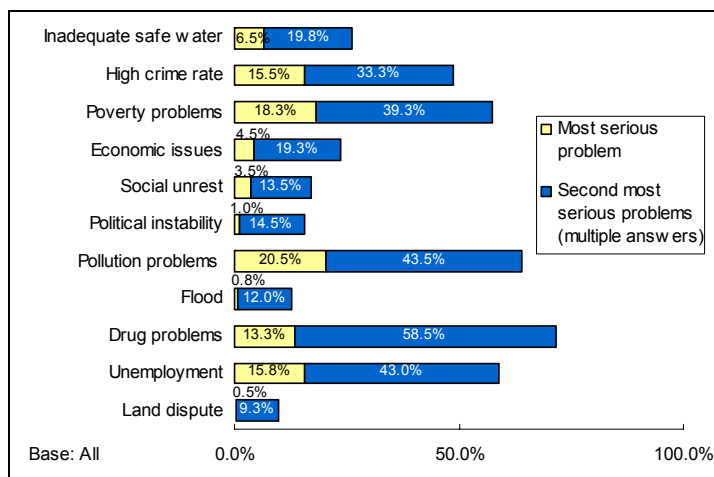


Figure 3-3: Most and second most serious problem in MPP (household survey)

Table 3-10: Most serious problem in MPP by location of residence

	Urban area	Rural area without collection service
Inadequate supply of safe water	1.7%	19.8%
High crime rate	16.0%	14.2%
Poverty problems	17.7%	19.8%
Economic issues such as Inflation	5.8%	0.9%
Social unrest	4.4%	0.9%
Political instability	1.4%	0%
Pollution problems	20.7%	19.8%
Flood	0%	2.8%
Drug problems	16.0%	5.7%
Unemployment	15.6%	16.0%
Land dispute	0.7%	

Base: All (households)

The business establishments survey showed that unemployment was the primary problem followed by the pollution problem

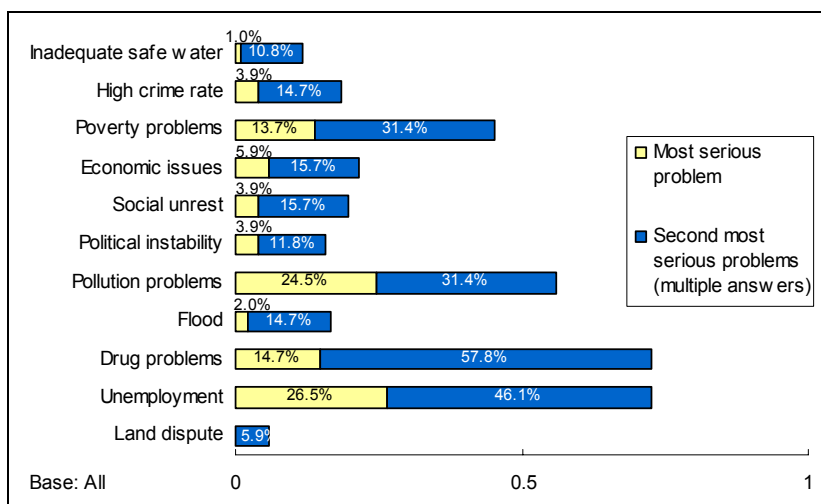


Figure 3-4: Most and second most serious problem (business establishment)

About 90% of respondents of the household survey replied that they are interested in environmental issues. In total, 98.5% of respondents were somehow interested in environmental issues. In the case of the business establishment survey, all the respondents



replied that they were somehow interested in environmental issues. Compared to the results of the survey in Bangkok in 2000<sup>1</sup> and considering the current situation in MPP, the share of respondents that replied “Yes” seems a little bit too high. Since it is unclear how they defined the term “environment” and what criteria they had to select the answer “Yes”, it is necessary to evaluate the results carefully.

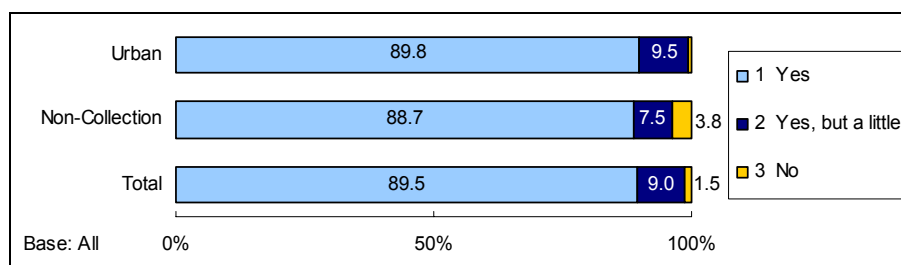


Figure 3-5: Are you interested in environmental issues? (household survey)

Respondents in the urban area of the household survey thought that air pollution was the most serious environmental problem in Phnom Penh, while in the rural area water pollution was selected as the most serious problem. On the other hand, more than half of the respondents of the business establishment survey thought that the solid waste problem was the most serious environmental problem. In addition, almost all the respondents replied that environmental degradation somehow affected their lives.

Table 3-11: Most serious environmental problem now in Phnom Penh

	Household Survey			Business Establishment Survey
	Urban Area	Rural Area without Collection Service	Total	
Water Pollution	13.6%	<b>38.2%</b>	20.1%	7.8%
Air Pollution	<b>43.2%</b>	33.3%	40.9%	31.4%
Noise problems	10.9%	2.9%	8.9%	9.8%
Solid waste problems	28.9%	15.7%	25.6%	<b>51.0%</b>
Flooding	2.7%	9.8%	4.6%	0.0%

Base: All

The household survey showed that water supply was the highest priority followed by electricity supply. Business establishments, on the other hand, set solid waste collection as the highest priority.

Table 3-12: Priority to be solved or improved in daily life

Household Survey (Urban area)

	Water supply	Sewer Pipe	Storm water drainage	Septic tank waster collection	Solid waste collection	Electricity supply	Access road	Telephone
1 Very Important	63.9%	21.8%	13.6%	19.7%	56.5%	64.6%	9.9%	8.5%
2 Important	33.3%	65.3%	48.6%	58.2%	39.8%	31.6%	62.2%	52.7%
3 Little Important	2.7%	11.6%	32.7%	18.0%	3.7%	3.1%	19.7%	30.6%
4 Not Important	0%	1.4%	5.1%	4.1%		0.7%	8.2%	8.2%
<b>Mean</b>	<b>1.39</b>	<b>1.93</b>	<b>2.29</b>	<b>2.06</b>	<b>1.47</b>	<b>1.40</b>	<b>2.26</b>	<b>2.38</b>

Base: All

<sup>1</sup> According to the Study on Master Plan of Industrial Waste Management in the Bangkok Metropolitan Area and its Vicinity in the Kingdom of Thailand, the share of respondents who replied “Yes”, “Yes, but a little”, and “No” were 66%, 28% and 6% respectively.

### Household Survey (Rural Area)

	Water supply	Sewer Pipe	Storm water drainage	Septic tank waster collection	Solid waste collection	Electricity supply	Access road	Telephone
1 Very Important	82.1%	26.4%	8.5%	24.5%	36.8%	73.6%	8.5%	4.7%
2 Important	13.2%	51.9%	54.7%	49.1%	38.7%	20.8%	59.4%	46.2%
3 Little Important	2.8%	19.8%	27.4%	19.8%	20.8%	4.7%	21.7%	34.0%
4 Not Important	1.9%	1.9%	9.4%	6.6%	3.8%	0.9%	10.4%	15.1%
<b>Mean</b>	<b>1.25</b>	<b>1.97</b>	<b>2.38</b>	<b>2.08</b>	<b>1.92</b>	<b>1.33</b>	<b>2.34</b>	<b>2.59</b>

Base: All

### Business Establishment Survey

	Water supply	Sewer Pipe	Storm water drainage	Septic tank waster collection	Solid waste collection	Electricity supply	Access road	Telephone	Internet
1 Very Important	51.0%	15.7%	19.6%	21.6%	64.7%	68.6%	28.4%	41.2%	4.9%
2 Important	43.1%	63.7%	44.1%	43.1%	27.5%	18.6%	28.4%	35.3%	14.7%
3 Little Important	3.9%	14.7%	28.4%	24.5%	7.8%	9.8%	11.8%	18.6%	49.0%
4 Not Important	2.0%	5.9%	7.8%	10.8%	2.9%	2.9%	31.4%	4.9%	31.4%
<b>Mean</b>	<b>1.57</b>	<b>2.11</b>	<b>2.25</b>	<b>2.25</b>	<b>1.43</b>	<b>1.47</b>	<b>2.46</b>	<b>1.87</b>	<b>3.07</b>

Base: All

### 3.2.3 Problems Caused by Solid Waste

Almost all the respondents (98.8%) of the household survey and all the respondent of the business establishment survey recognized that improper solid waste management caused problems in general.

94% of respondents of the household survey and 98% of respondents of the business establishment survey recognized that there were problems caused by improper waste management in Phnom Penh.

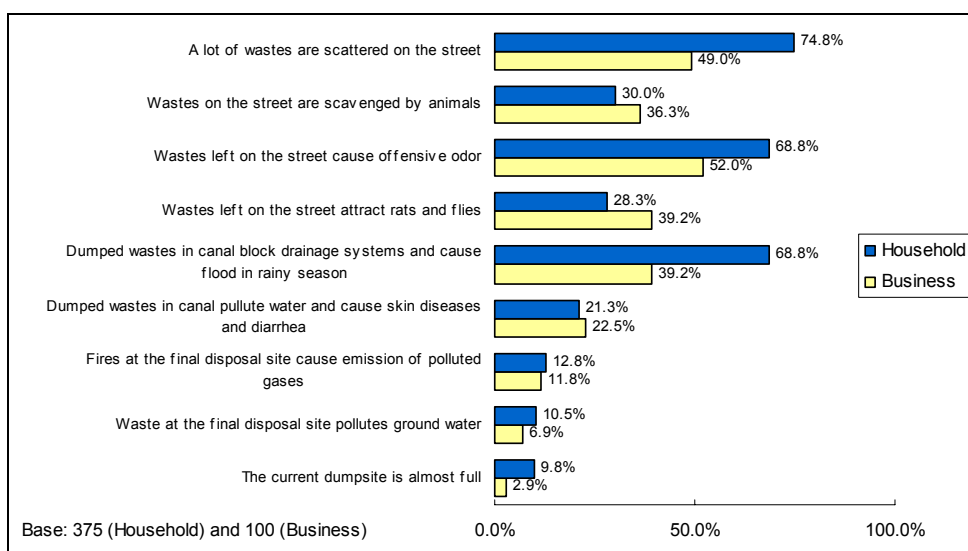


Figure 3-6: What kinds of problems are caused by bad management of waste in Phnom Penh?

Figure 3-6 shows that problems close to them such as offensive odor caused by scattered waste on the street are more recognized. On the other hand, problems related to the final disposal of waste are not well known. Nevertheless, as newspaper and TV news recently took up problems related to the Stung Mean Chey disposal site, more people had heard of the Stung Mean Chey disposal site. As a result, about half of the respondents knew that their waste was brought to the disposal site in Stung Mean Chey.

### 3.2.4 About Your Waste and Its Management

#### a. Waste Generation and Handling

##### a.1 Waste Generation

The survey asked the interviewees about the daily amount of waste generated at their houses or shops/offices. Since the answers were not accurate quantitatively, the results are shown only as a reference. Please refer to the results of WACS to obtain more precise quantitative data.

Table 3-13: Daily Average of Waste Amount Generated at Household

Item	Unit	Urban	Rural	Total
Organic Waste	Plastic Bag	1.2	1.1	1.2
Aluminum Can	Can	0.7	0.1	0.6
Glass Bottle	Bottle	0.2	0.1	0.2
Plastic Bottle	Bottle	0.5	0.1	0.4
Paper/cardboard	Piece	2.1	0.8	1.8
Plastic Bag	Piece	4.4	4.2	4.3

##### a.2 Waste Handling

Female adults were mainly responsible for handling and discharging household waste, as shown in Figure 3-7. In particular, in the case of door-to-door collection services, in which waste collectors visit each house to collect waste, the role of female family members was bigger.

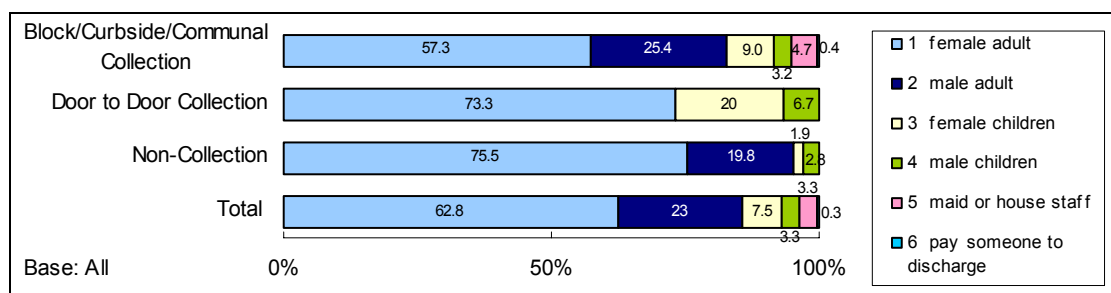


Figure 3-7: Who Handles and Discharges Waste in Your Household? (Q.9: Household Survey)

In the case of business establishments, 70% of the shops/offices had a person who was in charge of waste management. The person in charge of waste management is summarized in Table 3-14.

Table 3-14: Who is in charge of waste management on the decision making level in your office or shop?

	Col %
Owner/general manager	54.9%
The person who is in charge of environment issues	9.9%
The person who is in charge of hygiene/cleansing issues	35.2%

Base: 71

Most respondents of both the household and business establishment survey in the urban area used some kind of bag or container to store waste. The reasons for using such containers are summarized in Table 3-15.

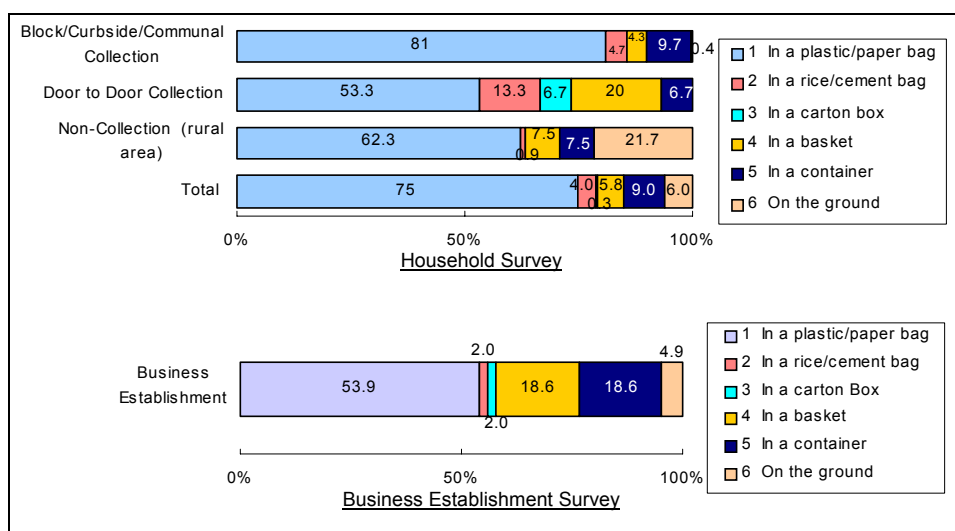


Figure 3-8: How do you store your waste?

Table 3-15: Why do you use such containers? (Multiple Answer)

	Household	Business
It keeps the place clean after the collection work	61.7%	58.8%
It prevents foul odors	79.5%	72.2%
It is easy to handle	75.3%	79.4%
Keeps away pests such as flies	26.1%	23.7%
Low cost or available free	29.3%	15.5%

Base: 376 (households) and 97 (businesses)

**b. Discharge/Treatment of Waste**

The interviewees are divided into two groups: (1) those who enjoy the collection service in the urban area and (2) those who cannot receive the collection service in the rural area. The results are reported separately.

**b.1 Discharge of Waste in the Collection Area (Urban area)**

At first, the type and frequency of the collection service were asked. The results are summarized below. This is the result of a self-statement by respondents, and does not always reflect the actual situation. It is necessary to verify how much the respondents recognize the actual type and frequency of the collection service accurately.

Table 3-16: Type of collection service

	Household	Business Establishment				
		Shop	Restaurant	Office	Hotel	Market
Block (bell) collection	32.3%	9.1%	10.0%		10.0%	
Curbside collection	53.1%	90.9%	90.0%	100%	90.0%	15.0%
Communal collection	9.2%					65.0%
Door-to-door collection	5.1%					
Individual market shop owner collected						20.0%
I do not know	0.3%					

Base: 294 (households) and all (businesses)

Regarding the frequency of the collection service, 87.3% of business establishment respondents received the collection service every day, while there were less frequent collection services for the households.

Table 3-17: What is the frequency of the waste collection service? (per week)

Frequency	Household		Business
	Block/Curbside/ Communal Collection	Door to Door Collection	
Everyday	45.9%	60.0%	87.3%
6 times	1.8%	26.7%	2.0%
5 times	1.4%	6.7%	
4 times	4.7%		1.0%
3 times	30.8%		6.9%
2 times	6.8%		
Once a week	0.7%		
Irregular	5.7%	6.7%	2.9%
I do not know	2.2%		

Base: 294 (Block/Curbside/Communal), 15 (Door to Door) and 102 (Business)

The frequency of discharging waste was also questioned. A lot of people discharge waste more often than the waste collection service. In the case of door-to-door collection, 73.3% of respondents replied that they discharge waste more often than the collection service.

Table 3-18: How often do you discharge your waste? (per week)

Frequency	Household	Business
	Block/Curbside/ Communal Collection	
Everyday	69.2%	89.2%
6 times	2.5%	2.0%
5 times	3.2%	1.0%
4 times	2.5%	1.0%
3 times	16.8%	4.9%
2 times	1.8%	
Irregular	3.6%	2.0%
I do not know	0.4%	

Base: 279 (households) and all (businesses)

In addition, the collection service time and discharge time were questioned, and the results are summarized below.

Table 3-19: What time is your waste collected?

	Block/Curbside/ Communal Collection	Business				
		Shop	Restaurant	Office	Hotel	Market
In the morning	33.7%	18.2%	20.0%	10.0%	35.0%	5.0%
In the afternoon	16.8%		10.0%	5.0%	10.0%	
In the evening	15.8%	40.9%	25.0%	30.0%	10.0%	20.0%
At night	7.9%	36.4%	40.0%	30.0%	35.0%	65.0%
Irregular	24.7%	4.5%	5.0%	25.0%	10.0%	10.0%
I do not know	1.1%					

Base: 279 (households) and all (businesses)

Table 3-20: What time is your waste discharged?

**Household**

	Block/Curbside/ Communal Collection
Just before the collection service/ After the collection vehicle gives a signal	58.8%
In the morning regardless of the collection service time	14.3%
In the afternoon regardless of the collection service time	1.1%
In the evening regardless of the collection service time	2.5%
At night regardless of the collection service time	5.0%
Whenever wastes are generated	18.3%

Base: 279

### Business Establishment

	Shop	Restaurant	Office	Hotel	Market
Just before the collection service/ After the collection vehicle gives a signal	40.9%	35.0%	35.0%	30.0%	
Before the office/shop is opened (in the morning) regardless of the collection time	27.3%	40.0%	35.0%	25.0%	
After the office/shop is closed (in the evening or at night) regardless or collection time	31.8%	15.0%	20.0%	25.0%	80.0%
In the afternoon regardless of the collection time		5.0%	5.0%	5.0%	15.0%
Whenever wastes are generated		5.0%	5.0%	15.0%	5.0%

Base: All (businesses)

40% of household respondents, whose type of collection service was block, curbside, or communal collection, and 60% of business respondents discharged waste regardless of the collection time. The reasons why these respondents discharge their waste regardless of the collection time are summarized below. 10% of the all households discharged their waste regardless of the collection time because they did not want to keep it long at home. On the other hand, inappropriate or irregular collection time also resulted in inappropriate discharge manners. Most of those who discharge waste regardless of the collection time recognized that waste left on the street for a long time causes problems such as animal scavenging and bad smell.

Table 3-21: Why do you discharge waste regardless of the collection service time?

### Household

	Block/Curbside/ Communal Collection		Door to Door Collection	
	Count	Percentage	Count	Percentage
Frequency of collection service is too few	25	21.7%	0	
No one is home at collection time	21	18.3%	6	54.5%
A collection vehicle does not come regularly and I do not know when it comes	31	27.0%	2	18.2%
I do not want to keep the waste long at home and want to discharge the waste as early as possible	38	33.0%	3	27.3%

Base: 115 (Block/Curbside/Communal) and 11 (Door to Door)

### Business Establishment

	Shop	Restaurant	Office	Hotel	Market
The frequency of collection service is too few					5.0%
The collection time is inappropriate, e.g. during the business hour	46.2%	7.7%	30.8%	21.4%	35.0%
A collection vehicle does not come regularly and I do not know when it comes	38.5%	53.8%	23.1%	21.4%	15.0%
I do not want to keep the waste long at office/shop	15.4%	38.5%	46.2%	57.1%	45.0%

Base: 13 (shops), 13 (restaurants), 13 (offices), 14 (hotels) and 20 (markets)

The way of discharging waste was also questioned. Most respondents put their waste in a bin or on the ground where a collection vehicle pass.

Table 3-22: Where is your waste discharged?

	Block and other types	Business Establishment				
		Shop	Restaurant	Office	Hotel	Market
In a bin or on the ground at a collection point	47.3%	22.7%	35.0%	5.0%	15.0%	35.0%
In a bin/on the ground along the street, where a collection vehicle passes	52.3%	77.3%	65.0%	95.0%	85.0%	25.0%
On the ground along the alley, where collection vehicle does not pass						
Any place I want	0.4%					30.0%
I do not know						5.0%
Leave the garbage at the corner of market store						5.0%

Base: 279 (household: Block/Curbside/Communal) and all (Business)

Table 3-23: How do you transport and dump your waste?

	Household (Urban)		Business Establishment				
	Block and other types	Door to Door Collection	Shop	Restaurant	Office	Hotel	Market
1.*	79.5%	53.3%	68.2%	55.0%	55.0%	20.0%	95.0%
2.**	20.5%	46.7%	31.8%	45.0%	45.0%	80.0%	5.0%

Base: All (households in urban area) and all (businesses)

\* 1: bring waste in a bag and put the bag on the ground or in a collection bin

\*\*2: bring wastes in a bag, box, basket or container and put the waste on the ground or in bin or collection vehicle directly

## b.2 Treatment/Disposal of Waste in the Non-Collection Area (Rural area)

At first, interviewees from the non-collection area were asked how they treated waste. They were required to select all the methods they were applying. They were also asked what problems they faced.

Table 3-24: How is your waste disposed of? (Multiple answer)

It is dumped on the street, in the canal or open land	36.8%
It is burned outside	69.8%
It is buried	17.0%
It is composted	10.4%
It is transported to a collection point in other areas	4.7%
I do not know	0.9%

Base: All (households in rural area)

Table 3-25: What kinds of problems do you face now because there is no collection service? (Multiple answer)

Wastes are scattered around my house	49.1%
There are a lot of rats and flies	46.2%
There is a problem of offensive odor	56.6%
River/underground water is contaminated by waste	25.5%
People suffer from skin diseases	13.2%
People suffer from diarrhea	18.9%
Drainage canals are blocked with waste	7.5%
There are no problems	11.3%

Base: All (households in rural area)

## c. Opinion about Collection Service

This section also asked different questions to those who enjoy the collection service and those who cannot receive the collection service. The results are summarized separately.

### c.1 Opinion of those who receive collection service (Urban area)

The first question was about the collection fee and its payment. Table 3-26 shows that almost all respondents pay the collection fee, but this contradicts another survey, which indicates that the service fee collection rate of business establishments was much lower than that of households.

Table 3-26: Do you pay the collection fee?

	Household		Business
	Block other types of Collection	Door to Door Collection	
Yes, I pay collection fee directly	10.0%	100%	25.5%
Yes, I pay collection fee with electricity bill	87.5%		73.5%
No, I do not pay collection fee	1.4%		1.0%
I do not know	1.1%		

Base: All (households in urban area) and all (businesses)

Table 3-27: How much are you charged for the collection service?

**Household**

Collection Fee (Riel)	Block and other types of Collection	Door to Door Collection
I do not know	0.7%	
1,000	0.4%	
2,000	0.4%	
2,300	0.4%	
2,500	1.8%	
3,000	2.9%	
3,200	9.2%	
3,500	0.4%	
4,000	<b>79.0%</b>	<b>93.3%</b>
6,000	0.4%	
7,000	0.4%	
8,000	0.4%	6.7%
20,000	2.2%	
28,000	1.5%	

Base: All (households in urban area)

**Business Establishment**

Collection Fee (Riel)	Shop	Restaurant	Office	Hotel	Market	Total
3,000					45.0%	8.8%
3,200		5.0%				1.0%
4,000	50.0%	40.0%	35.0%	10.0%		<b>27.5%</b>
6,000		5.0%			55.0%	11.8%
20,000	36.4%	35.0%	30.0%	10.0%		<b>22.5%</b>
40,000			5.0%			1.0%
50,000	4.5%		5.0%			2.0%
60,000		5.0%		5.0%		2.0%
80,000	9.1%	5.0%	20.0%	30.0%		12.7%
120,000			5.0%			1.0%
160,000		5.0%				1.0%
200,000				30.0%		5.9%
320,000				10.0%		2.0%
1,800,000				5.0%		1.0%

Base: All

Interviewees were then asked about the collection fee and collection service. More than 80% of household respondents and 60% of business respondents were somehow satisfied with the current collection service. Those who were not satisfied with the service were asked why, and the results are shown in Table 3-30.

Table 3-28: What do you think about the collection fee?

	Household		Business Establishment				
	Block and other types of collection	Door to Door Collection	Shop	Restaurant	Office	Hotel	Market
Too expensive	3.2%		13.6%		15.0%	10.0%	
Expensive	25.1%	13.3%	40.9%	50.0%	30.0%	50.0%	25.0%
Appropriate	69.2%	86.7%	45.5%	50.0%	55.0%	40.0%	75.0%
I do not know	2.5%						

Table 3-29: Are you satisfied with the collection service?

	Household		Business Establishment				
	Block and other types	Door to Door	Shop	Restaurant	Office	Hotel	Market
Yes very much	12.2%	13.3%	22.7%	35.0%	25.0%	25.0%	55.0%
Yes to some extent	67.7%	80.0%	31.8%	30.0%	40.0%	35.0%	35.0%
Not much	18.3%	6.7%	40.9%	35.0%	35.0%	40.0%	10.0%
Not at all	1.1%		4.5%				
I do not know	0.7%						



Table 3-30: Why are you unsatisfied with the collection service?

	Household		Business Establishment				
	Block and other types	Door to Door	Shop	Restaurant	Office	Hotel	Market
Frequency of collection is too few	10			1	2	1	
Frequency of collection is irregular	25	1	3	1		1	
Collection time is not appropriate	8			2		3	
A lot of wastes are left on the streets	11		1	1	5	2	1
Collection point is far away from my house	2						1
Collection points are full of waste and dirty			2	2			
Collection fee is too expensive			4			1	
Total	56	1	10	7	7	8	2

The survey asked interviewees if they were willingness to pay more for better collection services. Most respondents disagreed with an increase in the collection fee. Instead, they required their collection service company to make an effort to improve their service without increasing the fee.

Curbside collection is the people's most preferable type of waste collection service, but those who receive the door-to-door collection service at present supported this type of collection.

Table 3-31: What kinds of collection method do you prefer?

	Household		Business Establishment				
	Block and other types	Door to Door	Shop	Restaurant	Office	Hotel	Market
Block (bell) collection	20.8%		4.5%	10.0%		10.0%	
Curbside collection	54.5%	26.7%	72.7%	70.0%	95.0%	65.0%	25.0%
Communal collection	6.8%	13.3%		5.0%			50.0%
Door to door collection	17.9%	60.0%	22.7%	15.0%	5.0%	25.0%	5.0%
To collect in place							20.0%

Base: All (households in urban area) and all (businesses)

### c.2 Need for Collection Service in the Non-Collection Area (Urban Area)

The survey tried to reveal how much people in the non-collection service area needed the collection service. In total, 70% of the respondents need the collection service to some extent and were willing to pay to some extent, but the average collection fee they were able to pay was less than the normal household fee, R 4,000.

Table 3-32: Do you need the collection service? Are you willing to pay?

Necessity of collection service	
Yes, very much	23.6%
Yes to some extent	46.2%
I do not need very much	25.5%
I do not need at all	4.7%

Willingness to pay	
Very willing	13.2%
Willing to some extent	53.8%
Not willing very much	23.6%
Not at all	9.4%

Base: All (households in rural area)

Table 3-33: How much can you afford to pay per month for the collection service?

500	5.7%
600	1.9%
1000	16.0%
1500	1.9%
2000	19.8%
3000	7.5%
4000	25.5%
Nothing	0.9%
Refuse	20.8%

### 3.2.5 Reuse/Recycling of Waste

About 70% of household respondents and 60% of business respondents replied that recycling non-hazardous waste such as paper, glass and metals is necessary. Practically, 60% of the household respondents in the urban area and 50% in the rural area recycled some kinds of waste, but 80% of the business respondents did not separate and sell recyclables.

Table 3-34: Do you separate recyclable goods and sell them?

	Household		Business
	Urban	Rural	
Yes	58.8%	49.1%	21.6%
No	41.2%	50.9%	78.4%

Table 3-35 shows the shares of the respondents who recycle waste by type of material. Glass bottles and aluminum cans are the two main recyclables in Phnom Penh. Almost all the buyers of recyclables were those who visit each house or shop/office to buy recyclables.

Table 3-35: Share of respondents who recycle waste

Item	Household		Business				
	Urban	Rural	Shop	Restaurant	Office	Hotel	Market
Paper	6.1%	0%	0%	0%	0%	0%	0%
Cardboard	2.7%	0%	4.5%	5.0%	0%	0%	10.0%
Glass bottles	45.9%	45.3%	4.5%	20.0%	0%	5.0%	0%
Aluminum can	42.9%	17.9%	18.2%	35.0%	0%	30.0%	0%
Metal can	11.2%	0%	4.5%	5.0%	0%	0%	0%
Plastic bottles	9.5%	0.9%	4.5%	15.0%	0%	15.0%	0%
Hard plastic	1.7%	0.9%	4.5%	0%	0%	0%	0%
Soft plastic	0%	0%	0%	0%	0%	0%	0%
Cloth/textile	0%	0%	0%	0%	0%	0%	0%
Metal	0%	0%	0%	0%	0%	0%	0%
Organic waste	0.7%	0%	0%	0%	0%	0%	0%

Base: All

The interviewers asked those who do not separate recyclable goods the reasons why they do not. The results are summarized below.

Table 3-36: Why don't you separate recyclable goods?

	Household		Business
	Urban	Rural	
It is inconvenient or difficult	28.9%	18.5%	6.3%
It would take too much time	33.9%	16.7%	62.5%
The need/benefit of recycling are not clear	36.4%	64.8%	28.8%
Small house	0.8%		2.5%

Base: 121, 54, and 80

About half of the business respondents used wrappings in their business. New plastic bags are the main wrapping material. However, some shops used used-paper or plastic bags as wrapping materials, along with new materials.

To obtain the baseline data for the Compost Pilot Project, the questions about compost were added to the questionnaire. About half the household respondents had heard of the term "compost" and 11 households had the experience of composting kitchen waste.

### 3.2.6 Public Cooperation

Almost all the respondents of the business establishment survey recognized that cleanness and hygiene were matters of customer preference. They took the following measures to keep their shop or office clean and hygienic.

Table 3-37: What kinds of activities do you do to keep your shop/office clean and hygienic

Clean the sidewalk or adjacent public area near the office/shop every day	52.5%
Clean the waste collection place near the office/shop every day	71.7%
Prepare dust boxes and ask customers and employees to put garbage in these boxes	47.5%
Keep waste in a closed bin like a container with a cover	40.4%

Base: 99

About 20% of the respondents replied that they had received instruction on how to discharge waste. In many cases, the instructor was the Municipality. 90% of those who received the instruction said that they changed their way of discharging waste.

The respondents' most popular solution for problems such as scattered waste on the street was the enactment of an anti-littering law. Almost all the respondents agreed with an anti-littering law to some extent.

Table 3-38: To solve problems such as scattered waste on the street, which measures do you think most effective?

	Household		Business
	Urban	Rural	
To enact an anti-littering law and regulation and control it strictly	48.0%	9.4%	47.1%
The number of collection vehicles and workers should be increased	20.4%	24.5%	15.7%
To instruct people how to discharge waste in order to improve the manner	14.3%	37.7%	22.5%
More street side waste containers have to be installed	17.3%	26.4%	14.7%
I do not know		1.9%	

Base: All

Almost all the respondents recognized the need for a public campaign to keep the city clean. The Municipality was selected as the most preferable campaigner.

Table 3-39: Who should take the public campaign?

	Household		Business
	Urban	Rural	
Central government	16.2%	8.5%	28.4%
Municipality	67.9%	69.8%	61.8%
Community leaders	3.1%		2.9%
School	1.0%	2.8%	1.0%
NGO	6.9%	9.4%	3.9%
Private enterprise	1.7%		1.0%
Ministry of Environment	3.1%	9.4%	
Market Manager			1.0%

Base: 290 (households in urban), all (households in rural) and all (businesses)

In order to improve the manner of discharging waste, a community-based approach utilizing existing organizations such as a community association is effective. Therefore, questions about community-based activities were included in the questionnaire. Most of the household respondents were not involved in community activities. All the business respondents but one hotel did not belong to any associations such as an industry association or the chamber of commerce.

### **3.3 Findings of the Survey**

#### **(1) Awareness of environmental and waste issues**

As a whole, the results of the POS indicate a high environmental awareness, as shown in Annex 3 of the Supporting Report (Figure 3-5). However, it is unclear how the respondents define the term “environment” or what criteria they had when they chose the answer “they are interested in environmental issues”. It can be assumed that the meaning of “environment” is mixed with that of hygiene. It seems necessary to analyze the results with considerable care. Judging from the Japanese standard, the degree of awareness of the environment is probably not high, but more people are becoming interested in environmental issues as pollution problems such as air pollution become serious due to the increase in the traffic.

People are aware of problems close to them such as offensive odor caused by scattered waste on the street. However, they are not well informed about problems related to the disposal site.

#### **(2) Discharge of waste**

Most respondents put their waste in proper places, but in some cases the discharge time was inappropriate. In the tropical climate, waste decomposes quickly and many people do not want keep it long at home, which often results in the discharge of waste at an inappropriate time. On the other hand, an inappropriate or irregular collection time also leads to the discharge of waste at an inappropriate time.

It is necessary for the collection service company to know the pattern of people’s daily life and their preferable collection time before deciding the collection day and time. On the other hand, local residents have to recognize the importance of following waste discharging rules and realize their responsibility. It is necessary to achieve better communication among the collection service company, local residents and local authority concerned.

#### **(3) Opinion about the current collection service**

In total, 80% of the household respondents and 60% of business respondents were somehow satisfied with the current collection service. It can be said that many respondents recognized the improvements in the collection service, since CINTRI succeeded the collection service business almost one year ago.

The cross-sectional analysis of the household data showed that the degree of satisfaction had little correlation with the frequency of the service and the level of collection fee. In the case of business establishments with a collection fee over R 20,000, the respondents tended to be more unsatisfied with the collection service, but the inappropriate or irregular collection time and waste left on the street after the collection service were main reasons for dissatisfaction. In the center of the MPP, the improvement of the quality of the collection service is a problem to be solved.

#### **(4) Recycling**

Glass bottles and aluminum cans are the two main items of recycling. Papers and cardboards are rarely collected separately and recycled. At present, people in the MPP store recyclables at home for several months before a buyer come to their houses to collect them. It is necessary to check whether or not more frequent visits by the waste buyers will promote recycling activities.

# Annex 4

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*Social Environment Survey  
in and around the Disposal Site*

## Annex 4 Social Environmental Survey in and around the Disposal Site

### 4.1 Method of the Survey

#### 4.1.1 Design of the Survey

The Stung Mean Chey disposal site is located in the Sangkat (District) Stung Mean Chey close to the border with Sangkat Boeng Tumpun, but most of the waste pickers are living on the periphery of the disposal site in Stung Mean Chey, in particular Phum (Village) Prek Tal and Phum Damnak Thom, while there is a small commune of waste pickers in Phum Chamroeun Phol of Sangkat Boeng Tumpun. Therefore, in the SES, the team conducted the survey, paying more attention to Phum Prek Tal and Phum Damnak Thom.

Table 4-1: Number of Households and Waste Picker Families in Each Phum of Sangkat Stung Mean Chey and Boeng Tumpun

Sangkat	Stung Mean Chey							Boeng Tumpun Chamroeun Phol
	Russey	Thmey	Trea	Mean Chey	Phnet	Prek Tal	Damnak Thom	
Number of Households	785	427	1,400	947	671	551	771	579
Waste Picker families	48	19	40	46	44	204	128	30

Source: Total household data: National Census in 1998

Waste picker family data: from Phum chiefs

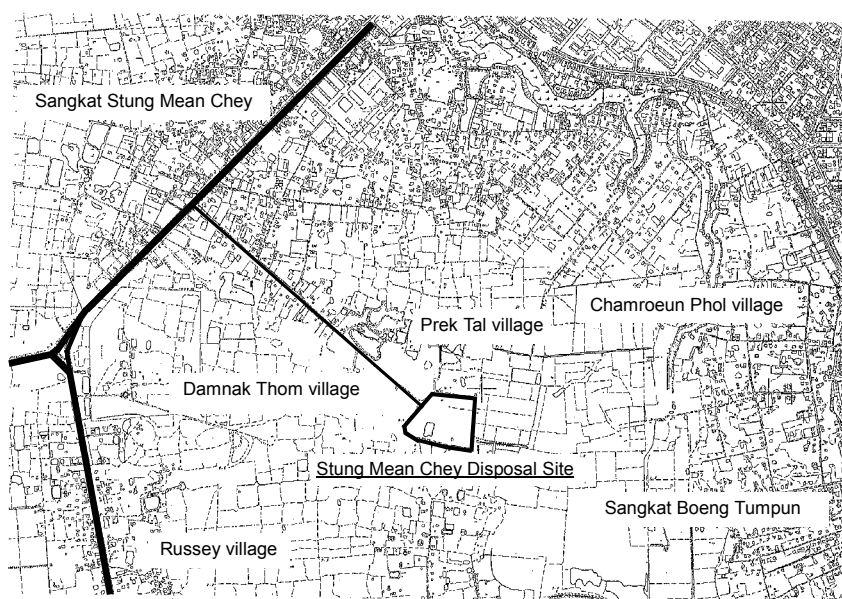


Figure 4-1: Location of Disposal Site

Since the income level of Phum Prek Tal and Phum Damnak Thom is low and there are many waste picker families, various NGOs have projects in these phums. These NGOs provide various programs to child waste pickers, while they are also involved in community based development projects such as micro-credit finance, in cooperation with Village Development Committees (VDCs). Phum chiefs and VDC members know the low-income household groups including waste picker families very well. Therefore, it is very important to cooperate with local authorities and NGOs to conduct the survey smoothly.

Table 4-2: Monthly Average Household Income in Phum Prek Tal

	Phum Prek Tal			Average Household
	Low	Medium	High	Income in Phnom Penh
Monthly Household Income	105,000	240,000	360,000	1,139,553

Source: Phum Prek Tal Development Committee in May, 2003

In the Social Environmental Survey, World Vision Cambodia (WVC) was in charge of coordinating focus group meetings and interview surveys as a local partner, and WVC asked the village development committee to select the participants of focus group meetings and samples of the interview surveys.

#### a. Local Resident Survey

The local resident survey consists of the two focus group meetings and an interview survey, and the design of these surveys is summarized separately. In the inception report, the team proposed to organize one meeting in each of the two target phums, inviting both the local authority and local residents. However, in consultation with World Vision, the team changed the original plan and arranged one local authority meeting and one local resident meeting separately, so that local residents could express their opinions more freely.

##### a.1 Focus Group Meeting

1. Target area: Stung Mean Chey, in particular Phum Prek Tal and Phum Damnak Thom
2. Participants of the two meetings:
  - Meeting 1: local authorities of Sangkat Stung Mean Chey and seven phums
  - Meeting 2: local residents of Phum Prek Tal and Phum Damnak Thom
3. Number of participants: around 20 in each meeting
4. Subject of discussion:
  - Current problems related to the disposal site
  - Opinion about current SWM
  - Causes of problems and possible solutions.

##### a.2 Interview Survey

1. Target area: Stung Mean Chey and Boeng Tumpun surrounding the disposal site
2. Number of samples: 40
3. Number of questions: around 40
4. Subject of survey:
  - Problems caused by the disposal site and opinion about possible solutions
  - Environmental awareness

#### b. Waste Picker Survey

The waste picker survey also consists of a series of focus group meetings and an interview survey. The focus group meeting was the most important part of the SES, but waste pickers were not familiar with this kind of meeting, so the team tried to make meeting participants feel as comfortable as possible and encouraged them to express their opinion freely. The team did not make a fixed schedule except for the first meeting. Based on the results of the first meeting, the team flexibly arranged additional meetings, so that the team could deepen the discussion and finally reach a certain level of consensus with the waste pickers about the introduction of rules at the disposal site.

### **b.1 Focus group meeting**

1. Target group: waste pickers working at the disposal site
2. Number of meetings: one meeting plus additional ones due to the progress of discussions.
3. Number of participants: as many as possible based on the capacity of the meeting place
4. Subject of discussion:
  - Problems they face while working at the disposal site
  - Causes of problems and possible solutions.
  - Opinion about introducing rules at the disposal site

### **b.2 Interview Survey**

1. Target group: waste pickers working at the disposal site
2. Number of samples: 20
3. Number of questions: around 40
4. Subject of survey:
  - Problems they face while working at the disposal site
  - Opinion about possible solutions
  - Living conditions and environmental awareness
  - Future plans

### **b.3 Additional Surveys**

To obtain other baseline data, the following surveys were conducted.

- Survey on the number of adult and child waste pickers at the disposal site (observation survey)
- Survey on recycled items and the daily earnings of both adult and child waste pickers (interview survey at the disposal site)
- NGO meeting about child waste pickers

## **4.1.2 Selection of meeting participants and interviewees**

Selection of the meeting participants and interview survey samples was conducted by VDC in consultation with phum chiefs.

### **a. Local Resident Survey**

Most of the participants of the local resident meeting and samples of the interview survey were selected from the low-income groups, which were involved in village development projects. Therefore, these samples did not always represent the entire resident population. Nevertheless, the team judged that the results of the survey could be used as the opinion of those who were more affected by the disposal site.

### **b. Waste Picker Survey**

VDC was mainly responsible for selecting interviewees. The criteria for selection were as follows:

- Full-time waste pickers
- Those who have lived in the target area more than one year
- Priority was given to poorer family.
- Medium level income families are also given the opportunity if they are interested
- Some people, e.g. members of "Play Boy", were excluded from the selection process.



### **4.1.3 Preparation of Questionnaire and Show Card**

#### **a. Questionnaire**

##### **a.1 Local Resident Survey**

The questionnaire is divided into nine sections: (1) general questions, (2) problems caused by solid waste, (3) your waste and its management, (4) reuse/recycling issues, (5) situation at the Stung Mean Chey disposal site, (6) solutions of problems caused by waste, (7) relations with Municipality of Phnom Penh, (8) health conditions, and (9) about the interviewee. The questions of the sections 1, 2, 3, and 4 were almost the same as those of the POS, so that the team could compare the opinions and behaviors of people in Stung Mean Chey to those of other areas of MPP. The questionnaire used in the survey is shown in Annex D along with the results of the primary data analysis.

##### **a.2 Waste Picker Survey**

The questionnaire is divided into seven sections: (1) family status, (2) family history, (3) general questions, (4) working conditions, (5) current living conditions and your health, (6) reason for starting waste picking and future plan, and (7) about you and your family. The questions of section 3 were the same as the POS and the local resident survey, and the results were compared to those of these two surveys. The questionnaire used in the survey is shown in Annex D along with the results of the primary data analysis.

#### **b. Show Card**

The Show Card was prepared for both the local resident and waste picker surveys along with the questionnaire sheet, as with the POS.

### **4.1.4 Execution of the Survey**

The focus group meetings (two local resident meetings and one waste picker meeting) were coordinated by World Vision Cambodia, and organized by the team on the 20<sup>th</sup> and 21<sup>st</sup> of May. The entire discussion was facilitated by Mr. Bunloeur. Two additional meetings for waste pickers were arranged on the 4<sup>th</sup> and 6<sup>th</sup> of June.

The interview survey for both local residents and waste pickers was conducted by three research assistants from the 21<sup>st</sup> of May to the 23<sup>rd</sup> of May. All the interviewees for the local resident survey but ten were invited to a meeting place and research assistants conducted interviews individually. The rest of the interview survey took place at the houses of the interviewees.

Additional surveys such as an observation survey at the disposal site were conducted by two research assistants between the 29<sup>th</sup> of May and the 9<sup>th</sup> of June.

## **4.2 Results of the Survey**

### **4.2.1 Local Resident Survey**

#### **a. Focus Group Meetings**

The focus group meetings consist of a local authority meeting and a local resident meeting. The results of the two meetings are summarized separately.

##### **a.1 Local Authority Meeting**

At the meeting, 12 local authorities such as the phum chief, village development committee members and commune council members participated in the discussion.

In the first half of the meeting, the participants discussed the problems caused by the disposal site. Pollution problems such as air and water pollution and offensive odor were listed as the main problems in the Sangkat. However, they mostly talked about topics related to picker issues such as poverty problems, poor working and living conditions, and the high accident rate of children at the disposal site. Illegal activities such as threats and stealing at the disposal site were also mentioned as serious problems.

In the second half, the participants discussed possible solutions. Many of the participants expressed their hopes that JICA and NGOs as well as the government would provide various support programs to start new jobs and send their children to school. Nobody but one participant mentioned waste management policies. He put forward the idea of constructing a recycling center to recycle piled-up waste at the disposal site and to create jobs for waste pickers.

## a.2 Local Resident Meeting

Twenty participants from the target phums, Phum Prek Tal and Phum Damnak Thom, were invited to the meeting.

As with the local authority meeting, many of the participants talked about waste picker issues, while pollution problems were also mentioned. Many participants complained about health problems caused by the disposal site.

Most participants thought that the government should take the necessary measures to improve the disposal site and to support waste pickers. One participant proposed to construct a recycling center, but most participants did not mention waste management issues.

## b. Interview Survey

The results of the interview survey are briefly summarized. The details are shown in Appendix D.

### b.1 About Interviewee

First of all, the characteristics of the interviewees are summarized. Three quarters of the respondents were selected from the two target phums, but the others were selected from other phums including Sangkat Boeng Tumpun.

The distribution of the respondents by age and sex is shown in the table below. As already mentioned, the respondents were selected from low-income and more vulnerable groups, so the average age of the respondents was older than that of the population. In addition, more female respondents were selected than male. More than 65% of the respondents did not complete or never attended primary school, but 72.5% of them said that they were literate. All of them were Khmer.

Table 4-3: Distribution of Age and Sex

Age	Male	Female
30-39	7.5%	25.0%
40-49	0.0%	22.5%
50-59	7.5%	27.5%
60-69	2.5%	2.5%
70-	2.5%	2.5%
sub-total	20.0%	80.0%

Base: All

Table 4-4: Monthly Household Income

Income	
Less than \$50 (R200,000)	45.0%
\$50 - \$100	42.5%
\$101 - \$150	5.0%
\$150 - \$200	5.0%
\$201 - \$250	0.0%
\$251 - \$300	2.5%

Base: All

TV and radio are popular media to get news. More than 70% of the respondents never read the newspaper.

Table 4-5: Frequency of access to news by type of media

	Radio	TV	Newspaper
Never	25.0%	15.0%	72.5%
Rarely	10.0%	12.5%	10.0%
Once or twice per week	12.5%	17.5%	10.0%
Every day	52.5%	55.0%	7.5%

Base: All

## b.2 General Environment issues

In the target area, the poverty problem was the biggest concern as shown in Figure 4-2. Comparison to the results of the POS reveals that the inadequate supply of safe water was a more serious problem than in other areas. A question about priority shows the same result, as shown in Table 4-6.

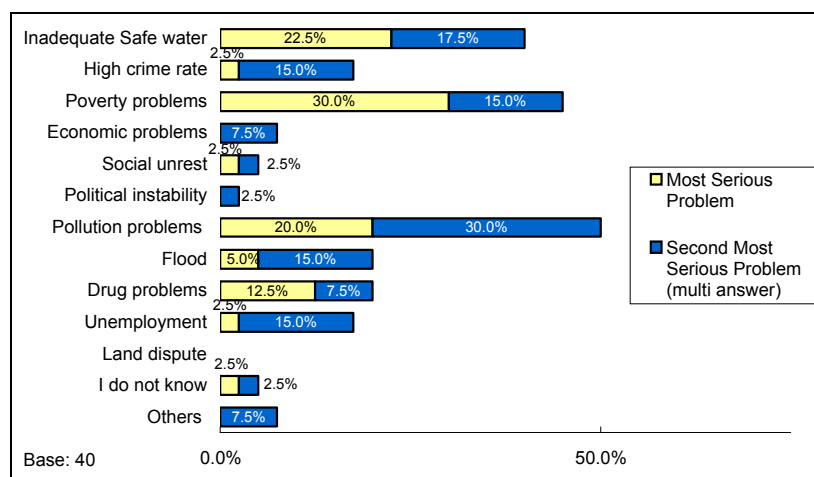


Figure 4-2: Most Serious Problem and Second Most Serious Problems

Table 4-6: Priority to be solved or improved.

	Water supply	Sewer pipe network	Storm water drainage	Septage sludge collection	Solid waste collection	Electricity Supply	Access road to the house	Telephone
1. Very important	35	31	18	11	16	14	17	5
2. Important	4	9	17	22	17	20	18	15
3. Little important	0	0	2	4	5	5	5	8
4. Not important at all	1	0	3	3	2	1	0	12
Mean	1.18	1.23	1.75	1.98	1.83	1.83	1.7	2.68
Comparison								
Mean (POS)	1.35	1.94	2.32	2.07	1.59	1.38	2.28	2.42

Like the POS respondents, almost all the respondents replied that they were interested in environmental issues, but their concerns were diversified ranging from water and air pollution to flooding. These areas were low wetlands before Boeung Tumpon dam was constructed, and flooding is still a major problem. 80% of respondent felt that their lives were seriously affected by environmental degradation; this figure is higher than that of the POS (64.5%).

### b.3 Problems caused by solid waste

95% of the respondents recognized that improper waste management caused problems. In addition, more than 90% of the respondents replied that there were problems caused by improper waste management in Phnom Penh. Offensive odor was the answer that most respondents chose. Even though respondents know the situation of the disposal site, only 5.4% of them recognized that the disposal site was almost full.

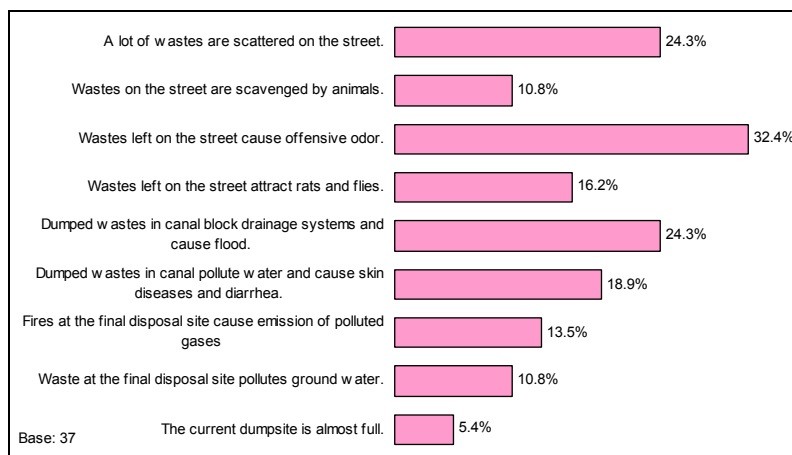


Figure 4-3: In Phnom Penh, what kinds of problems are there now? (Multiple Answer)

### b.4 Your waste and its management

In Sangkat Stung Mean Chey, a part of the area is covered by the collection service. Respondents were asked how their waste is treated. 50% of the respondents received the collection service, while 42.5% transported their waste to collection points in other areas, as shown in Figure 4-4. Female adults were mainly responsible for handling waste, as in other areas.

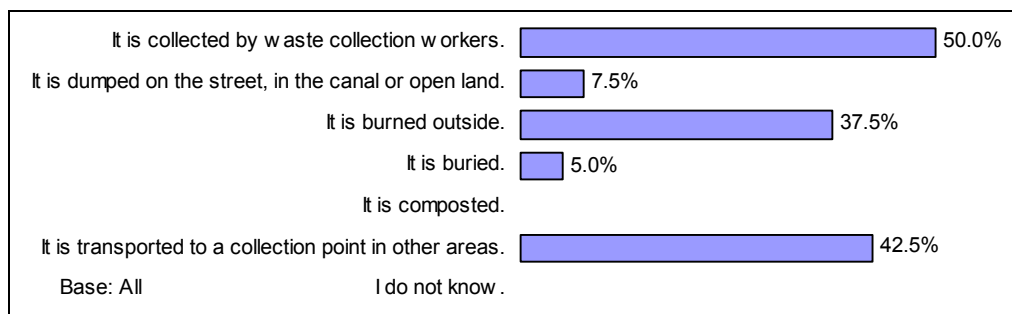


Figure 4-4: How is your waste disposed of?

### b.5 Reuse/recycling of waste

The local resident survey revealed that the recycling rate in the target area was remarkably high compared to other areas. The share of the respondents of the POS and the local resident survey who replied that recycling is necessary was almost the same, but there was a significant difference in the share of those who actually recycled waste, 56.3% and 77.5% respectively. Moreover, respondents of the survey recycled a variety of items, as shown in Table 4-7. A lot of depots and recycling factories are concentrated near the disposal site, and local residents can sell various recyclables there any time they want. This probably promotes not only recycling activities at the source but also waste picking activities outside their

houses. It seems that there are a lot of part-time waste pickers around the disposal site. The sum of monthly earnings by selling the following items was R 22,155.

Table 4-7: Share of the respondents who are recycling waste

Items	Col%	To whom recyclables are sold	
		Depo	Those who come to house
paper	47.5%	8	11
cardboard	35.0%	5	9
glass bottles	55.0%	12	10
aluminum cans	55.0%	11	11
metal cans	17.5%	2	5
plastic bottles	25.0%	3	7
soft plastics	17.5%	3	4
hard plastics	42.5%	7	10
cloth/textile	12.5%	3	2
metal (such as metal parts)	15.0%	1	5
organic waste (such as kitchen waste)	10.0%	2	2

Base: 40

Table 4-8: Why do you think that it is necessary?

Recycling would reduce the amount of waste to landfill	3.8%
Recycling would help to protect the environment	26.9%
Recycling would earn you some extra money	69.2%
Others (Please specify):	0.0%

Base: 26

#### b.6 Situation at the Stun Mean Chey Disposal Site

One of the main purposes of the survey was to obtain local residents' opinions about the current situation of the disposal site. 95% of the respondents were concerned about the disposal site. The reasons for their concerns are summarized below. The environment is their primary concern.

Table 4-9: Why are you concerned about the dumpsite?

It affects the surrounding environment.	71.1%
It attracts more waste pickers to this area.	21.1%
It affects the land price and asset value.	5.3%
Others	2.6%

Base: 38

However, half of the respondents replied that the current situation was better than five years ago. This probably reflects the improvement of inside roads, which mitigated traffic jams of collection vehicles in the rainy season.

Table 4-10: Compared to five years ago, what do you think the current situation is like?

It is worse than five years ago.	26.3%
It is the same as five years ago.	21.1%
It is better than five years ago.	50.0%
I do not know.	2.6%

Base: 38

Among environmental problems, what the respondents were most concerned about was air pollution caused by fires, as shown in Figure 4-5. Contamination of ground water was also a big concern for them.

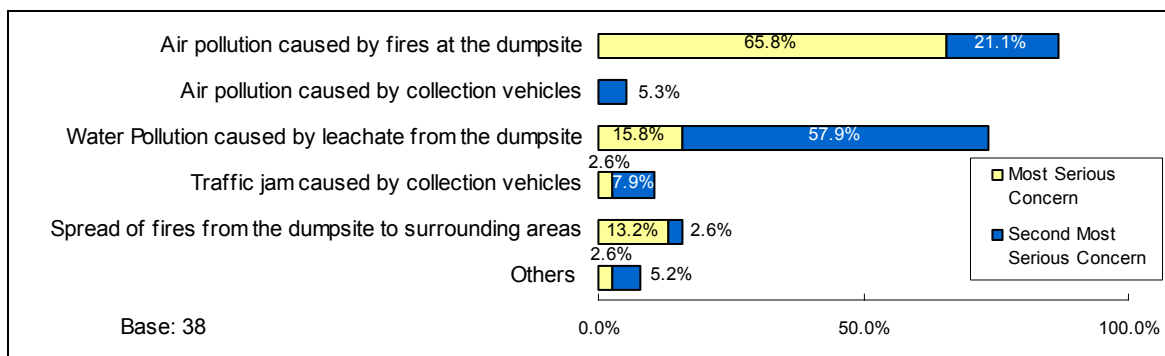


Figure 4-5: What concerns you most about the current situation at the dumpsite? How about the second most?

About 70% of the respondents had at one time or another consulted with someone else and the people whom they consulted with were mainly their neighbors. Among officials, the phum chief was the person whom local resident consulted with most

#### b.7 Solutions of problems caused by waste

To solve problems of scattered waste on the street, control by law and regulation was the most popular measure among the respondents. On the other hand, most respondents agreed with waste-discharge rules, as shown in Table 4-12

Table 4-11: To solve problems of scattered waste on the street, which measure do you think most effective?

To enact an anti-littering law and regulation and control it strictly.	47.5%
The number of collection vehicles and workers should be increased.	5.0%
To instruct people how to discharge waste in order to improve the manner.	27.5%
More street side waste containers have to be installed.	27.5%
I do not know	0.0%
Others	0.0%

Base: All

Table 4-12: Do you agree with waste-discharge rules?

To establish rules is good and I follow the rules.	82.5%
To establish rules is good and if waste collection vehicle/worker come on time, I will follow the rules.	17.5%
To establish rules is good, but I do not want to follow the rules.	0.0%
To impose rule is not good, and I do not want to follow the rules.	0.0%
I do not know.	0.0%

Base: All

All the respondents recognized that a public campaign to raise awareness of people for maintaining a cleaner city and environment is necessary. The Municipality and community leaders were selected as the most preferable campaigner.

As a possible solution to improving the situation at the dumpsite, government control by strict regulation was the most popular solution, followed by the reduction of waste through further recycling by ordinary people and business establishments, as shown in Table 4-13.

Table 4-13: To improve the situation at the dumpsite, which measure do you think most effective?

The central government establishes strict regulations to control operation/management of the dumpsite	55.0%
Municipality of Phnom Penh increases waste collection fee to finance the operation/management cost of the dumpsite	10.0%
Ordinary people and businesses make an effort to reduce the volume of waste by further reuse/recycling of waste.	30.0%
Others	5.0%
I do not know	0.0%

#### b.8 Relations with MPP

At present, more than three quarters of the respondents get information from MPP through radio or TV. 10% of the respondents get information from the phum chief. Radio and TV were selected as the most preferable tool to get information, followed by the phum chief by a considerable margin.

When the respondents faced social problems such as crime, 72.5% of them consulted with the phum chief. Phum chiefs in Stung Mean Chey have people's trust.

77.5% of the respondents replied that there were community organizations such as residents' association and support group of Buddhist temples and they participated in some activities in their community. This high percentage reflected the lively community-based activities by VDCs in the target phums. The functions of these organizations are summarized below.

Table 4-14: What kinds of functions does the community organization have?

I get information from the government through the organization.	16.1%
The organization conducts a public campaign.	51.6%
There is a meeting organized by the committee.	41.9%
I can submit a request to the government through the committee.	6.5%
Others	
Train to people	3.2%
Credit	9.7%
Don't know	6.5%

Base: 31

### 4.2.2 Waste Picker Survey

#### a. Focus Group Meeting

As already mentioned, during the preparation period, the team decided on only the content and schedule of the first meeting. Based on the results of the first meeting, two additional meetings were arranged.

##### a.1 First meeting

Twenty waste pickers were selected from Sangkat Stung Mean Chey and Beng Tumpun. The first meeting was divided into two parts: (1) discussion about problems at the disposal site and (2) problem analysis and possible solutions. The purpose of the first half of the meeting is to know what kinds of problems waste pickers were facing at the disposal site and whether they had a common recognition that the current chaotic situation of the disposal site was a problem or not. The second half of the meeting tried to provide an opportunity for the participants to think of whether they could do something by themselves to improve the chaotic situations.

### **(1) First half of the meeting**

In the first half of the meeting, participants discussed the problems they face during work. All the participants positively expressed their opinions, and various problems were pointed out. They are categorized into three groups, as shown below.

- 1) Problems caused by improper management of the disposal site
  - Air pollution caused by fires
  - Offensive odor
  - Unsanitary conditions such as breeding of a large amount of flies and worms
  - Risk of infection by waste mixed with needles and health damage by hazardous waste
- 2) Chaotic situation at the disposal site
  - Frequent occurrence of accidents with heavy vehicles
- 3) Conflicts with other waste pickers and outlaws in the area
  - Keen competition with other waste pickers
  - Payment to the driver of the collection vehicle
  - Illegal activities such as threats and stealing by a group called “Play Boy”

The results of the discussion revealed that participants were seriously concerned not only with safety but also security at the disposal site and that most of them really need for order at the disposal site.

### **(2) Second half of the meeting**

Since all the participants recognized that working around heavy vehicles was very dangerous in the first half of the meeting, in the second half the team tried to encourage participants to analyze the causes of the frequent occurrence of accidents by themselves.

Several participants pointed out keen competition as a background of this problem. They said that the competition among waste pickers was so intensive that they have to collect recyclables soon after collection vehicles unloaded waste. Moreover, many of participants, in particular female waste pickers, expressed their hope that someone else would bring about order, so that they could work under safer conditions.

The discussions at the meeting reveal that all the participants recognized that working near heavy vehicles was dangerous and that some kinds of rules were necessary. However, they did not know what kinds of rules could solve this problem, so the team proposed to show some examples in which the disposal site operator succeeded in improving its operation in cooperation with waste pickers in the next meeting and all the participant agreed with it.

## **a.2 Additional Meetings**

The team arranged two meetings based on the results of the first meeting. At the first additional meeting, the team showed successful examples in Honduras and the Philippines, and at the second meeting the team presented the draft of the improvement plan, in particular the detailed waste picking rules.

Generally, waste pickers work independently and do not share information with each other. To further disseminate information on the improvement plan, it was necessary to increase the number of participants as much as possible, as well as ask the participants to inform the content of the meeting to other waste pickers. The team increased the number of participants of the first additional meeting from 20 to 40 and allowed each participant to take one more person to the next meeting.

### **(1) First additional meeting**



At the first additional meeting, the team showed two cases, in Honduras and the Philippines, as successful examples and after the presentation the team and participants discussed the causes of the successful outcome. In these cases, the introduction of a registration system and the establishment of waste picking rules such as a workspace separation rule were the two key elements for the successful implementation of the improvement plan in cooperation with waste pickers. For the sustainable management of the rules, an autonomous organization by waste pickers also plays a critical role. Almost all the participants showed an interest in the introduction of the registration system and waste picking rules.

## (2) Second additional meeting

Some participants of the previous meeting brought other waste pickers to the second additional meeting, and the total number of the participants increased to around 60.

At the second additional meeting, the team introduced the draft of the disposal site improvement plan, in particular the details of the registration system and proposed waste picking rules. Almost all the participants basically agreed with the draft plan, except for the issue of child waste pickers, after the discussion with the team. The team made a promise to arrange another meeting to explain the final improvement plan, including the issue of child waste pickers, in September.

### b. Interview Survey

The results of the interview survey are briefly summarized. The details are shown in Appendix D.

#### b.1 About the interviewees

First of all, the characteristics of the respondents are shown. Interviewees were selected from three phums: Damnak Thom, Prek Tall, and Chamroeun Phol. More than half the respondents did not complete primary school and 40% of them said that they were illiterate. All of the respondents were Khmer.

Table 4-15: Distribution of Samples (Location)

Damnak Thom (Stung Mean Chey)	55.5%
Prek Tall (Stung Mean Chey)	25.0%
Chamroeun Phol (Beung Tompum)	20.0%

Base: All (20)

Table 4-16: Distribution of Samples (Age and Sex)

Age	Male	Female
20-29	2	4
30-39	0	3
40-49	3	4
50-59	0	3
60-69	1	0
Total	6	14

Table 4-17: Educational Background

	Count
No formal schooling	5
Some primary school	9
Completed primary school	0
Some secondary school	4
Completed secondary school	1
Refused	1

The average daily household income and the number of family members are shown in the table below.

Table 4-18: Daily Household Income and Number of Family Members

Daily household income (R)	Count	Number of Family Member							
		3	4	5	6	7	8	9	10/more
1. 1000 - 3000	4	1	0	2	0	1	0	0	0
2. 3001 - 6000	7	2	1	2	0	0	0	1	1
3. 6,001 - 10,000	5	0	2	1	1	0	0	0	1
4. 10,001 - 13,000	2	1	0	0	1	0	0	0	0
5. 13,001 - 18,000	1	0	0	0	0	0	0	0	1
6. more than 18,000	1	0	0	0	0	0	1	0	0

The average working years at the disposal site was 6.7 years, and 60% of the respondents had experienced doing other jobs such as farming and selling from stalls.

### b.2 General Environment Questions

Before asking about working and living conditions, interviewees were questioned about problems and priorities in their lives. The POS and local resident survey asked the same questions, so the results could be compared. Pollution problems were listed as the second most serious problem, following the poverty problem. This shows that the disposal site seriously affected their working and living conditions. Since ground water is polluted, the first priority was given to the supply of safe water, as shown in Table 4-19.

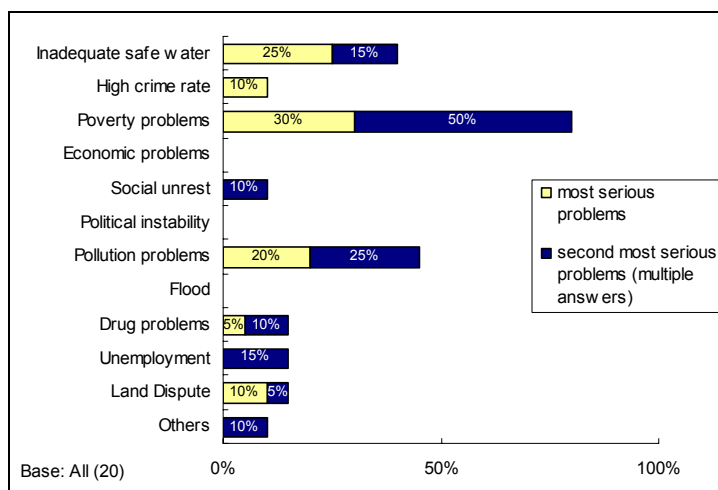


Figure 4-6: What are the most and second most serious problems?

Table 4-19: Priority to be solved or improved.

	Water supply	Sewer pipe network	Storm water drainage	Septic Tank Water collection	Solid waste collection	Electricity Supply	Access road to the house	Telephone
1. Very important	19	14	7	10	5	7	9	2
2. Important	1	5	12	6	11	7	10	6
3. Little important	0	0	1	3	3	3	1	6
4. Not important at all	0	1	0	1	1	3	0	6
Mean	1.05	1.40	1.70	1.75	2.00	2.10	1.60	2.80
Comparison								
Mean (Stung Mean Chey)	1.18	1.23	1.75	1.98	1.83	1.83	1.70	2.68
Mean (POS)	1.35	1.94	2.32	2.07	1.59	1.38	2.28	2.42

All the respondents replied that they were interested in environmental issues. Air and water pollution were the two main environmental problems for them. 95% of the respondents felt

that their lives were seriously affected by environmental degradation. Compared to the results of the POS and the local resident survey, the figure was extremely high.

Table 4-20: How much do you feel environmental degradation affects your life?

	Waste pickers	SMC	POS
It does not affect at all.		2.5%	0.5%
It affects to some degree.	5%	15.0%	34.3%
It caused serious problems.	95%	80.0%	64.5%
I do not know		2.5%	0.8%
Base:	20	40	400

### b.3 Working Conditions

The average working hours of male and female waste pickers were 10.3 hours and 9.5 hours respectively.

The interviewees were asked what kinds of items they collect every day, how much they sold and how much they earned by selling these items, and to whom they sold these items. The results are summarized below. Average earnings were obtained by dividing the total number of interviewees, not total number of those actually collected these items. These figures were based on their memory and the stated earnings for each item probably tended to be higher than the actual amount. As a result, the sum of the earnings from selling items was R 7,734, higher than the daily household income that they answered in another question.

Waste pickers collected various recyclable at the disposal site. Since many of valuable items such as aluminum cans and glass bottles were separated at the source or collected on the street before reaching to the disposal site, soft/hard plastic and organic waste became main sources of income along with aluminum cans and glass bottles.

Table 4-21: Collected Items, Earnings, and Waste Buyers

Items	Number of those who collect the item	Average earning by selling the item (Riel)	To whom you sell?	
			1. Depo, 2. to those who come to the disposal site	
			1 (Count)	2 (Count)
paper	18	580	5	13
cardboard	18	743	5	13
glass bottles	18	355	5	13
aluminum cans	18	510	5	13
metal cans	18	720	5	13
plastic bottles	14	855	5	9
soft plastics	17	800	5	12
hard plastics	17	1,071	5	12
cloth/textile	5	350	1	4
metal (such as metal parts)	18	400	5	13
organic waste (such as kitchen waste)	13	1,350	2	11

40% of the respondent had taken a hygiene training program and 90% of the respondents had some kind of protective goods or equipment. The protective goods and equipment they were using are summarized below. Most of them replied that they bought these items.

Table 4-22: Protective Clothes or Equipment Respondents use

Shoes	22%
Boots	67%
Gloves	39%
Thick clothes	17%
Mask	17%
Others: hat and scarf	28%

Base: 18

As the most serious problem at the disposal site, competition with other waste pickers was selected, followed by the possibility of being infected by diseases. Since there are so many problems, interviewees had difficulty choosing answers and the selection of answers was wide-ranging.

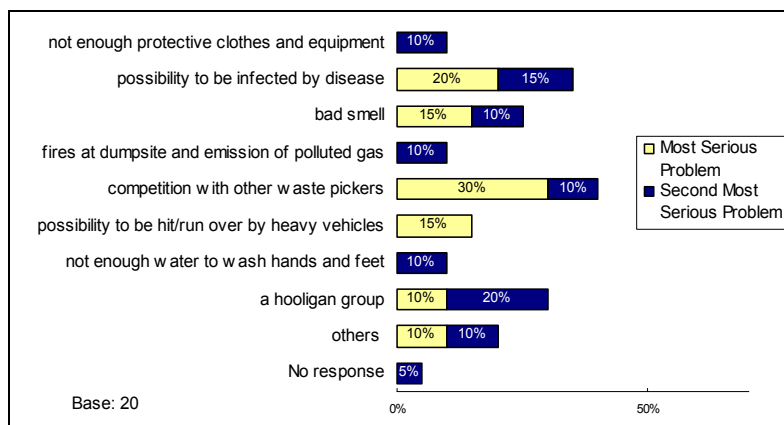


Figure 4-7: Most and Second most Serious Problem at the Disposal Site

The survey tried to determine what percentage of the respondents had experienced an accident. 70% of the respondents had the experience of almost colliding with a heavy vehicle and knew the risks well.

Table 4-23: Experience of accidents

Have you ever had any experiences of being injured at the dumpsite?

Yes	85%
No	15%

Have you ever had an experience of being hit by a collection vehicle or bulldozer at the dumpsite?

Yes	35%
No	65%

Have you ever had a narrow escape from a collision with a collection vehicle or bulldozer at the dumpsite?

Yes	70%
No	30%

Base: 20

40% of the respondents had at least one child that was also working at the disposal site. All of them were worried about the possibility that their children could be involved in an accident.

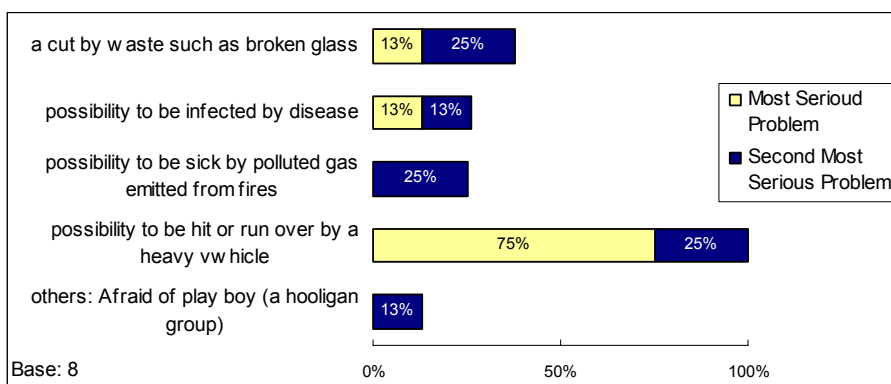


Figure 4-8: What are you concerned most about your children at the dumpsite?

A lot of child waste pickers are working at the disposal site. For many of them, the disposal site is not only a working place but also a playing ground, and visitors to the disposal site

often see children jumping onto or hanging on the collection vehicle. Most of the respondents recognized that these kinds of activities were very dangerous.

Table 4-24: What do you think about children playing around a heavy vehicle?

They enjoy it and this is not a bad thing.	0
It is dangerous but acceptable.	10%
It is dangerous and children are not allowed to do this kind of play.	90%
I do not care.	0

Base: 20

All the respondents somehow agreed that it was necessary not only to improve the environment at the disposal site but also to take measures to protect themselves and their children from accidents. All the respondents but one agreed with the introduction of rules at the disposal site in order to enhance the safety of the disposal site, as shown in Table 4-25.

Table 4-25: What do you think about the introduction of such rules?

If I can work more safely at the dumpsite and the environment of the dumpsite is improved, I agree with the introduction of rules.	95%
It is good that the dumpsite becomes safer during the work, but if this reduces the working time and revenue, I am against the introduction of rules.	0
I do not care the accidents and I am against the introduction of any rules.	5%

Base: 20

#### b.4 Living Conditions

Inadequate safe water was selected as the most serious problem concerning living conditions, followed by air pollution. The respondents thought that fires at the disposal site affected their living conditions most, as shown in Figure 4-9. All the respondents replied that their living conditions were affected by the disposal site and were concerned about their health. 60% of the respondent have bought medicines to treat themselves when they became sick and, more than 50% of the respondent spent more than R40,000 per month on the health care of the whole family. The survey made it clear that waste pickers living close to the disposal site are the people most affected by the disposal site.

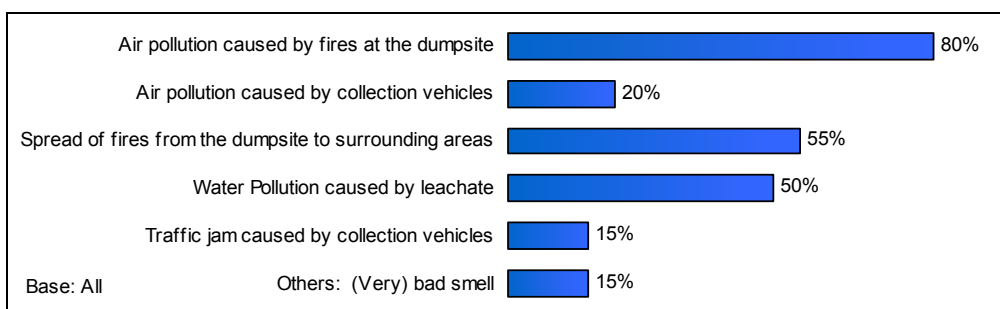


Figure 4-9: Problems caused by the disposal site (multiple answers)

#### b.5 Reasons for starting waste picking and future plan

More than half of the respondents replied that they started waste picking because there was no need for capital or skills. All the respondents wanted to do other jobs such as a seller at a stall or a factory worker, if possible. Lack of capital was the main obstacle to starting a new job.

The current disposal site will be out of use in several years. The survey asked the interviewees about their plan after the current disposal site is closed. 60% of them replied that they wanted to start a new job such as seller and motorbike taxi driver.

Table 4-26: Future plan after the disposal site moves to another place

I want to move to the new dumpsite to continue to work at the dumpsite	5%
I do not want to move to the new dumpsite, but want to continue waste picking work on the street.	30%
I want to start a new job such as a seller at a stall or a motorbike taxi driver.	60%
Others: Pig feeder	5%

Base: 20

### 4.2.3 Additional Surveys

#### a. Number of waste pickers at the disposal site

Since the number of waste pickers increased recently, the team visited the disposal site to count the number of waste pickers. The number was counted by observation and the distinction between adult and child was decided by their appearances. The average result of the nine observations is shown below. On holiday, the number of both adult and child waste pickers increased to over 500 (the largest number was 540), because there are many waste pickers that work at the disposal site only during weekend. Compared to the data in 2002 by Vulnerable Children Assistance Organization (VCAO), the number of adult waste pickers has grown considerably, while the number of child waste pickers has decreased<sup>1</sup>.

Table 4-27: Average Number of Waste Pickers at the Disposal Site

	Adult	Child	Total
Number	327.8	132.4	460.2

#### b. Additional Interview Survey

An additional interview survey was conducted at the disposal site in order to obtain the data on child waste pickers. For comparison, adult waste pickers were also selected for the interview. Samples were selected randomly by interviewers at the disposal site. The main questions were about the working hours, collected items, and daily earning. In the survey, interviewees were asked what items they collected and how much they earned by selling these items the previous day, so that they could answer easily. The results are briefly summarized below. Many of the child waste pickers work long hours and their average daily earnings were about two-thirds of adult earnings.

Table 4-28: Number of Samples

	Adult	Child	Total
Number	26	28	54

Figure 4-10: Age Distribution of Child Waste Pickers

Age	0-6	7-10	11-12	13-15	16-17
	0	6	4	16	2

<sup>1</sup> According to the annual report of Vulnerable Children Assistance Organization (VCAO), during the year 2002, the average number of adult and child waste pickers working at the dumpsite was 83 and 209 respectively.

Table 4-29: Average Working Hours and Total Earnings

Working Hours	Adult	Child	Total Earnings	Adult	Child
	10.7	9.3	R 6,400	R 4,100	

## 4.3 Findings of the Survey

### 4.3.1 Local Resident Survey

- Participants of the local resident meeting were selected from low-income and vulnerable groups.
- Almost all the local resident meeting participants and interview survey respondents were aware of the environmental degradation caused by the disposal site, but they had not pushed neither MPP nor PPWM hard to improve the operation of the disposal site. Some participants expressed their wishes that the disposal site be moved somewhere else, but they recognized it was not a fundamental solution.
- All the meeting participants and interviewees generally agreed with the improvement of the disposal site.
- Both local authorities and local residents were concerned about waste pickers. They hope that the improvement plan will decrease the number of accidents at the disposal site. There were few conflicts between local residents and waste pickers, although there were some conflicts among waste pickers.
- In Sangkat Stung Mean Chey, recycling activities were much more active than in other areas. The accumulation of deposes and recycling factories probably gave local people incentives to earn a small amount of money by recycling waste. Furthermore, it is estimated that some local residents were working as part-time waste pickers.

### 4.3.2 Waste Picker Survey

- In total, more than 100 waste pickers participated in either a focus group meeting or an interview survey. The number was about one third of the total waste pickers, and most participants were selected from those who had participated in community development projects. In other words, they were selected from those who were more cooperative than others, and there might be other waste pickers who have different opinions about the improvement plan. Therefore, it is necessary to make sure of the intention of the whole waste picker population before the improvement plan is implemented.
- Waste pickers face various problems. Both their working and living conditions were affected by the environmental degradation caused by the disposal site.
- Waste pickers collected various recyclable at the disposal site. Since many of valuable items such as aluminum cans and glass bottles were separated at the source or collected on the street before reaching to the disposal site, soft/hard plastic and organic waste became main sources of income along with aluminum cans and glass bottles.
- All the participants took the frequent occurrence of accidents seriously.

- Most of them were seeking not only safety but also security at the disposal site. They agreed that some kinds of rules were necessary to bring about both safety and security at the disposal site.
- Several participants insisted that children also be allowed to continue to work at the disposal site.
- Even though the number of child waste pickers has decreased due to the efforts of NGOs, there is still a large number of child waste pickers and they contribute a lot to their families.



# Annex 5

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## *Cleansing Worker Survey*

## **Annex 5 Cleansing Workers Survey**

### **5.1 Objectives**

#### **5.1.1 Objective**

The objective of this study was to evaluate current working and health conditions for cleansing workers involved in solid waste management in Phnom Penh. This information will be used in the preparation of the Master Plan for Solid Waste Management for Phnom Penh.

### **5.2 Methodology**

#### **5.2.1 Survey Approach**

To obtain an accurate picture of existing conditions it was decided to conduct a series of semi-structured interviews with selected workers. Responses would be recorded on standardized interview sheets in the field and later brought to the office for compilation and data entry. A research team would be assembled under the supervision of the Study Team, Transport and Collection Specialist and trained in interview techniques.

#### **5.2.2 Target Group**

The main target group for this study was garbage collectors, truck drivers, street sweepers and supervisors who are staff of CINTRI, the private waste management contractor for Phnom Penh. Data was also collected from a smaller group of cleansing workers who are known as members of the “Self Help Group” (SHG) who provide manual waste collection service (with pushcarts) in three special zones (two under sub-contract from CINTRI, and one under contract from Phnom Penh Waste Management).

#### **5.2.3 Sample Composition**

To obtain a broad data sample it was decided to conduct interviews with at least 50 cleansing workers. This would be broken down as 40 workers from CINTRI and 10 from the SHG. The workers selected for interview would be chosen at random from worker classifications that roughly represent the distribution of workers within the overall work force. Several reserve interviews would also be conducted in the event that some data was invalidated.

#### **5.2.4 Survey Preparation**

After developing a study plan and data collection methodology, the transportation and collection specialist and a research assistant met with Cintri management to obtain information on the number and types staff employed by the company and to request permission to conduct interviews.

Data collection forms were prepared and tested and a database set-up.

#### **5.2.5 Survey Questions**

The main focus of the survey questions was on the following:

- Basic information on type and nature of the employment
- Employment history, education level and training
- Problems related to the work
- Safety equipment and health issues
- Recycling activities
- Personal information on age, sex, housing and family conditions

A supplementary “mini” questionnaire was also used to collect additional data specific to SHG members relating to economic situation before and after joining the group.

### 5.2.6 Data collection

Two researchers conducted field interviews with workers from 15 to 30 May. Garbage collectors were mainly interviewed at the entrance to the Stung Mean Chey disposal site while the collection vehicles queued to enter the facility, similarly, drivers were interviewed in their vehicles during queuing. Street sweepers were mainly interviewed on the street in their work areas. Supervisors were interviewed by appointment in their work areas. SHG members were interviewed at the Waste Recycling Development Center during their breaks. Average interview time was 22 minutes.

### 5.2.7 Data compilation and analysis

Counterpart staff from PPWM were trained in use of the database program and assisted in inputting data received for the research teams on a daily basis. The database was manually queried for totals, averages and means in each data field as well as secondary correlations.

## 5.3 Key Findings

### 5.3.1 Study Sample

A total of 56 standard interviews were conducted (45 with CINTRI staff and 11 with SHG members). 20 supplementary interviews were also carried out just with SGH members. As there were no data sets invalidated, this report reflects data from all 76 interviews. A breakdown of the survey sample is shown below.

Table 5-1: Breakdown of Workers Sampled

	Collectors	Sweepers	Drivers	Group leaders	Supervisors	Compost / recycle workers
Cintri	27	10	6		2	
SHG	9			2		
Supplimentary	15			2		3
TOTAL	51	10	6	4	2	3

The sample was also analyzed by gender with 82% of the respondents being male, 18% female. All respondents were ethnic Khmers. Age of interviewees ranged from 18 to 56 years old, with the average being 30.6 years. A breakdown of age distribution is shown in figure below.

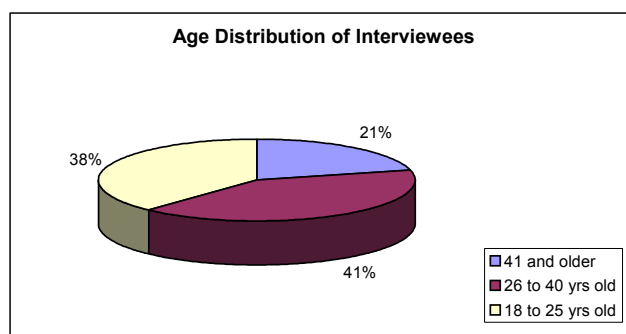


Figure 5-1: Age Distribution of Interviewees

### 5.3.2 Cleansing Worker Background

Most cleansing workers worked in the informal or agricultural sector prior to being employed in their present position. Table 1.2 details prior employment. The majority of the workers are literate (79%), but levels of formal education were generally low as shown below.

Table 5-2: Prior Employment

Waste Picker	Other Self employed	Ag /fish	First job	Gov't	Private	Driver	Factory worker	Technician	Labourer	Other
27	7	10	7	4	9	5	1	2	3	3
35%	9%	13%	9%	5%	12%	6%	1%	3%	4%	4%

Table 5-3: Years of Formal Education

0	< 3	6 <sup>th</sup>	9 <sup>th</sup>	12 <sup>th</sup>	Univ
7	16	18	13	1	1
13%	29%	32%	23%	2%	2%

Most interviewees reported that they had entered this work because a friend or family member already working in the sector (66%), other reasons were no other opportunities (22%) and random hiring (5%), with the remainder reporting various other reasons.

### 5.3.3 Working Conditions

Most workers reported that they work regular hours, with 78% starting their shift starts in the mornings, 22% in the afternoon or evening. However, 20% reported that they work split shifts (this was described as working 4-5 hours in the early evening and again 4-5 hours in the early morning). Average working hours was reported as 8 hours 30 minutes, with 16% reported working overtime (more than 8 hrs per day). Relating to stability of the work situation, 100% reported that they were permanent staff, with 89% stating that the work hours seldom change and 80% that the work location was stable (collection routes change frequently, but workers generally work in the same districts).

The cleansing workers reported a variety of work related problems as illustrated below.

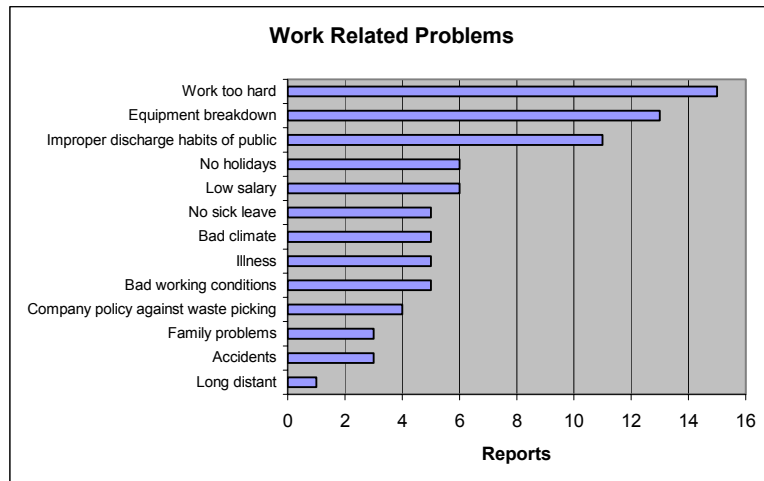


Figure 5-2: Work Related Problems

Many of the problems related to health and safety issues. These concerns were further illustrated when interviewees were asked if they were concerned that the work is hazardous. Figure shows the breakdown of responses.

### Concerns About Work Hazards

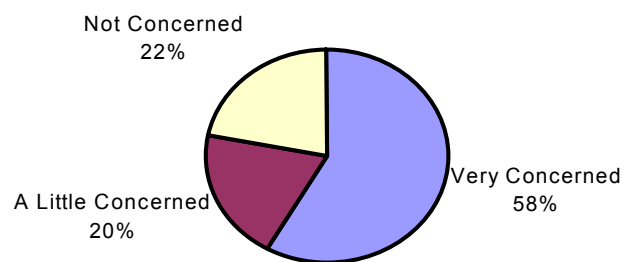


Figure 5-3: Concern about Work Hazards

When asked about safety equipment most workers responded that they use some sort of equipment supplied either by their employer or themselves. Table below shows the breakdown of responses.

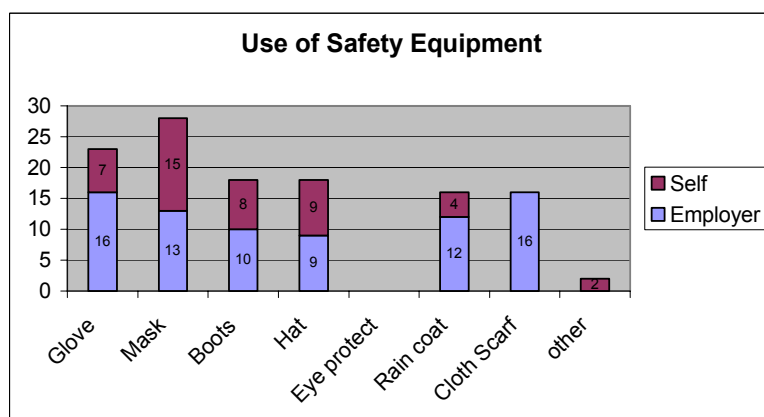


Figure 5-4: Use of Safety Equipment

Relating to health, 71% of respondents said that they had suffered illness or injury during the previous six months, and 64% stated that they had an ailment at the time of the interview.

Most attributed their health problems to the nature of their work, however the study team had no means to check the validity of these statements. The range of reported ailments are detailed in figure 1.5 below.

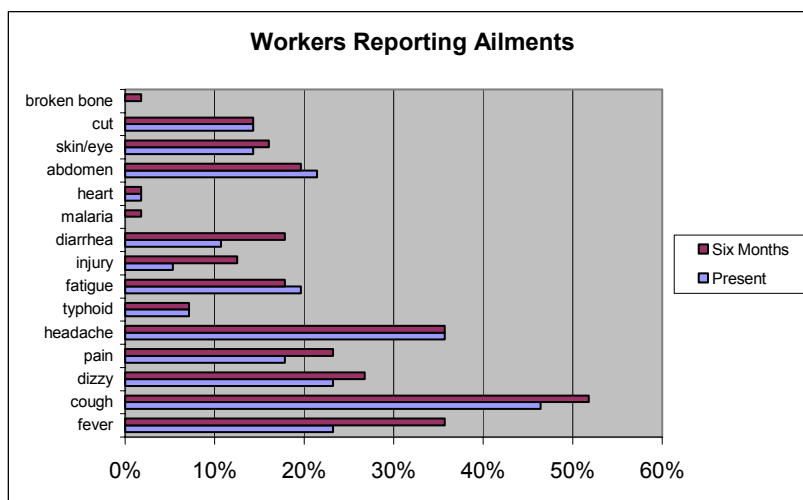


Figure 5-5: Workers Reporting Ailments

Cleansing workers were also asked to relate how they thought the public regards the value of their work. Table 1.4 shows that the cleansing workers responded that the public generally does not consider their work very important.

Table 5-4: Do you feel the public considers your job is important for society?

Yes	Some Importance	Not Important	They look down on us	Don't know
10	30	2	20	1
16%	48%	3%	32%	2%

### 5.3.4 Recycling Activities

Relating to the collection of recyclable materials, 55% of SHG members and 33% of CINTRI workers stated that they collect materials for resale. Officially, workers of CINTRI are prohibited from collecting recyclable materials during working hours, so it was not clear if the collection activities take place during working hours or outside work period. Figure 1.6 shows the breakdown of responses on this subject. Perhaps because this subject has been a sensitive issue recently among CINTRI staff, a high percentage of non-responses were noted on this subject from the private company's staff. SHG members on the other hand are encouraged to collect materials as their work schedule allows, however the materials should be collected at the recycling center and sold for the benefit of the entire group. When asked who gets the benefit from the sale of the collected materials, 100% of the SHG members and 60% of the CINTRI staff responded said the profits were shared (however, only 33% of CINTRI staff actually responded to this question).

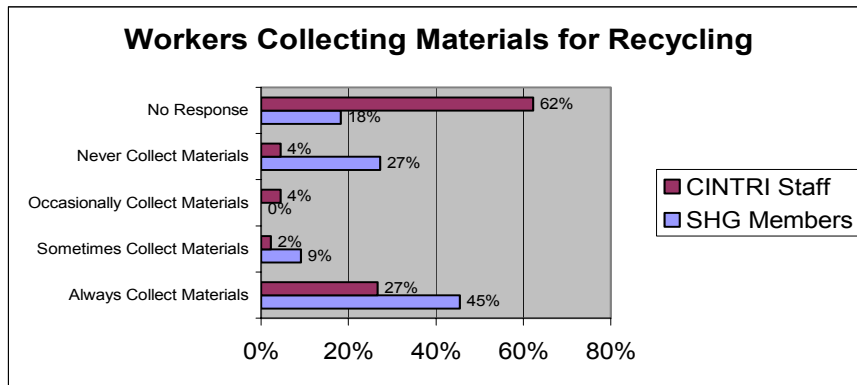


Figure 5-6: Workers Collecting Materials for Recycling

When queried on the types of materials collected, the most commonly collected materials were plastic bottles, aluminum cans, other types of plastic and cardboard. Figure below shows a breakdown of responses for types of materials collected.

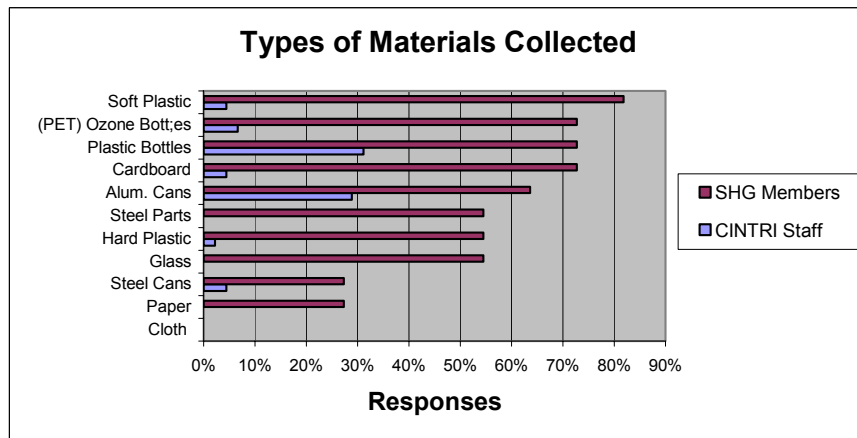


Figure 5-7: Types of Materials Collected

Reported income from recycling activities varied widely. CINTRI staff stated that they receive between \$0.25 and \$15.00 dollars per month (\$4.08 average), while SHG members said they make between \$1.25 and \$50.00 (\$17.71 average).

### 5.3.5 Income and Living Condition

A number of questions were asked relating to living conditions and social/economic indicators. Household size of workers ranged from 1 person up to 13 members, with the average being 4.88 persons (below the city average of 5.8). Figure below gives a breakdown of household size.

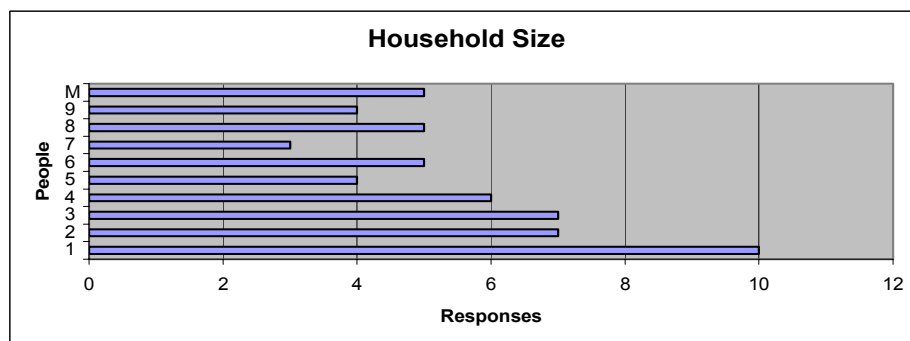


Figure 5-8: Household Size

Salary levels were reported as ranging from \$30 to more than \$160. The breakdown in Table 1.5 of salary levels, other income and family size gives a picture of family economic position.

Table 5-5: Average Family Income

	Average Salary		Other household income*		Average Family Monthly Income		Number of household members		Average income per HH member per day	
	SHG	CINTRI	SHG	CINTRI	SHG	CINTRI	SHG	CINTRI	SHG	CINTRI
Supervisors		130		32.5		162.5		5		1.08
Group leaders	50		42.5		92.5		6		0.51	
Collectors	55	44.37	16.39	51.13	71.39	95.5	7.11	5	0.33	0.64
Drivers		62.5		59.67		122.17		7.3		0.56
Sweepers		34.7		54.8		89.5		6.4		0.47

\* Includes income from recycling activities as well as other household members' earnings

More than half (55%) of the cleansing workers indicated that they rent their lodging. This is significant in Cambodia where a large majority of the population (even among the very poor classes) owns their homes. Also significant, was the fact that 9% said they were homeless. See figure 1.7 for breakdown of family size. A large majority of the families live in a single room (77%) or two rooms (13%). Only one person reported having more than two rooms.

Type of housing was also an important indicator of living conditions. The large majority of cleansing workers reported that they live in wooden housing. Only a small minority reported living in more durable (and fire resistant) brick houses. Figure 1.9 shows a breakdown of housing types.

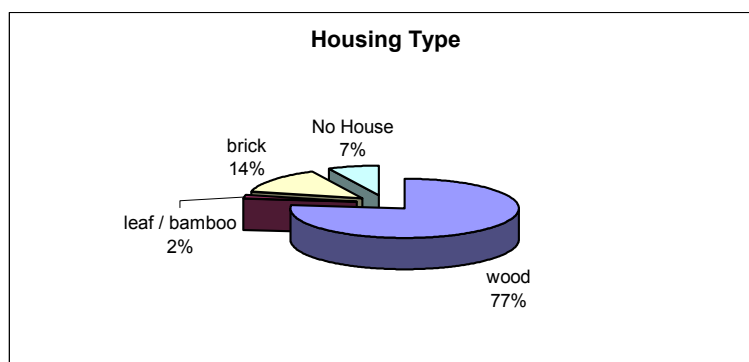


Figure 5-9: Housing Type

Access to services was also investigated. Only 20% of interviews said that they have a piped water connection, most (50%) buy water from vendors, from neighbours (15%) or get water from a well (13%), while one family gets water from a pond (some families use multiple sources). More than half the workers said that have a toilet in the house (64%), while 20% use public or pay toilets. No toilet facilities were reported by 14% of workers. Access to electric supply was also low at 21% with direct connection, 55% reported that they purchase electricity from neighbors and 18% had no electricity supply in the home.

The “mini” survey of SHG members’ economic condition before and after joining the groups showed a significant improvement in most indicators as indicated in the Table below.



		Type of Employment					How much is your income in US\$	People working in family	Combined income	House type					Family debt in US\$	Family savings in US\$	Major assets					Children age 6 to 16 in school
		Waste picker	Street Vendor	Construction worker	Farmer	Factory				Brick	Wood	Leaf	Plastic	Homeless			Moto	Bicycle	TV	Radio	Cydo	
Before SHG	TOTAL	17	2		1	1	59	1643	1	20				5153	121	2	6	2	1	2	2	32
	%	81%	10%		5%	5%			5%	95%						10%	29%	10%	5%	10%	10%	80%
	AVERAGE						34.19	2.81	78.24					245.38	5.76							
Present	TOTAL	15	3	2			41	1932	2	19			4020	170	4	11	9	5			38	
	%	71%	14%	10%					10%	90%					19%	52%	43%	24%				81%
	AVERAGE						52.62	1.95	92.00				191.43	8.10								

## 5.4 Conclusions

This survey shows that the living and working conditions of the cleansing workers questioned are maybe not the worst in Phnom Penh, but they are certainly difficult. Salary levels for CINTRI's collectors and street sweepers are lower than SHG collector's salaries, however staff of the private company also receive other benefits provided under the Cambodian labor law (meal allowance, medical plan, holidays, ect...). However, living conditions and per capita incomes were quite low for both groups. Efforts should be made to increase salaries as much as possible and also provide training and other opportunities for low-level workers to allow them to develop skills and increase income potential.

It was noted that SHG members pool their recycling income and make collective decisions on work organization and use of income. This type of group process builds management skills, helps develop a sense of solidarity among workers and creates a support network. In this process, former waste pickers move from very insecure informal sector employment to a more stable employment situation and they are recognized as service providers in the community. It can also help improve the family living condition as indicated in the SHG survey results. In the case of the SHG, this process is very much linked to the recycling center, which they more or less manage collectively. Center based or other models of Self-Help Groups with participatory social development components should be encouraged where possible. As waste collection improves in the city and operations at the disposal site change, it will be increasingly difficult to survive as a waste picker. Creation of SHGs should be seen as one strategy of providing alternative employment for these people.

# Annex 6

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*Medical Institution Survey*

## Annex 6 Medical Institutions Survey

### 6.1 Method of the Survey

There are a total of 870 medical institutions in the target areas generating medical waste as shown in the table below.

Table 6-1: Number of Present Medical Institutions and the Survey Coverage

Category of Institution	Whole Area <sup>*1</sup>	Medical institution survey	Coverage of the survey
	Fr.	Fr.	
1. Hospital	15	12	80.0
2. Poly-clinic	33	14	42.4
3. Clinic	822	9	1.8
4. Health center		6	
Grand Total	870	41	

(Source) Ministry of Health

41 medical institutions in the Phnom Penh City were selected to conduct survey (see Table 6-2). The survey is based largely on information collected directly from resource persons or directors or those who are responsible for medical waste management of the selected 41 medical institutions in Phnom Penh City. The information and data were collected through the following methods:

- Interview with resource persons or directors or persons who are responsible for medical waste management in/of the medical institutions.
- Observation of the temporary storage bins/site and final disposal of general waste and medical waste.

The interview focused on the generation, segregation, storage, discharge, collection, treatment, and disposal of medical waste.

Table 6-2: Medical Institutions Surveyed

Category of The Institution	Fr.	Number of Beds				
		Total		Average	Maximum	Minimum
		Nos	%			
1. Hospital	12	2,593	83.2	216	550	24
2. Poly-clinic	14	329	10.6	23	50	8
3. Clinic	9	100	3.2	11	18	4
4. Health center	6	92	3.0	15	30	3
Grand Total	41	3,114	100.0	-	-	-

### 6.2 Results of the Survey

This study covered 4 categories of medical institutions including (i) hospitals; (ii) poly-clinics; (iii) clinics; and (iv) health centers. In the case study by Ministry of Environment and Ministry of Health in association with Blacksmith Institute in 2002, hospitals refer to places providing medical treatment to public. The hospital, by and large, consists of more than 50 beds and belongs to the government while a health center comprises less than 50 beds. Most hospitals are able to treat all kinds of diseases. Clinics and polyclinics refer to places providing medical treatment to people who are ill or injured. The clinics and polyclinics are generally managed by private sectors and provide outpatient services. The

polyclinics may provide medical care services for multi-diseases; while the clinics may not. Some clinics however are able to provide services for multi-disease treatments.

## 6.2.1 General Information

### a. Categories and types of medical institutions

The categories of medical institutions covered in this study were 12 hospitals (29%), 14 poly-clinic (34%), 9 clinics (22%) and 6 health centers (15%). The institutions were divided into 2 types: 18 public (44%) and 23 private (56%).

Table 6-3: Categories and Types of Medical Institutions

Base: Population = 41											
Category of the Institution	1.Hospital		2.Poly-clinic		3.Clinic		4.Health center		Total		
	Public	Private	Public	Private	Public	Private	Public	Private	Nos.	%	
1. Chamkar Mon	2	-	-	5	-	-	1	-	8	20	
2. Daun Penh	6	-	-	2	-	4	1	-	13	32	
3. Prampir Makara	2	-	-	4	-	3	1	-	10	24	
4. Toul Kork	2	-	-	1	-	2	1	-	6	15	
5. Dang Kor	-	-	-	1	-	-	-	-	1	2	
6. Mean Chey	-	-	-	1	-	-	1	-	2	5	
7. Russei Keo	-	-	-	-	-	-	1	-	1	2	
Grand Total	Fr.	12		14		9		6		41	100
	%	29		34		22		15			

### b. What is the number of employees?

The average number of employees of medical institutions are 107 for full-time and 7 for part-time. In a short, employees more than 94% have been employed on a full-time basis.

Table 6-4: Number of Employees

Base: Population = 41								
Category of the institution	Full time				Part time			
	Total	Average	Maximum	Minimum	Total	Average	Maximum	Minimum
1. Hospital	3,792	316	533	133	190	16	114	0
2. Poly-clinic	311	22	54	3	74	5	26	0
3. Clinic	86	10	18	4	18	2	7	0
4. Health center	204	34	56	13	10	2	7	0
Grand Total	4,393	107	533	3	292	7	114	0

### c. Outline of institution: Number of beds

There were disparities in the average number of beds: 216 in hospitals, 23 in poly-clinics, 11 in clinics, and 15 in health centres.

Table 6-5: Number of Beds

Base: Population = 41						
Category of The Institution	Fr.	Number of Beds				
		Total		Average	Maximum	Minimum
		Nos	%			
1. Hospital	12	2,593	83.2	216	550	24
2. Poly-clinic	14	329	10.6	23	50	8
3. Clinic	9	100	3.2	11	18	4
4. Health center	6	92	3.0	15	30	3
Grand Total	41	3,114	100.0	-	-	-

**d. Outline of institution: Season of occupancy**

The survey outcomes emphasized that during the dry season where temperature is high, the occupancy trend is higher than wet season. Table below indicates the trend of occupancy in a general view.

Table 6-6: Season of Occupancy

Base: Population = 41				
Category of The Institution	High Occupancy			
	Dry		Wet	
	Fr	%	Fr	%
1. Hospital	9	22	3	7
2. Poly-clinic	12	29	2	5
3. Clinic	8	20	1	2
4. Health center	4	10	2	5
Grand Total	33	81	8	19

**e. Outline of institution: Average bed occupation rate**

The average bed occupation rate of medical institutions was 39.8% in hospitals, 19.5% in poly-clinics, 23.0% in clinics and 31.5% in health centres, with an average grand total of 36.9%.

Table 6-7: Average Bed Occupation Rate

Base: Population = 41					
Category of The Institution	Fr.	Average bed occupation rate			
		Total		Maximum %	Minimum %
		Nos	%		
1. Hospital	12	1,033	39.8	99.1	2.7
2. Poly-clinic	14	64	19.5	40.0	4.2
3. Clinic	9	23	23.0-	80.0	6.7
4. Health center	6	29	31.5	76.9	8.3
Grand Total	41	1,149	36.9	-	-

**f. Outline of institution: Number of out-patients per day**

The number of out-patients per day on average was 664 in hospitals, 18 in poly-clinics, 14 in clinics and 32 in health centres, with an overall average of 208. There were great disparities between the numbers of out-patients in each category.

Table 6-8: Number of Out-patients/Day

Base: Population = 41						
Category of The Institution	Fr.	Number of out-patients/day				
		Total		Average	Maximum	Minimum
		Nos	%			
1. Hospital	12	7,962	93.3	664	5,500	15
2. Poly-clinic	14	257	3.0	18	55	4
3. Clinic	9	130	1.5	14	40	2
4. Health center	6	189	2.2	32	50	9
Grand Total	41	8,538	100.0	208	-	-

**g. Outline of institution: Number of in-patients/day**

The number of in-patients per day on average was 73 in hospitals, 2 in poly-clinics, 2 in clinics and 3 in health centres, with an average grand total of 23. There were also great disparities between the numbers of in-patients in each category.

Table 6-9: Number of In-patients/Day

Base: Population = 41						
Category of The Institution	Fr.	Number of in-patients/day				
		Total		Average	Maximum	Minimum
		Nos	%			
1. Hospital	12	877	93.6	73	350	5
2. Poly-clinic	14	28	3.0	2	4	1
3. Clinic	9	15	1.6	2	5	1
4. Health center	6	17	1.8	3	5	1
Grand Total	41	937	100.0	23	-	-

**h. Outline of institution: Total floor area**

The total floor area of the medical institutions was 25,832m<sup>2</sup> in hospitals, 551m<sup>2</sup> in poly-clinics, 348m<sup>2</sup> in clinics and 428m<sup>2</sup> in health centres, with an average grand total of 5,846m<sup>2</sup>. There were also great disparities between the total floor area in each category.

Table 6-10: Total floor area

Base: Population = 33						
Category of The Institution	Fr.	Total floor area (m <sup>2</sup> )				
		Total		Average	Maximum	Minimum
		m <sup>2</sup>	%			
1. Hospital	7	180,822	94	25,832	86,790	2,202
2. Poly-clinic	13	7,160	4	551	1,680	160
3. Clinic	8	2,780	1	348	72	120
4. Health center	5	2,142	1	428	960	120
Grand Total	33	192,904	100	5,846	86,790	120

**6.2.2 Medical Waste Management**

**a. Generation**

**a.1 How many kilograms of medical waste are generated per day?**

The results showed disparities among categories, with 22.50kg in hospitals, 1.43kg in poly-clinics, 0.67kg in clinics and 4.60kg in health centers. The medical waste generation per bed for each category of the institutions is shown in “Findings” in the main report.

Table 6-11: Generation Amount of Medical Waste

Base: Population = 41							
Category of The Institution		Fr.	Waste Generation Amount (kg/day)				
			Total		Average	Maximum	Minimum
			kg	%			
Medical waste	1. Hospital	12	269.97	83.4	22.50	64.64	0.93
	2. Poly-clinic	14	20.04	6.2	1.43	3.86	0.38
	3. Clinic	9	6.05	1.9	0.67	1.44	0.07
	4. Health center	6	27.58	8.5	4.60	10.01	0.35
Grand total		41	323.64	100.0	7.89	64.64	0.07

**a.2 Which of the following types of general waste do you produce?**

The major types of medical waste are (i), infectious waste (ii) pathological waste and (iii) sharps for solid waste, and radioactive waste for liquid waste.

Table 6-12: Types of Generated Medical waste

Types	Base: Population = 41									
	Quantity (units)									
	kg/day					liter/day				
	Fr.	Total	Ave.	Max.	Min.	Fr.	Total	Ave.	Max.	Min.
1. Infectious waste	31	115.54	3.73	40.00	40.00	-	-	-	-	-
2. Pathological waste	34	119.76	3.52	32.86	32.86	1	1.20	1.20	1.20	1.02
3. Sharps	40	28.77	0.72	7.14	7.14	-	-	-	-	-
4. Pharmaceutical waste	4	3.43	0.86	2.86	2.86	-	-	-	-	-
5. Genotoxic waste	1	13.57	13.57	13.57	13.57	-	-	-	-	-
6. Chemical waste	1	0.29	0.29	0.29	0.29	3	3.00	1.00	1.50	0.50
7. Wastes with high content of heavy metals	-	-	-	-	-	-	-	-	-	-
8. Pressurized containers	-	-	-	-	-	-	-	-	-	-
9. Radioactive waste	-	-	-	-	-	21	38.08	1.81	17.14	0.03

**b. Storage, Discharge, Collection**

**b.1 Storage**

- How do you store the medical waste?

37 (90%) institutions separate their medical waste from general waste, but 4 (10%) institutions mix them together. These figures indicated that a health risk resulted from infection, which derived from medical waste disposal, is generally not so high.

Table 6-13: Storage Manner for Medical Waste

Category of The Institution	Base: Population = 41		
	Fr.	Storage general waste and medical waste	
		1. We mix them all together.	2. We store them separately.
1. Hospital	12	-	12
2. Poly-clinic	14	-	14
3. Clinic	9	4	5
4. Health center	6	-	6
Grand Total	41	4	37
	%	10	90



Figure 6-1: Proper medical waste management in the Calmet Hospital



Figure 6-2: Separated medical waste for recycling/reusing

- Why don't you separate medical waste?

As surveyed and monitored, most medical institutions separate their wastes in complying with proper sound management. However, some institutions do not separate their wastes. When asked for the reason why they do not separate their medical waste before disposal, the interviewees of the four selected medical institutions did not raise any response to the question.

Base: Population = 4					
Category of The Institution	Fr.	Storage general waste and medical waste			
		1. There is no reason to separate them.	2. It is troublesome to separate them.	3. The waste collectors separate them.	4. Others
3. Clinic	4	-	-	-	4 (little)
Grand Total	4	-	-	--	4

- How do you store your waste within your institution?

The surveyed medical institutions store their medical waste in different ways. Some medical institutions use plastic bag containers to store waste and others use varied types of bags and/or containers.

Table 6-14: Present Containers for the Storage method of Medical Waste

Base: Population = 41										
Waste Categories/Types		Storage method								No Answer
		a.	b.	c.	d.	e.	f.	g.	h.	
Medical waste	1. Infectious waste	21	1	1	7	-	-	-	3	5
	2. Pathological waste	21	1	1	8	-	-	-	2	4
	3. Sharps	9	2	2	6	6	-	-	11	5
	4. Pharmaceutical waste	1	-	1	-	-	-	-	1	1
	5. Genotoxic waste	1	-	-	-	-	-	-	-	-
	6. Chemical waste	-	-	-	-	-	-	-	1	1
	7. Wastes with high content of heavy metals	-	-	-	-	-	-	-	-	-
	8. Pressurized containers	-	-	-	-	-	-	-	-	-
	9. Radioactive waste	1	-	2	2	-	1	-	14	2
	10. Mixed waste	-	-	-	-	-	-	-	-	-

Legend:

- |    |                    |    |                                   |
|----|--------------------|----|-----------------------------------|
| a. | Plastic bag        | e. | Cardboard box                     |
| b. | Paper bag          | f. | Direct disposal (i.e. no storage) |
| c. | Open container     | g. | Own large concrete bin            |
| d. | Container with lid | h. | Others                            |



## b.2 In house collection system

- Specify the present medical waste collection system in your institution.

Few medical institutions use a standard system with containers or coloured bags with labels, and different types of labelled containers, while many use other types.

Table 6-15: In-house Collection System (Medical Waste)

Base: Population = 41				
Waste Categories/Types		Waste collection system		
		a.	b.	c.
Medical waste	1. Infectious waste	3	7	28
	2. Pathological waste	3	6	28
	3. Sharps	4	6	31
	4. Pharmaceutical waste	-	1	3
	5. Genotoxic waste	-	1	-
	6. Chemical waste	-	-	1
	7. Wastes with high content of heavy metals	-	-	-
	8. Pressurized containers	-	-	-
	9. Radioactive waste	-	2	21
	10. Mixed waste	-	-	-

Legend:

- a. We use a standard system with containers or colored bags with labels
- b. We use different types of labeled containers
- c. Others

\* Other containers are being used for putting medical wastes.

These containers include: plastic bottles of water, normal plastic bags, etc.

- Describe the present container for collection of general/medical waste in your institution.

For medical waste collection and storage, the surveyed medical institutions take different approaches. Some medical institutions use plastic bag containers to collect waste and others use varied types of bags and/or containers. Noticeably, only one medical institution disposes its waste directly without storage.

Table 6-16: Present Containers for the Collection of Medical Waste

Base: Population = 41										
Waste Categories/Types		Waste collection system								No Answer
		a.	b.	c.	d.	e.	f.	g.	h.	
Medical waste	1. Infectious waste	29	1	-	-	-	-	-	-	2
	2. Pathological waste	29	1	-	-	-	-	-	-	2
	3. Sharps	14	3	1	7	7	-	-	8	1
	4. Pharmaceutical waste	4	-	-	-	-	-	-	-	-
	5. Genotoxic waste	1	-	-	-	-	-	-	-	-
	6. Chemical waste	-	-	-	-	-	1	-	-	1
	7. Wastes with high content of heavy metals	-	-	-	-	-	-	-	-	-
	8. Pressurized containers	-	-	-	-	-	-	-	-	-
	9. Radioactive waste	1	-	3	4	-	1	-	12	1
	10. Mixed waste	-	-	-	-	-	-	-	-	-

Legend:

- a. Plastic bag
- b. Paper bag
- c. Open container
- d. Container with lid
- e. Cardboard box
- f. Direct disposal (i.e. no storage)
- g. Own large concrete bin
- h. Others



Figure 6-3: Different types of medical waste containers/bags

- Specify the collection frequency of the medical waste (of the department) in your institution.

89% of the medical institutions answered that in-house waste collection was carried out once per day or more frequently. At least two medical institutions in the Phnom Penh City collected their medical wastes more than once per day by private waste-collecting company and transports to final disposal site.

Table 6-17: In-house Collection Frequency (Medical waste)

Base: Population = 41			
Collection frequency		Medical	
		Fr.	%
1.	More than once daily	2	5
2.	Once daily	34	84
3.	Every 2-3 days	2	5
4.	Every 4-5 days	1	2
5.	Weekly	1	2
6.	Other	1	2
Grand Total		41	100

- Are there cool storage points for pathological wastes in your institution?

Based on the responses of the medical institutions' representatives, the team understand that at least two institutions, among the surveyed medical institutions, carry out suitable management for pathological wastes. The cool storage points are being used in these two institutions.

Table 6-18: Possession of Cool Storage Point

Base: Population = 41			
Category of The Institution	Fr.	Cool Storage	
		Yes	No
1. Hospital	12	1	11
2. Poly-clinic	14	1	13
3. Clinic	9	-	9
4. Health center	6	-	6
Grand Total	41	2	39

### b.3 Collection

- Who collects your waste?

CINTRI has contracts with 40 medical institutions to collect their wastes and transport to the final disposal site. There is only hospital that receives service carried out by PPWM.

Table 6-19: Collection Manner of Medical Waste

Base: Population = 41					
Category of The Institution	Fr.	Who collects your waste?			
		1. PPWM (Phnom Penh Waste Management)	2. CINTRI	3. Private company other than CINTRI	4. Don't know
1. Hospital	12	1	11	0	0
2. Poly-clinic	14	0	14	0	0
3. Clinic	9	0	9	0	0
4. Health center	6	0	6	0	0
Grand Total	41	1	40	0	0
	%	2	98		

- How often is it collected?

In regard to the frequency of waste collection, the medical institutions receiving general waste collection service and medical waste collection service more than once per day are 80% and 73%, respectively. Waste collection more than once per day are carried out at two medical institutions.

Table 6-20: Collection Frequency of Medical Waste

Base: Population = 41			
Frequency		Medical waste	
		Discharge	Collection
1.	More than once daily	3	2
2.	Once daily	25	28
3.	Every 2-3 days	9	7
4.	Every 4-5 days	1	1
5.	Weekly	3	2
6.	Less than weekly	-	-
7.	Irregularly	-	-
8.	Other	-	1
Grand total		41	41

#### b.4 Disposal (Intermediate treatment and final disposal)

- What do you do with your waste?

It is, based on data sheet, indicated that most medical institutions treat their wastes by incineration plants. There are few institutions that burn their medical waste on site. Practically, incineration plants in the medical institutions vary and some of them were equipped with out of date facilities.



Figure 6-4: Incineration plants in medical institutions in Phnom Penh city

Table 6-21: Medical Waste Treatment

Waste Categories/Types		" Medical waste" Base: Population = 41											
		Main method for Medical waste											
		Fr.											
		a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.
Medical waste	1. Infectious waste	4	6	1	2	1	-	-	-	14	-	-	8
	2. Pathological waste	4	4	2	2	2	-	-	-	13	-	-	7
	3. Sharps	3	4	4	2	-	1	-	-	19	-	-	8
	4. Pharmaceutical waste	-	-	1	-	-	-	-	-	1	-	-	1
	5. Genotoxic waste	-	-	-	-	1	-	-	-	-	-	-	-
	6. Chemical waste	-	-	-	-	-	-	-	-	1	-	-	-
	7. Wastes with high content of heavy metals	-	-	-	-	-	-	-	-	-	-	-	-
	8. Pressurized containers	-	-	-	-	-	-	-	-	-	-	-	-
	9. Radioactive waste	-	-	2	-	-	-	-	-	-	-	-	12
	10. Mixed waste	-	-	-	-	-	-	-	-	-	-	-	-

Legend:

- a. Place outside for collection by CINTRI or other collectors
- b. Directly carry garbage to a waste collection vehicle
- c. Take the waste to waste collection point of CINTRI or other collectors
- d. CINTRI or other collectors collects from institution (including own bin)
- e. Bury on site
- f. Burn on site
- g. Recycle
- h. Compost on site
- i. Incinerate on site
- j. Autoclave disinfection on site
- k. Open dumping outside property
- l. Other

14 out of 19 medical institutions that treat medical waste by incineration answered about the operational conditions of the incinerators, as shown in the table below.

Table 6-22: Information of Medical waste Incinerator

Base: Population = 14		
	Information	Answers
1.	Location:	At hospital, and health center
2.	Capacity (furnace volume (m <sup>3</sup> ) and waste burning capacity (kg/h):	- From 0.97 m <sup>3</sup> /h to 2 m <sup>3</sup> /h - From 10 kg/h to 100 kg/h
3.	Combustion fuel:	Diesel x 8, wood x 1, charcoal x 2, petroleum x 2, rice hulls x 1
4.	Height of chimney	Average 6 m. (max.20 m, min 1.5 m)
5.	Proximity of living/working spaces to incinerator:	Average 7 m <sup>2</sup> . (max. 15m <sup>2</sup> , min 1m <sup>2</sup> )
6.	Scrubbing/filtering of exhaust gases: Yes/No	Yes = 4      No = 9
7.	Normal operating hours:	Average 3 hours (max. 15 hours, min 15 min)
8.	Ash disposal (amount and frequency):	Average 5 kg/week (max. 30 kg/week, min 1.5 kg/week)
9.	Age:	Average 7 years (max. 13 years, min 2 years)
10.	Reliability (no of days out of service per year; average outage time):	Average 176 days (max. every day, min 10 days)
11.	Problems:	No x 3, No answer x 11

- In regard to the medical waste collected by CINTRI or other collectors, how are they disposed of?

There are 40 medical institutions receiving CINTRI's service. There are two kinds of methods for the treatment of medical waste: (i) disposed of at the Stung Meanchey dump site; and (ii) incinerated at incineration plants of some medical institutions. However, few medical institutions bury their waste at open areas or landfills.

Table 6-23: Final Disposal Method for Medical Waste

Waste Categories/Types		" Medical waste" Base: Population = 41					
		Main method for Medical waste					
		Fr.					
		a.	b.	c.	d.	e.	f.
Medical waste	1. Infectious waste	15	1	-	9	2	2
	2. Pathological waste	14	1	-	9	2	2
	3. Sharps	14	2	-	12	1	4
	4. Pharmaceutical waste	1	-	-	1	-	-
	5. Genotoxic waste	-	-	-	-	1	-
	6. Chemical waste	-	-	-	1	-	-
	7. Wastes with high content of heavy metals	-	-	-	-	-	-
	8. Pressurized containers	-	-	-	-	-	-
	9. Radioactive waste	1	-	-	-	1	4
	10. Mixed waste	-	-	-	-	-	-

Legend:

- a. Disposed of to the Stung Mean Chey landfill together with other waste
- b. Buried in a special pit at the landfill
- c. Burned at the landfill
- d. Incinerated at an incinerator
- e. Buried at the town/city crematorium
- f. Other

### b.5 Discharge

- How do you discharge medical wastes?

Among 34 medical institutions which store medical and general waste separately, 6 institutions discharge medical waste by type while the remaining 28 discharge mixed medical waste.

It is to be noted that according to Table 6-13, there were 37 institutions that answered that they separately store waste. The reason for this disparity will be the three institutions separately store waste at the time of generation, but they mix them during in-house collection by which waste is centrally stored at one designated place within the institutions.

Table 6-24: Medical Waste Discharge

Category of The Institution		Base: Population = 41			
		Fr.	How do you discharge medical wastes?		
			1. Separate storage but mixed discharge.	2. Separate storage and separate discharge.	3. Mixed storage and mixed discharge.
1. Hospital	12	8	3	1	
2. Poly-clinic	14	13	-	1	
3. Clinic	9	3	2	4	
4. Health center	6	4	1	1	
Grand Total	41	28	6	7	
	%	68	15	17	

- In case of "separate storage but mixed discharge", who mixes them?

Employees and collectors mix wastes in 20 and 8 institutions respectively which store medical waste separately but mix it up for discharge.

Table 6-25: Who mixes medical waste which has been separated?

Category of The Institution		Base: Population = 28			
		Fr.	In case of "separate store but mix discharge", who mixes them?		
			1. Collector	2. Our employee	3. Others
1. Hospital	8	1	7	-	
2. Poly-clinic	13	6	7	-	
3. Clinic	3	1	2	-	
4. Health center	4	0	4	-	
Grand Total	28	8	20	-	
	%	29	71	-	

- Please tick appropriate boxes on the answer table to indicate your discharge manner of medical wastes.

Table 6-26: Discharge Manner of Medical Waste

Waste Categories/Types		Base: Population = 41		
		Your discharge manner of medical waste		
		Fr.		
		1. separated discharge	2. mixed discharge	3. not generated
Medical waste	1. Infectious waste	2	34	-
	2. Pathological waste	1	34	-
	3. Sharps	9	30	-
	4. Pharmaceutical waste	1	1	-
	5. Genotoxic waste	-	-	-
	6. Chemical waste	-	-	-
	7. Wastes with high content of heavy metals	-	-	-
	8. Pressurized containers	-	-	-
	9. Radioactive waste	10	7	-
	10. Mixed waste	-	-	-

### 6.2.3 General Waste Management

#### a. Generation

##### a.1 How many kilograms of General waste are generated per day?

The results showed disparities among categories, with 445.0kg in hospitals, 4.9kg in poly-clinics, 3.4kg in clinics and 24.5kg in health centres. The team analysed the general waste generation amount per bed as shown in “Findings” of the main report.

Table 6-27: Generation Amount of General Waste

Category of The Institution		Fr.	Base: Population = 41				
			Waste Generation Amount (kg/day)				
			Total		Average	Maximum	Minimum
kg	%						
General waste	1. Hospital	12	5,339.9	95.7%	445.0	1,200.0	4.7
	2. Poly-clinic	14	68.0	1.2%	4.9	10.0	1.1
	3. Clinic	9	30.2	0.5%	3.4	10.7	0.4
	4. Health center	6	146.9	2.6%	24.5	50.0	2.9
Grand total		41	5,585.0	100.0%	136.2	-	-

##### a.2 Which of the following types of general waste do you produce?

Major types of general waste generated by the medical institutions are (i) food/kitchen waste, (ii) paper, and (iii) plastic. These types are commonly observed in all the categories of the medical institutions.

Table 6-28: Types of Generated General waste

General Waste	Base: Population = 41					
	Total.		1. Hospital	2. Poly-clinic	3. Clinic	4. Health center
	Fr.	%				
1. Food/kitchen waste	41	100	12	14	9	6
2. Paper	39	95	12	14	8	5
3. Textile	11	27	3	8	-	-
4. Grass and wood (Garden waste)	16	39	10	2	1	3
5. Plastics	39	95	11	14	8	6
6. Leather and rubber	-	-	-	-	-	-
7. Metals	-	-	-	-	-	-
8. Glass and bottle	18	44	6	4	4	4

9. Ceramics and stone	-	-	-	-	-	-
10. Other (soil, etc.)	2	5	-	2	-	-

## b. Storage, Discharge, Collection

### b.1 Storage

- How do you store your waste within your institution?

Toward General waste storage, the surveyed medical institutions carry out these tasks in almost same ways.

Table 6-29: Present Containers for the Storage of General Waste

Base: Population = 41									
Waste Categories/Types	Storage method								
	a.	b.	c.	d.	e.	f.	g.	h.	No Answer
General waste	25	-	6	6	-	-	-	1	3

Legend:

- |                           |                                      |
|---------------------------|--------------------------------------|
| a. Plastic bag            | b. Paper bag                         |
| c. Open container         | d. Container with lid                |
| e. Cardboard box          | f. Direct disposal (i.e. no storage) |
| g. Own large concrete bin | h. Others                            |

### b.2 In house collection system

- Specify the present general waste collection system in your institution.

Only a few medical institutions use a standard system with containers or coloured bags with labels, and different types of labelled containers, while many use other types.

Table 6-30: In-house Collection System (General Waste)

Base: Population = 41			
Waste Categories/Types	Waste collection system		
	a.	b.	c.
a. General waste	5	1	35

Legend:

- a. We use a standard system with containers or colored bags with labels  
 b. We use different types of labeled containers  
 c. Others  
 \* Other containers are being used for putting medical wastes in.  
 These containers include: plastic bottles of water, normal plastic bags, etc.

- Describe the present container for collection of general/medical waste in your institution.

For general waste collection and storage, the surveyed medical institutions take 3 ways. Some medical institutions use plastic bag containers to collect waste and others use varied types of bags and/or containers.

Table 6-31: Present Containers for the Collection of General Waste

Base: Population = 41									
Waste Categories/Types	Waste collection system								
	a.	b.	c.	d.	e.	f.	g.	h.	No Answer
General waste	32	-	4	5	-	-	-	-	-

Legend:

- |                       |                                      |
|-----------------------|--------------------------------------|
| a. Plastic bag        | e. Cardboard box                     |
| b. Paper bag          | f. Direct disposal (i.e. no storage) |
| c. Open container     | g. Own large concrete bin            |
| d. Container with lid | h. Others                            |

- Specify the collection frequency of the general waste (of the department) in your institution.

93% of the medical institutions answered that in-house waste collection was carried out once per day.

Table 6-32: In-house Collection Frequency (General Waste)

Base: Population = 41			
Collection frequency		General	
		Fr.	%
1.	More than once daily	5	12
2.	Once daily	33	81
3.	Every 2-3 days	3	7
4.	Every 4-5 days	-	-
5.	Weekly	-	-
6.	Other	-	-
Grand Total		41	100

### b.3 Collection

- Who collects your waste?

CINTRI has contracts with 40 medical institutions to collect their wastes. There is only hospital used a service carried out by PPWM.

Table 6-33: Collection Manner of General Waste

Base: Population = 41					
Category of The Institution	Fr.	Who collects your waste?			
		1. PPWM (Phnom Penh Waste Management)	2. CINTRI	3. Private company other than CINTRI	4. Don't know
1. Hospital	12	1	11	0	0
2. Poly-clinic	14	0	14	0	0
3. Clinic	9	0	9	0	0
4. Health center	6	0	6	0	0
Grand Total	41	1	40	0	0
	%	2	98		

- How often is it collected?

Most medical institutions (78.05%) answered that collection of general waste was carried out once per day. The waste collected more than once per day is performed at the only medical institution.

Table 6-34: Collection Frequency of General Waste

Base: Population = 41			
Frequency		General waste	
		Discharge	Collection
1.	More than once daily	—	1
2.	Once daily	29	32
3.	Every 2-3 days	10	6
4.	Every 4-5 days	1	1
5.	Weekly	1	1
6.	Less than weekly	-	-
7.	Irregularly	-	-
8.	Other	-	-
Grand total		41	41

### b.4 Disposal (Intermediate treatment and final disposal)

- What do you do with your waste?



No medical institutions treat or disposed of general waste on site: all general waste is discharged outside.

Table 6-35: General Waste Treatment

Waste Categories/Types		"General waste" Base: Population = 41											
		Main method for General waste											
		Fr.											
		a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.
General waste	1. Food/kitchen waste	19	9	11	2	-	-	-	-	-	-	-	-
	2. Paper	19	3	8	2	-	-	-	-	-	-	-	-
	3. Textile	6	-	1	2	-	-	-	-	-	-	-	-
	4. Grass and wood (Garden waste)	3	1	5	-	-	-	-	-	-	-	-	-
	5. Plastics	16	3	7	2	-	-	-	-	-	-	-	-
	6. Leather and rubber	-	-	-	-	-	-	-	-	-	-	-	-
	7. Metals	-	-	1	-	-	-	-	-	-	-	-	-
	8. Glass and bottle	3	-	5	-	-	-	-	-	-	-	-	-
	9. Ceramics and stone	-	-	-	-	-	-	-	-	-	-	-	-
	10. Other (soil, etc.)	-	-	-	-	-	-	-	-	-	-	-	-

Legend:

- |    |  |    |                                |
|----|--|----|--------------------------------|
| a. | Place outside for collection by CINTRI or other collectors               | f. | Burn on site                   |
| b. | Directly carry garbage to a waste collection vehicle                     | h. | Compost on site                |
| c. | Take the waste to waste collection point of CINTRI or other collectors   | j. | Autoclave disinfection on site |
| d. | CINTRI or other collectors collects from institution (including own bin) | l. | Other                          |
| e. | Bury on site   |    |                                |
| g. | Recycle  |    |                                |
| i. | Incinerate on site   |    |                                |
| k. | Open dumping outside property  |    |                                |

- In regard to the general waste collection by CINTRI or other collectors, how are they disposed of?

All medical institutions dispose of their general wastes at the Stung Meanchey dumping site via the CINTRI waste collection company.

Table 6-36: Final Disposal Method for General Waste

Waste Categories/Types		"General waste" Base: Population = 41					
		Main method for General waste					
		Fr.					
		a.	b.	c.	d.	e.	f.
General waste	1. Food/kitchen waste	41	-	-	-	-	-
	2. Paper	32	-	-	-	-	-
	3. Textile	9	-	-	-	-	-
	4. Grass and wood (Garden waste)	9	-	-	-	-	-
	5. Plastics	27	-	-	-	-	-
	6. Leather and rubber	1	-	-	-	-	-
	7. Metals	1	-	-	-	-	-
	8. Glass and bottle	8	-	-	-	-	-
	9. Ceramics and stone	-	-	-	-	-	-
	10. Other (soil, etc.)	-	-	-	-	-	-

Legend:

- |    |   |    |                               |
|----|---|----|-------------------------------|
| a. | Disposed of to the Stung Mean Chey landfill together with other waste | d. | Incinerated at an incinerator |
| b. | Buried in a special pit at the landfill                               | f. | Other                         |
| c. | Burned at the landfill  |    |                               |
| e. | Buried at the town/city crematorium                                   |    |                               |

**c. Financial Management (Medical and General waste)**

- Collection fee: Do you pay the CINTRI or a private collector an official waste collection fee?

All medical institutions pay fee for the collection of medical waste. The amounts to be paid by hospitals are higher than by the other three categories.

Table 6-37: Official waste collection fee

Base: Population = 41				
Category of The Institution	Fr.	Payment (US\$/month)		
		Average	Maximum	Minimum
1.Hospital	12	41	100	5
2.Poly-clinic	14	31	50	5
3.Clinic	9	9	20	5
4.Health center	6	12	20	5

- Collection fee: Have you ever given direct unofficial payment to waste collection workers for collection your waste?

7 poly-clinics answered that they unofficially paid to waste collection workers in the past. The average amount was US\$ 7/month, but they did not tell the reasons for the payment.

Table 6-38: Direct Unofficial payment to Waste Collection Worker

Base: Population = 41			
Category of The Institution	Fr.	Have you ever given a direct unofficial payment to waste collection workers for collection your waste?	
		Yes	No
1. Hospital	12	-	12
2. Poly-clinic	14	7	7
3. Clinic	9	-	9
4. Health center	6	-	6
5. Others	0	-	-
Grand Total	41	7	34
	%	17	83

Table 6-39: Total Amount of the Unofficial Payment

Base: Population = 7				
Category of The Institution	Fr.	Payment (US\$/month)		
		Average	Maximum	Minimum
1.Hospital	-	-	-	-
2.Poly-clinic	7	7	15	3
3.Clinic	-	-	-	-
4.Health center	-	-	-	-

- Are you satisfied with the existing waste collection and disposal service?

Most medical institutions are satisfied with the existing waste collection and disposal service. 10% are not satisfied because (i) the waste (medical and general) is not separated; and (ii) the collection fee is expensive.

Table 6-40: Satisfied with the Existing Waste Collection and Disposal Service

Base: Population = 41			
Category of The Institution	Fr.	Are you satisfied with the existing waste collection and disposal service?	
		Yes	No
1. Hospital	12	11	1
2. Poly-clinic	14	12	2
3. Clinic	9	8	1
4. Health center	6	6	-
5. Others	0	-	-
Grand Total	41	37	4
	%	90	10

Table 6-41: The Reasons for Unsatisfied Service

"No" Base: Population = 4			
		Category of The Institution	Why?
1.	Discharge system is poor (e.g. no bins, bins are broken or too small)	- Hospital - Poly-clinic	Not separate in the different bins
2.	Waste collection point is too far away		
3.	Waste collection/sweeping is not properly done		
4.	Waste collection service/sweeping is irregular		
5.	Waste collection/sweeping frequency is too low		
6.	Collection time is too early or too late		
7.	Waste collection workers behave badly	Poly-clinic	Do not keep the wastes
8.	Waste collection workers demand payment for waste collection		
9.	Waste collection fee of the CINTRI or a private collector is too high	Poly-clinic	The fee is expensive
10.	Lack of recycling		
11.	Problems with handling medical waste		
12.	Other	Clinic	High cost

- How many times have you complained about the waste collection service in the last year?

Six medical institutions (15% of total) have complained about the waste collection service before, but did not answered what was the complaint.

Table 6-42: Complained about the Waste Collection Service in the Last Year

Base: Population = 41					
Category of The Institution	Fr.	How many times have you complained about the waste collection service in the last year?			
		1. None	2. Once only	3. Several times	4. More than five times
1. Hospital	12	10	1	1	-
2. Poly-clinic	14	12	1	1	-
3. Clinic	9	8	1	-	-
4. Health center	6	5	1	-	-
Grand Total	41	35	4	2	-
	%	85	10	5	-

- Is any staff member of your institution responsible for ensuring that medical waste is collected and disposed of properly?

The staff members as shown in the table below are responsible for waste collection and disposal at the medical institutions.

Table 6-43: Staff of Waste Collection and Disposal in the Medical Institutions

"Yes" Base: Population = 41					
Category of The Institution	Fr.	Position			
		Chief of sanitary unit	Cleaner	Staff	Worker
1. Hospital	12	1	3	-	8
2. Poly-clinic	14	-	8	-	6
3. Clinic	9	-	5	1	3
4. Health center	6	-	2	-	4

## 6.2.4 Improvements to waste collection and disposal

### a. General

- What improvements would you like to see to waste collection and disposal?

All the medical institutions surveyed expect the improvement of waste collection and disposal. Specifically they are interested in (i) improved waste discharge system, (ii) improved collection and disposal of medical waste, (iii) education to change people's bad habits.

Table 6-44: Improvement of Waste Collection and Disposal

Base: Population = 41						
Answer		Fr.	Priority			
			first	second	third	
1.	Improved waste discharge system	36	17	15	4	
2.	Shorter distance to waste collection point	2	-	-	2	
3.	More reliable waste collection service	1	1	-	-	
4.	Improved collection frequency	10	1	9	-	
5.	Greater recycling of waste	4	1	2	1	
6.	Improved collection and disposal of medical waste	22	11	8	3	
7.	Improvement of landfill operation	5	3	1	1	
8.	Education to change people's bad habits	24	8	7	9	
9.	Other	2	2	-	-	
Grand Total		Nos	106	44	42	20

- Improved waste collection and disposal will cost additional money. Who do you think should pay these costs?

The medical institutions consider the organization to additionally pay for improvement as shown in the table below.

Table 6-45: Payer for Improved Waste Collection and Disposal

Base: 41					
Category of The Institution	Fr.	1. Central Government	2. Municipality of Phnom Penh	3. Individual medical institutions	4. Other
1. Hospital	29	10	9	8	2
2. Poly-clinic	41	11	11	11	8
3. Clinic	24	5	9	9	1
4. Health center	14	5	4	5	-
Grand Total	108	31	33	33	11

- Suppose that you are satisfied with the municipal solid waste management service, either as is or as a result of improvement. Think for a moment about the largest amount of money that your medical institution would be willing to pay each month as a garbage collection fee.

The medical institutions replied to this question by telling the same figures as they currently pay for the waste service. It is doubtful that they clearly understood the question. The result, however, may indicate their unwillingness to pay more than present.

Table 6-46: Willing to Pay Each Month as a Garbage Collection fee

Base: Population = 29				
Category of The Institution	Fr.	Garbage collection fee (US\$/month)		
		Average	Maximum	Minimum
1. Hospital	7	42	100	10
2. Poly-clinic	11	28	50	5
3. Clinic	7	10	20	5
4. Health center	4	14	20	5

- If the current waste collection fee is more than this amount, your medical institution will not be able to afford to pay and will not be able to use the waste

collection service. If you are still not willing to pay the current waste collection fee, explain why below:

The reasons expressed by 12 medical institutions are shown in the table below.

Table 6-47: The reasons

Base: Population = 12		
Nos. of Institution	Reasons	Fr.
1.Hospital	Depend on Government	1
	Depend Profit	2
	High cost	2
	No regular collection	1
2.Poly-clinic	Depend on profit	1
	High cost	1
3.Clinic	Depend on profit	2
	Little waste	1
4.Health center	Depend on Government	1

### 6.2.5 Training and Instructions

- Is there some written instruction to separate and manage medical wastes in the institution?

It was found that 26 medical institutions have instruction about the separation and management of medical waste.

Table 6-48: Instruction to Separate and Manage Medical Wastes

Base: Population = 41			
Category of The Institution	Fr.	Is there some written instruction to separate and manage medical solid wastes in the institution?	
		Yes	No
1. Hospital	12	10	2
2. Poly-clinic	14	6	8
3. Clinic	9	7	2
4. Health center	6	3	3
Grand Total	41	26	15
	%	63	37

- How often the waste management staff is trained as a caution against contaminated or hazardous waste?

The frequency of training varies among the medical institutions. It should be stressed that the medical institutions that gave training very often are only 11 (or 42%) among those having medical waste instruction.

Table 6-49: Frequency of Training

Base: Population = 26					
Category of The Institution	Fr.	How often the staff of waste management is trained as a caution against contaminated or hazardous waste?			
		1.Only at the start of the job	2.Once a year	3.Very often	4.Never
1. Hospital	10	6	2	6	2
2. Poly-clinic	6	5	-	3	-
3. Clinic	7	5	1	1	1
4. Health center	3	3	-	1	-
Grand Total	26	19	3	11	3
	%	73	12	42	12

## 6.2.6 Environmental education and general cleanliness

- Has anyone of this institution received any health and environmental education or information relating to solid waste?

33 (80%) of the medical institutions answered that someone of the institutions received health and environmental education. The most popular information source is school, followed by community organization/NGO, TV program, and leaflets/posters.

Table 6-50: Health and Environmental Education or Information

Base: Population = 41			
Category of The Institution	Fr.	Has anyone of this institution received any health and environmental education or information relating to solid waste?	
		Yes	No
1. Hospital	12	11	1
2. Poly-clinic	14	12	2
3. Clinic	9	7	2
4. Health center	6	3	3
Grand Total	41	33	8
	%	80	20

Table 6-51: Information Source

Base: Population = 33						
Information source	Fr.	Category of The Institution				Remark
		1. Hospital	2. Poly-clinic	3. Clinic	4. Health center	
1. School	20	6	5	6	3	-
2. Leaflets/posters, etc.	4	3	1	-	-	-
3. Medical worker/centre/hospital	1	1	-	-	-	-
4. Community organization/NGO	5	1	2	-	2	Name:
5. Newspaper	1	-	-	-	-	-
6. Radio program	0	-	-	-	-	-
7. TV program	6	2	2	1	1	-
8. MPP	2	8	-	-	-	-
9. CINTRI	0	-	-	-	-	-
10. Central government	23	9	12	2	-	- MoH and MoE
11. Other	8	1	2	2	3	Specify: Weekly meeting

- Do you think that a campaign to raise the awareness of people for maintaining a cleaner city and environment is necessary?

40(98%) of the medical institutions answered that a campaign for cleaner city and the environment is very necessary.

Table 6-52: Necessary of Campaign

Base: Population = 41				
Category of The Institution	Fr.	Do you think that a campaign to raise the awareness of people for maintaining a cleaner city and environment is necessary?		
		1. Very necessary	2. Somewhat necessary	3. Not very necessary
1. Hospital	12	12	-	-
2. Poly-clinic	14	14	-	-
3. Clinic	9	8	1	-
4. Health center	6	6	-	-
Grand Total	41	40	1	-
	%	98	2	-

## 6.2.7 Sewerage

- Where does the toilet waste from your institution go?

25(61%) of the medical institutions have septic tanks for toilet waste. One medical institution treats toilet waste with its wastewater treatment facility. The remaining institutions answered that they discharge their toilet waste to ponds, rivers, or sewerage.

Table 6-53: Toilet Waste from the Medical Institutions

Base: Population = 41							
Category of The Institution	Fr.	Where does the toilet waste from your institution go?					
		1. Into septic tank	2. Into pit	3. Into pond, river, canal directly	4. Into storm water drain or sewerage pipe directly	5. Into wastewater treatment plant of the institution	6. Don't know
1. Hospital	12	8	-	1	1	1	1
2. Poly-clinic	14	8	-	2	3	-	1
3. Clinic	9	4	-	2	3	-	-
4. Health center	6	5	-	1	-	-	-
Grand Total	41	25	-	6	7	1	2
	%	61		15	17	2	5

- Wastewater and/or sludge removed from your institution by vacuum truck?

22 medical institutions, or 88% of the medical institutions having septic tanks, answered that sludge in the septic tanks is occasionally removed.

Table 6-54: Removed Sludge to the Septic Tank

Base: Population = 25				
Category of The Institution	Fr.	Is wastewater and/or sludge removed from your institution by vacuum truck?		
		1. Yes	2. No	3. Don't know
1. Hospital	8	7	-	1
2. Poly-clinic	8	7	1	-
3. Clinic	4	3	1	-
4. Health center	5	5	-	-
Grand Total	25	22	2	1
	%	88	8	4

- How many cubic meters of your septic tank or pit?

The hospitals and poly-clinics have larger septic tanks than the clinics and health centers have.

Table 6-55: Volume of Septic tank

Base: Population =17				
Nos. of The Institution	Type (tank or pit)	Capacity of septic tank or pit (m3)		
		Average	Maximum	Minimum
1. Hospital	Tank	41	100	6
2. Poly-clinic	Tank	62	225	5
3. Clinic	Tank	13	15	12
4. Health center	Tank	15	20	9

- How often is septic tank or pit clean-up?

14(64%) medical institutions answered that their septic tanks or pits is cleaned more than once a year.

Table 6-56: Frequency of Clean-up of Septic tank

Base: Population = 22					
Category of The Institution	Fr.	How often is septic tank or pit clean-up?			
		1. Once a half year	2. Once a year	3. Less than once a year	4. Don't know
1. Hospital	7	4	2	1	0
2. Poly-clinic	7	-	2	-	5
3. Clinic	3	1	2	-	0
4. Health center	5	1	2	1	1
Grand Total	22	6	8	2	6
	%	27	37	9	27

- Who clean-up septic tanks or pits?

PPWM cleans the septic tanks of 17(77%) institutions, while private companies cleans the septic tanks of 5(23%) institutions.

Table 6-57: Clean-up Septic Tank or Pit

Base: Population = 22				
Category of The Institution	Fr.	Who clean-up septic tank or pit?		
		1. PPWM (Phnom Penh Waste Management)	2. Private company	3. Don't know
1. Hospital	7	5	2	-
2. Poly-clinic	7	6	1	-
3. Clinic	3	2	1	-
4. Health center	5	4	1	-
Grand Total	22	17	5	-
	%	77	23	-

## 6.2.8 Financial Matter

- How much do you pay for medical waste collection services per month?

No medical institutions know the cost of medical waste collection service.

Table 6-58: Cost of Medical Waste Collection Service

Q.48 Base: Population = 41			
Category of The Institution	Fr.	1. I know	2. I don't know
1. Hospital	12	-	12
2. Poly-clinic	14	-	14
3. Clinic	9	-	9
4. Health center	6	-	6
Grand Total	41	-	41

- How much do you pay for general waste collection services per month?

All the medical institutions answered to this question. The answers to this question and the last question suggest that there will be no independent fee system for the collection of medical waste.

Table 6-59: Cost of General Waste Collection Service

Base: Population = 41					
Category of The Institution		Fr.	Cost of General Waste Collection Service (US\$/month)		
			Average	Maximum	Minimum
Medical waste	1. Hospital	12	41	100	5
	2. Poly-clinic	14	14	50	5
	3. Clinic	9	9	20	5
	4. Health center	6	12	20	5
Total		41	27	-	-



- If the market price of waste collection rose, how much, at maximum, could you afford to pay per month?

All the medical institutions did not know the answer to this question.

Base: Population = 41			
Category of The Institution	Fr.	1. I know	2. I don't know
1. Hospital	12	-	12
2. Poly-clinic	14	-	14
3. Clinic	9	-	9
4. Health center	6	-	6
Grand Total	41	-	41

- Is there someone who comes around to collect or buy your reusable or recyclable materials?

17(41%) medical institutions positively answered. The materials collected for reuse or recycling are mainly bottles, glass and plastic, followed by kitchen waste, paper and cardboard.

Table 6-60: Collect or Buy of Reusable or Recyclable Materials

Base: Population = 41			
Category of The Institution	Fr.	Is there someone who comes around to collect or buy your reusable or recyclable materials?	
		Yes	No
1. Hospital	12	3	9
2. Poly-clinic	14	8	6
3. Clinic	9	3	6
4. Health center	6	3	3
Grand Total	41	17	24
	%	41	59

Table 6-61: Reusable or Recyclable Materials

Base: Population = 41						
Type of Material	Answer				Total	
	1. Hospital	2. Poly-clinic	3. Clinic	4. Health center	Nos.	%
1. Bottle	3	8	3	3	17	41
2. Glass	2	5			7	17
3. Cardboard	1	1		1	3	7
4. Paper	1	2		1	4	10
5. Aluminum can						
6. Steel can						
7. Metal						
8. Kitchen waste		3	1	1	5	12
9. Garden waste						
10. Plastic	2	7	3	2	14	34
11. Textile			1		1	2
12. Leathers						
13. Wood/timber						
14. Tire						
15. Others						

### 6.2.9 Cooperation for Waste Management

- Coping with wastes requires efforts of not only the municipality but also the general public. Do you think there is something which your institution can do for good waste management?

All medical institutions indicate a willingness to co-operate in order to improve the waste management.

Table 6-62: Willingness to Co-operate

Base: Population = 41					
Category of The Institution	Fr.	Do you think that a campaign to raise the awareness of people for maintaining a cleaner city and environment is necessary?			
		1. Very necessary	2. Somewhat necessary	3. Not very necessary	4. Not necessary at all
1. Hospital	12	12	-	-	-
2. Poly-clinic	14	14	-	-	-
3. Clinic	9	9	-	-	-
4. Health center	6	6	-	-	-
Grand Total	41	41	-	-	-
	%	100			

- What do you think your institution can do? (plural answer question)

35 medical institutions answered that they can cooperate by discharging waste neatly. Another 18 answered that they can contribute to providing information to the public. The other 7 answered that they can contribute to raising the environmental awareness of the public.

Table 6-63: Type of Co-operation

Base: Population = 41						
Type of Material	Category of The Institution				Total	
	1. Hospital	2. Poly-clinic	3. Clinic	4. Health center	Fr.	%
	1. Discharging wastes neatly.	11	9	9	6	35
2. Minimizing waste generation.	1	1	1	-	3	7
3. Reusing wastes.	5	5	3	2	15	37
4. Recycling wastes.	1	3	1	1	6	15
5. Treating toxic/infectious wastes appropriately.	-	-	-	-	-	-
6. Raising the environmental awareness of the public.	3	3	-	1	7	17
7. Providing information to the public.	8	6	1	3	18	44
8. Researching activities.	1	1	-	-	2	5

- Do you think the medical institutions should cooperate with the country and/or municipality in managing wastes?

Understanding and recognizing their obligation in public health and environmental protection with government responsible institutions, all medical institutions indicated that they are willing to co-operate with the country and/or municipality in managing wastes. In deed, medical institution owners/responsible persons usually cooperate and coordinate with concerned institutions if required.

Table 6-64: Willingness to Co-operate with the Country/Municipality

Base: Population = 41					
Category of The Institution	Fr.	Do you think the medical institutions should cooperate with the country and/or municipality in managing wastes?			
		1. Yes	2. No	3. I don't know	4. Others
1. Hospital	12	12	-	-	-
2. Poly-clinic	14	14	-	-	-
3. Clinic	9	9	-	-	-
4. Health center	6	6	-	-	-
Grand Total	41	41	-	-	-
	%	100	-	-	-

- How is the trend of your cost for waste management?

40(98%) medical institutions answered (i) it is getting significantly higher or (ii) it is getting higher.

Table 6-65: Trend for Waste Management

Base: Population = 41						
Category of The Institution	Fr.	How is the trend of your cost for waste management?				
		1. It is getting significantly higher.	2. It is getting higher.	3. It is relatively stable.	It is getting lower.	5. Others
1. Hospital	12	11	1	-	-	-
2. Poly-clinic	14	9	4	1	-	-
3. Clinic	9	7	2	-	-	-
4. Health center	6	5	1	-	-	-
Grand Total	41	32	8	1	-	-
	%	78	20	2	-	-

- How do you give the priority on the management of your wastes?

40(98%) medical institutions answered (i) We give very high priority.

Table 6-66: Priority on the Management

Base: Population = 41					
Category of The Institution	Fr.	How do you give the priority on the management of your wastes?			
		1. We give very high priority.	2. We give moderate priority.	3. We give little priority.	4. Others
1. Hospital	12	12	-	-	-
2. Poly-clinic	14	14	-	-	-
3. Clinic	9	9	-	-	-
4. Health center	6	5	1	-	-
Grand Total	41	40	1	-	-
	%	98	2	-	-

- Do you feel you need a support from the government or municipality or any other relevant organizations for the management of your waste? (plural answer question)

Based on interview, 34 medical institutions need technical support rather than financial support. There are 4 medical institutions do not need any supports from any kinds of institutions/organizations.

Table 6-67: Financial Support Need

Base: Population = 41					
Information source	Fr.	Category of The Institution			
		1. Hospital	2. Poly-clinic	3. Clinic	4. Health center
1. Yes, we need financial support.	20	10	4	2	4
2. Yes, we need technical support.	34	11	11	7	5
3. Yes, we need support of other kinds	5	1	2	1	1
4. No, we don't.	4	-	2	2	-
5. Others	3	1	1	-	1
Grand Total	66	23	20	12	11
	%	56	54	29	27

## 6.2.10 Others

- If there any additional comments you would like to make about solid waste management provision and your needs, please comment below:

Table 6-68: Additional Comments

Base: Population = 31		
Nos. of The Institution	Fr.	Additional comments
1.Hospital	8	Improved collection, public education, separate waste Need waste bin, regular collection Should have guidelines of waste management from MoE, MPP, CINTRI Should have good landfill Should be separated waste Regular collection Should be separated waste Improved waste management
2.Poly-clinic	13	Have landfill for medical waste Improved discharge and separate system, collection frequency Improved discharge and separate system Request to the company separate waste Need bin, and improved landfill Separated discharge Separated discharge Separated waste and waste management Discharge system Separate discharge Need technical system for medical waste Separate waste Separate waste
3.Clinic	6	Medical waste should be collected by other service Respond for medical waste collection service Need bin CINTRI must separate wastes Transport neatly and separate waste Should have landfill
4.Health Center	4	Should be cooperated with institutions Need bin; Regular collection MoE should disseminate environmental Management Training and material support, separate waste
Total	31	-

### 6.3 List of Medical Institutions Surveyed in Phnom Penh City

Category		Name of the medical institution	Number of beds	Bed occupation rate	No of Beds occupied	In-patients	Out-patients	full time	part-time
Hospital	1	National Maternal and Children Health	156	60.9%	95	30	90	444	0
	2	Preah Ang Doung	80	60.0%	48	20	100	113	0
	3	P.P Municipal Referral	150	22.7%	34	10	15	180	10
	4	Calmet	268	37.3%	100	200	130	389	114
	5	Preah Ketomealea	550	2.7%	15	5	290	494	0
	6	Preah Monivong	60	50.0%	30	30	50	389	14
	7	National Center for TB	120	79.2%	95	30	67	200	0
	8	Preah Kosamak	200	35.0%	70	78	120	363	0
	9	Preah Norodom Sihanouk	500	60.0%	300	350	300	533	52
	10	National Pediatric	114	99.1%	113	20	300	233	0
	11	Sihanouk (Center of Hope)	24	41.7%	10	24	5,500	247	0
	12	Kunthak Bopha	371	33.2%	123	80	1,000	207	0
Poly-Clinic	1	Bayon	25	16.0%	4	2	25	41	16
	2	Tong Sing	21	4.8%	1	1	5	9	0
	3	Chhun Ming	39	25.6%	10	4	20	34	0
	4	Mekong	32	37.5%	12	4	28	12	0
	5	Phsar Chas	24	4.2%	1	1	20	22	0
	6	Fara Amra	8	37.5%	3	1	5	6	5
	7	Long Hour	21	9.5%	2	1	4	32	0
	8	Aurore	26	26.9%	7	2	25	25	9

	9	Visal Sok	25	8.0%	2	2	27	54	0
	10	Chantrea	50	14.0%	7	3	55	17	26
	11	Bopha Phoung	8	12.5%	1	2	8	3	4
	12	Sok Kret	15	33.3%	5	3	5	6	14
	13	Phnom Penh Thmey	15	6.7%	1	1	10	13	0
	14	Sok San	20	40.0%	8	1	20	37	0
Clinic	1	Phnom Penh	13	7.7%	1	1	6	7	0
	2	Tito	4	25.0%	1	1	5	4	0
	3	Panya	18	11.1%	2	2	40	12	2
	4	Lux	10	80.0%	8	2	20	10	3
	5	Sok Hok	15	6.7%	1	1	15	8	2
	6	Phsar Depot	10	10.0%	1	1	2	5	0
	7	International SOS	15	46.7%	7	5	20	15	7
	8	Sorphea	10	10.0%	1	1	10	18	2
	9	Prum Vihear	5	20.0%	1	1	12	7	2
Health Center	1	Daun Penh	10	20.0%	2	2	20	13	0
	2	7 Makara	3	33.3%	1	1	9	40	0
	3	Rose Charities Cambodia	24	41.7%	10	5	30	30	7
	4	National Center Red Cross	13	76.9%	10	3	50	56	0
	5	Toul Kok	12	8.3%	1	1	30	45	0
	6	Meanchey	30	16.7%	5	5	50	20	3

## 6.4 Findings

Since Phnom Penh is the capital, it is the city of the highest population growth in the country. In parallel with population growth, the number of hospitals, polyclinics, clinics and health care centers has remarkably grown too, thus generating larger volume of medical waste than the other cities and provinces. According to the survey that we have conducted during May and June 2003 we get the result as the following.

### 6.4.1 Waste Generation

#### a. Waste Unit Generation Rate

##### a.1 Medical Waste

Medical waste generation rate in Phnom Penh was calculated for hospitals, polyclinics, clinics and health care centers. The rate can be given by dividing the waste amount (i) by the number of bed with taking account of bed occupancy or (ii) by the sum of medical staff (full time and part time), in-patients and out-patients.

As for either the generation rate per bed or the generation rate per person, the health centers have higher figures than the other categories.

As indicated in the table, the proportion of medical waste generation rate in Phnom Penh City is still lower if compared with the other countries in the world.

Table 6-69: Medical Waste Unit Generation Rate (Base: No of Beds)

Generation Source	Base of Calculation (bed)	Bed occupation rate	Generation of Medical Waste (kg/day)	Unit Generation Rate (kg/bed/day)
1. Hospital	2,593	39.8 %	269.97	0.262
2. Poly-clinic	329	19.5 %	20.04	0.312
3. Clinic	100	23.0 %	6.05	0.263
4. Health center	92	31.5 %	27.58	0.952
Total	3,114	36.9 %	323.64	0.282

Table 6-70: Medical Waste Unit Generation Rate (Base: No of Staffs + Patients)

Generation Source	Base of Calculation (person)	Generation of Medical Waste (kg/day)	Unit Generation Rate (kg/person/day)
1. Hospital	13,854	269.97	0.0195
2. Poly-clinic	734	20.04	0.0273
3. Clinic	272	6.05	0.0222
4. Health center	449	27.58	0.0614
Total	15,309	323.64	0.0211

Table 6-71: Medical Waste Generation in Other Cities Overseas

Country/City	Generation of General Waste (kg/bed/day)	Generation of Medical Waste (kg/bed/day)
Santiago	1.9187	0.6561
Chile	5.3235	1.6598
Latin America <sup>1)</sup>	3	0.60 (=20%)
Denmark	---	1.3
Mexico City	4.73 - 5.38	---
Netherlands	2.3 - 6.5	---
Portugal	---	---
Spain	4 - 4.5	0.4 - 0.5
United Kingdom	2.5 - 3.3	---
USA	4.1 - 5.24	---
Turkey (Adana) <sup>2)</sup>		0.77
Turkey (Mersin) <sup>2)</sup>		0.83

Note: 1) Average assumed generation for Latin America according to *Pan American Health Organization and World Health Organization (NK3)*.  
2) JICA study, 2000.

## a.2 General Waste

General waste generation rate from hospitals, polyclinics, clinics and healthcare centers in Phnom Penh City are shown in the following table below. As in the case of medical waste, generation unit of general waste was calculated in the two ways. The general waste generation rates of the hospitals and health centers are close and three to four times higher than those of the poly-clinics or clinics.

Table 6-72: General Waste Unit Generation Rate (Base: No of Beds)

Generation Source	Base of Calculation (bed)	Bed occupation rate	Generation of General Waste (kg/day)	Unit Generation Rate (kg/bed/day)
1. Hospital	2,593	39.8 %	5,339.9	5.174
2. Poly-clinic	329	19.5 %	68.0	1.060
3. Clinic	100	23.0 %	30.2	1.313
4. Health center	92	31.5 %	146.9	5.069
Total	3,114	36.9 %	5,585.0	4.861

Table 6-73: General Waste Unit Generation Rate (Base: No of Staffs + Patients)

Generation Source	Base of Calculation (person)	Generation of General Waste (kg/day)	Unit Generation Rate (kg/person/day)
1. Hospital	13,854	5,339.9	0.385
2. Poly-clinic	734	68.0	0.093
3. Clinic	272	30.2	0.111
4. Health center	449	146.9	0.327
Total	15,309	5,585.0	0.365

**b. Waste Generation Amount**

**b.1 Medical Waste**

The figure below shows the process of the estimation of medical waste generation amount from all the medical institutions in the city, with taking an example of the hospitals. The bold lines were the procedure originally intended by the team. The total waste amount could have been estimated in two ways: one using the unit generation rate per employee per day and the other using the unit generation rate per occupied bed per day both of which were calculated in the previous section.

These two ways, however, necessitate data of the number of employees (indicated in Box E in the figure) or the number of beds and bed occupancy rates (in Box F in the figure) of all the medical institutions in the city. Unfortunately, however, only the data of the number of hospitals, poly-clinics and clinics together with health centers were available as shown in KOKUSAI KOGYO CO., LTD..

Therefore, the team took the procedure indicated by the dotted lines. In this procedure,  $E=BH/A$  and  $F=CH/A$ , and the final output is simply given by  $DH/A$ . In other words, the estimation was based on the generation unit per institution.

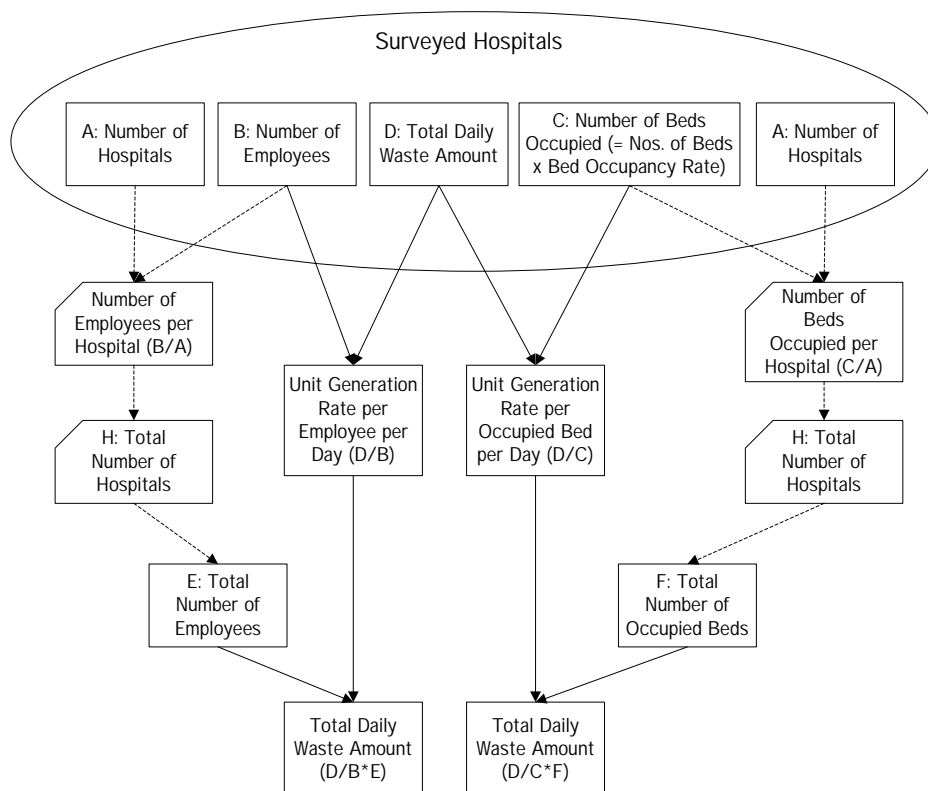


Figure 6-5: Waste Amount Estimation Process

The available information did not provide the number of clinics and the number of health centers individually, but the total number (822) of these two types of institutions. Since there are further more clinics than health centers in the city, the team assumed that six health centers that were surveyed were all the health centers existing in the city and all the rest (816) are clinics.

The estimated medical waste generation is shown in the table below. The medical waste amount from all the medical institutions in the city is calculated at about 1 ton per day.

This figure can be underestimation since the generation unit per institution for the clinics is very small while its number was assumed to be very large. Furthermore, using the generation unit per institution can provoke wrong estimation because it does not take the scale variation of institutions in to account. The team recommends the Cambodian side to gather information of medical institutions to allow more precise estimation.

Table 6-74: Medical institution of Whole Phnom Penh

Generation Source	Studied Medical Institution		Whole Phnom Penh	
	Nos. (A)	Total Daily Medical Waste Amount (D)	Nos. (H)	Grand Total of Daily Medical Waste Amount (DH/A), (kg/day)
1. Hospital	12	269.97	15	337.5
2. Poly-clinic	14	20.04	33	47.2
3. Clinic	9	6.05	816	548.5
4. Health center	6	27.58	6	27.6
Total	41	323.64	870	960.8

## b.2 General Waste

The table below shows the result of calculation of the general waste generation amount from all the medical institutions in the entire city. The method taken was same with that for the calculation of medical waste amount.

As shown in the table, the total general waste amount from all the medical institutions is about 9.7 tons. The hospitals are the major generation source, followed by the clinics, poly-clinics and health care centers.

The unit generation rate (D/H) for the clinics is, again, very small thus the result may be underestimation. More detailed information on medical institutions may give larger volume of total general waste amount.

Table 6-75: General Waste Generation Amount

Generation Source	Studied Medical Institution		Whole Phnom Penh	
	Nos. (A)	Total Daily General Waste Amount (D)	Nos. (H)	Grand Total of Daily General Waste Amount (DH/A), (kg/day)
1. Hospital	12	5,339.9	15	6,674.9
2. Poly-clinic	14	68.0	33	160.3
3. Clinic	9	30.2	816	2,738.1
4. Health center	6	146.9	6	146.9
Total	41	5,585.0	870	9,720.2

## c. Generation Forecast

The forecast generation amount of medical waste and general waste for 2008, 2012 and 2015 was estimated according to the population growth in Phnom Penh from 2003 to 2015, thus also calculated with the increase total number of beds proportional to the population increase. As shown in the following Table, the medical waste generation is estimated at 1,135 kg/day in 2008, 1,267 kg/day in 2012 and 1,364 kg/day in 2015.

Amount of the general waste, additionally, is also increase more than double from 9,719 kg/day in 2003 to 13,793 kg/day in the year of 2015. In this connection, if we compare the amount of medical waste and the amount of general waste generate in the medical institutions, the amount of general waste much more than the medical almost 10 times.



Table 6-76: Forecast Generation Amount

Year	Population forecast**	Medical Waste (kg/day)	General waste (kg/day)	Total (kg/day)
2003	1,199,414	961	9,720	10,681
2008	1,416,445	1,135	11,479	12,614
2012	1,581,432	1,267	12,816	14,083
2015	1,702,166	1,364	13,794	15,158

\* Based on data survey.

\*\* See Chapter 4.2.1 for population forecast.

## 6.4.2 Observations on Medical Waste Management

### a. Medical Waste

#### a.1 Storage

Medical waste management in big hospitals in Phnom Penh City are mostly good as they separate and store in different containers and bags; while most of the poly-clinics, clinics and health centers still mix medical waste and general waste because they do not know how to separate them. Their efforts of preventing the spread of toxic chemicals and pathogens are insufficient.

The hospitals and health centers generally have their own places for the storage of wastes while the polyclinics and clinics use medium containers for storage. The waste storage places are commonly opened and can be flooded during the rainy season. Transmission of disease can occur through injuries from contaminated water.

#### a.2 Incineration of Medical Waste

19 among 41 medical institutions surveyed treat some of the medical waste with the incinerators. The table below shows the proportion of incinerated medical waste to the total medical waste amount. As a result, medical waste amount incinerated by the 19 institutions accounted for 59% of the total generation (See Table 6-77).

Using this result, the team estimated that about 0.4ton out of 1ton of the total medical waste in the whole city is incinerated, taking account of the fact that most medical institutions having incinerators are the hospitals. Assuming the proportion of incineration residue to the original waste amount at 15%, the ash after incineration is about 0.06ton.

Table 6-77: Incineration Method of Medical waste

Waste Categories/Types		Incineration method		Other methods		Total generation	
		kg/day	% to total	kg/day	% to total	kg/day	%
Medical waste	Infectious waste	94.5	82	21.04	18	115.54	100
	Pathological waste	76.33	63	44.63	37	120.96	100
	Sharps	16.49	57	12.28	43	28.77	100
	Pharmaceutical waste	3	87	0.43	13	3.43	100
	Genotoxic waste	-	0	13.57	100	13.57	100
	Chemical waste	1	30	2.29	70	3.29	100
	Radioactive waste	-	0	38.08	100	38.08	100
Total		191.32	59	132.32	41	323.64	100

Problems of incineration are twofold. One is that not all sorts of waste which need special treatment do not undergo incineration, or any other comparative treatment measures. As a result, not small quantity of medial waste, which threatens the human health, is disposed of without due attention.

Secondly, existing incinerators are not well functioning. Their ability to make medical waste safe and stable is uncertain due to its too simple structure. The team found that the incinerators in the most hospitals and some health centre in Phnom Penh City are operated in the low temperature, probably causing uncompleted combustion and the release of dioxin into the atmosphere. Their performance should be carefully assessed and countermeasures should be examined.

### **a.3 Waste Discharge**

Most medical institutions in the Phnom Penh City separately store waste. Their waste, however, ends up mixed with general waste in many cases, either by waste collectors or by the staff of the medical institutions when discharged. It is finally disposed of at the municipal landfill, where a number of vulnerable waste pickers are working.

### **a.4 Collection**

Waste collection is normally done by the so-called CINTRI Company, to which collection work has been contracted out by the city. Their collection frequency at most of the surveyed institutions is as high as once per day. As medical waste contains materials which putrefy rapidly, such frequent collection service is important.

Some institutions transport medical wastes to an off-site treatment facility at Calmet Hospital and small amount of institutions transport to Wat Preah Put (local name of pagoda) for burning.

### **a.5 In-house Collection System**

In-house collection system is carried out daily normally by workers of the facilities themselves. Wastes at the point of origin are mostly contained in small plastic bins with different colors of plastic bags. The workers daily collect the primary bins or containers of medical waste, which is mixed with solid wastes from other rooms and buildings to store in medium containers or in the places within the premises of the facilities. Some of the primary bins or containers used for general and medical wastes have not been labeled and neither covered or locked. The collection system defers from one to another facility and in many cases, waste is stored in a central collection point.

### **b. General Waste**

The system of general waste collection within the hospitals, polyclinics, clinics, and health centers are the similar system with medical waste collection. As reported earlier, general waste is usually once stored separately from medical waste, but in many medical institutions they are mixed together when discharged.

Medical institutions in the whole city generate about 9,700 kg/day of general waste daily, almost all of which is collected and transported by CINTRI Company.

## **6.4.3 Financial Observation**

100% of the surveyed medical institutions in Phnom Penh City pay the collection fee for medical waste as well as general waste. Their payment ranges 5-100 USD for hospital, 5-50 USD for Polyclinic, 5-20 USD for Clinics and health centers.

There are 37 institutions that stated their satisfaction with the waste collection and disposal services. The reasons for dissatisfaction of the rest 4 medical institutions are that waste is not separated in the different bin, the collection workers are improperly keep all the waste into

the truck allowing the refuse to fall down on the street, and the fee of the collection and disposal are expensive. 6 medical institutions surveyed, including two hospitals, two polyclinics, one clinic and one health centre, have ever complained in the year 2002 about the waste collection procedure. Even though, they are still willing to pay the fee corresponding to appropriate collection, treatment and disposal of medical waste.

#### **6.4.4 Overall evaluation**

The team concludes that the management system of medical waste in Phnom Penh requires much improvement. The important issues revealed by the present survey are as below.

- The separation of medical waste is not adequate. Although it is often separated from general waste, they are finally disposed of together.
- One of the reasons for this is that both the staff of the medical institutions and the waste collection workers are not well recognizing risks possibly posed by medical waste.
- The second, and probably fundamental, reason is that there are no or only few facilities that can appropriately treat medical waste in the city. This will makes the medical staff and the collection workers reluctant to strictly separate medical waste.

A leadership of the responsible authorities including Ministry of Health and MPP in the development of medical waste management system, and particularly in awareness raising of health risks on people, should be urgently strengthened.

# Annex 7

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*Factory Survey*

## Annex 7 Factory Survey

### 7.1 Method of the Survey

#### 7.1.1 Preparation of the Survey

##### a. Classification of IW

In this factory survey, IW was divided into two, one being non-hazardous and the other being hazardous. Non-hazardous industrial waste (non-HIW) and hazardous Industrial waste (HIW) are further divided into groups as shown in the two tables below.

Table 7-1: Non-Hazardous Industrial Waste (Non-HIW)

Type of Non-Hazardous industrial waste	Non-HIW Code
Waste generated from non-production sources (general industrial waste)	GIW
Waste from animal such as bone, skin, hair	NH01
Wood	NH02
Paper	NH03
Plastic or polymers and resins	NH04
Textile and fiber	NH05
Grease, animal oil, vegetable oil	NH06
Natural rubbers	NH07
Metals and metal alloys such as aluminum, copper, bronze	NH08
Ceramic & Glasses	NH09
Stone, ash/dust from coal-fired power plants, sand or material that have composition of soil such as tile, brick, gypsum, cement	NH10
Mixed waste	NH11
Others	NH12

Table 7-2: Hazardous Industrial Waste (HIW)

Type of Hazardous industrial waste	HIW Code	Example of Hazardous industrial waste
Inorganic acid	HW01	Sulfuric acid (H <sub>2</sub> SO <sub>4</sub> ), Hydrochloric acid (HCl), Nitric acid (HNO <sub>3</sub> ), Phosphoric acid (H <sub>3</sub> PO <sub>4</sub> ), Other inorganic acids
Organic acid	HW02	Acetic acid (CH <sub>3</sub> COOH), Formic acid (HCOOH), Other organic acids
Alkalis	HW03	Caustic soda (NaOH), Ammonia (NH <sub>3</sub> ), Sodium carbonate (Na <sub>2</sub> CO <sub>3</sub> ), Other alkaline materials
Toxic-Metal Compounds	HW04	Salts (Hg, As, Cd, Pb, Cr, etc)
Inorganic Compounds	HW05	Plating wastes, Cyanides, Picking waste, Sulphide, etc.
Other Inorganic	HW06	Asbestos, Slug, etc.
Organic Compounds	HW07	Reactive chemical wastes (Oxidizing agents, Reducing agents, etc), Solvents etc.
Polymeric Materials	HW08	Epoxy resin, Chelate resin, Polyurethan resin, Latex rubber etc.
Fuel, Oil and Grease	HW09	Fats, Waxes, Kerosene, Lubricating oil, Engine oil, Grease etc
Fine Chemicals and Biocides	HW10	Pesticides, Medicine, Cosmetic, Drugs, etc.
Treatment Sludge and contaminated rubbish	HW11	Inorganic sludge, Organic sludge etc.
Ash including from incinerator	HW12	---
Dust and APC products	HW13	Soot and dust waste from incineration facilities, treating exhaust gas
Other Hazardous substance (besides HW01-HW13)	HW14	HIWs other than the above

## b. Preparation of Survey Sheet

The survey should clarify current generation, reuse/recycling and treatment/disposal. The contents of the questionnaire of the survey are listed in the table below.

Table 7-3: Main Contents of the Factory Survey

Subject	Content
1.General information	(1) Name of company
	(2) Type of Industry and Factory code
	(3) Factory registration No.
	(4) Share capital
	(5) Number of employees
	(6) Working period
	(7) Production flow chart
	(8) Major products
2.IW management	(1) Waste generation
	(2) Storage, Intermediate treatment and recycling
	(3) Collection, Off-site treatment and reuse/recycling and disposal
	(4) Future management of IW
	(5) Financial matter
	(6) Evaluation of the present IW system

## c. List of Factory

Ministry of Industry (MOI), Mines and Energy publicized the factory list in Cambodia in 2002. The team referred to this list in choosing the factories subject to this factory survey.

The table below shows the number of factories of each industrial sector in Phnom Pech, together with the number of factory category code that was used in the study.

As the table indicates, 80.5% of the factories in the city in terms of the number, or 97.0% in terms of the number of employees, are engaged in the sector related to textile and wearing apparel. Therefore the present survey also mainly covered textile and apparel factories.

Table 7-4: Classification of Factory (Phnom Penh City)

Classification of Factory			No of factories	No of Employee
M1	M2	Factory survey category code		
I	A: Food Factories	G01	7	449
	B: Beverages Factories		7	686
	C: Tobacco Factories		7	1,305
II	A. Textile, Wearing Apparel & Leather Industries	G02	23	30,687
	B : Wearing Apparel		148	112,673
	C : Hats-Caps- Bags- Gloves Factories		5	2,484
	D : Jeans and Washing Factories		11	10,650
	E : Shoes and Shoe Parts Factories		14	11,735
	F: Leather Factories		1	53
III	Manufacture of Wood Products, Including Furniture	G07	3	145
IV	Manufacture of Paper Product, Printing & Publishing	G08	2	112
V	Manufacture of Chemicals & of Chemical Petroleum, Coal, Rubber & Plastic Products	G04	10	1,354
VI	Manufacture of non Metallic mineral Products, Except Product of Petroleum & Coal	G05	4	344
VII	Fabricated Metal Products	G06	9	761
-	Others	G09	-	-
Grand Total			251	173,438

## 7.1.2 Method of the Survey

The methodology for preparation of the factory survey is as following:

- The selection of samples taking account of the type of factory and the number of employees.
- Distribution of the questionnaire to the factories to be interviewed and appointment making for interviewing.
- Interviewing with owner or representative of the factories.
- Analyzing the survey results.

The number of factories surveyed of each industrial sector is shown in the table below. The team tried to cover factories with large number of employees, but not all the factories that the team planned to visit did not accept the survey due to the nature of this kind of survey. Nevertheless, the survey was considered to reflect the present state of factories as the distribution of the factories surveyed well resembled the actual distribution of the factories in the city.

The study covered 13% of the factories in the city, which have 35% of factory employees.

Table 7-5: Factories Selected for Factory Survey

Category Code	Whole Phnom Penh city				Factories Surveyed			
	No of Factories		No of Employees		No of Factories		No of Employees	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
G01	21	8.3%	2,440	1.4%	4	12.5%	1,268	2%
G02	23	9.1%	30,687	17.7%	4	12.5%	16,249	27%
G03	179	71.0%	137,595	79.3%	22	68.8%	43,068	71%
G07	3	1.2%	145	0.1%	-	0.0%	-	0%
G08	2	0.8%	112	0.1%	1	3.1%	92	0%
G04	10	4.0%	1,354	0.8%	-	0.0%	-	0%
G05	4	1.6%	344	0.2%	-	0.0%	-	0%
G06	9	3.6%	761	0.4%	-	0.0%	-	0%
G09	1	0.4%	30	0.0%	1	3.1%	30	0%
Total	252	100.0%	173,468	100.0%	32	100.0%	60,707	100%

## 7.2 Results of the Survey

### 7.2.1 Industrial Waste (IW) Management

#### a. Waste Generation

**Q1.** Are Non-Hazardous Industrial Waste (Non-HIW) and Hazardous Industrial Waste (HIW) discharged separately from your factory?

Following table shows that the 65 % of factory separate the discharge of Non-HIW and HIW 100%, 16 % of factory separates the discharge of Non-Hazardous Industrial Waste and Hazardous Industrial Waste partly and 19 % of factory puts the Non-HIW and HIW together.

Table 7-6: Separation of Non-HIW and HW

Base: Population = 32		Answer	%
1.Yes, 100%	(Go to Q.3)	21	65
2.Yes, partly	(Go to Q.3)	5	16
3.No	(Go to Q.2)	6	19
Total		32	100

**Q2.** What is the reason why these waste are not separated? You can select all that correspond to your factory.

From the result of the survey is shown that 6 (19%) factories didn't separates the discharge of (Non-HIW) and (HIW) in they factories, due to the volume of waste is too small to separate and HIW waste is not generated in they factories.

Table 7-7: Reason of No Separation (Non-HIW and HIW)

Base: Population = 6		Answer	%
1.We don't know the difference between Non-HIW and HIW.		0	0
2.The volume of waste is too small to separate.		6	100
3.The production process makes it difficult to separate Non-HIW and HIW.		0	0
4.The collection service does not require to separate Non-HIW and HIW.		0	0
5.It is troublesome and waste of time to separate Non-HIW and HIW.		0	0
6.It seems unnecessary to separate Non-HIW and HIW		0	0
7.It is difficult to separate Non-HIW and HIW.		0	0
8.Even though Non-HIW and HIW are separated, there are no ways to utilize them		0	0
9.HW is not generated in our factory.		3	50
10.Others		0	0
Total		9	-

**Q3.** Is Non-HIW generated at the production process separated from general industrial waste (GIW) generated at other sections such as office in your factory?

Following table shows that the 59 % of factory separate the discharge of Non-HIW and GIW 100%, 16 % of factory separates the discharge of Non-HIW and GIW partly and 25 % of factory puts the Non-HIW and GIW together.

Base: Population = 32		Answer	%
1.Yes, 100%	(Go to Q.5)	19	59
2.Yes, partly	(Go to Q.5)	5	16
3.No	(Go to Q.4)	8	25
Total		32	100

**Q4.** What is the reason why your factory does not separate them?

From the result of survey we can see that 8 (25%) factory does not separate the Non-HIW and GIW due to the volume of wastes is too small to separate, the collection service does not require separating them and it seems unnecessary to separate them.



Table 7-8: Reason of No Separation (Non-HIW and GIW)

Base: Population = 8		Answer	%
1. The volume of wastes is too small to separate.		8	100
2. The production process makes it difficult to separate them.		0	0
3. The collection service does not require to separate them.		1	13
4. It is troublesome and waste of time to separate them.		0	0
5. It seems unnecessary to separate them.		1	13
6. It is difficult to separate them.		0	0
7. Even though Non-HIW and HIW are separated, there are no ways to utilize them.		0	0
8. Others		0	0
Total		10	-

**Q5.** How many tons of IW (Non-HIW/HIW) is generated in your factory per year?

The table below shows waste generation amount of each industrial sector and each waste category. It was found that the factories surveyed generate about 6,840 tons of waste in total in a year. There is, however, only factory which answered that it generates HW. It is difficult to interpret the discrepancy between the answers to this question and to Q1. The team presumes the unclear definition of HIW and non-HIW.

Table 7-9: IW generation Amount

Base: Population = 32				
Category Code	IW code	Name of IW/ Generation Source	Fr.	Waste amount (ton/year)
G01	GIW	Food mix office waste	1	0.4
		Office & Foot	1	252
		Office and food waste	2	7.3
	NH02	Container	1	6
		Fish sauce tank	1	125
	NH03	No answer	1	2.4
	NH04	Container	1	3.6
	NH09	Bottles waste	2	7
		Production	1	39
	NH12	Alcohol waste	1	5
Water treatment		1	108	
G02	GIW	Office and food waste	1	1.8
		Sewing Shoes Office and food waste	1	626
	NH01	Shoe processing	1	125
G03	GIW	Office and food waste	10	27.9
		Office and Sewing and food waste	1	63
		Office and Sewing waste	5	548
	NH05	Sewing	15	4,681
		Sewing knitting	1	30
	NH11	Cutting food	1	12.5
		Mix waste	1	2.5
Office		1	1	
G08	GIW	Office & Foot	1	0.73
		Cutting	1	6.26
	NH03	Cutting	1	6.26
G09	GIW	Office and food waste	1	1.8
	NH02	Packing	1	6
	NH03	PMD	1	5
	NH04	SMD	1	33
	NH12	PMD SMD	1	81
	HW09	Generator	1	7
	HW14	PMD SMD	1	23
Grand Total			63	6,843.29

Note: PMD: Premiere production process  
SMD: Secondary production process

**b. Storage**

**Q6. Is IW stored inside your factory?**

From the result of survey we can see that 18 factories stored the IW inside their factories and another 14 factories stored the IW outside their factories.

Table 7-10: Storage of IW inside Factories

Base: Population = 32		Answer	%
1. Yes, 100%	(Go to Q.7)	18	56
2. No	(Go to Q.10)	14	44
Total		32	100

**Q7. How do you store IW?**

In amount 18 factories that stored the IW inside their factories, have 10 factories were stored the IW mixed all together inside their factories before its collection by haulers. And another 7 factories were stored the IW separately into two categories, first category is waste from operation process and second category is waste from office and food inside their factory, before its collection by haulers. The last one factory (category: G01) was stored only waste that, can be reused inside it factory.

Table 7-11: Storage manner

Base: Population = 18		Answer	%
1. We mix them all together.	(Go to Q.9)	10	55
2. We store them separately.		7	39
3. We store only waste that can be reused/recycled.		1	6
Total		18	100

**Q8. Into how many categories is IW classified in your factory?**

Table 7-12: Category of IW stored

Base: Population = 8	Answer	%	Description
1. One category	0	0	-
2. Two categories	6	75	Fish waste and bottle waste
			Non-Hazardous industrial waste and Hazardous industrial waste
			Office waste and mixed waste
			Sewing waste and office, food wastes
			Wood waste and food waste
3. More than two	2	25	Bottle waste, alcohol waste and mixed waste
			Bottle waste, can waste, wood, sugar sack, cardboard and general waste
Total	8	100	-

**Q9. What is the purpose of on-site storage of IW?**

The purpose for 16 factories (89%) was temporary storage before collection. There is one factory that store waste prior to intermediate treatment, by which waste is dried to be used as fuel.

Table 7-13: Purpose of On-site Storage

Base: Population = 18		Answer	%
1. Temporary storage before its collection by haulers.		16	89
2. Temporary storage for on-site reuse and recycling.		1	6
3. Temporary storage for on-site treatment and disposal.		1	6
4. Temporary storage due to no existence of proper treaters.		0	0
5. Others		0	6
Total		18	-

**c. Intermediate Treatment and Recycling**

**Q10. Is IW treated on-site in your factory?**

From the result of survey, we can see that most of factories do not treat the IW in their factories, except one factory (G01). It dries the office and food wastes in site it factory for using as source of energy (It burns the drying waste in the incinerator to get the energy).

Table 7-14: IW treated On-site

Base: Population = 32		Answer	%
1. Yes		1	3
2. No, all the IW are treated off site.		31	97
Total		32	100

**Q11. Is IW reused or recycled inside your factory?**

Most of the factories do not have plan to reuse/recycle IW generated in they factories and only two factories (G01 and G09) plan to recycle/reuse IW in they factories. The G01 factory had planed to recycle of office and general wastes inside factory by drying wastes and put its in incinerator and the G09 factory had planed to reuse the cardboard for store tobacco.

Table 7-15: IW Reuse or Recycling

Base: Population = 32		Answer	%
1. Yes		2	6
2. No, all the IW are treated off site.		30	94
Total		32	100

**Q12. Is there any plan to reuse/recycle IW generated in your factory?**

Table 7-16: Plan to Reuse/Recycle IW

Base: Population = 32		Answer	%
1. Yes, 100%	(Go to Q.15)	2	6
2. No	(Go to Q.16)	26	81
3. I don't know	(Go to Q.16)	4	13
Total		32	100

Table 7-17: Specify Plan to Reuse/Recycle IW

Base: Population = 2		
Code	Specify	Fr.
G01	To use the office waste and food waste by burn its in incinerator for getting energy	1
G09	Reused the cardboard box for stored the tobacco leaf	1
Grand Total		2

**d. Collection**

**Q13.** Who collects wastes generated in your factory?

- CINTRI were collected wastes generated in 6 factories
- CINTRI and Sarom Trading were collected wastes generated in 6 of factories
- Sarom Trading were collected wastes generated in 18 factories and
- Two factories ( both G01 category) have not collection service.

Related to the collection frequency, it vary from 1 time/day to 1 time/15 day

Table 7-18: Collection service

Base: Population = 32	Answer	%
1.CINTRI	6	19
2.CINTRI and Sarom Trading	6	19
3. PPWM	0	0
4.Others Private company (Sarom Trading company)	18	56
5. No collection service	2	6
Total	32	100

**e. Off-site Treatment and Reuse/Recycling and Disposal**

**Q14.** Do you know how IW discharged from your factory are treated/disposed of outside the factory?

Most of the representatives of factory do not know how IW discharged from their factory is treated/disposed of outside the factory. There is two factory (G08 and G09) know that, private subcontractor transports the IW discharged from his factory to the final disposal at municipal landfill.

Table 7-19: IW Treated/Disposal of Outside

Base: Population = 32	Answer	%
1.I know	2	6
2. I don't know (Go to Q.19)	30	94
Total	32	100

**7.2.2 Future Management of IW**

**Q15.** How will the generation of IW develop in your factory?

Following table shows that 66% of factory will not increase so much of IW volume., 19% of factory will increase the IW volume due to the expansion of production, change of raw materials, etc. On the other hand 9% of factory will decrease the volume of IW due to improvement of manufacturing process, change of raw material, etc. and 6.6% of factory will increase or decrease the volume of IW due to the quantity of production or according to the operation time.

Table 7-20: Future Trend of IW Amount

Base: Population = 32	Answer	%
1. The volume of IW will not increase so much.	21	66
2. The volume will increase due to the expansion of production, change of raw materials, etc.	6	19
3.The volume will decrease due to improvement of manufacturing process, change of raw materials, etc..	3	9
4.Others	2	6
Total	32	100

**Q16. Are there any future plans to reduce and recycle IW in your factory?**

Following table shows that 30 factories no plans to reduce and recycle the IW in its factory, its will apply the present management. One factory (G03) will intend to improve the present waste reduction and recycling system by decreasing of waste. Another one factory (G09), it will have a specific plan to improve waste reduction and recycling system in it factory by reducing tobacco dust from improvement of machinery equipment.

Table 7-21: Future Plan to Reduce and Recycle IW

Base: Population = 32	Answer	%
1. No, basically we will apply the present management.	30	94
2. Yes, we intend to improve the present waste reduction and recycling system.	1	3
3. Yes, we have a specific plan to improve waste reduction and recycling system in our factory.	1	3
Total	32	100

**Q17. Are there any future plans to improve treatment and final disposal system of IW in your factory?**

Following table shows those 31 factories no any plans to improve the treatment and final disposal system of IW in its factory, so it's basically will apply the present management. Only one factory (G09) have a future plan for improvement of final disposal system of IW in it factory by building a incinerator plans, which capacity 45-60 kg/hour.

Table 7-22: Future Plan to Improve Treatment and Final Disposal System

Base: Population = 32	Answer	%
1. No, basically we will apply the present management.	31	97
2. Yes, we intend to improve present treatment and disposal system of our company.	0	0
3. Yes, we have a specific plan to improve treatment and disposal system in our factory.	1	3
Total	32	100

**Q18. How will a possible future rise in disposal cost of IW affect your factory?**

- 38% of factories are not significant of the present costs of waste disposal and an possible increase in disposal costs in future will have little impact on its business.
- 22.3% of factories are significant of the present costs of waste disposal and a substantial rise in disposal costs in the future will affect the price of its products
- 9% of factories are very significant of the present costs of waste disposal and a substantial rise in disposal costs in the future will threaten its business.
- 25% of factories are no matter how expensive the disposal cost is, an improved waste management is necessary to obtain environmental image of products, and
- 6% of factories will collect the waste by it-self if the costs of waste disposal will increase in the future.

Table 7-23: Disposal Cost of IW

Base: Population = 32	Answer	%
1. The present costs of waste disposal are not significant and an increase in disposal costs will have little impact on our business.	12	38
2. The present costs of waste disposal are significant and a substantial rise in disposal costs will affect the price of our products.	7	22
3. The present costs of waste disposal are very significant and a substantial rise in disposal costs will threaten our business.	3	9
4. No matter how expensive the disposal cost is, an improved waste management is necessary to obtain environmental image of products.	8	25
5. Others	2	6
Total	32	100

### 7.2.3 Financial Matter

**Q19.** How much is the rate of waste management cost (total cost of on-site and off-site disposal) in the production cost?

All interviewees don't know the rate of waste management cost in the production cost.

Table 7-24: Waste Management Cost

Base: Population = 32	Answer	%
1.I know	0	0
2.I don't know	32	100
Total	32	100

**Q20.** How much do you spend for off-site disposal (collection, treatment and final disposal) of IW to the collection company per year?

The amount of money that factories spend to the Collection Company per year for off-site disposal can see in following table.

Table 7-25: Off-Site Disposal Cost

Base: Population = 32	Answer	%
1.I know	28	88
2.I don't know	4	12
Total	32	100

"I know " Base: Population = 28				
Category	Fr.	Cost (US\$/year)		
		Average	Maximum	Minimum
G01	2	1,140	1,200	1,080
G02	2	1,620	1,800	1,440
G03	21	2,033	3,600	840
G08	1	360	360	360
G09	2	2,600	4,600	600
Grand Total	28	1,921	-	-

**Q21.** Do you know the cost of off-site disposal of each IW?

All interviewees don't know the cost of off-site disposal of each IW.

Table 7-26: The Cost of Off-Site Disposal Of Each IW

Base: Population = 32	Answer	%
1. Yes	0	0
2. No	32	100
Total	32	100

**Q22.** Are you willing to pay more for the off-site disposal (collection, treatment and final disposal) of IW, if the quality of collection service is improved?

22% of factories have willing to pay more for the off-site disposal of IW, if the quality of collection service is improved, on the other hand 78% of factory don't want to pay more.

Table 7-27: Willing to Pay for Off-Site Disposal

Base: Population = 32	Answer	%
1. Yes	7	22
2. No.	25	78
Total	32	100

**Q23.** How much does your factory spend annually for the on-site disposal (treatment and final disposal) of IW?

All interviewees don't know how much the factory spends annually for the on-site disposal of IW.

Table 7-28: On-site Disposal Cost

Base: Population = 32	Answer	%
1. I know	0	0
2. I don't know	32	100
Total	32	100

**Q24.** Do you know the cost of on-site disposal (treatment and final disposal) of each IW?

Most of factories do not know the cost of on-site disposal of each IW. One factory (G08) positively answered, but it did not answer the unit cost.

Base: Population = 32	Answer	%
1. I know	1	3
2. I don't know	31	97
Total	32	100

#### 7.2.4 Evaluation of the Present IW System

**Q25.** Which of the following phrases best describes the present status of IWM in your factory?

53% of factories have no problem with the present IWM and another 47% of factory have some problems with present IWM.

Table 7-29: Present Status

Base: Population = 32	Answer	%
1. There are no problems with the present IWM. (Go to the end)	17	53
2. There are some problems with present IWM.	15	47
Total	32	100

**Q26.** Do you think what are the problems of present IWM in your factory? (You may choose more than one answer given below)

15 factories answered as below.

Table 7-30: Problems of Present IWM

Base: Population= 15	Answer	%
1. We do not know the difference between hazardous and non-hazardous waste.	7	22
2. We do not segregate hazardous from non-hazardous waste.	2	6
3. There is no or only limited services available for industrial waste treatment.	5	16
4. High cost of industrial waste treatment	3	11
5. Reuse and recycling of industrial waste is non-existent or limited.	11	34
6. Others (-Collection waste service not irregularity, and -We don't generated the Hazardous industrial waste)	2	6
Total	30	---

**Q27.** Do you think what measures and actions need to be taken to solve the above problems? (You may choose more than one answer given below)

The answers were raised in both “hard” aspects such as the development of final disposal facilities and reuse/recycling market and “soft” aspects such as the development of IWM guidelines and relevant laws.

Table 7-31: Measures and Actions

Base: Population = 15	Answer	%
1. Formulation and enforcement of relevant laws and regulations.	9	28
2. Guidance on proper IWM to the factories (generators).	10	31
3. Introduction of financial and economic incentives to promote proper IWM.	5	16
4. Preparation of the guidelines for proper IWM	11	34
5. Development of the waste reuse and recycle market	5	16
6. Development of the intermediate treatment facilities for industrial waste.	1	3
7. Development of the final disposal facilities for industrial waste.	9	28
8. Others	3	28
Total	53	---

“ Others” Base: Population = 5		
Code	Fr.	Specify
G03	1	Collection waste on time and reasonable price
	1	Improvement collection waste service and providing the recycling box
	1	improvement of collection service and collection waste vehicles
	2	Improvement of collection waste vehicles



## 7.3 Findings of the Survey

### 7.3.1 Current Industrial Waste Management (IWM)

#### a. Waste Separation

The factories that separate non-HW and HW either thoroughly or partly accounted for 81%, hence the separation of non-HW and HW seemed to be general practice.

In reality, however, when asked the generation amount of each type of waste, all factories but one answered only the generation amount of non-HW: there was only one factory that answered the generation amount of hazardous waste.

It is anticipated that this happened because the definition of HW and non-HW is not clear, and/or it is not well known to the factories.

#### b. Storage, Intermediate Treatment and Reuse/Recycling

18 out of 32 factories (56%) store waste within the factories. The reason of waste storage for all but one factory was temporary storage before collection. The rest stores waste prior to intermediate treatment, which dries waste to be used as fuel.

To the question about the future plans for reuse/recycling, most of factories (30 out of 32) answered that they do not have any such plans.

Therefore, it is considered that it is not popular for the factories to reuse/recycle or treat waste on-site, and they are not well motivated to do so.

#### c. Collection, Off-site Treatment and Reuse/Recycling, Disposal

It is interesting to know that as many as 24 factories receive collection service of Sarom Trading, that is the company to collect, transport and treat HW. It can be presumed that the factories using Sarom Trading generate HW. It is to be noted that the factories using CINTRI not necessarily generate only non-HIW, and there is possibility for HIW and general waste to be mixed and collected together. In fact, there was a factory that answered that it generates HW but also said that it discharges its waste to CINTRI.

Most factories do not know about off-site treatment or reuse/recycling of waste. A lack of interest of the factories in the fate of waste that they generate is a problem. The factories should know how non-HW and HW are differentiated, and how each of them should be collected, transported, treated and disposed of.

### 7.3.2 Future Management of IW

To the question about future IW generation, 27 factories answered that it will increase more or less, and 30 factories replied they will not change their IWM, indicating that there is no future plan for waste reduction. It is anticipated that many factories do not have future vision of waste management.

### 7.3.3 Financial Matter

The replies about off-site disposal cost were obtained from 28 factories out of 32. The cost per unit waste weight is shown in the table below.

Data used for the calculation are total waste generation amount of the factory and off-site disposal cost regardless of the types of waste. As the table shows, average unit cost varies from sector to sector: it ranges from 8.2 US\$/ton for G02 (textile and apparel) to 96.6 US\$/ton for G01 (food, beverage and tobacco). It was also found that unit cost varies from factory to factory within the same industrial sector.

Table 7-32: Off-site Disposal Unit Cost

Category	Answer	Off-site Disposal Unit Cost (US\$/ton)		
		Average	Maximum	Minimum
G01	2	96.6	190.5	2.6
G02	2	8.2	14.2	2.3
G03	21	93.6	372.4	0.4
G08	1	51.5	51.5	51.5
G09	2	53.9	76.9	30.9
Total	28	83.4	-	-

### 7.3.4 Evaluation of the Present IW system

About half of the factories surveyed (47%) told that the present IWM has problems.

One of the major problems they have is “We do not know the difference between hazardous and non-hazardous waste” (7 factories). This conforms to the problem of the lack of clear definition of non-HW and HW, as the team pointed out earlier.

Another major problem expressed by the factories was “Reuse and recycling of industrial waste is non-existent or limited” (11 factories). Although there were only a few factories that have future reuse or recycling plans, it seems that some factories have noticed the necessity to change the present waste management by reuse/recycling.

To solve these problems, the factories require the development of hardware such as final disposal site or reuse/recycling market, and software such as guidelines and laws of IWM.

### 7.3.5 Waste Generation

#### a. Waste Unit Generation Rate

Unit generation rate of waste from factories of each industrial sector was calculated. Unit generation rate is in this case expressed by generation per employee.

It was found that waste unit generation rate varies according to the industrial sector.

Table 7-33: Waste Unit Generation Rate

Factory Code	Generation Amount (ton/day)	No of Employees	Unit Generation Rate (kg/employee/day)
G01	1.522	391	3.893
G02	2.062	5,043	0.409
G03	14.716	58,016	0.254
G08	0.019	56	0.339
G09	0.429	504	0.851
Total	18.748	64,010	0.293

## b. Waste Generation Amount

The team estimated the IW generation amount from all the factories in the entire city as shown in the table below. For the waste generation unit of the industrial sectors which were not covered by the present factory survey, the average of unit generation rates of the industrial sectors covered by the present survey was substituted. The unit generation rate of G09 (others) obtained from the present survey was applied to G09.

As a result, total IW amount from factories of the whole city was calculated at about 58 tons. Its major sources were textile factories (35 tons/day) and leather factories (13 tons/day), accounting for 82% together.

Table 7-34: Generation Amount of IW

Type of Factory	Factories in Phnom Penh city	No of Employees	Unit Generation Rate (kg/employee/day)	Generation Amount (kg/day)
	No	persons		
G01	21	2,440	3.893	9,499
G02	23	30,687	0.409	12,551
G03	179	137,595	0.254	34,949
G04	10	1,354	0.293	397
G05	4	344	0.293	101
G06	9	761	0.293	223
G07	3	145	0.293	42
G08	2	112	0.339	38
G09	1	504	0.851	429
Total	252	173,942	---	58,229

### 7.3.6 Waste Flow

In order to understand the waste flow, the team estimated the recycling, treatment and disposal amount of waste from 32 factories.

From the survey results, on-site recycling is merely 0.1%, and the rest of waste is discharged outside. CINTRI and Sarom Trading equally share waste collection service. Assuming that waste collected by CINTRI goes to the municipal landfill, 50% of waste from factories is disposed of with general waste. Whether or not this practice must be stopped immediately should be carefully considered since not all the waste from factories is hazardous. More detailed survey should be carried out and measures should be taken if necessary, to prevent HIW from being mixed with GIW.

Sarom Trading, which is known as a HW treatment company, collects the other half of waste from the factories. The study, however, did not make it clear whether all of what they receive is hazardous. There is no sufficient information to evaluate the waste management activity of this company.

Table 7-35: Recycling Amount and Collection Amount at 32 factories

Factory Code	Recycling Amount (kg/day)	Collection Amount (kg/day)				Total
		1 CINTRI	2 CINTRI /Sarom	3 Sarom	4 Others	
G01	0.021	0.017		1.127	0.357	1.522
G02				2.062		2.062
G03		8.964	0.657	5.095		14.716
G08		0.019				0.019
G09			0.429			0.429
Total	0.021	9	1.086	8.284	0.357	18.748
	0.1%	48.0%	5.8%	44.2%	1.9%	100.0%

The team developed the waste from as below. It is to be noted that the present survey did not give data on the reuse/recycle or intermediate treatment of waste after discharged from factories. Therefore, the waste flow does not express the whole waste flow of IW.

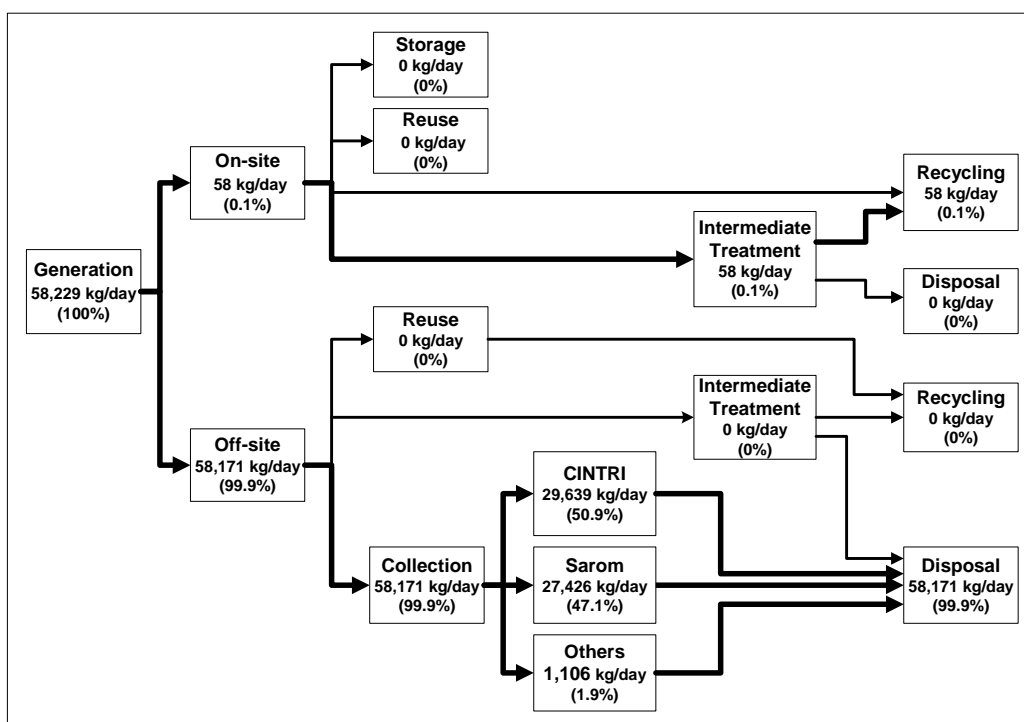


Figure 7-1: Waste Flow of IW (Whole Phnom Penh)

# Annex 8

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## *Recycling Survey*

## Annex 8 Recycling Market Survey

### 8.1 Method of the Survey

#### 8.1.1 Method of the Survey

The recycling market survey was implemented through four steps as below.

- The samples were randomly selected from a list of companies taken from the Small Industry and Handicraft Office of Department of Industry, Mines and Energy, which is responsible for giving a license to recycling companies, and Department of Commerce of Phnom Penh city, which is responsible for giving a license to waste depots.
- A questionnaire was distributed to companies to be interviewed and appointment for interviewing was made.
- The owners or representatives of the waste recycling companies were interviewed.
- The survey results were analyzed.

#### 8.1.2 Surveyed companies

- 20 private recycling companies, located in different districts of Municipality of Phnom Penh, were surveyed.
- The 20 companies cover paper recycling, glass recycling, plastic recycling, aluminium recycling, steel recycling, composting and waste depot companies. Their distribution is shown in the following table.

Table 8-1: Recycle Markets Surveyed

Name of Recycle Market	Nos. of Whole Phnom Penh city <sup>*1</sup>	Nos. of Surveyed	
		Fr.	Survey Coverage
Paper	5	1	20%
Cardboard	3	2	67%
Glass	3	1	33%
Plastic	20	4	20%
Metal	Steel	6	3
	Aluminum	11	2
	Copper	1	0
Compost	2	2	100%
Itinerant	5	5	100%
Total	56	20	36%

\*1 :Source: "The Small Industry and Handicraft Office of Department of Industry Mines and Energy" and "Department of Commerce of Municipality Phnom Penh"

### 8.2 Results of the Survey

#### 8.2.1 Overview of Your Company

- Category of your company

The 20 private companies were interviewed cover as the following category:

1. 25% were the waste depots;
2. 35% were the final users (factories);
3. 5% were the Final users (other than factories) and
4. 35% were the Others (handicrafts).

Table 8-2: Category of your Company

Base: Population = 20		Answer	%
1. Waste buyer (without stock yard)		0	0
2. Waste depot (with stock yard)		5	25
3. Final user (factory)		6	35
4. Final user (other than factory like livestock farm, fire woods user, etc.)		2	5
5. Others (Specify: Handicraft)		7	35
Grand Total		20	100

- What is work shift of your company?

Answer: 13 recycling companies are 8 hours of work shifts and other 3 companies are 16 hours.

Table 8-3: Work Shift

Base: Population = 20		Answer	%
1. Basically 8 hours		13	65
2. Basically 16 hours		3	15
3. Basically 24 hours continuously		0	0
4. Others (Specify: No answer)		4	20
Grand Total		20	100

- Do you have a licence or permit of operation?

Most of the recycling companies have a license from Department of Industry Mines and Energy, except one iron foundry Company. And all waste depots have a license from department of Commerce of municipality of Phnom Penh.

Table 8-4: Licence or Permit of Operation

Base: Population = 20		Answer	%
1. Yes.		19	95
2. No. <sup>1</sup>		1	5
3. Don't need.		0	0
Grand Total		20	100

<sup>1</sup>: Steel recycling handicraft

### 8.2.2 Reuse/Recycle/Recover

- Which of the following types of waste do you recycle? (tick please) And how many kilograms of this/these recyclable waste(s) are treated in your company per day?

The table below shows the amount of each waste type treated by the 20 recycling companies. The total amount is about 24.3 tons/day.

Table 8-5: Amount of Reuse/Recycle/Recover Materials

Base: Population = 20						
Waste Type			Waste Type Code	Answer		Quantity (kg/day)
				Fr.	%	
1. Paper waste	1	office paper	RW01-1	3	15	1,060
	2	cardboard	RW01-2	6	30	8,950

	3	paper other than the above	RW01-3	-	-	-
2. Plastics	1	PET bottles	RW02-1	3	15	120
	2	plastics other than the above	RW02-2	9	45	1,342
3. Textile (cloth, thread and fabric etc.)			RW03	-	-	-
4. Grease, animal oil, vegetable oil			RW04	-	-	-
5. Rubber	1	natural	RW05-1	-	-	-
	2	synthesis	RW05-2	-	-	-
6. Metal	1	aluminum (cans, etc.)	RW06-1	9	45	465
	2	ferrous/ferric compounds	RW06-2	8	40	4,075
	3	metal other than the above	RW06-3	3	15	58
7. Glass	1	bottles	RW07-1	5	25	1,991
	2	glass other than the above	RW07-2	1	5	1,500
8. Construction waste	1	brick	RW08-1	-	-	-
	2	construction waste other than the above	RW08-2	-	-	-
9. Food waste			RW09	1	5	705
10. Parts of plants, woods			RW10	-	-	-
11. Others (cell of sugar cane, vegetable waste) (specify: _____)			RW11	1	5	4,000
Grand Total				-	-	24,266

- Whom (suppliers) do your company purchase from? (tick one or more)

20 recycling companies purchase materials mainly from waste pickers, waste buyers, and waste depots.

Table 8-6: Supplier of Reuse/Recycle/Recover Materials

Base: Population = 20		Answer	%
1. Waste picker		8	40
2. Waste buyer (without stock yard)		8	40
3. Waste depot (with stock yard)		9	45
4. Household and commercial enterprises like shops, restaurants, etc.		1	5
5. Factories		3	15
6. Others		4	20
Grand Total		33	---

- What are the names of major suppliers? Please fill the names in following tables.

20 recycling companies were asked the name of suppliers of each waste type. 69% of them answered, but the rest did not. The team, however, will not disclose the names of the suppliers in this report.

Table 8-7: Name of Major Supplier

Waste Code	Base: Population = 20		
	Answer		
	Answer of Specific name	Don't know	Total
RW01-1	4	1	5
RW01-2	8	1	9
RW02-1	5	2	7
RW02-2	7	3	10
RW06-1	13	4	17
RW06-2	9	5	14
RW06-3	1	2	3
RW07-1	2	3	5
RW07-2	2	0	2
RW09	0	1	1
RW11	0	1	1
Grand Total	51	23	74
	69%	31%	100%



- How much does your company pay to them (suppliers)?

18 recycling companies answered the purchase price of each waste type as shown in the table below. The other two recycling companies acquire waste that is rich in organic matter free of charge.

Table 8-8: Pay Price of Reuse/Recycle/Recover Materials

Base: Population = 18 <sup>1</sup>				
Waste Type Code	Pay Price ( Riel/kg)			
	Fr.	Average	Maximum	Minimum
RW01-1	3	167	250	100
RW01-2	4	206	275	100
RW02-2	9	1,169	3,000	200
RW06-1	8	3,213	4,000	2,000
RW06-2	8	274	520	100
RW06-3	1	350	350	350
RW07-1	5	56	70	50
RW07-2	1	50	50	50
RW09	1	2,000	2,000	2,000

\*1: Without 2 compost recyclers which do not pay for material.

- Whom (customers) do you sell them to?

20 recycling companies sell domestic final users or waste buyers/depots/final users in foreign country, but 90% answered “others” that include “local market” and “by purchase order”.

Table 8-9: Customers of Reuse/Recycle/Recover Materials

Base: Population = 20		Answer	%
1. Waste buyer		0	0
2. Waste depot		0	0
3. Final user (factory)		5	25
4. Final user (other than factory like livestock farm, fire woods user, etc.)		1	5
5. Waste buyer/depot and final user in foreign country		6	30
6. Others		18	90
Grand Total		30	---

Others Base: Population = 18		
Category	Q.8-6 Specify	Fr.
All	Recycling handicraft	1
	Sauce fish and alcohol handicrafts	1
	Sauce fish and soy sauce handicrafts	1
	Sauce fish handicraft	1
	Sauce fish, soy sauce handicrafts	1
Compost	Farmers	1
	NGO buy for distribution to farmers	1
Glass	Sauce fish, soy sauce and alcohol handicrafts	1
Metal	Fence's maker handicraft, Lathe's shop	1
	Local market	3
	Purchase order	1
Paper	Local market and printing shop	1
Plastic	Local market	2
	Local market, fish sauce handicrafts	1
	Plastic handicrafts	1
Grand Total		18

- What are the names of the customers? Please fill the name in following tables.

20 recycling companies were asked about the names of their customers of each waste type. 78% gave answers, but the rest did not. The team will not disclose the names of customers in this report.

Table 8-10: Name of Customer

Base: Population = 20			
Waste Code	Answer		
	Answer of Specific name	Don't know	Total
RW01-1	4	0	4
RW01-2	6	3	9
RW02-1	2	1 (1 Viet Nam)	3
RW02-2	13	7 (1 Viet Nam)	20
RW06-1	13	3	16
RW06-2	10	4	14
RW06-3	1	0	1
RW07-1	7	0	7
RW09	2	0	2
RW11	6	0	6
Grand Total	64	18	82
	78%	22%	100%

- How much do you sell to them (customers)?

The selling prices of each waste type as answered by 20 recycling companies are shown in the table below.

Table 8-11: Sell Price of Reuse/Recycle/Recover Materials

Base: Population = 20				
Waste Type Code	Sell Price ( Riel/kg)			
	Fr.	Average	Maximum	Minimum
RW01-1	3	267	440	140
RW01-2	6	347	1,000	140
RW02-1	3	387	420	340
RW02-2	9	1,820	6,000	240
RW06-1	9	4,762	11,000	2,040
RW06-2	8	648	2,000	120
RW06-3	2	2,340	4,400	280
RW07-1	6	280	420	200
RW09	1	400	400	400
RW11	2	300	400	200

### 8.2.3 Treatment/Disposal

- Are recyclable waste treated on-site in your company?

33% of the recycling companies treat waste in some way including sorting, but 67% do not. It is, however, common that waste needs sorting after delivered to recycling companies. Therefore the team assumes that some kind of treatment should be given by any recycling companies.

Table 8-12: Treatment Matter of Reuse/Recycle/Recover Materials

Base: Population = 20				
Waste Code	Main Method	Description		k. No Treat
RW01-1	f, h, j	Shorting out the tailband part of book and sticking plastic after that put it into chesting machine and at some chemical	1	2
RW01-2	e, f, h	Hauling the recyclable cardboard material put into the chesting machine for chesting, after that sorting and chemical treatment.	1	4
		Put the recyclable cardboard material in the chesting machine, sorting all plastic material and put some chemical agent for chemical treatment.	1	
RW02-1	---	---	0	3
RW02-2	b, e, f, j	First sorting the recyclable plastic material, chesting, washing after that drying and melting	1	6
		Sorting, crushing and melting the recyclable plastic material, then filter sand and paper slag	1	
		Melting the recyclable plastic material and filter sand and mud	1	
RW06-1	e, j	Crushing the recyclable material into the small pieces, after that hauling it into the iron foundry	1	5
		Sorting the recyclable aluminum material after that put it in the aluminum foundry	1	
		Melting the recyclable aluminum material in the aluminum foundry	1	
RW06-2	e, j	Crushing the recyclable material into the small pieces, after that hauling it into the iron foundry	1	5
		Crushing the recyclable steel material in to small pieces and hauling the recyclable steel material to the iron foundry. Melting it.	1	
		Crushing the recyclable steel material in to small pieces and put it into steel foundry for melting.	1	
RW06-3	---	---	0	3
RW07-1	---	---	0	5
RW07-2	j	Screening the recyclable waste for take out soil, sand and very small size of glass, after that washing the recyclable material before put it in the glass foundry	1	--
RW09	e, f	Sorting by hand (selected only organic material) after that crushing it into small pieces)	1	--
RW11	e, f	Sorting the recyclable organic material, if it have a big size, it must be crushing into small pieces	1	--
		Sorting the recyclable organic material, if it have a big size, it must be crushing into small pieces	1	--
Grand Total	---	---	16	33
			33%	67%

Legend

- |  |                  |                         |
|--|------------------|-------------------------|
| a. Dewatering                                  | d. Incineration  | h. Chemical treatment   |
| b. Drying                                      | e. Crushing      | i. Biological treatment |
| c. Volume reduction<br>(Baling, Pressing etc.) | f. Sorting       | j. Others               |
|  | g. Reutilization | k. Not treat            |

• Your Treatment Equipment

15 recycling companies have treatment equipment as in the list below.

Information of Your Treatment equipment Base: Population = 15					
Category	Waste Code	Treatment equipment	Capacity	Memo	Fr.
Compost	RW09	Crushing machine	705 kg/20 min.	-	1
	RW11	Man power	2.8 tons/day	-	1
Glass	RW07-2	Glass foundry	1.5 tons/day	-	1
Metal	RW06-1	Aluminum foundry	1.5 tons/day	-	1
			500 kg/day	-	1
	RW06-2	Iron foundry	1 ton/day	-	1
			Steel foundry	1.5 tons/day	-
RW08-1	Aluminum foundry	3 tons/day	-	1	
Paper	RW01-1	Baling machine	200 kg/3hours	-	1
	RW01-2	Bailing machine	2.5 tons/day	Bought from Viet Nam	1
			6 tons/day	Bought from Viet Nam	1
Plastic	RW02-2	Baling and melting	1 ton/day	Bought from Viet Nam	1
			150 kg/day	Bought from Viet Nam	1
	RW08-2	Melting machine	33 kg/day	Bought from Viet Nam	1
			400 kg/day	Bought from Viet Nam	1

- Do you generate waste (including residue) from your business activity?

Among the 20 recycling companies, only 13 companies generate waste from their business activity and all the waste is sent to dump at the Stuen Mean Chey dumpsite by CINTRI. Other 7 companies that do not generate waste from their activities are mainly the waste depots.

Table 8-13: Waste Generation from Recycling Company

Base: Population = 20	Answer	%
1. Yes.	13	65
2. No.	7	35

- What are the treatment/disposal method, destination and amount of above waste?

13 recycling companies have known that how their waste is treated and disposed of. 12 out of 13 respondents answered yearly waste generation amount as shown in the table below. According to their answers, the compost companies generate large volume of waste.

With the supplemental study on the composting facilities, the team considers that the composting companies are functioning as a sort of transfer station. Therefore, the team assumes that the amount of waste replied by the composting companies is not waste from the compost production process, but waste rejected from compost production.

Table 8-14: Amount of Waste at Recycling Companies

Base: Population = 13		
Category	Amount (ton/year)	Fr.
Compost	312.0	1
	5,932.8	1
Glass	21.9	1
Metal	2.0	1
	5.1	1
	6.0	1
	36.5	1
	0	1
Paper	1.0	1
	36.0	1
	91.0	1
Plastic	1.0	1
	3.6	1
Grand Total	6,448.9	12

#### 8.2.4 Pollution Control & Monitoring

- Do you have the pollution control measures(PCM)?

Most of the recycling companies don't have the pollution control measures (PCM), except one company (Compost recycling company). It cleans the operation area every day after it finished the work to eliminate bad smell.

Table 8-15: Pollution control Measures (PCM)

Base: Population = 20	Answer	%
1. Yes.	1	5
2. No.	19	95

Base: Population = 1	Answer	%
1. Water treatment facility	0	0
2. Air pollution control facility	0	0
3. Noise/Vibration pollution control facility	0	0
4. Odor pollution control facility	0	0
5 Others (Specify : Cleanup - Compost)	1	100

- Do you take the environmental monitoring?

Most of the recycling companies don't take the environmental monitoring, except three companies. A cardboard recycling company carries out environmental monitoring on wastewater pollution by renting the pumping sewage tank truck to pump wastewater from its operation area every month and another company was carries out environmental monitoring on noise pollution.

Table 8-16: Environmental Monitoring

Base: Population = 20	Answer	%
1. Yes.	3	15
2. No.	17	85

Base: Population = 3	Answer	%
1. Waste water	1	5
2. Air emission	0	0
3. Groundwater	0	0
4. Noise/Vibration	1	5
5. Others	1	5

## 8.2.5 Management

- Do you have operation manuals or technical guidelines of operation?

14 recycling companies do not have operation manuals or technical guidelines of operation and remaining companies have manuals and guidelines on safety procedure, data keeping and reporting, receiving procedure of the waste etc.

Table 8-17: Operation Manual or Technical Guideline

Base: Population = 20	Answer	%
1. Yes.	6	30
2. No.	14	70

Base: Population = 6	
Category	Description
Compost	1. Receiving procedure of the wastes
	2. Operation criteria
	3. Safety procedure
	4. Data keeping and Reporting
	5. Sampling and analysis procedure
Compost	1. Safety procedure
	2. Data keeping and Reporting
	3. Training program
	4. Sampling and analysis procedure
Glass	1. Self-inspection procedure
Metal	1. Safety procedure
Paper	1. Receiving procedure of the wastes
Plastic	1. Safety procedure

## 8.2.6 Others

- Which of the following phrases best describes the present status of IWM in your company?

In regard to the present status of IWM in they companies, most companies do not know problems or do not have problems with the present their business, except one cardboard recycling company, which has some problems on IWM such as the high price of waste collection and irregularity of waste collection by waste collection company.

Table 8-18: Present Status of IWM

Base: Population = 20		Answer	%
1. There are no problems with the present your business.		19	95
2. There are some problems with present your business.		1	5
Grand Total		20	100

Base: Population = 1		
Category	Problems	Comments, Opinions, etc.
Paper	The price of solid waste collection is very high	Request to CINTRI company to reduce the price of waste collection
	Not good service from solid waste collection company (CINTRI)	and Regularly come to collect the waste

- If you have opinions and/or comments regarding governmental support for your business, please write down in the table below.

Opinions or comments about governmental support given by the 20 recycling companies are listed in the table below.

Their opinions or comments are related to three aspects including high utility prices, the needs for market development, and the necessity to control overseas trade. All the opinions or comments seem to derive from the financial difficulty that the recycling companies have been encountering.

Table 8-19: Opinions and/or Comments

Base: Population = 20		
Category	Opinions/Comments	Fr.
All	Need money for increasing capital	1
	No opinions	4
Compost	Extension the farmers about the importance of compost and how to use the compost	1
	Request to the government to encourage the local producer, helping to extent the knowledge of compost to the farmers.	1
Glass	Helping to reduce the price of electricity and diesel oil and don't allow to export the bottle from Viet Nam	1
Metal	Don't allow to export the ferrous compounds to foreign country	1
	Don't allow to import all kind of goods, that can produce in country	1
	Encourage the local producer, who use raw material from recycling waste, by helping to reduce the price of electricity and diesel oil	1
	Request to the government to reduce the import recycling things without paying customs duties	1
	The government should reduced import goods and encourage the local producers as discount the price of electricity	1
Paper	Help to construct the drainage system around the factory, and don't allow to export kind of waste material, that can recycle in country	1
	Need technical support for improvement quality of paper, encourage the waste recycling handicraft, reducing the electricity price.	1

	Request to the government to encourage the local producers and don't be oppressive	1
Plastic	Control all kind of imported good from foreign country, especially the government should should increase the tax all kind of goods, that can produced in country. Help to reduce the price of electricity and waste collection price of CINTRI company	1
	Electricity price is very high, and there are a lot of plastic recycling equipments, imported from abroad, so the local production is difficult to find the markets	1
	Request to the government to discount the price of electricity	1
	Request to the government to help to discount the electricity price and waste collection price	1
	Grand Total	20

- Is there any association or union of recycling industry in this country?

All the 20 recycling companies replied that there is no association or union of recycling industry.

Table 8-20: Association or Union of Recycling Industry

Base: Population = 20	Answer	%
1. Yes.	0	0
2. No.	20	100

## 8.3 Findings of the Survey

### 8.3.1 Amount of Materials for Recycling

From the present survey, the team obtained average amount of each sort of recycled material for each recycling industry per day (e.g. average amount of paper recycled by a paper recycling company per day, or average amount of PET bottles recycled by an itinerant per day, etc.). These figures are multiplied by the total number of companies of each recycling industry in order to estimate total amount of materials for recycling.

The table below shows the total amount of each recycling material calculated in the aforementioned manner. It was found that the major recycling materials are paper and metal, accounting for 40.3% and 20.9%, respectively. This is rather natural since these materials can be easily recycled and their recycling is profitable.

Table 8-21: Amount of Reuse/Recycle/Recovered Materials of each Type of Waste

Type of Waste		Amount of Materials	
		kg/day	%
RW01-1	Office paper	5,060	11.2%
RW01-2	Cardboard	13,200	29.2%
RW02-1	Pet bottle	520	1.2%
RW02-2	Plastics	5,755	12.7%
RW06-1	Aluminum	1,905	4.2%
RW06-2	Ferrous/Ferric	7,317	16.2%
RW06-3	Others	217	0.5%
RW07-1	Glass bottle	1,991	4.4%
RW07-2	Glass others	4,500	10.0%
RW09	Food waste	705	1.6%
RW11	Others	4,000	8.8%
Grand Total		45,170	100.0%

The present survey did not involve companies that recycle textile, auto parts, oil, or other material that can be easily recycled. Since the team has observed recycling activities of these kinds of waste in the city, there should be recycling systems that

were not covered by the present survey. It is recommended to carry out another recycling market survey similar to the present one but in a larger scale to attain a more comprehensive picture of the recycling market.

### 8.3.2 Treatment/Disposal

In this survey, what the recycling companies do was almost limited to simple treatment works including sorting and crushing.

It was found that there are small factories (to be called handicraft workshop) that process waste such as paper, plastic and metal. As for PET bottles and other kinds of plastics, there was an example of exporting those wastes to Vietnam. This fact implies that there may not be large-scale recycling facilities to receive them in Cambodia.



Steel waste for recycling at steel recycling handicraft workshop



Screening activity at glass recycling handicraft workshop



Recycling Company of Paper



Recycling Company of Iron-Steel

### 8.3.3 Pollution Control and Monitoring

19 recycling companies out of 20 did not carry out pollution control or monitoring. Since most of the surveyed companies only sort or crush waste, it may be not highly necessary to seriously consider the environmental influences. Crushing, however, can require measures to prevent the spread of particles. Moreover, other waste recycling methods, which are associated with pollution risks, may be introduced in Phnom Penh in near future. It is recommended to gradually diffuse the necessity to control and monitor pollution to the recycling factories and encourage them to take some anti-pollution measures.



## 8.4 List of Recycling Market Surveyed in Phnom Penh City

No	Type of company	Category	Business (type of Wastes)
1	Plastic recycling Handicraft	Others (Handicraft)	RW2-2
2	Steel recycling Handicraft	Others (Handicraft)	RW6-2
3	Buying & Selling Waste	Waste Depot	RW01-2, RW02-1, RW02-2, RW06-1, RW06-2, RW07-1
4	Glass recycling factory	Final user	RW07-1
5	Plastic recycling handicraft	Others (Handicraft)	RW02-2
6	Aluminum recycling factory	Final user	RW06-1
7	Cardboard recycling factory	Final user	RW01-2
8	Steel recycling handicraft	Others (Handicraft)	RW06-1, RW06-2
9	Buying & Selling Waste	Waste Depot	RW01-1, RW01-2, RW02-2, RW06-1, RW06-2, RW06-3, RW07-1
10	Buying & Selling Waste	Waste Depot	RW01-1, RW01-2, RW02-1, RW02-2, RW06-1, RW06-2, RW07-1
11	Compost	Final user	RW09
12	Paper recycling Handicraft	Others (Handicraft)	RW01-1
13	Aluminum recycling factory	Final user	RW06-1
14	Buying & Selling Waste	Waste Depot	Rw02-2, RW06-1, RW06-2, RW06-3, RW07-1
15	Plastic recycling Handicraft	Others (Handicraft)	RW02-2
16	Compost	Final user	RW11
17	Buying & Selling Waste	Waste Depot	RW01-2, RW02-2, Rw06-1, RW06-2, RW06-3, RW07-1
18	Steel recycling factory	Final user	RW06-1, RW06-2
19	Recycling plastic handicraft	Others (Handicraft)	RW02-1, RW02-2
20	Cardboard recycling factory	Final user	RW01-2

# Annex 9

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*Water Quality Survey*

## Annex 9 Water Quality Survey

### 9.1 Objectives

The purpose of this work is to obtain data on the water quality of

- Leachate
- Rivers
- Groundwater

around SMCDS

#### 9.1.1 Samples and Sampling Points

There were ten samples in total. The sample number and sampling points and shown below.

Table 9-1: Sampling points and location in dry season

No.	Sample No.	Sampling point & Location	Water Sources
1	LE1	Leachate south-west of SMC disposal site	WW
2	LE2	Leachate north of SMC disposal site	WW
3	LE3	Leachate north-east of SMC disposal site	WW
4	MW1	Existing well at the Health Care Center	GW
5	MW2	Existing well north-east of SMC disposal site	GW
6	MW3	Existing well east of SMC disposal site	GW
7	DR1	Canal east of SMC disposal site	WW+SW
8	DR2	A pond east of waste pile	WW+SW
9	NR1	Prek Thnot River 200m upstream of Prek Chrey Pagoda	SW
10	NR2	Irrigation canal at Choeung Ek Commune	SW

**Note:** WW: Wastewater; GW: Groundwater; SW: Surface water



Figure 9-1: Location of Sampling Point for LE, MW and DR in Dry Season

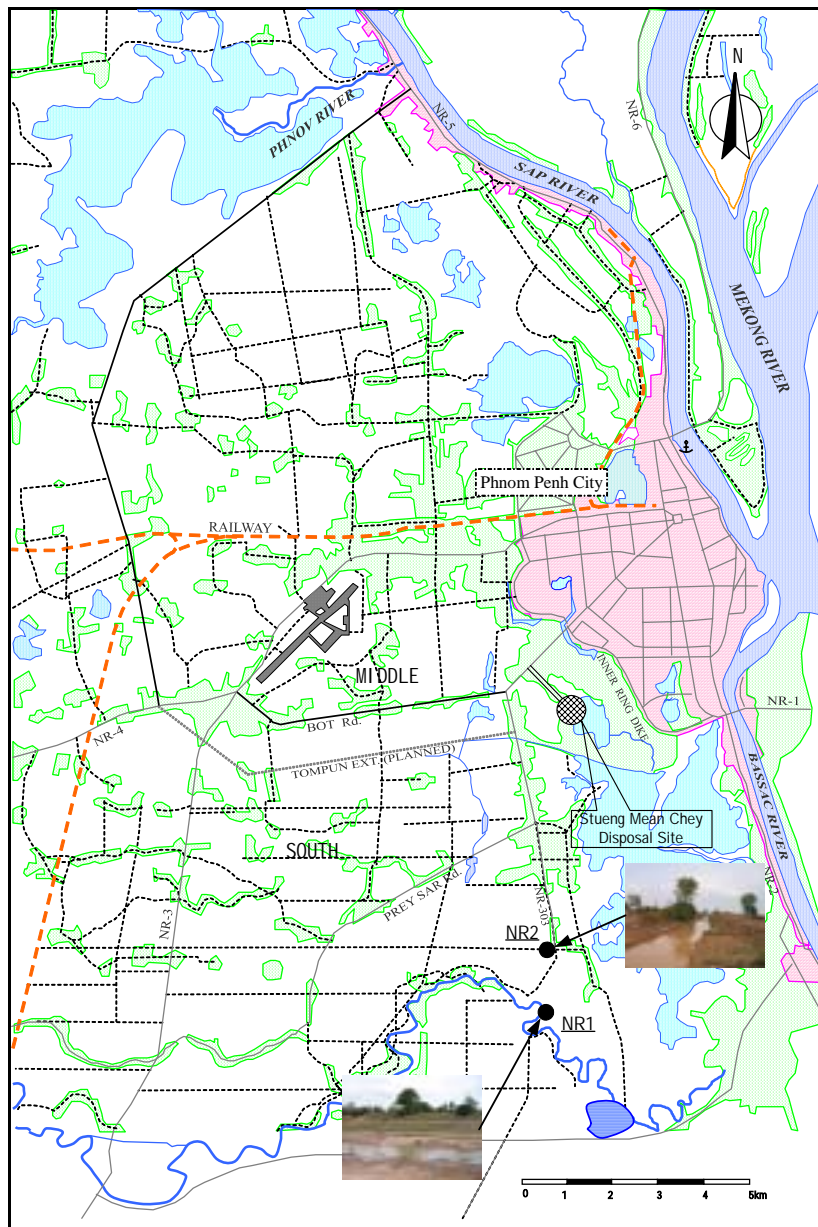


Figure 9-2: Location of Sampling Point for NR in Dry and Rainy Season

## 9.1.2 Methodology

### a. Water Sampling

Sampling was carried out from April 23 to 24, 2003 at the designated points by the Study Team.

- Water samples were taken in the daytime.
- Sampling points and locations were selected by the JICA study team.
- Water samples were stored in a cool box and protected from the sun after taking.
- Analysis started at the laboratories in Phnom Penh and in Bangkok approximately four hours after the samples were taken.

**b. Flow Volume and Groundwater Level Measurement**

- The flow volume of the river and channel was measured using the Mean Section Method.
- A dip-meter was used for measuring groundwater level

The cross section is regarded as being made up of a number of panels, each bordered by two adjacent verticals. If  $V_1$  and  $V_2$  are the mean velocities at the first and second vertical respectively, and  $d_1$  and  $d_2$  are the depths measured at verticals I and II respectively and "b" is the width between the said verticals, than the discharge of the panel is to be calculate as:

$$Q_p = (V_1 + V_2/2) * (d_1 + d_2/2) * b$$

where  $Q_p$  is the total partial discharge through the considered panel.

This is to be repeated for each panel and the total discharge is the summation of the discharges per panel. For the panel at the site (close to the bank), the same equation as above can be used, whereas the velocity at the bank is taken as zero.

One should realize, however, that the mean velocity in the horizontal direction towards the banks in many cases has a parabolic form and therefore it may give a better estimate to calculate  $Q_p$  for the panels near the banks as

$$Q_p = 2/3 V_1 * 1/2(d_0 + d_1) * b$$

b = the width from the bank to vertical I

$V_1$  = the mean velocity in vertical I

The total discharge is the sum of all the calculated  $Q_p$  's.

The result of flow measurement of Prek Thnot River at Prek Chrey pagoda (NR1) and the irrigation Channel at Choeng Eak commune is shown in Table 9-3.

**c. Water Quality Measurement and Analysis**

Two laboratories, the MOE lab in Phnom Penh and Intertek Testing Services in Bangkok, were selected for conducting water quality measurement and analysis. Three parameters, i.e. temperature, pH and EC, were measured in the field.

The method of measurement and analysis met the Cambodian and Thai standards as per the standard method for the examination of water and wastewater.

Table 9-2: Examination method for each parameter

No.	Parameters	Method	Laboratory
1	Temperature	By Thermometer	Field test
2	pH	4500-H B Electrometric Method	Field test
3	Electric Conductivity	By Conductivity Meter, HACH Model 44600	Field test and MOE lab
4	Turbidity	2130 B Nephelometric Method	MOE lab
5	Color	2120 C Spectrophotometric Method	MOE lab
6	Alkalinity	2320 B Titration Method	MOE lab
7	Oil Content	5520 B Partition Gravimetric Method	MOE lab
8	Total Coliform	9221 Multiple Tubes Method	MOE lab
9	BOD <sub>5</sub>	5210 B 5-day BOD Test	MOE lab
10	COD	5220 C Closed Reflux Titrimetric	MOE lab
11	SS	2540 B Total Solid Dried	MOE lab
12	Ammonium-N	4500 F Phenate Method	MOE lab
13	Na <sup>+</sup>	3500-Na B Flame Emission Photometric	MOE lab
14	K <sup>+</sup>	3500-K B Flame Photometric Method	MOE lab
15	SO <sub>4</sub> <sup>-</sup>	4500-Sulfate E Turbidimetric Method	MOE lab
16	Cl <sup>-</sup>	4500-Chloride B Argentometric Method	MOE lab

17	Total Phosphorus	4500-P E Ascorbic Acid Method	MOE lab
18	Manganese	3500-Mn B Persulfate Method	MOE lab
19	Iron	3111 B AAS	MOE lab
20	Cadmium	3111 B AAS	MOE lab
21	Lead	3111 B AAS	MOE lab
22	Total Chromium	3111 B AAS	MOE lab
23	Hexavalent Chromium	3500-Cr B Colorimetric	MOE lab
24	Arsenic	3500-As C Silver Diethyldithiocarbamate	MOE lab
25	Copper	3111 B AAS	MOE lab
26	Zinc	3111 B AAS	MOE lab
27	HCO <sub>3</sub> <sup>-</sup>	2320 B Titration Method	ITS lab (Thailand)
28	Cyanide	4500-CN-E Colorimetric Method	ITS lab (Thailand)
29	Total Nitrogen	4500-N C Persulfate Method	ITS lab (Thailand)
30	Total Mercury	3122 B Cold-Vapor AAS	ITS lab (Thailand)
31	PCBs	6431 B GC	ITS lab (Thailand)

## 9.2 Results

### 9.2.1 Results in dry season

#### a. Flow Volume and Groundwater Level Measurement

The results of flow volume for the Prek Thnot River at Prek Chrey Pagoda (NR1) and the irrigation canal at Choeng Eak Commune (NR2) are shown in Table 9-3.

Table 9-3: Flow volume of Prek Tnot River and Choeng Ek irrigation channel

Sample No.	Date of measurement	Mean velocity (V), m/s	Area (F), m <sup>2</sup>	Discharge (Q), m <sup>3</sup> /s
NR1	23/04 /03	0.126	0.57	<b>0.072</b>
NR2	23/04/03	0.202	0.035	<b>0.007</b>

#### b. Groundwater Level

The measurements of groundwater level (static level) at MW1, MW2 and MW3 are shown in Table 9-4. They were 15 to 17 meters from the natural ground surface.

Table 9-4: The results of groundwater level

Sample No.	Location	Static Level (m)
MW1	Existing well at the Health Care Center	15
MW2	Existing well north-east of SMC disposal site	17
MW3	Existing well east of SMC disposal site	16

#### c. Water Quality

The results of the water quality analysis are shown in the table below.

Table 9-5: Results of Waste Quality Analysis for LE and DR

No .	Parameters	Unit	Standard for effluent*	Sample No.				
				DR1	DR2	LE1	LE2	LE3
1	Temperature	°C	< 45	29.0	30.5	29.0	29.0	29.5
2	pH		5-9	8.29	8.73	8.22	8.11	7.23
3	Electric Conductivity	μ S/cm		10,300	769	22,700	14,200	30,200
4	Turbidity	NTU		0.23	0.13	760	170	230
5	Color	Pt/Co		4,300	1,00	14,800	10,800	14,100
6	Alkalinity	mg/l		1,190	109	3,820	2,590	3,970
7	Oil Content	mg/l	< 15	1.0	<1	36	30	31
8	Total Coliform	MPN/100ml		110,000	4,600	15,000	93,000	150,000

9	BOD <sub>5</sub>	mg/l	< 80	510	50	700	900	980
10	COD	mg/l	< 100	6,400***	72***	18,000**	2,700***	20,700**
11	SS	mg/l	< 80	270	270	24,000	2,900	4,600
12	Ammonium-N	mg/l		1.0***	12	32	35	35
13	Na <sup>+</sup>	mg/l		69	27	76	120	72
14	K <sup>+</sup>	mg/l		17	6.5	17	16	16
15	SO <sub>4</sub> <sup>-</sup>	mg/l	<500	68	27	930	220	340
16	Cl <sup>-</sup>	mg/l		3,100	130	5,700	4,000	8,600
17	HCO <sub>3</sub> <sup>-</sup>	mg/l		2,500	463	4,910	3,650	6,680
18	Total Phosphorus	mg/l		3.4	1.9	13	6.7	1.1
19	Cadmium	mg/l	< 0.5	<0.1	<0.1	<0.1	<0.1	<0.1
20	Cyanide	mg/l	< 1.5	0.003	0.005	0.009	0.004	0.004
21	Lead	mg/l	< 1	< 1	< 1	< 1	< 1	< 1
22	Total Chromium	mg/l	<1.0	<0.1	<0.1	<0.1	<0.1	<0.1
23	Hexavalent Chromium	mg/l	< 0.5	<0.005	<0.005	<0.005	<0.005	<0.005
24	Arsenic	mg/l	< 1	<0.01	<0.01	<0.01	<0.01	<0.01
25	Copper	mg/l	< 1	<0.1	<0.1	0.13	0.27	0.70
26	Zinc	mg/l	< 3	3.5	0.28	0.20	1.4	2.1
27	Iron	mg/l	< 20	2.5	0.58	2.0	5.9	1.9
28	Manganese	mg/l	< 5	0.48	0.14	<0.1	0.72	2.9***
29	Total Nitrogen	mg/l		680***	87	2,100	1,100	2,100
30	Total Mercury	mg/l	< 0.05	0.13	0.003	0.26	0.31	0.13
31	PCBs	μ g/l	3	<0.2	<0.2	<0.2	<0.2	<0.2

\* Effluent standard in Cambodia for pollution sources discharging wastewater to public water areas or sewer

\*\*\* Data are suspected or even minimum quantitative limits are higher than the standard of Cambodia

Table 9-6: Results of Waste Quality Analysis for MW and NR

No	Parameters	Unit	Standard for in public**	Sample No.				
				MW1	MW2	MW3	NR1	NR2
1	Temperature	°C		26.0	25.0	25.0	24.5	25.5
2	PH		6.5-8.5	6.95	6.98	7.16	7.00	7.00
3	Electric Conductivity	μ S/cm		662	1,480	3,000	83.0	153
4	Turbidity	NTU		0.06	<0.02	<0.02	20	410
5	Color	Pt/Co		160	100	20	440	24,000
6	Alkalinity	mg/l		310	243	149	22.0	104
7	Oil Content	mg/l		<1	<1	<1	<1	<1
8	Total Coliform	MPN/100ml	<5000	0	0	0	150	430
9	BOD <sub>5</sub>	mg/l	1-10	2.7***	3.3	4.1	1.7***	<1
10	COD	mg/l		90***	23***	42***	15***	19***
11	SS	mg/l	25-100	410	180	67	360	5,600
12	Ammonium-N	mg/l		28***	<1	<1	19***	6.5
13	Na <sup>+</sup>	mg/l		65	70	44	<0.1	4.6
14	K <sup>+</sup>	mg/l		12	0.22	<0.1	17	2.8
15	SO <sub>4</sub> <sup>-</sup>	mg/l		31	21	35	46	530
16	Cl <sup>-</sup>	mg/l		900	230	36	9.9	79
17	HCO <sub>3</sub> <sup>-</sup>	mg/l		725	269	226	21.7	59.9
18	Total Phosphorus	mg/l		<0.05	0.12	0.07	0.32	0.13
19	Cadmium	μ g/l	<1	<100***	<100***	<100***	<100***	<100***
20	Cyanide	μ g/l	<0.005****	6	3	<1	6	<1
21	Lead	μ g/l	<10	<1000**	<1000**	<1000**	<1000**	<1000**
22	Total Chromium	mg/l		<0.1	<0.1	<0.1	<0.1	<0.1
23	Hexavalent Chromium	μ g/l	<50	<5	<5	<5	<5	<5
24	Arsenic	μ g/l	<10	<10	<10	<10	<10	<10
25	Copper	mg/l		<0.1	<0.1	<0.1	<0.1	0.13
26	Zinc	mg/l		3.2	0.25	<0.1	<0.1	<0.1
27	Iron	mg/l		2.7	<0.3	<0.3	14	<0.3
28	Manganese	mg/l		1.1	0.12	<0.1	<0.1	0.38
29	Total Nitrogen	mg/l		120	1.1	0.54	2.2***	6.5
30	Total Mercury	μ g/l	<0.5	14***	7***	3***	2***	12***
31	PCB	μ g/l	0	<0.2	<0.2	<0.2	<0.2	<0.2

\*\* Water Quality Standard in Cambodia in public water areas for public health protection  
\*\*\* Data are suspected or even minimum quantitative limits are higher than the standard of Cambodia  
\*\*\*\*Cambodian standard should be reviewed (more than 1,000 times higher than the Japanese drinking standard)

#### **d. Findings**

The survey was conducted in the dry season. The results obtained through this survey are limited for concluding all the characteristics of water quality in this region. However, some environmental pollution was recognized in the leachate, leachate drained canal and pond, groundwater, and also a river and a canal not contaminated by the SMC's leachate.

##### **d.1 Leachate, leachate drained canal and a pond**

Table 9-5 shows that the oil content in sample LE is two times over the effluent standard in Cambodia; that is, the effluent standard for pollution sources discharging wastewater into public water areas or sewers. It is not sure whether the oil content comes from mineral oil or animal and vegetable oil. This should be clarified and if found to come from mineral oil, illegal dumping of waste oil may have occurred. If so, countermeasures should be taken.

As for total mercury, LE and DR1 exceeded the effluent standard in Cambodia. Dumping of Hg contained batteries and fluorescent lamps may have caused the Hg contamination. As for Zinc, DR1 slightly exceeded the effluent standard in Cambodia.

BOD<sub>5</sub>, COD, SS, Cl<sup>-</sup>, HCO<sub>3</sub><sup>-</sup>, and total nitrogen also exceeded the effluent standard in Cambodia or showed very high concentrations.

However, the samples of leachate seem to be concentrated because it was not flowing as it was the dry season.

##### **d.2 Groundwater and Natural Rivers**

Table 9-6 shows the results of groundwater and natural rivers. As for total mercury, it is notable that all samples (MW1, MW2, MW3, NR1 and NR2) exceeded the standard in Cambodia in public water areas. Hg does not exist in normal environments except for volcanoes, etc. Therefore, MW1 to MW3 seem to be contaminated by SMC. However, NR1 and NR2 are far from SMC and there is no relation to SMC. The Study Team searched the upstream areas of these points, but could not find any factories. One possibility is contamination by pesticides. Pesticides that contain mercury were widely used throughout the world and are still being used in developing countries even though their use has been banned. According to FAO, although there is no data for the use of Hg containing pesticides in Cambodia, it is a quite high possibility. Although it is out of the scope of work, this should be clarified.

As for cyanide, MW1, MW2 and NR1 showed concentrations exceeding the standard in Cambodia in public water areas. However, as with mercury, it does not exist in natural environments. There is no reason for cyanide contamination so far. Even if the points are contaminated by cyanide, the results are below the WHO guideline for drinking water quality .

As for SS, MW1, MW2, NR1 and NR2 showed concentrations exceeding the standard in Cambodia in public water areas. In particular, NR2 had quite high concentrations.



### d.3 Data reliability

Data marked \*\*\* are questionable or even minimum quantitative limits are higher than the standard of Cambodia. Countermeasures are required. (See 9.2.3 Conclusions)

## 9.2.2 Results in Rainy season

### a. Samples and Sampling Points

There were ten samples in total. The sample number and sampling points and shown below.

Table 9-7: Sampling points and location in rainy season

No.	Sample No.	Sampling point & Location	Water Sources
1	LE1	Leachate south-west of SMC disposal site	WW
2	LE2	Leachate north of SMC disposal site	WW
3	LE3	Leachate north-east of SMC disposal site	WW
4	MW1A	Existing well at the Health Care Center	GW
5	MW2	Existing well north-east of SMC disposal site	GW
6	MW3	Existing well east of SMC disposal site	GW
7	DR1	Canal east of SMC disposal site	WW+SW
8	DR2	A pond east of waste pile	WW+SW
9	NR1	Prek Thnot River 200m upstream of Prek Chrey Pagoda	SW
10	NR2	Irrigation canal at Choeung Ek Commune	SW

Note: WW: Wastewater; GW: Groundwater; SW: Surface water  
MW1A is alternative existing well of MW1 since it was broken

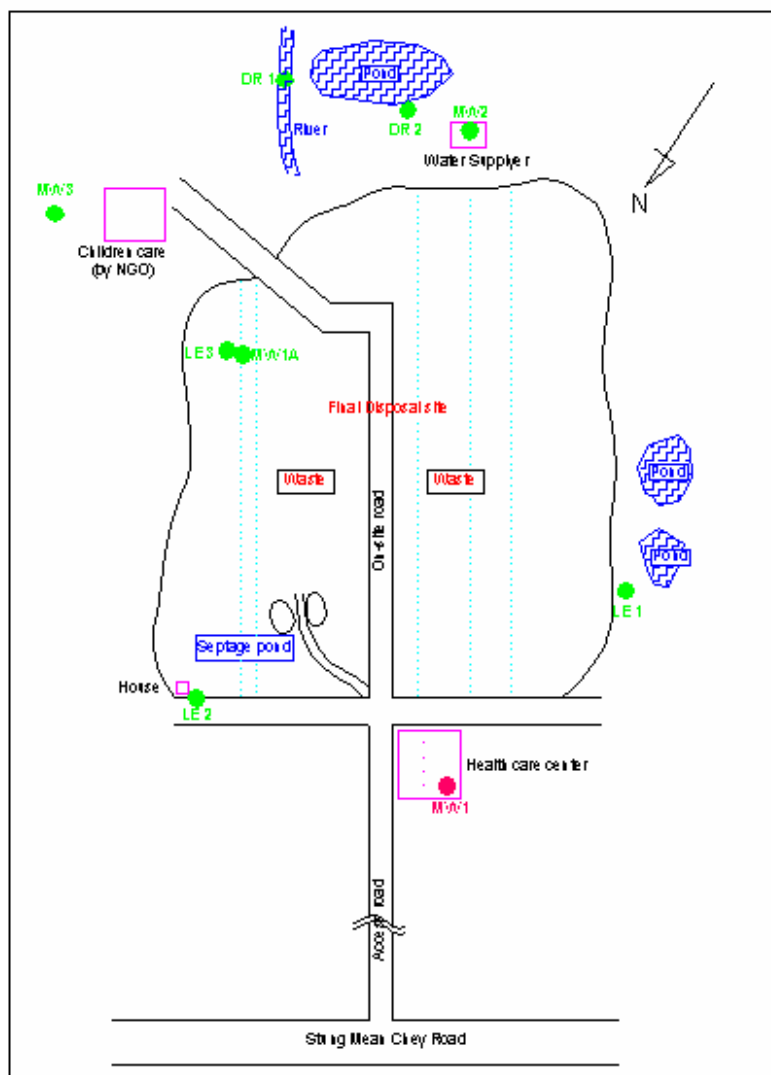


Figure 9-3: Location of Sampling Point for LE, MW and DR in Rainy Season  
(NR1, NR2 are shown in Fig 9-2)

## b. Results

### b.1 Flow Volume

The results of flow volume for the Prek Thnot River at Prek Chrey Pagoda (NR1) and the irrigation canal at Choeng Eak Commune (NR2) are shown in Table 9-8.

Table 9-8: Flow volume of Prek Tnot River and Choeng Ek irrigation channel

Sample No.	Date of measurement	Mean velocity (V), m/s	Area (F), m <sup>2</sup>	Discharge (Q), m <sup>3</sup> /s
NR1	28/10/03	1.8	414.24	746.68
NR2	28/10/03	0.426	0.135	0.058

### b.2 Water Quality

The results of the water quality analysis are shown in the table below.

Table 9-9: Results of Waste Quality Analysis for LE and DR

No.	Parameters	Unit	Standard for effluent*	Sample No.				
				DR1	DR2	LE1	LE2	LE3
1	Temperature	°C	< 45	29.0	29.0	31.0	31.0	39.0
2	pH		5-9	8.02	7.35	8.39	7.80	7.65
3	Electric Conductivity	μ S/cm		1,170	334	24,500	14,190	20,800
4	Turbidity	NTU		140	2.8	740	380	840
5	Color	Pt/Co		370	90	21,000	2,600	4,300
6	Alkalinity	mg/l		200	72.8	7,480	1,340	1,870
7	Oil Content	mg/l	< 15	7.0	9.0	20	13	16
8	Total Coliform	MPN/100ml		5.7x10 <sup>4</sup>	1.8x10 <sup>5</sup>	2.6x10 <sup>4</sup>	2.6x10 <sup>4</sup>	1.2x10 <sup>5</sup>
9	BOD <sub>5</sub>	mg/l	< 80	420	27	790	520	950
10	COD	mg/l	< 100	1,000***	590***	5,300***	14,000** *	5,400***
11	SS	mg/l	< 80	32	220	474	477	458
12	Ammonium-N	mg/l		5.76***	5.14***	<1***	<1***	<1***
13	Na <sup>+</sup>	mg/l		0.19	<0.1	1.0	1.1	0.96
14	K <sup>+</sup>	mg/l		0.26	0.11	1.1	0.65	1.0
15	SO <sub>4</sub> <sup>-</sup>	mg/l	<500	33	14	26	9.4	1.4
16	Cl <sup>-</sup>	mg/l		340	77	6,500	4,000	4,200
17	HCO <sub>3</sub> <sup>-</sup>	mg/l		2,060	258	8,660	3,040	8,400
18	Total Phosphorus	mg/l		<0.05	<0.05	<0.05	<0.05	<0.05
19	Cadmium	mg/l	< 0.5	<0.05	<0.05	<0.05	<0.05	<0.05
20	Cyanide	mg/l	< 1.5	<0.001	<0.001	<0.001	<0.001	<0.001
21	Lead	mg/l	< 1	<1	<1	<1	<1	<1
22	Total Chromium	mg/l	<1.0	<0.2	<0.2	<0.2	<0.2	<0.2
23	Hexavalent Chromium	mg/l	< 0.5	<0.005	<0.005	<0.005	<0.005	<0.005
24	Arsenic	mg/l	< 1	<0.01	<0.01	<0.01	<0.01	<0.01
25	Copper	mg/l	< 1	<0.2	<0.2	<0.2	<0.2	<0.2
26	Zinc	mg/l	< 3	<0.005	<0.005	0.67	0.54	0.86
27	Iron	mg/l	< 20	0.75	0.34	5.4	2.9	9.0
28	Manganese	mg/l	< 5	<0.1	<0.1	<0.1	1.1	4.3
29	Total Nitrogen	mg/l		270	23	2,400	460	1,800
30	Total Mercury	mg/l	< 0.05	0.005***	<0.005** *	0.014***	0.052***	0.025***
31	PCBs	μ g/l	3	<0.2	<0.2	1.184	<0.2	<0.2

\* Effluent standard in Cambodia for pollution sources discharging wastewater to public water areas or sewer

\*\*\* Data are suspected or even minimum quantitative limits are higher than the standard of Cambodia

Table 9-10: Results of Waste Quality Analysis for MW and NR

No.	Parameters	Unit	Standard for in public**	Sample No.				
				MW1A	MW2	MW3	NR1	NR2
1	Temperature	°C		31.0	30.0	30.0	26.5	30.0
2	pH		6.5-8.5	7.37	7.43	7.60	6.87	6.95
3	Electric Conductivity	μ S/cm		651	867	480	39.0	35.0
4	Turbidity	NTU		35.8	0.28	0.49	42.10	117
5	Color	Pt/Co		200	130	40	400	470
6	Alkalinity	mg/l		208	608	153	8.85	9.84
7	Oil Content	mg/l		<1	<1	<1	2	3
8	Total Coliform	MPN/100ml	<5000	0	0	0	1.3x10 <sup>2</sup>	5.1x10 <sup>2</sup>
9	BOD <sub>5</sub>	mg/l	1-10	12	1.6	1.1	14	9.6
10	COD	mg/l		51***	35***	19***	27***	24***
11	SS	mg/l	25-100	160	75	33	110	99
12	Ammonium-N	mg/l		<1	<1	<1	<1	<1
13	Na <sup>+</sup>	mg/l		0.33	0.37	0.24	<0.05	0.05
14	K <sup>+</sup>	mg/l		<0.1	<0.1	<0.1	<0.1	<0.1
15	SO <sub>4</sub> <sup>-</sup>	mg/l		4.5	19	24	8.3	6.0
16	Cl <sup>-</sup>	mg/l		99	190	83	5.4	6.9
17	HCO <sub>3</sub> <sup>-</sup>	mg/l		524	361	430	63.9	65.1
18	Total Phosphorus	mg/l		9.0	5.8	6.6	0.80	1.4

19	Cadmium	$\mu$ g/l	<1	<50***	<50***	<50***	<50***	<50***
20	Cyanide	$\mu$ g/l	<0.005****	<1	<1	<1	<1	<1
21	Lead	$\mu$ g/l	<10	<1,000* **	<1,000* **	<1,000* **	<1,000* **	<1,000* **
22	Total Chromium	mg/l		<0.2	<0.2	<0.2	<0.2	<0.2
23	Hexavalent Chromium	$\mu$ g/l	<50	<5	<5	<5	<5	<5
24	Arsenic	$\mu$ g/l	<10	<10	<10	<10	<10	<10
25	Copper	mg/l		<0.2	<0.2	<0.2	<0.2	<0.2
26	Zinc	mg/l		0.12	<0.1	<0.1	0.27	0.24
27	Iron	mg/l		0.41	<0.2	<0.2	0.62	1.0
28	Manganese	mg/l		<0.1	<0.1	<0.1	<0.1	<0.1
29	Total Nitrogen	mg/l		2.9	0.04	3.4	1.5	2.3
30	Total Mercury	$\mu$ g/l	<0.5	<5***	<5***	<5***	<5***	<5***
31	PCB	$\mu$ g/l	0	<0.2	<0.2	<0.2	<0.2	<0.2

\*\* Water Quality Standard in Cambodia in public areas

\*\*\* Data are suspected or even minimum quantitative limits are higher than the standard of Cambodia

\*\*\*\*Cambodian standard should be reviewed (more than 1,000 times higher than the Japanese drinking standard)

### c. Findings

The survey was conducted in the rainy season. The results obtained through this survey are limited for concluding all the characteristics of water quality in this region. However, some environmental pollution was recognized in the leachate, leachate drained canal and pond, and groundwater.

#### c.1 Leachate, leachate drained canal and a pond

The above table shows that the oil content in sample LE1 and LE3 is slightly over the effluent standard in Cambodia; that is, the effluent standard for pollution sources discharging wastewater into public water areas or sewers. It is not sure whether the oil content comes from mineral oil or animal and vegetable oil. This should be clarified and if found to come from mineral oil, illegal dumping of waste oil may have occurred. If so, countermeasures should be taken.

As for total mercury, LE2 slightly exceeded the effluent standard in Cambodia. Dumping of Hg contained batteries and fluorescent lamps may have caused the Hg contamination.

It should be noted that polychlorinated biphenyl (PCB) was slightly detected from LE1, though its concentration is below the effluent standard in Cambodia. As with Hg, it can be thought that this contamination may occur from buried materials because other samples had no PCB contamination. Continuous monitoring will be needed in future.

BOD<sub>5</sub>, COD and SS also exceeded the effluent standard in Cambodia.

#### c.2 Groundwater and natural rivers

The results show generally good conditions for groundwater and natural rivers. MW1A and NR1 slightly exceeded the standard in Cambodia in public water areas for BOD<sub>5</sub> and SS.

#### c.3 Data reliability

Data marked \*\*\* are questionable or even minimum quantitative limits are higher than the standard of Cambodia. Countermeasures are required. (See in the chapter 9.2.3 Conclusions)

### 9.2.3 Conclusions

From the results mentioned above, the following can be said.

**a. Review of the standard in Cambodia**

The parameters of the water quality standard in Cambodia in public areas such as cyanide and PCB should be reviewed. The standard of  $0.005 \mu\text{g/l}$  for cyanide seems to be too low compared with that of developed countries such as Japan, and the  $0 \mu\text{g/l}$  of PCB is not a suitable value as a standard.

**b. Strengthening of MOE laboratory work**

Firstly, the MOE laboratory should consider raising the analytical level and strengthen measurement data management. The role of the analytical laboratory is to produce measurement-based information that is technically valid and of known quality. Raising the analytical level and strengthen measurement data management are essential to provide precise and accurate laboratory data. Therefore, training to develop the skill of analysts and installation of data assurance systems such as QA/QC systems are required.

Secondly, the MOE laboratory should install advanced measurement systems to meet the Cambodian standard is needed. For example, the minimum quantitative limit of cadmium and lead were higher than the standard in Cambodia in public areas. This is because the analysis methods are basic and cannot reach the level of the standards. So far, there has been no other choice for the MOE laboratory as they do not have advanced equipment which can detect levels lower than the Cambodian standard. However, environmental monitoring is an essential part of their work, so the installation of advanced equipment to apply new techniques is indispensable.

The concentrations in COD were too high in comparison to other parameters such as BOD. This is because “5220 C Closed Reflux Titrimetric”, the method for measuring COD in the MOE laboratory, is for higher concentrations of COD such as 40-400 mg/l.

The MOE laboratory should install advanced equipment and establish an advanced monitoring system.

**c. Re-survey of mercury and others**

In the dry season, the concentrations of mercury in samples of the river and canal in and around DKDS exceeded the public standard in Cambodia. Although they were not in excess in the rainy season, they should be re-surveyed because mercury is very toxic and can accumulate in the aquatic food chain in the case of organic mercury. As mentioned in “section 9.2.1 Results in dry season” and “9.2.2 Results in rainy season”, there is a possibility of contamination by pesticide. If so, the possibility of organic mercury is very high.

Therefore, not only total mercury but also organic mercury must be re-surveyed for confirmation before the operation of DKDS. The measurements of total and organic mercury are very sensitive and the concentrations are expected to be very low, so the measurements should be done by agencies which have advanced techniques such as Thai or Japanese laboratories.

Some data of other parameters should also be re-measured before implementation of the project because the results are questionable, i.e. the manganese in a sample of LE3 in the dry season, the cyanide in samples of MW1, MW2 and NR1 in the dry season. All samples of COD, cadmium and lead in samples from MW1, MW2, MW3, NR1 and NR2 in the dry and rainy seasons, as well as ammonium-N in samples from DR1, DR2 LE1, LE2 and LE3 in the rainy season should also be re-measured due to the reason mentioned above.

Accurate results of the water quality survey are quite essential as baseline data so the re-survey mentioned above must be carried out before commencement of the project operation.

# Annex 10

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*Pilot Project  
Improvement of the SMCDS*

## Annex 10 Pilot Project: Improvement of the SMCDs

### 10.1 Summary of Construction Work

#### 10.1.1 Outline of Construction Work

**a. Project Name**

The Improvement Work of The Stung Mean Chey Disposal Site for The Study on Solid Waste Management in the Municipality of Phnom Penh in the Kingdom of Cambodia

**b. Scope of Works**

- 1) On-Site Road
- 2) Working Face
- 3) Fence (Fixed Type) and Gate
- 4) Model Block For Landfill Completion
- 5) Enclosing Bank
- 6) Leachate Collection
- 7) Leachate Treatment Facility
- 8) Expansion Of Existing Compost Plant Area

**c. Location of Project**

Stung Mean Chey Disposal Site, Phnom Penh City

**d. Duration of Project**

13 October 2003 - End of February 2004

**e. Implementing Agency**

Department of Public Works and Transport Municipality of Phnom Penh (DPWT)  
Street 211 Sangkat Veal Vong, Khan 7 Makara, Phnom Penh  
Tel : (855)-23-880-857  
Fax: (855)-23-883-618

The JICA Study Team  
Kokusai Kogyo Co., Ltd.  
Headquarters  
5 Sanban-cho Chiyoda-ku, Tokyo 102-0075 Japan  
Phnom Penh Office  
Department of Public Works and Transport Municipality of Phnom Penh (DPWT)  
Street 211 Sangkat Veal Vong, Khan 7 Makara, Phnom Penh

**f. Contractor**

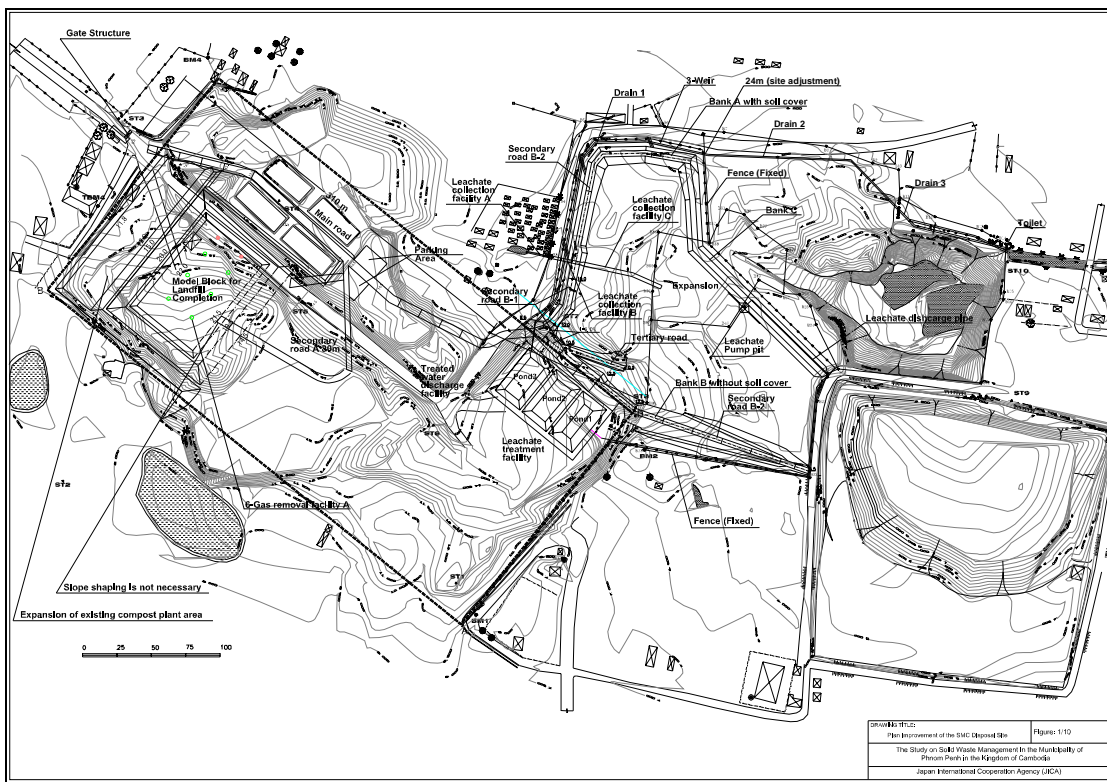
S.O.M Corporation, Ltd.  
#28AEo Street 310, Sangkat Boeng Keng Kang 1, Khan Chamcar Mon, PP  
Tel : (855)- 12-872-691  
Tel & Fax : (855)-23'428-958  
E-Mail : [som-corp@camnet.com.kh](mailto:som-corp@camnet.com.kh)

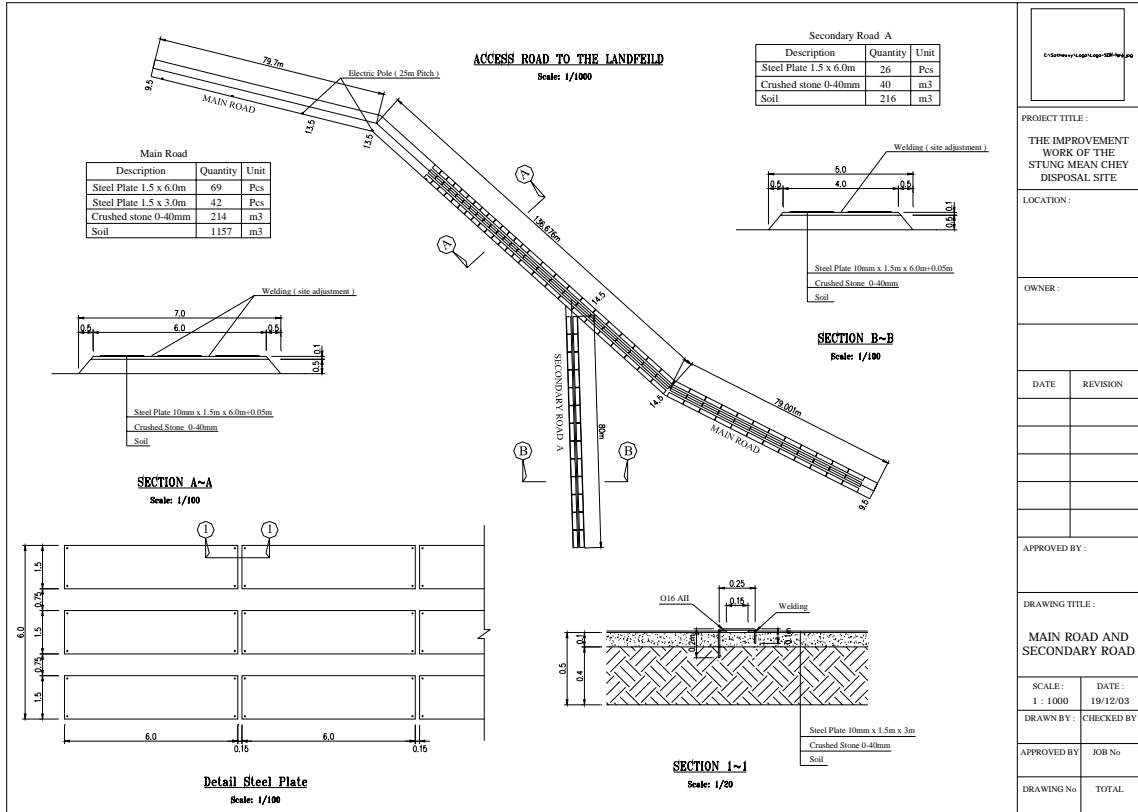


**g. Contract Status**

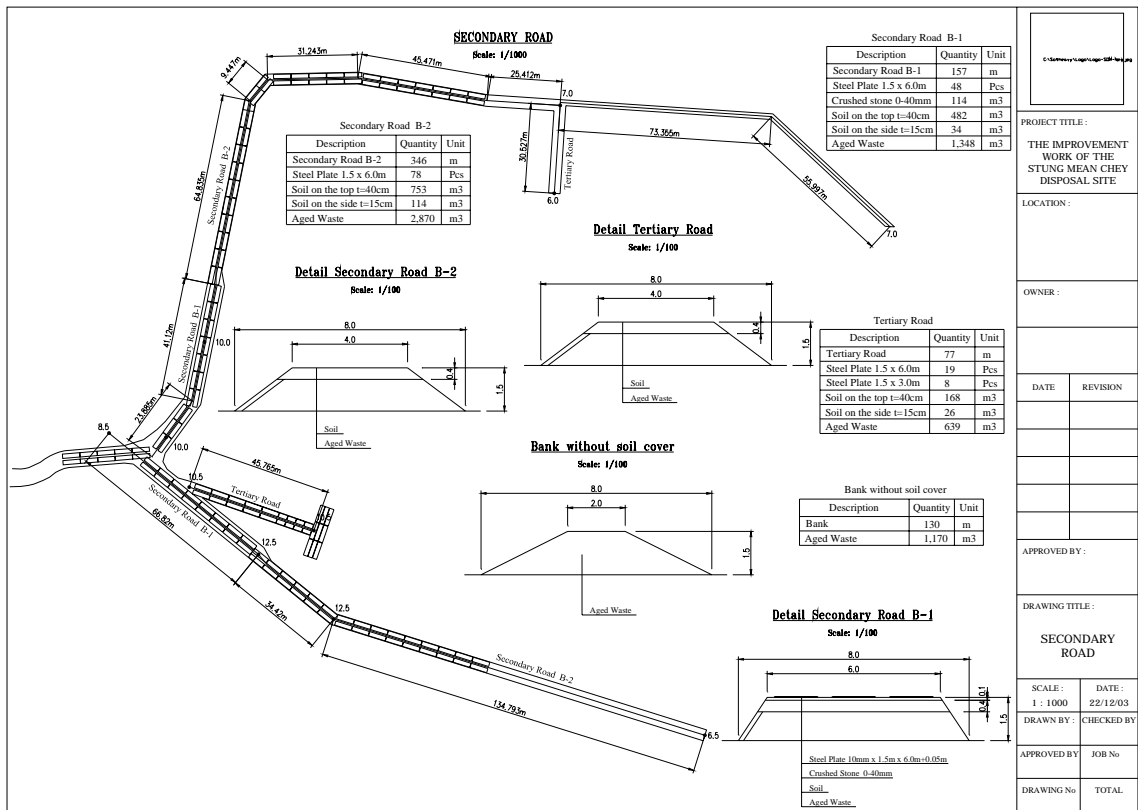
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 Duration of Contract : End of February 2004  
 Country : Kingdom Of Cambodia  
 Location : Stung Mean Chey Disposal Site, Phnom Penh City  
 Client : Kokusai Kogyo Co., Ltd. JICA Study Team  
 Contractor : S.O.M Corporation, Ltd.

**10.1.2 Completion Drawings**

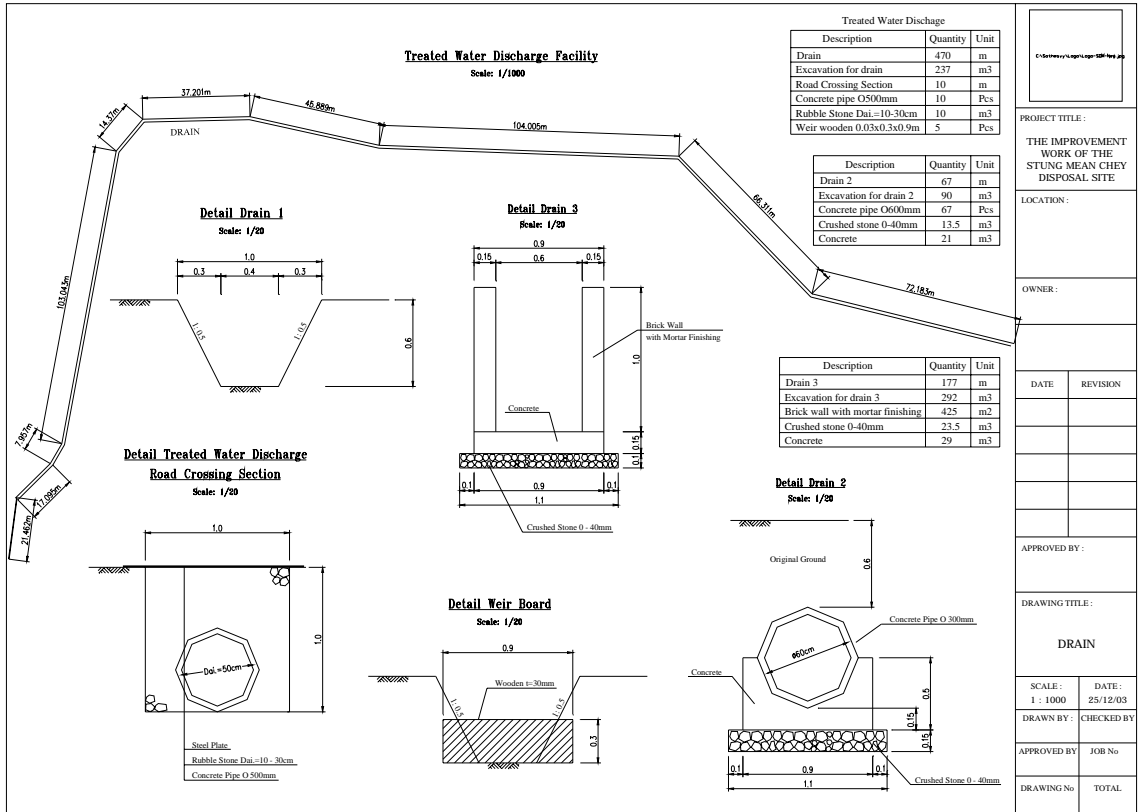




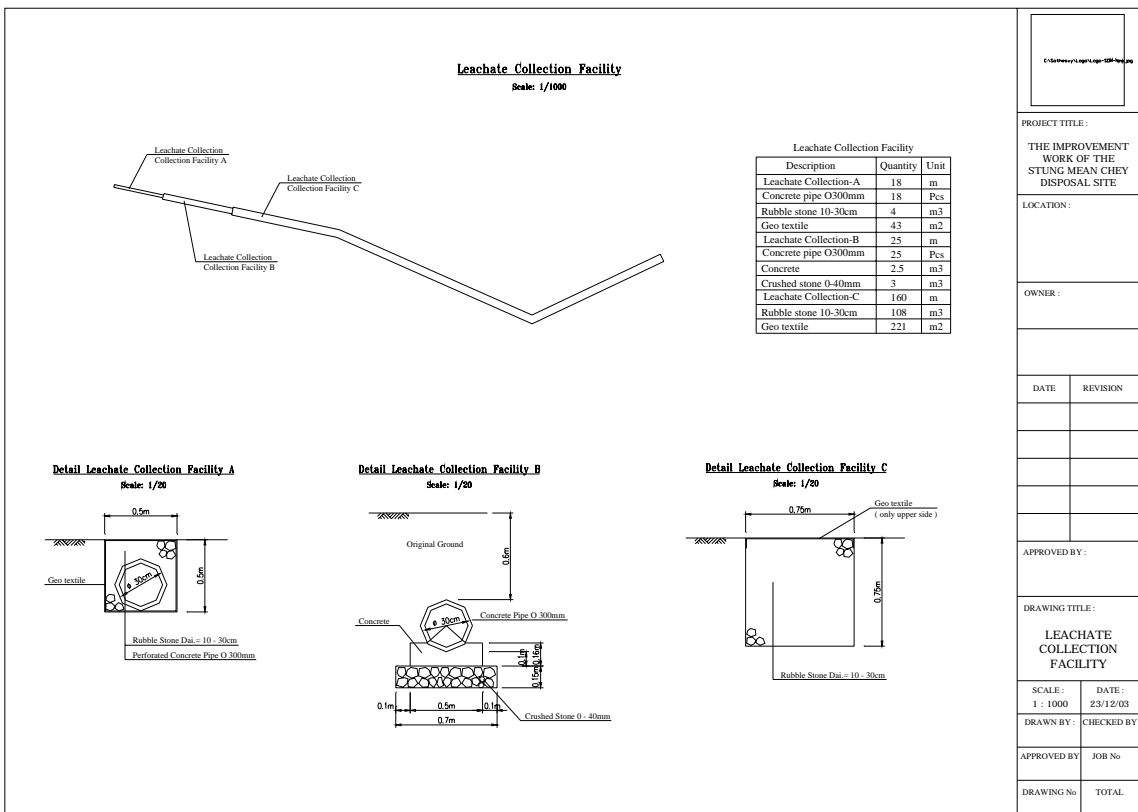
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APPROVED BY	JOB No
DRAWING No	TOTAL



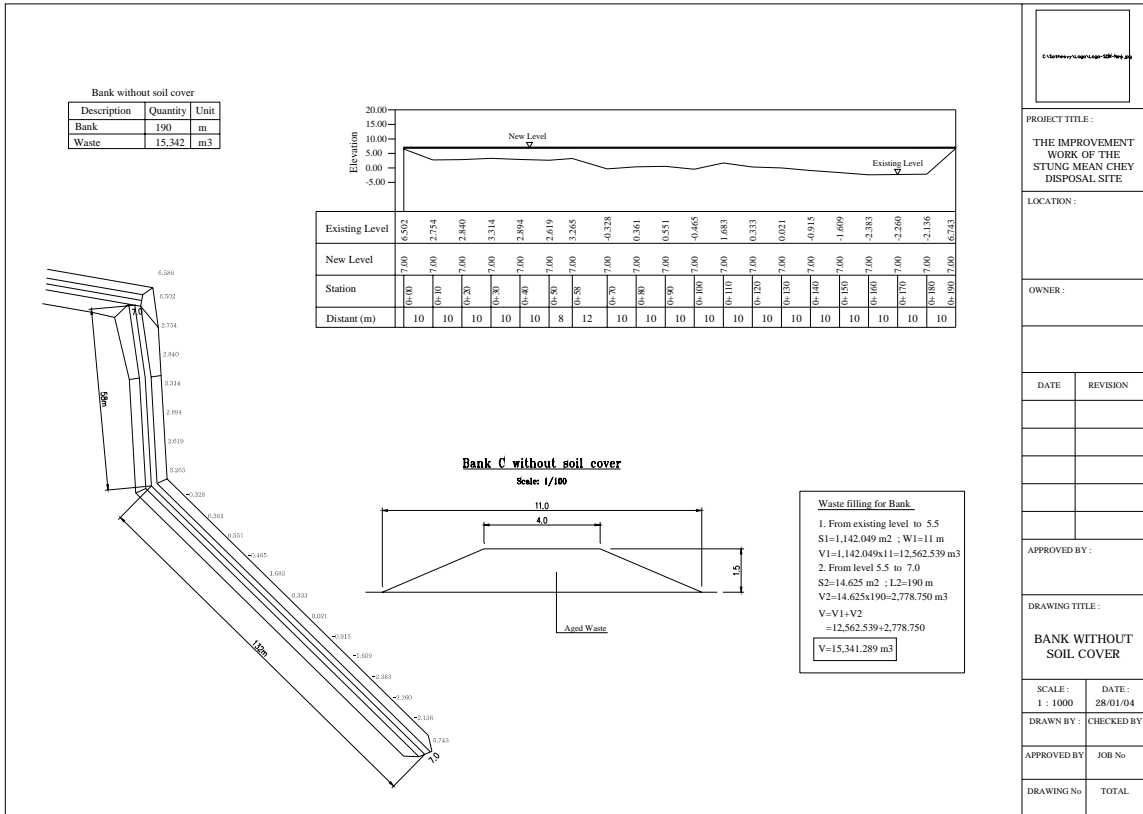
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DRAWING No	TOTAL



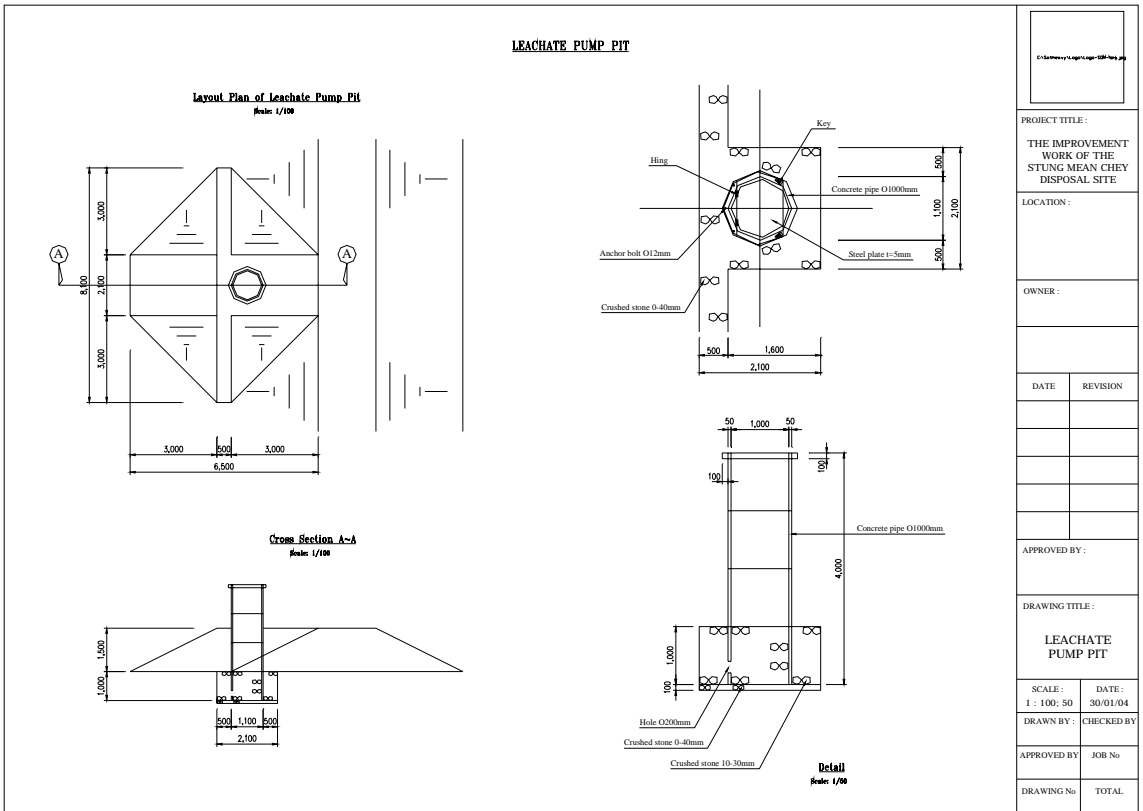
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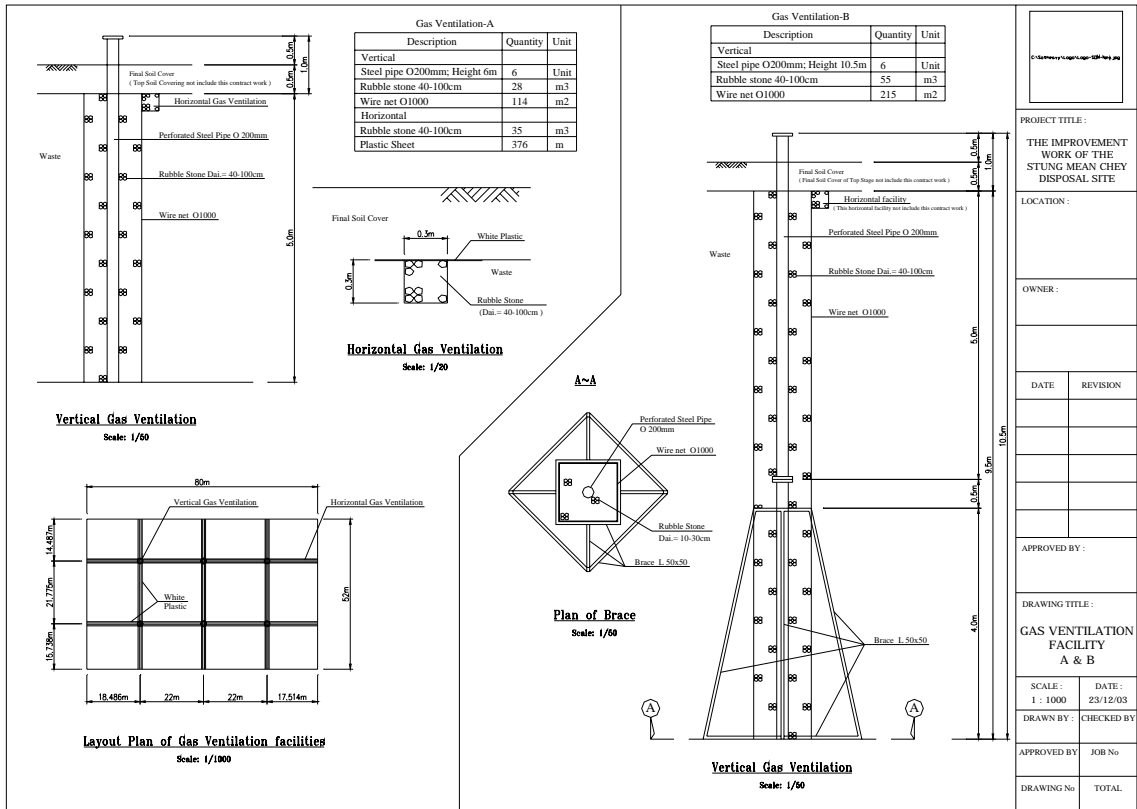
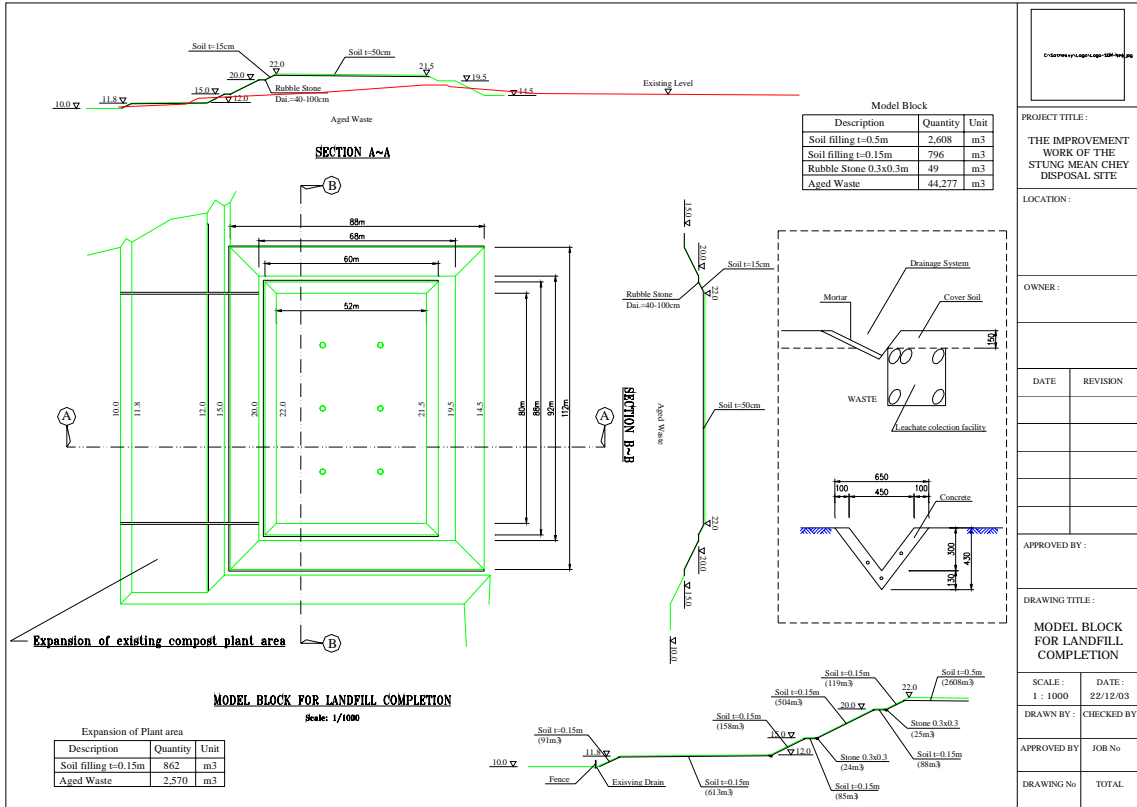
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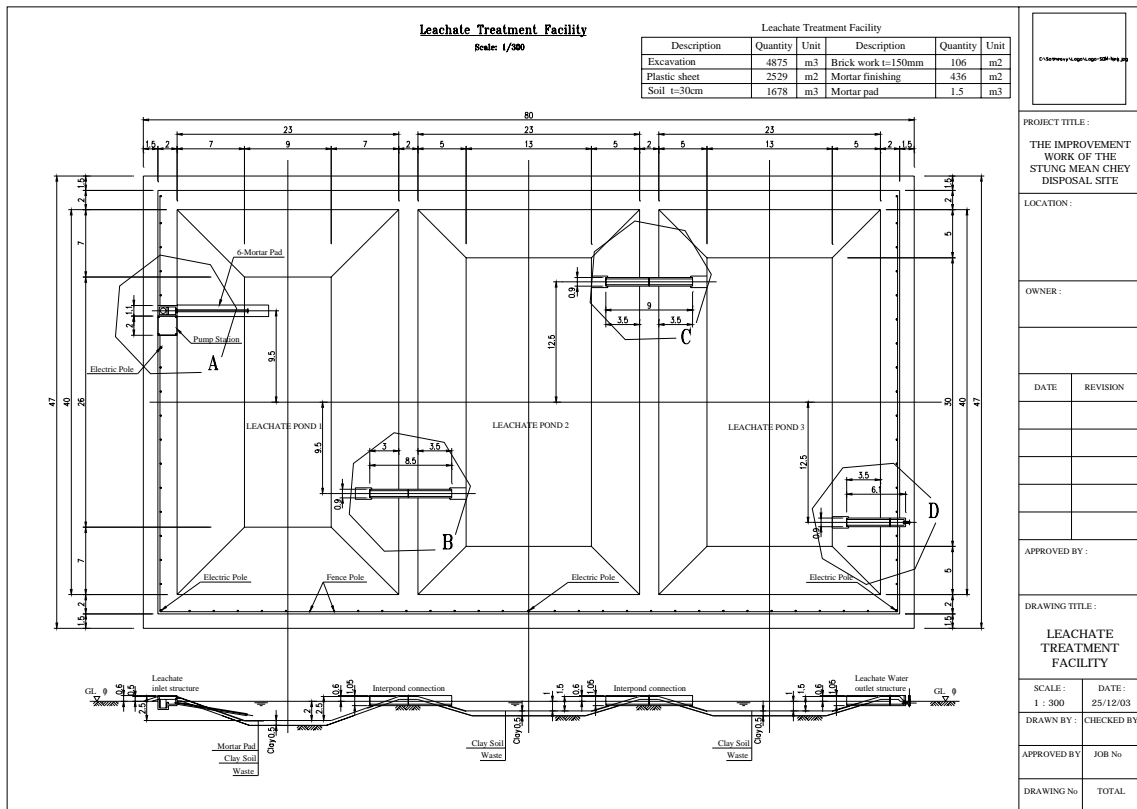
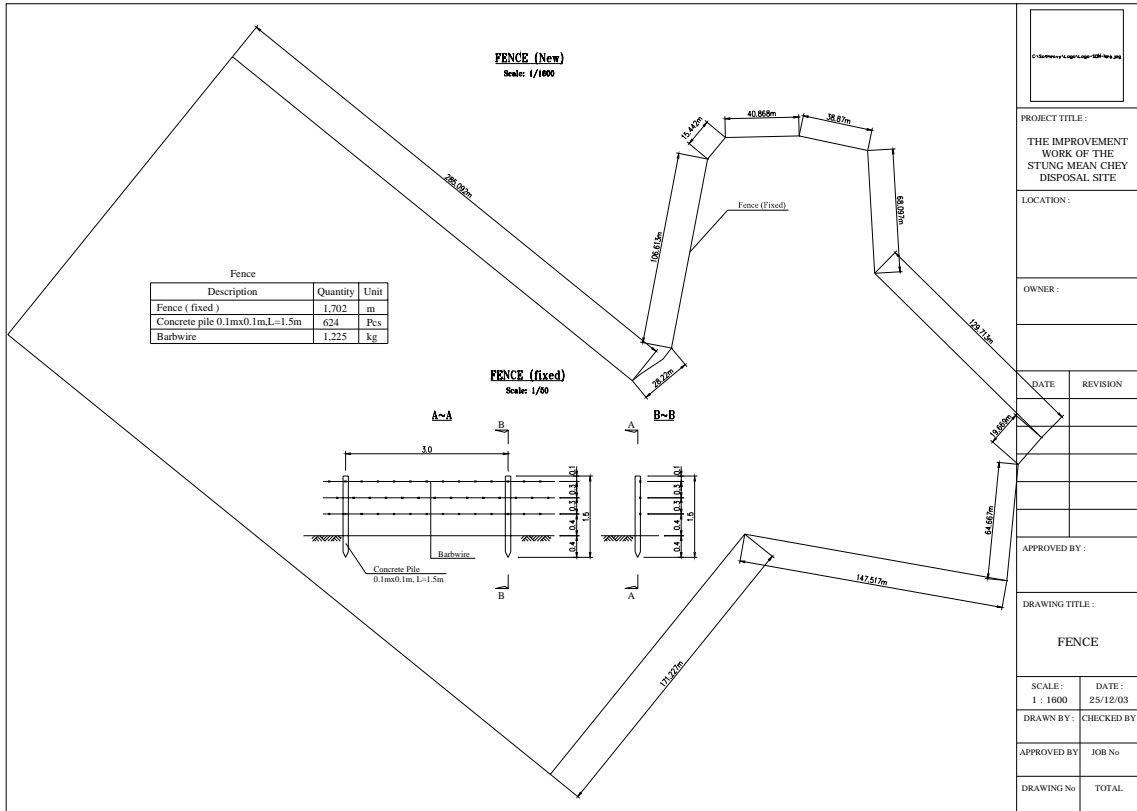


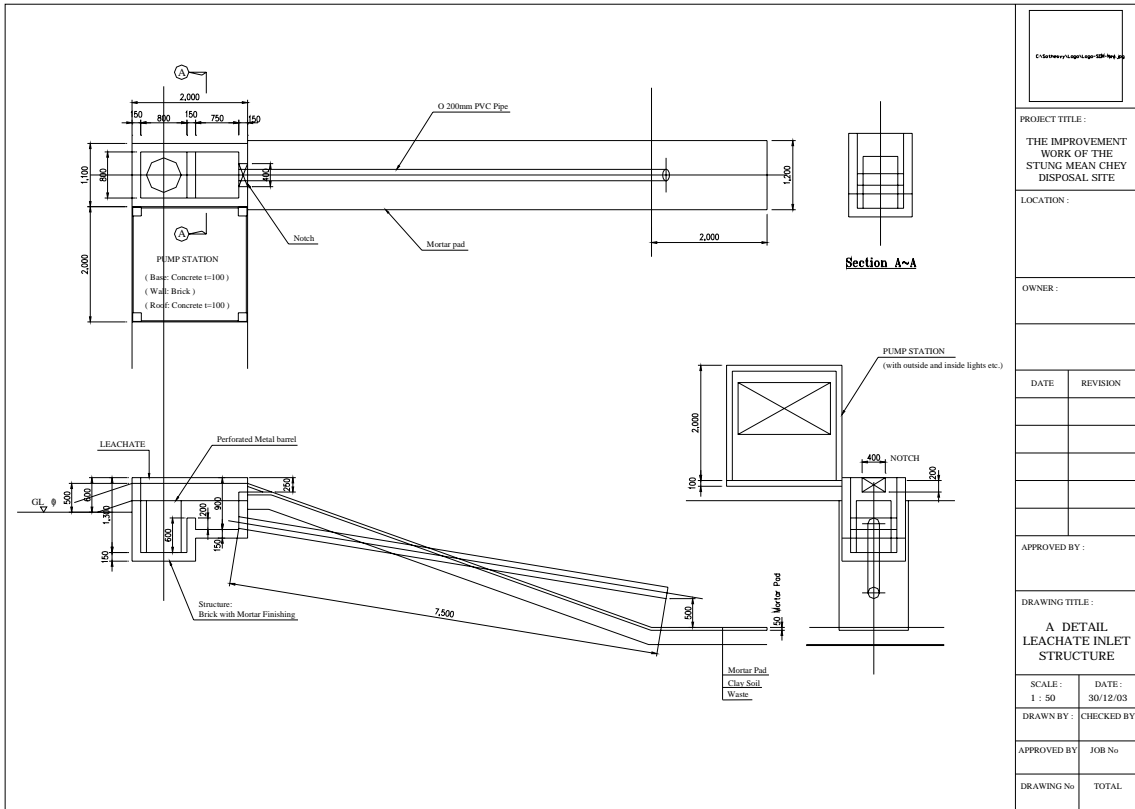
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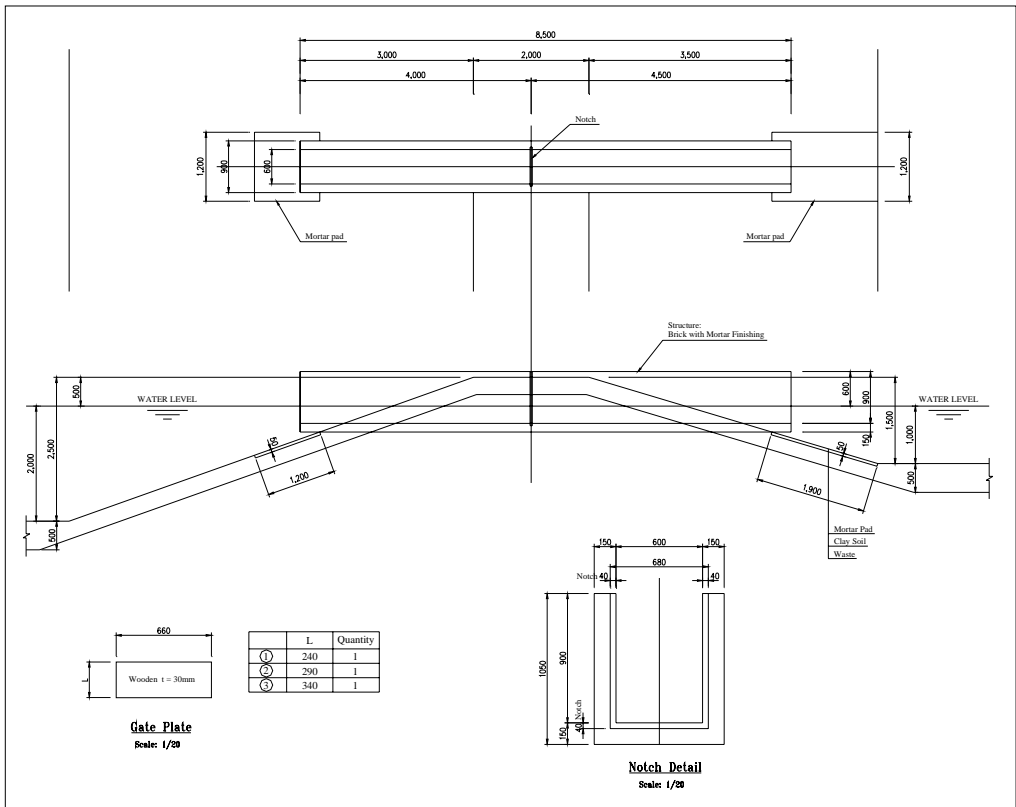
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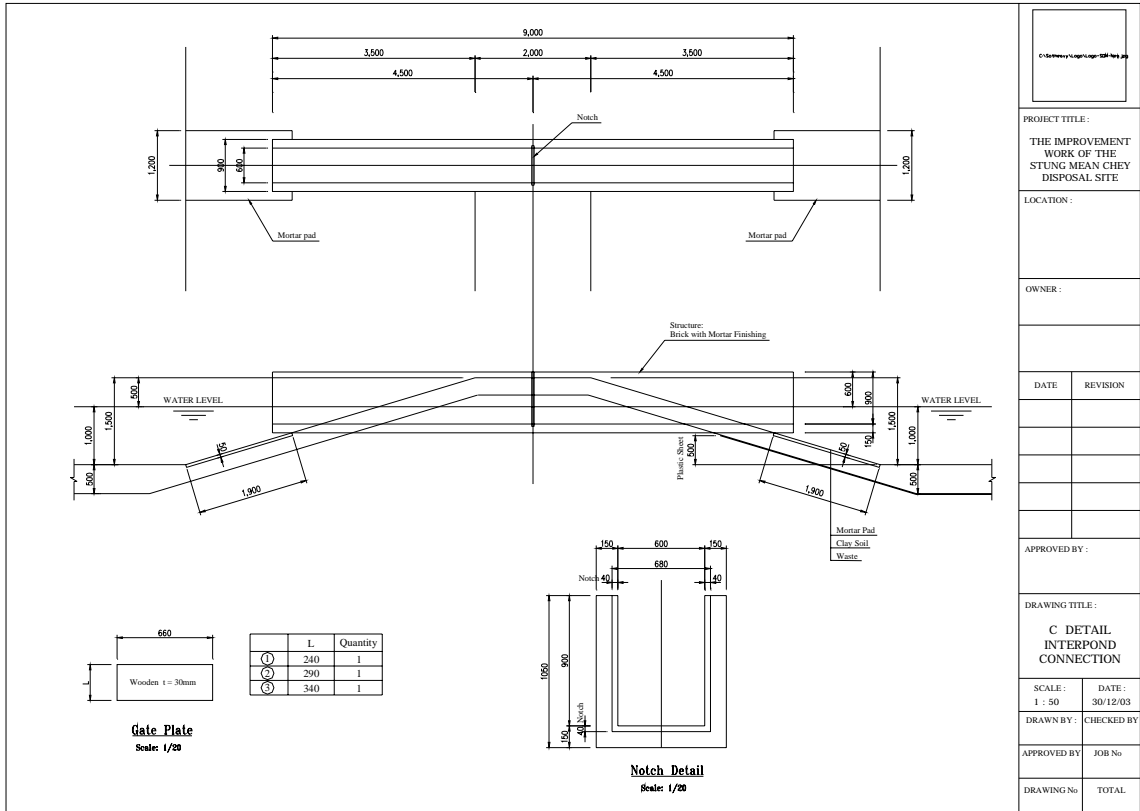




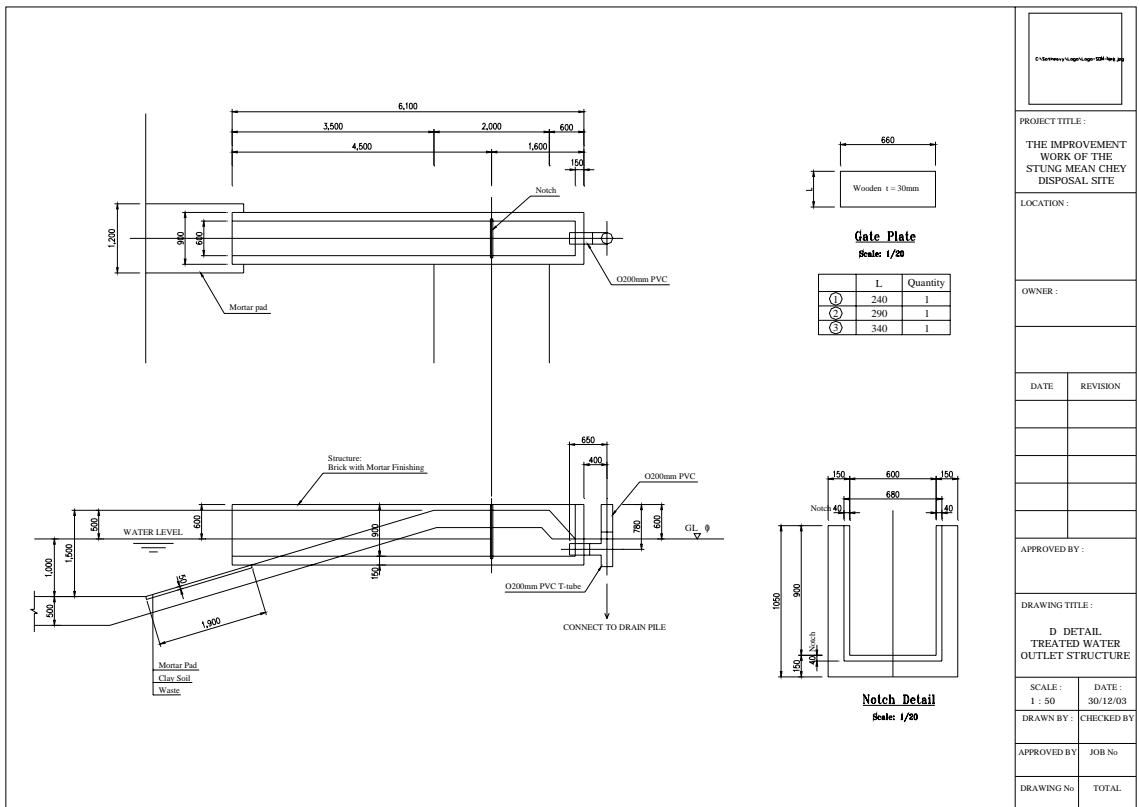
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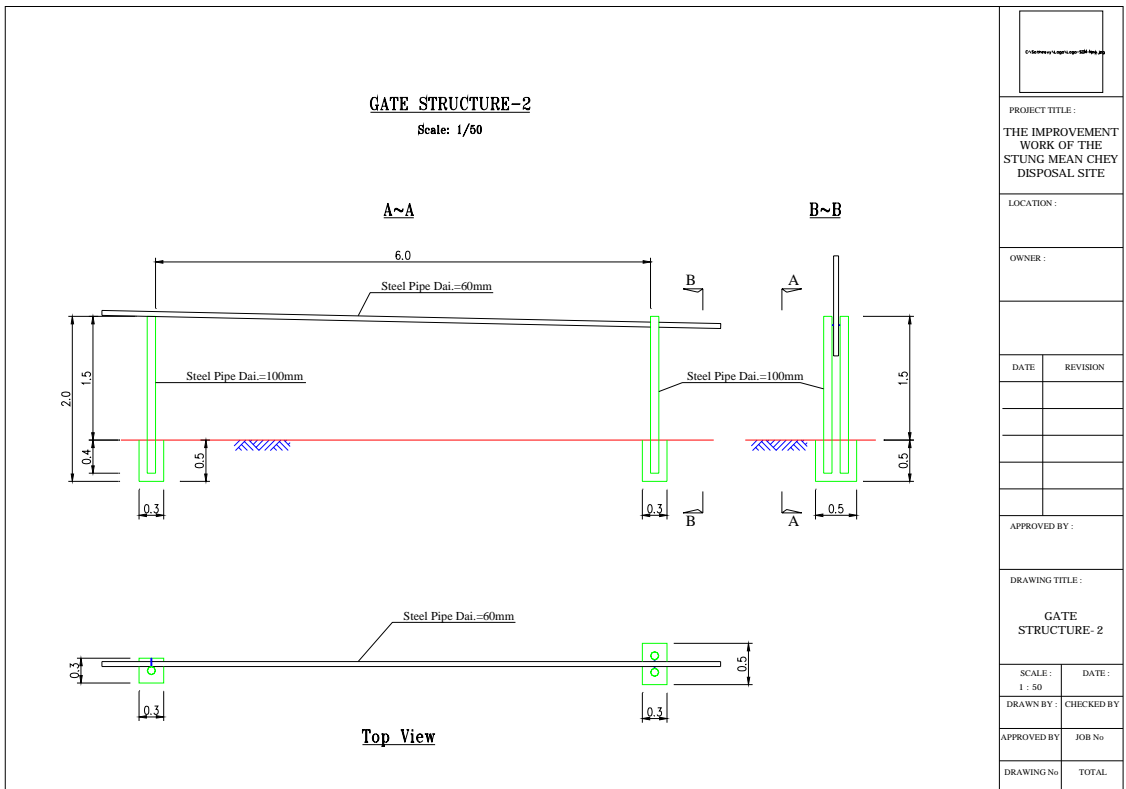
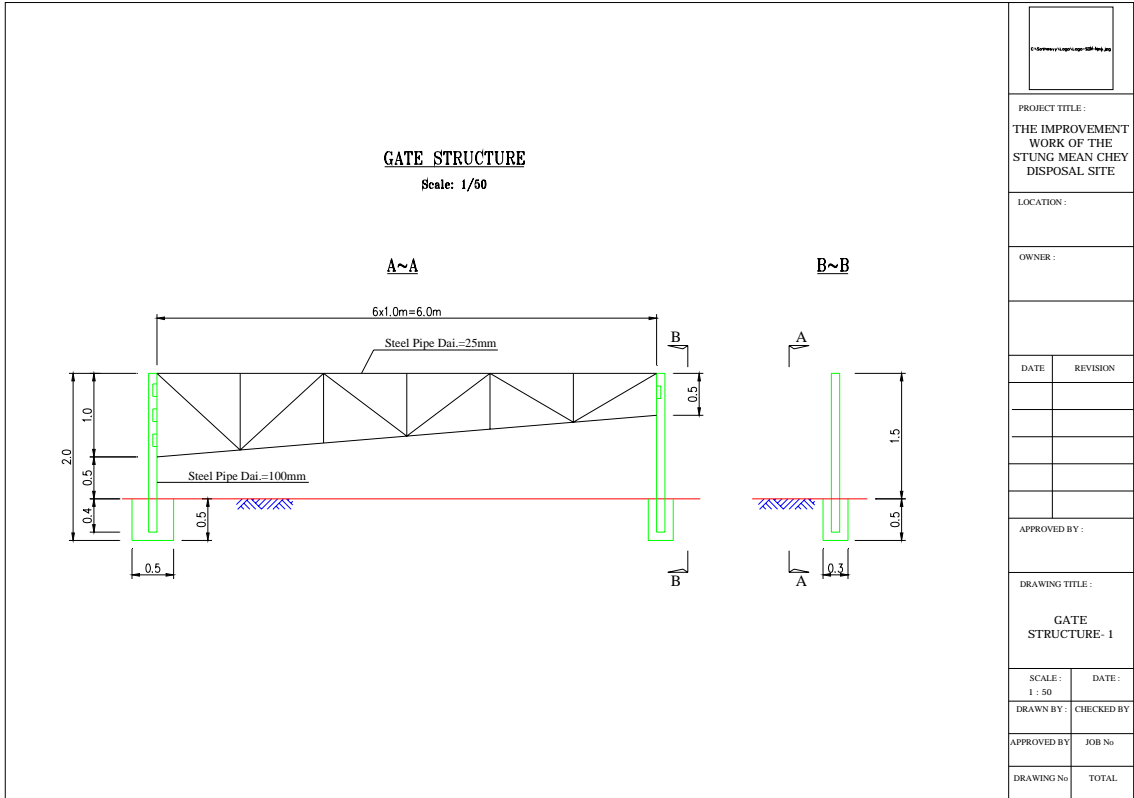


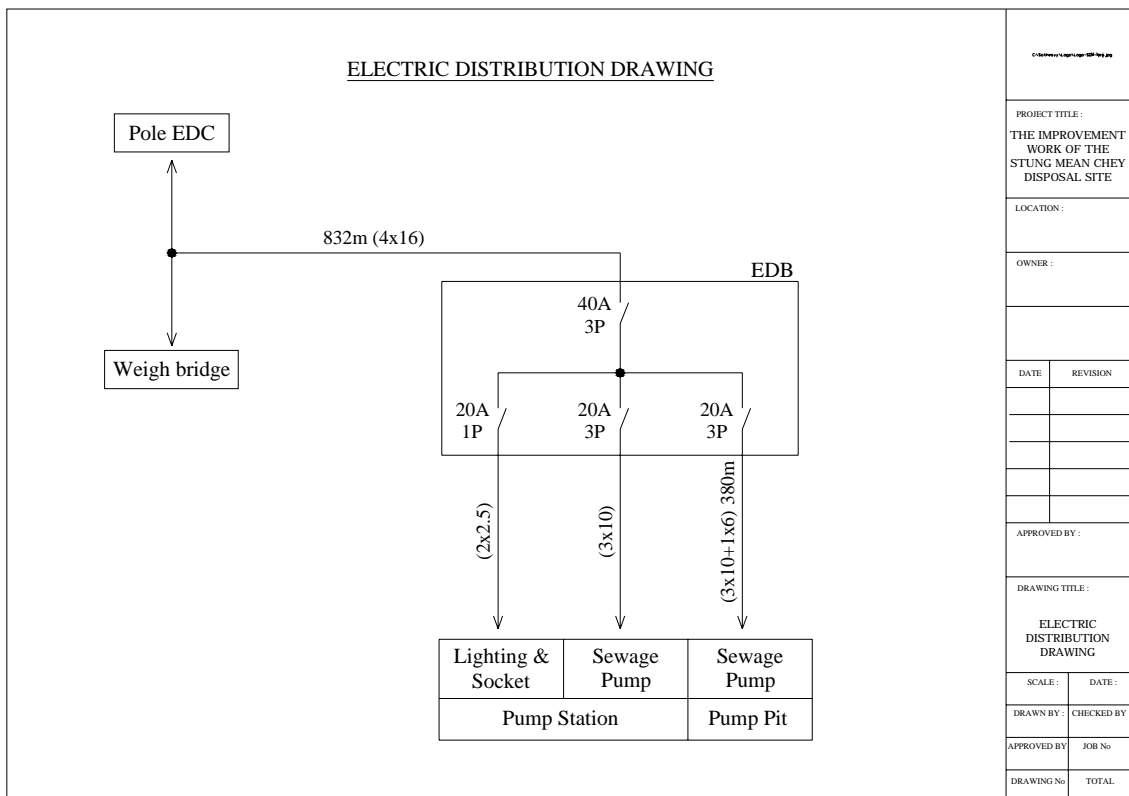
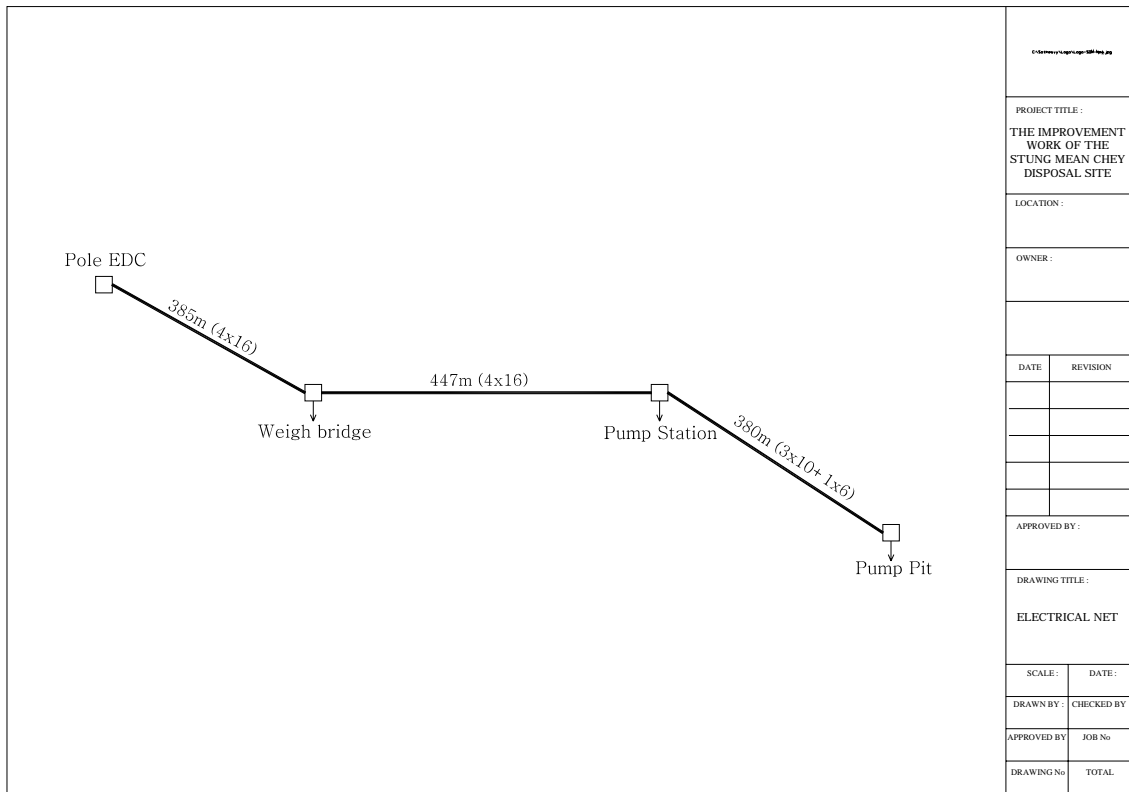
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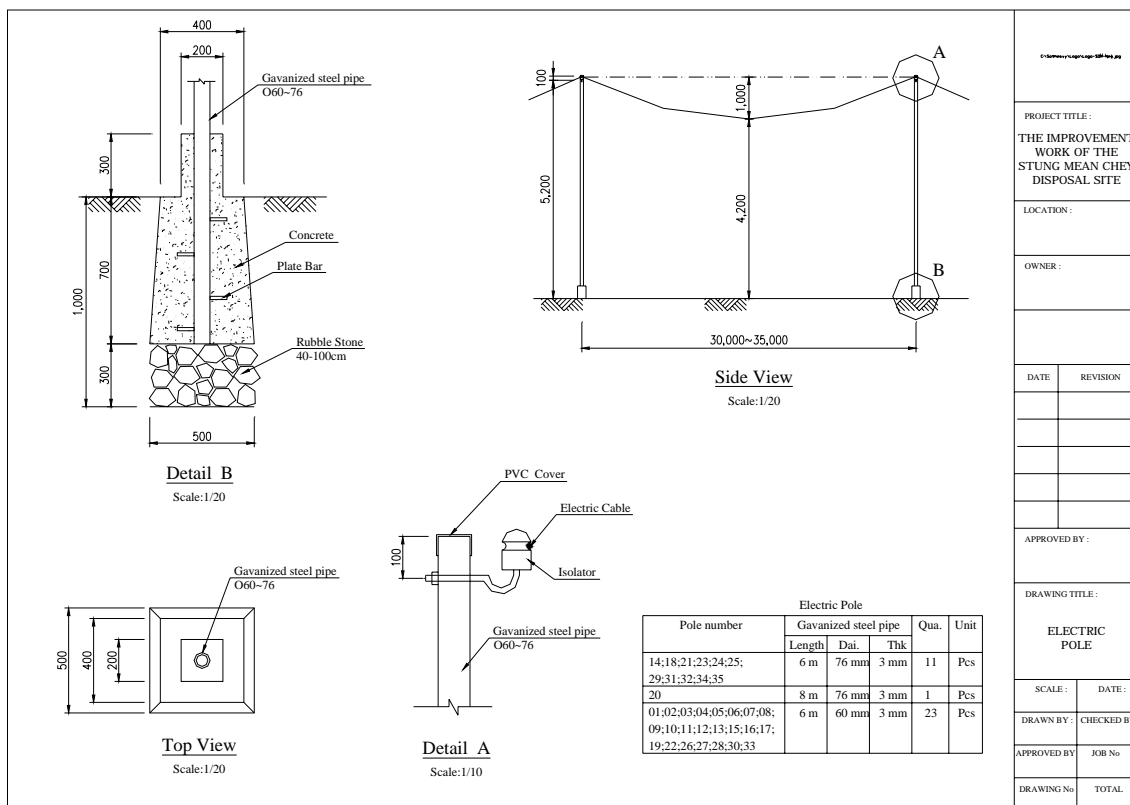


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## 10.2 Introduction of Waste Picking Rules

### 10.2.1 Background

The improper operation of the Stung Mean Chey disposal site (SMCDS) is causing serious environment problems, and it has become urgent for MPP to improve PPWM's operation and management of the disposal site. From the start of the JICA study, the improvement of SMDC was one of the possible Pilot Projects to be implemented during the second phase of the study.

On the other hand, a large number of waste pickers are working at the disposal site without any order, which has resulted in the frequent occurrence of accidents. The existence of waste pickers could be a major obstacle in the improvement of PPWM's operation of the disposal site. In general, the introduction of waste picking rules is regarded as an effective measure to solve this kind of problem. Since it is impossible for PPWM to enforce waste picking rules without the understanding and cooperation of waste pickers, the team decided to introduce such rules at the disposal site as a part of the pilot project to improve the SMCDS, provided that the team was able to reach a consensus with waste pickers about the rules.

### 10.2.2 Project Purpose

The overall goal of the pilot project is to improve the social and environmental situation of the disposal site by improving the operation and management of PPWM.

One of the main purposes of the pilot project is to prepare the draft of waste picking rules based on the first phase of the study and to examine the applicability of these rules through

trials. The team also aimed at examining appropriate waste picking rules, as well as necessary PPWM staff and equipment, for the sustainable management of waste picking rules.

### 10.2.3 Result of the First Phase Study

As mentioned above, it is imperative for the team and PPWM to reach a consensus and cooperate with waste pickers in order to introduce waste picking rules. During the first phase of the study, the team conducted the following surveys in order to know how waste pickers themselves perceived the current situation of SMCDS, if they wanted to improve working and living conditions, and what opinions they had about the proposed waste picking rules.

#### a. First Phase Studies and Their Contents

- Focus group meetings (Local authorities, ordinal people and waste pickers)  
Discussion items:
  - environment and social problems at SMC
  - possible solutions
  - roles and responsibilities of each group
- Interview Survey with full-time waste pickers with permanent living status selected by World Vision Cambodia  
Survey items:
  - types and volume of recyclables they collected and the total earnings
  - working hours
  - living conditions
  - health conditions
  - problems they faced at the disposal site and their possible solutions
  - problems they faced at home and their possible solutions
  - opinions about waste picking rules
- Interview survey with waste pickers randomly selected at the disposal site  
Survey items:
  - the types and volume of recyclables they collected and the total earnings
  - the frequency of working at the disposal site
- Observation Survey at the disposal site  
Survey items:
  - the number of waste pickers at the disposal site
  - the share of children

#### b. Result of the First Phase Study

The first phase study revealed the following points. One of the features of waste pickers at SMCDS is their large number and diversification. In addition, they rarely helped each other or were organized. On the other hand, most of the respondents of the interview survey and meeting participants recognized the chaotic situation of SMCDS as a serious problem and agreed with the proposed waste picking rules.

- There are a large number of waste pickers working at the SMCDS (the team assumed far exceed 700), and there is a continuous influx of new comers from rural areas.
- Waste pickers at SMCDS were diversified in terms of age, income, frequency of working at the disposal site, and living status.
- There were no groups or associations in which waste pickers help each other.
- The competition with other waste pickers was selected as the most serious problem at the disposal site.

- Most of the interviewees and meeting participants were concerned about not only safety but also security at the disposal site, and that they need some kind of order at the disposal site.
- Most of them agreed that waste picking rules have a potential to bring about order at the disposal site and to decrease the number of accidents.

Most of the interviewees and meeting participants were selected from those who cooperate with NGOs, which resulted in the unanimous agreement with the proposed rules. It is highly likely that some waste pickers, in particular those who earn more than the average, would oppose to the proposed rules.

However, the team drew the conclusion that the majority of waste pickers would accept the basic idea of waste picking rules, if the team and PPWM succeeded in showing the advantage of rules clearly and reflected their opinions and ideas in the final waste picking rules.

On the other hand, the lack of self-organization of waste pickers would make it difficult for the team to understand waste pickers' collective opinion, which would be necessary to make a consensus with them. The continuous cooperation with NGOs which are working at SMCDS is indispensable to establish a good relationship with waste pickers.

#### **10.2.4 Preparation of the Trial (Second phase study)**

Since the number of waste pickers is very large and they are considerably diversified, the team expected a lot of difficulties in introducing waste picking rules. In addition, Cambodian people are generally not familiar with basic social rules. These elements required careful preparation before the start of the trial. The procedure for preparing the trial is as follows.

##### **a. Formulation of the Draft of Waste Picking Rules**

The draft of waste picking rules was formulated referring to experiences in other countries and based on the results of second phase studies.

Since the registration system and the issue of ID cards make it easy for the operator of a disposal site to control waste pickers, the registration system is generally one of main components of waste picking rules.

In the case of SMCDS, due to the large number of waste pickers and their diversification, the registration system could be a powerful tool for PPWM to grasp the entire picture of waste pickers and to control them. Therefore, the team decided to make the registration system one of the main items of the waste picking rules and to formulate a database based on the registration data.

One of the most difficult issues was how to deal with child waste pickers. In light of their economic contribution to their households, it is impossible to eliminate child waste pickers from the disposal site. PPWM and the team decided to allow children of 7 years old or older to continue to work at the disposal site. Instead, a regular monitoring system on child waste pickers between 7 and 15 years old will be conducted aiming at encouraging all the child waste pickers to continue to study at school.

To increase security at the disposal site and ensure proper operation by PPWM, the separation of the working area of waste pickers and that of heavy vehicles is indispensable. The team made the separation of working areas a priority.

### ***Main purpose of the waste picking rules***

- to increase safety
- to improve operation by PPWM

### ***Main items of planned waste picking rules***

- Introduction of a registration system and issuance of ID cards (Permission card to enter the disposal site)
- Separation of the working area of waste pickers and that of heavy vehicles such as bulldozers and collection vehicles
- Prohibition of illegal activities and nuisances, in particular buying waste from collection vehicle drivers

To make sure that all the registered waste pickers know the rules, a rulebook is to be prepared and distributed to all the registered waste pickers. In addition, jackets will also be prepared and distributed to full-time waste pickers so that PPWM can easily identify registered waste pickers.

## **b. Community Meetings to Explain the Draft of Waste Picking Rules**

The total number of waste pickers was assumed to far exceed 700. In addition, there are a lot of part-time waste pickers, who are working only one or two days per week at the disposal site. Moreover, some waste pickers go back and forth between the disposal site and the streets in the center of the city. Therefore, it is very difficult to contact all the waste pickers only at the disposal site.

The team decided to ask village authorities for their cooperation and tried to get preliminary information on waste pickers from them. In addition, the team arranged one or two meetings in each village to explain the draft of waste picking rules to waste pickers. As a result, the team organized 11 meetings in total in 8 villages of Commune Stung Mean Chey and Beung Tompum, in cooperation with village chiefs.

The procedure for organizing community meetings is summarized below.

- ask village authorities to make a list of waste picker families in each village
- organize one or two community meetings in each village and invite one person from each family based on the list
- show the outline of the improvement plan including construction works and explain the details of the planned waste picking rules

## **c. Registration of Waste Pickers and Formulation of the Waste Picker Database**

### **c.1 Procedure of Registration and Database Formulation**

Since it is very difficult to contact all the waste pickers at the disposal site, as mentioned before, the team tried to utilize the community meetings as an opportunity for waste pickers to apply for preliminary registration. The preliminary registration was expected to mitigate the disorder that could occur when receiving applications for ID cards at the disposal site.

Since many waste pickers go back and forth between the disposal site and the streets in the center of Phnom Penh, it was difficult to distinguish waste pickers working at the disposal site from others. Hence the team relaxed the criteria for the registration. Even though the number of applicants for the preliminary registration seemed to more than the actual number, this could keep PPWM from being overloaded with additional registrations.

The procedure for the registration of waste pickers and the formulation of the database is shown below.

- The waste picker family data was formulated based on the waste picker family lists which village officers made for the community meetings in their villages.
- One or two community meetings were arranged in each village in cooperation with the Village Chief. At the end of the community meetings, the meeting participants, each of which was a representative of his/her waste picker family, provided information on all the family members that were working at the disposal site.
- The database was formulated based on the data that was obtained at community meetings
- The team set up a registration desk at the disposal site and accepted the applications for ID cards by individual waste pickers for around 2 weeks (from November 17 to November 31). A photograph of each waste picker was taken for the ID card.
- The ID cards were prepared for the actual applicants.

### c.2 Waste Picker Database

In many waste picker families, plural members including children are working at the disposal site, so the waste picker database was managed based on the family unit. The initial family data is based on the lists village authorities made for the community meetings. Waste pickers who want to apply for ID cards later on have to register their families first.

In addition, in order to get a full picture of the diversity of waste pickers, the items below were included in the database. In particular, to make it easier for PPWM to monitor child waste pickers, child waste pickers were asked if they were going to formal/informal school or not.

As a part of the establishment of the registration system, jackets for waste pickers were prepared and vaccinations against tetanus and hepatitis B were administered. The database was also designed taking these activities into consideration.

The main items of the database are shown below.

#### *Family data*

Household No.	Name of Household Head	Age	Sex	Village code	Street	No of House Group	Housing No.

#### *Individual waste picker data*

ID No.	Household No.	Name	Date of Birth	Sex	Permanent or tentative Yes: ✓ No:	Frequency of working number of days per week	Age between 7-15	
							Going to formal school Yes: ✓ No:	Going to informal school Yes: ✓ No:

Application to Vaccination	Selected as Jacket target	Date/time of vaccination	Vaccination	Application to registration	ID Card
Finish: ✓ No:	Yes: ✓ No:		receive: ✓ not receive:	finish: ✓ not yet	receive: ✓ not yet

### c.3 Registered Waste Pickers

At the end of the community meetings, around 700 families applied for preliminary registration. At the end of the registration period on November 31, 1,106 households were registered.

According to the database as of January 16, 2004, the registered waste pickers can be summarized as follows.

- In total, 2,907 people applied for preliminary registration and 2,215 actually applied for ID cards.
- PPWM checked whether the individual waste pickers worked at the disposal site for several days and distributed ID cards to those who were spotted three times. The number of people who received ID cards is 1,456.
- Among the applicants, there are more than 400 child waste pickers.

younger than 10 years old	32	2.2%
10-15 years old	390	26.8%
16-19 years old	246	16.9%
20-29 years old	262	18.0%
30-39 years old	237	16.3%
40-49 years old	183	12.6%
50-59 years old	78	5.4%
60-69 years old	22	1.5%
70-79 years old	4	0.3%
80-89 years old	2	0.1%
total	1456	100.0%

- The frequency of working at the disposal site is shown in the table below.

1 day/week	13	0.9%
2 days/week	262	18.0%
3 days/week	103	7.1%
4 days/week	84	5.8%
5 days/week	120	8.2%
6 days/week	114	7.8%
7 days/week	760	52.2%
total	1456	100%

- The number of child waste pickers who go to formal or informal school is summarized below.

Age	total number	number of children		
		go to formal school	go to informal school	go to neither formal nor informal school
7	6	2	2	2
8	12	7	1	4
9	14	5	4	5
10	52	22	19	11
11	45	16	21	8
12	71	26	28	17
13	84	38	28	18
14	62	15	34	13
15	76	13	33	30
total	422	144	170	108

#### d. Matters of Concern

During the preparation period in the second phase study, the team faced additional concerns, other than the problems that had been expected due to the result of the first phase study such



as (1) diversity of waste pickers in terms of age, income and living and working status, (2) intense competition among waste pickers, and (3) lack of self-help organizations.

Just before the start of the trial, the team summarized the additional problems and examined their countermeasures.

#### **d.1 Weak Sense of Basic Social Rules**

In general, Cambodian people are not familiar with social rules such as traffic rules and do not respect them much. Social rules cannot take root in the society without a tacit understanding that other people also follow rules. Since waste pickers are not familiar with rules and do not trust each other, it seems difficult to introduce rules regardless of their contents.

Due to the behavior of waste pickers at the community meetings and the registration desk, they were expected to have difficulty in following directions in a mass group. Once one person disregards the rules, the rest of the group tends to surge forward in crowds and it becomes very difficult to restore order. Therefore, when PPWM starts to separate the working areas, it is necessary to assume possible reactions of waste pickers and to examine countermeasures, so that PPWM can give appropriate directions before their behavior is out of order.

Until waste pickers become familiar with waste picking rules, it might be necessary to take measures to force them to follow the rules to some extent. Employing assistants is one possible measure, along with asking police for cooperation.

#### **d.2 Problem Waste Pickers**

Since the NORDAD project, there has been a problem in which some waste pickers buy waste from collection vehicle drivers and keep it to themselves. At present, a handful of people continue to buy waste from specific drivers and keep other waste pickers away from their waste by force.

The trial revealed that their activity of keeping a pile of waste to themselves became a serious obstacle in implementing working area separation. However, since some of the staff members at the disposal site are also involved in this activity, it is necessary to take careful measures to eliminate this kind of business.

On the other hand, the team already asked Commune and Village authorities for their cooperation to deal with violence in which problem waste pickers are involved. Commune authorities agreed to summon them to the offices to ask them for a written consent to stop buying waste.

### **10.2.5 Trial of Waste Picking Rules**

Due to a dispute about the content of the land lease contract between PPWM and some landowners, there was a reduction in the planned expanded area, which resulted in a delay of the construction work. As a result, the trial started at the end of December, 2003.

Separation of the working areas requires a certain number of personnel and heavy vehicles, but due to financial problems PPWM could not fully operate the bulldozers. In addition, as mentioned in the previous section, it was assumed that there would be a lot of difficulties in establishing a cooperative relationship with waste pickers. Therefore, the team decided to focus on increasing safety and to narrow the activity of the trial down to separating the waste pickers from the area where heavy vehicles are operated.

ID checks at the gate, another main component of the waste picking rules, could not be conducted during the trial due to the delay of the construction work.

It was still assumed to be difficult to separate working areas because of the large number of waste pickers, so the team decided to apply various approaches flexibly.

**a. Final Preparation**

Just before the start of the trial, the following preparations were made.

**a.1 Modification of Waste Picking Rules**

In the original plan, the team proposed to separate the landfill area into 4 different types of working areas; (1) waste unloading area, (2) waste picking area, (3) waste leveling area, and (4) waste compaction area, and rotate them every half day, as shown in Figure 1.

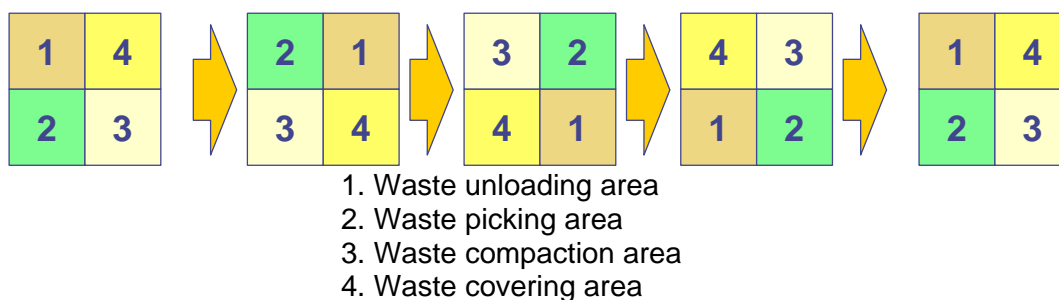


Figure 10-1: Rotation of Working Area

Due to the lack of PPWM personnel and heavy vehicles, as mentioned before, the team decided to decrease the number of working areas from 4 to 3, combining the waste leveling and compaction areas into one area, as shown in the following figure. These working areas are rotated after a certain period of time. Moreover, due to the reduction of the expansion area caused by the dispute between PPWM and landowners, the number of working areas was reduced further from 3 to 2.

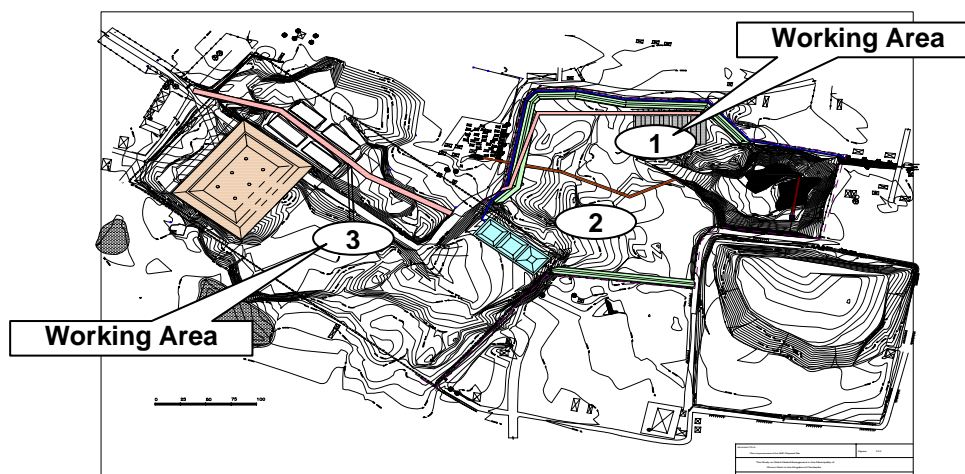


Figure 10-2: Original Plan of Working Area Separation

**a.2 Construction of the Working Areas**

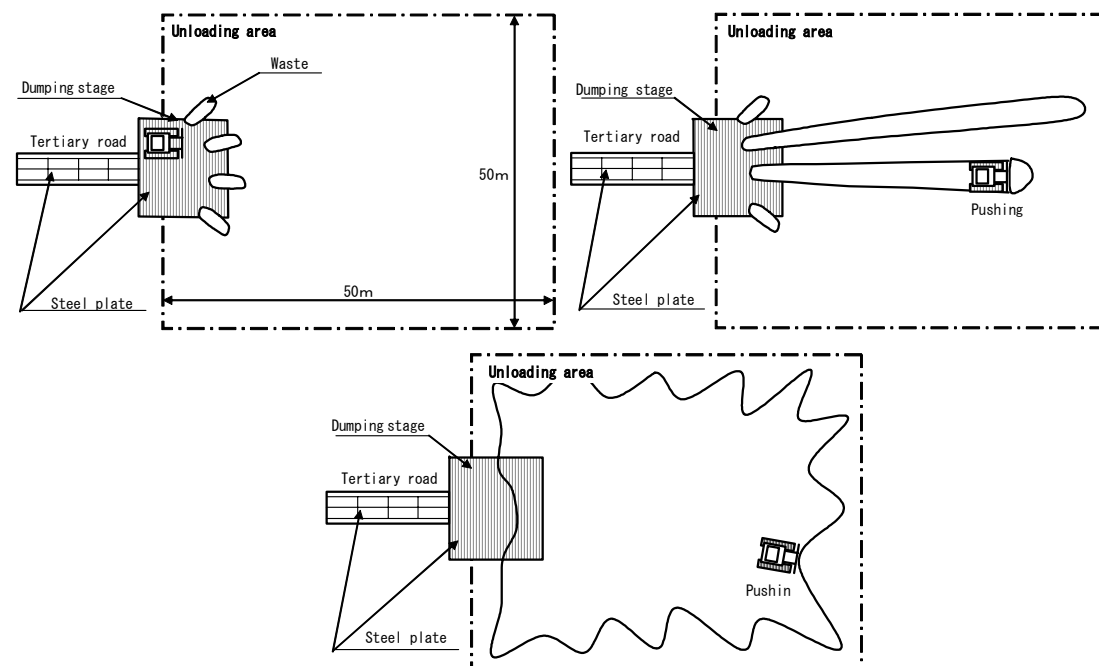
In each working area, a dumping stage was constructed along with a dozen of iron plates along with the tertiary road, as shown in Figure 10-3. (This time, the contractor of the

improvement work, SOM, constructed the dumping stage, but in the future PPWM should construct it itself).

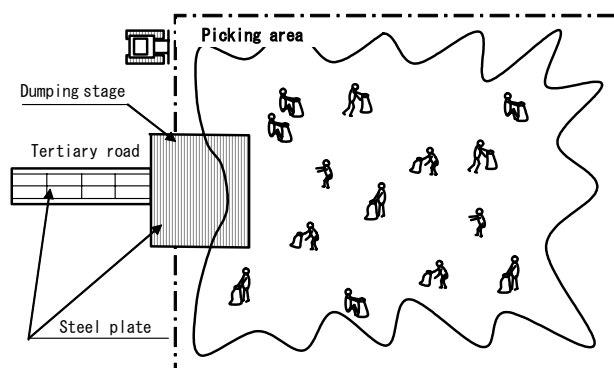
### a.3 Operation at the Waste Unloading Area

First, the original idea of the basic operation at the unloading area is shown. Collection vehicles go along the tertiary road and unload waste at the edge of the dumping stage. After a certain amount of waste is unloaded by several vehicles, a bulldozer starts the leveling work as shown in Figure 10-3. After the repetition of this work, the waste is leveled evenly throughout the area by a bulldozer, and the area is open to waste pickers.

#### Waste Unloading Area



#### Waste Picking Area



#### Waste Compaction Area

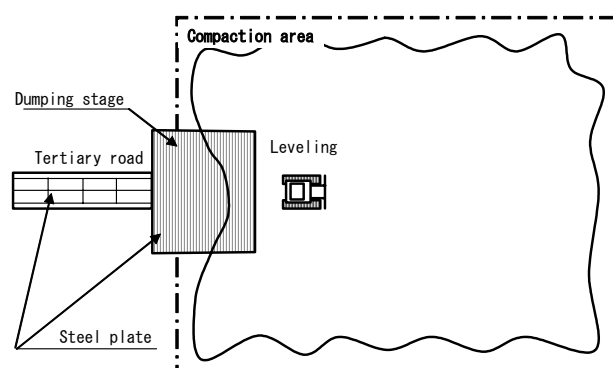


Figure 10-3: Operation Work at Each Working Area

### a.4 Arrangement of Assistants and Police

The team had a plan to rope off the waste unloading area, but it was clear that roping off the area was not enough to keep waste pickers out. Therefore, the team decided to arrange

assistants around the unloading area. Assistants were selected from waste pickers, based on the advice of VCAO. In order to keep the order, the team thought that it would be effective to organize people with authority to monitor the behavior of waste pickers. The team asked the local police for cooperation through PPWM.

Since the team assumed the work to be in three shifts in the original idea, three working groups, consisting of one PPWM staff member as the leader, 5 assistants and 4 policemen, were organized. The biggest issue is how to keep waste pickers off of the unloading road, which is why all the assistants and policemen were assigned to the unloading area.

The roles and responsibilities of each person are summarized in the table below and the arrangement of personnel is shown in Figure 10-4.

Table 10-1: Roles and Responsibilities of Each Party

Member of Working Group	Number	Responsibility
PPWM Staff	1	<ul style="list-style-type: none"> <li>to manage the whole operation</li> </ul>
Assistant	5	<ul style="list-style-type: none"> <li>to monitor whether waste pickers enter the unloading area and to inform to policemen if someone enter</li> </ul>
Policemen	4	<ul style="list-style-type: none"> <li>to expel waste pickers who enter the unloading area out of the unloading area</li> </ul>

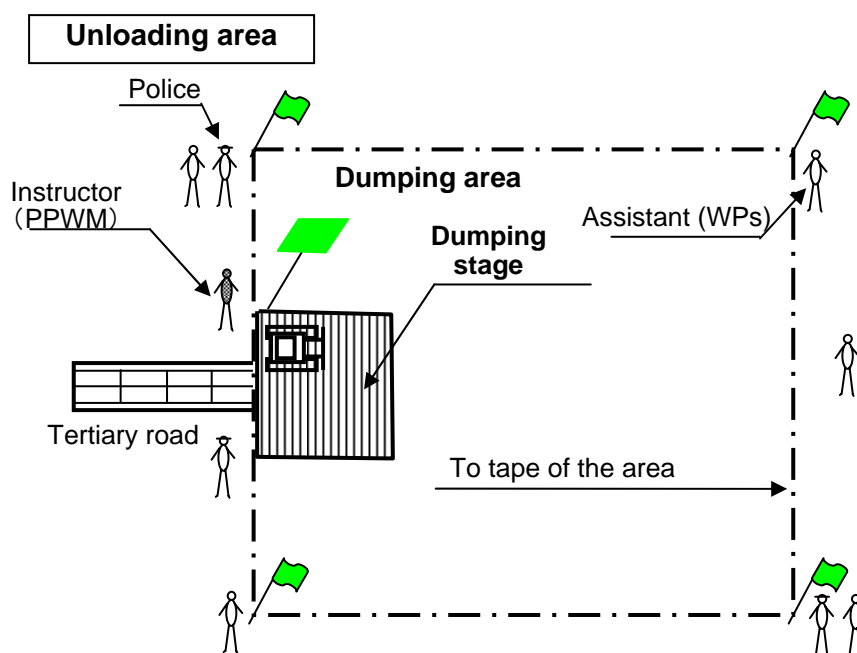


Figure 10-4: Arrangement of Personnel at the Waste Unloading Area

#### a.5 Issuing ID cards (Permission cards), Final explanation of rules and Distribution of jackets

As PPWM intended, PPWM was solely in charge of issuing ID cards and distributing rulebooks and jackets. PPWM checked the registered waste pickers at the disposal site several times and distributed ID cards to those who were spotted more than three times. The number of waste pickers who received ID cards as of January, 2004, was 1,450. Since many waste pickers work at the disposal site irregularly, many applicants have not received their ID card yet.

Although rulebooks should be distributed along with the ID cards, PPWM did not distribute rulebooks to waste pickers before the trial. The team distributed rulebooks at the start of the trial.

PPWM could not distribute jackets either because of the large number of applicants. The team selected the targets of the jackets, full-time waste pickers who work daily at the disposal site, based on the database, and advised PPWM to lend jackets to target waste pickers based on the list the team made.

## **b. Implementation of the Trials**

The trials were done from December 26, 2003, to January 15, 2004.

### **b.1 Trial 1**

In Trial 1, three working areas were prepared and the team tried to rotate the working areas every 6-7 hours. Since the landfill operation at SMCDS continues at night except between the hours of 11pm to 2am, the team tried to implement the working area separation in three shifts.

#### ***Result of Trial 1***

Trial 1 revealed that the 6-7 hour rotation time was too long for waste pickers to wait and the layer of waste after the leveling work became too thick to pick through waste on the bottom. Moreover, the leveling work caused a serious problem for waste pickers; some types of waste such as remains of a meal were flattened and lost their value. As a result, a lot of waste pickers expressed their discontent with the new rules.

In particular, those who bought waste from collection vehicle drivers openly resisted against the working area separation and provoked other waste pickers. This made it very difficult for PPWM to keep order at the waste unloading area.

On the other hand, a lot of waste pickers worked at night. Considering the limited number of PPWM staff, their working conditions and safety, the team drew the conclusion that at present it was impossible for PPWM to continue the working area separation at night.

### **b.2 Trial 2**

Due to the dispute between some landowners and PPWM, the landfill operation could not be done in the expansion area and the working areas had to be rearranged in the existing landfill area. Because of the limited operation area, the number of working areas was reduced from 3 to 2.

It took 2-3 days to reconstruct the dumping stages. While the new dumping stages were prepared, the team organized a meeting with PPWM, assistants, policemen and VCAO and examined the modification of waste picking rules. In addition, there are still a lot of waste pickers that did not know the waste picking rules well, so over the weekend, assistants distributed rulebooks while explaining the rules to waste pickers.

#### ***The modified waste picking rules***

- |                           |   |
|---------------------------|---|
| 1) mber of working areas: | 2   |
| 2) ngth of rotation time: | 2 hours   |
| 3) veling work:           | There is no leveling work during the unloading operation.<br>The leveling work is done after waste pickers finish their work. |

The team tried applying light leveling work during the waste picking time. After most of the waste on the surface was collected, the team asked all the waste pickers to get out of the waste picking area. Then a bulldozer pushed the waste from the dumping stage and leveled the waste lightly, so that the waste on the bottom came to the surface. After a short break, waste pickers were allowed to enter the waste picking area again and continued to pick through the waste. Even though this light leveling work won the support of many waste pickers, it was impossible to continue the work because there was only one bulldozer available.

4) hedule of daily operation: Two shifts during the daytime (no night work)

5) rangement of personnel: **Assistants:** one group is stationed in each working area; 4 groups in total (2 groups × 2 shifts = 4 groups)

**Policemen:** one group moves between the two working areas to monitor the unloading work; 2 groups in total

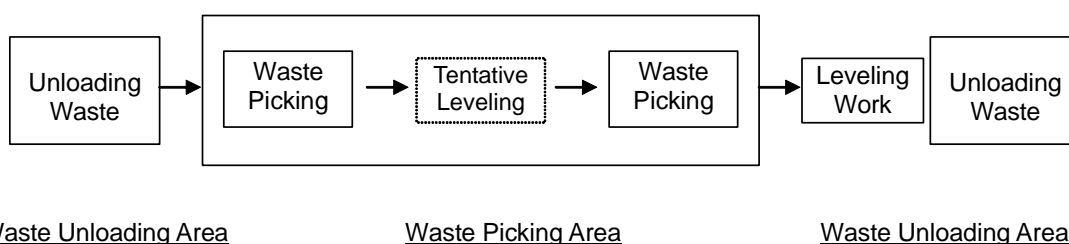


Figure 10-5: Rotation of Working Areas

### **Result of Trial 2**

Shortening the unloading time from 6 hours to 2 hours made separation of the working areas more acceptable to waste pickers, but 2 hours still seems too long to wait for them. In particular, when an interval of collection vehicles was long, it became impossible for PPWM to keep waste pickers out of the waste unloading area.

As a trial, PPWM allowed waste pickers to enter the waste unloading area until the next collection vehicles came. However, it turned out that once they entered the waste unloading area it was impossible to get them out of the area until they finished picking through the waste.

On the other hand, the efficiency of unloading work by collection vehicles and leveling work by a bulldozer seemed to be improved considerably. The result of trial showed that waste picking rules had the potential not only to reduce the operational cost of PPWM but also to shorten the waiting time of collection vehicles at the disposal site.

### **b.3 Trial 3**

In Trial 3, the team tried rotating the working areas by the number of collection vehicles (around 5 vehicles) not by the period of time.

### **Result of Trial 3**

The rotation time was further shortened to 30-40 minutes, which appeared to be an acceptable length for the waste pickers. As a result, trial 3 won the most support from the waste pickers.

However, a short rotation time requires at least 2 bulldozers for smooth operation of two different areas. Since only one bulldozer was available, PPWM could not rotate the working areas smoothly.

When the rotation time was controlled by a fixed number of collection vehicles, many waste pickers could not wait for the last collection vehicle to finish unloading waste. In many cases, they rushed into the unloading area while the last vehicle was being unloaded and it became impossible for PPWM to control them.

#### b.4 Other trials

- Reduction of Waste Unloading Area

In the beginning, the team secured a large space in each working area, but it seemed that the large space encouraged the waste pickers to enter the unloading area. At the end of the trial, the area was reduced to a minimum space. Outside the unloading area another space was prepared as shown in Figure 10-6, and waste pickers could continue to collect waste during the unloading time.

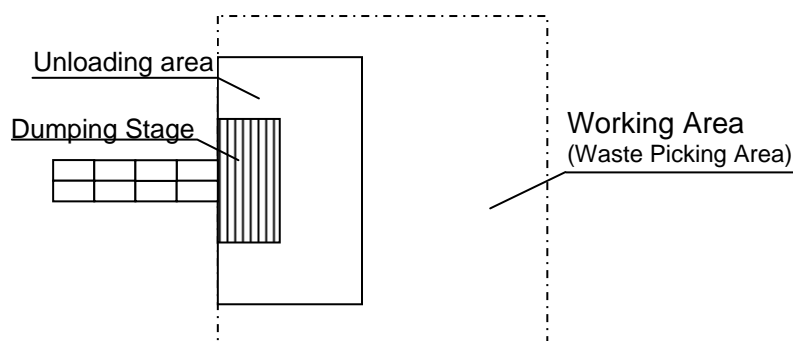


Figure 10-6: Reduced Unloading Area

- Use of Rope  
The team tried to separate the working areas without rope. It was impossible for PPWM to control waste pickers without rope.

### 10.2.6 Result of Interview Survey with Waste Pickers on Waste Picking Rules

To obtain the opinions and comments of waste pickers about working area separation, two team assistants conducted an interview survey with waste pickers for two days at the end of the trial.

#### a. About the Interviewees

The interviewees were selected randomly by the team assistants at the disposal site. The number of interviewees was 40. The outline of interviewees is briefly summarized below.

#### Distribution of Age

Age Group	Female	Male	Total
9 or younger		1	1
10-19	12	7	19
20-29	5	11	16
30-39	7	6	13
40-49	6	1	7
50-59	2		2
60-69	1		1
70-79		1	1
Grand total	33	27	60

#### Living Status

Permanent	37	61.7%
Temporarily	22	36.7%
no reply	1	1.7%
total	60	100.0%

### ID Possession

I have it at home	53	88.3%
I keep it now	1	1.7%
I have not received yet	2	3.3%
I have not applied yet	2	3.3%
no reply	2	3.3%
total	60	100.0%

#### b. Before the Start of the Trial

Two-thirds of the respondents replied that they had already heard about the waste picking rules before the start of the trial. About one-third of them thought that it was good to implement waste picking rules, while the same number of them did not understand the rules well. Most people got some kind of information on the waste picking rules through the application for ID cards, but less than one-third of them understood the rules well.

#### **Q Did anyone from your family attend a community meeting?**

I attended	19	31.7%
A family member attended	12	20.0%
No one attended from my family	19	31.7%
I do not know	9	15.0%
No reply	1	1.7%
Total	60	100.0%

#### **Q (to those who had heard about rules before the trial) what did you think about it?**

I thought it was good to introduce rules	21
I did not understand them well	21
I thought there was no need for rules	3
Total	45

#### **Q (to those who attended the meeting) Were you prepared for the introduction of WP rules at the start of the trial?**

Yes, I was ready	13
I remember them, but was surprised when the rules started	3
I forgot them and was stunned when the rules started	1
No reply	1
Total	18

#### c. Opinions about waste picking rules

Three-quarters of the respondents recognized the main purpose of waste picking rules precisely. In addition, the same number of them considered that the increase in safety at the disposal site was important.

Regarding the method for separating the working areas, two-thirds of respondents chose 30 minutes as the most appropriate rotation time, while most of them thought it was better to arrange working areas closer to each other.

About half of the respondent replied that there was no change in income, while the rest of them thought their income decreased. Regarding the question about easiness of picking waste, the respondents were almost evenly divided into 3 groups; (1) It becomes easier, (2) It does not change, and (3) It becomes difficult. The division of their opinion could be attributed to the effect of waste picking rules to equalize the opportunity of waste pickers. It can be said that those who earned more than average tend to be negative towards waste picking rules, while the weak recognized its benefit. In conclusion, more than 70% of them agreed with the waste picking rules.



As for comments on the waste picking rules, 5 respondents requested that the buying of waste from collection vehicle drivers be banned. If PPWM succeeds in controlling problem waste pickers, it could win the confidence of ordinary waste pickers, which would make it easier for PPWM to ask them for cooperation.

**Q5a Do you know the main purpose of the working area separation?**

Yes	45
No	15
Total	60

**Q5b (For those who answered "Yes") What is it?**

To increase security, stop the buying of waste, and stop "play boys"	1
To make waste picking fair	1
To reduce accidents	32
To reduce accidents and make waste picking fair	1
To reduce the number of "play boys"	1
To stop accidents	8
No reply	1
Total	45

**Q6 What do you think about the increase in safety?**

It is good and I hope it is realized	44
It is good but securing income is more important	13
Safety is not so important	3
Total	60

**Q What is the most appropriate unloading time for you?**

Around 2 hours	4
Around 1 hour	11
Around 30 minutes	41
I cannot wait no matter how short	4
Total	60

**Q How about the distance between areas?**

The closer, the better	56
I do not mind	4
Total	60

**Q Is there any change in income?**

It increases	5
It does not change	29
It decreases	26
Total	60

**Q9 Is there any change in safety?**

It increases	57
It does not change	3
It decreases	0
total	60

**Q10 How about easiness of waste picking?**

It becomes easier	24
It does not change	20
It becomes difficult	16
Total	60

**Q11 How about competition?**

It is harder	6
It does not change	43
It is eased	11
Total	60

**Q11 In general, what do you think about working area separation?**

	Female	Male	Total
I agree with it and am willing to follow the rules	22	22	44
I think that it is good, but I do not follow the rules	9	4	13
I do no mind safety and do not want to follow rules	2	3	3
total	33	27	60

## 10.2.7 Conclusion

As a part of the pilot project, the team and PPWM tried separating the waste unloading area from the waste picking area. Due to the limited personnel and equipment of PPWM and the difficulty in controlling waste pickers, the team expected that it was very difficult for PPWM to continue the operation by itself. The problems to be solved and countermeasures are summarized below.

### (1) Insufficient personnel and equipment of PPWM

During the pilot project, assistants were employed to supplement PPWM personnel. The limited number of personnel and lack of heavy vehicles such as wheel loaders are fatal obstacles to proper landfill operation. In particular, as heavy vehicles are indispensable for proper landfill operation, it is necessary for MPP to examine a scheme to obtain such vehicles.

After the construction work is completed, PPWM has to start the ID card check at two gates of the disposal site. PPWM also has to continue to receive applications for Waste Picker Registration from newcomers and to issue ID cards. It is necessary for PPWM to arrange personnel properly.

### (2) Consensus with waste pickers

At present, the disposal site is like a public open space. It is necessary for PPWM to show clearly that the disposal site is under its control and it has a responsibility to operate the disposal site properly. In addition, PPWM has to make sure waste pickers understand that they have an obligation to follow the orders of PPWM at the disposal site.

PPWM also has a responsibility to enhance transparency and to ensure impartial treatment to all the waste pickers, so that it can win the trust of waste pickers and reach a consensus with them more smoothly.

### (3) Problem waste pickers

The introduction of waste picking rules could be a major threat to those who earned a considerable amount of income at the disposal site. In particular, for those who buy waste from specific collection vehicles and keep it for themselves, the introduction of rules means a loss of that privilege. Since their interests are contrary to the basic idea of waste picking rules, it is impossible for the team and PPWM to compromise. Moreover, as they try to control other waste pickers by force, it is necessary for PPWM to stop their activities as soon as possible in cooperation with local authorities.

Ordinary waste pickers recognized that problem waste pickers were the main source of problems. PPWM could win their support by solving this problem quickly. In this sense, it is preferable for PPWM to control problem waste pickers.

### (4) Final plan of working area separation

Based on the result of the trials, the team proposed that the working areas be separated as follows:

- Two large working areas, one in the existing landfill area and the other in the expanded landfill area, are constructed

- Inside each working area, two dumping stages are constructed side by side, as shown below.

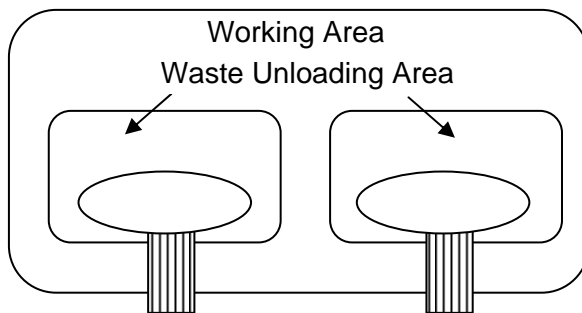


Figure 10-7: Working Area

- Every day, one working area is used in turn for the landfill operation, and inside the Working Area, the two dumping stages are rotated every 5-6 collection vehicles (for 30-40 minutes), as applied in Trial 3.

The layout of the two dumping stages requires only one bulldozer for its operation and can save on the fuel of a bulldozer.

- In the unused working area, the leveling and compaction work is done. Waste that is unloaded the previous day is pushed to the Modal Block (in the existing landfill area) or dumped into a hole (in the expanded landfill area), as shown below.

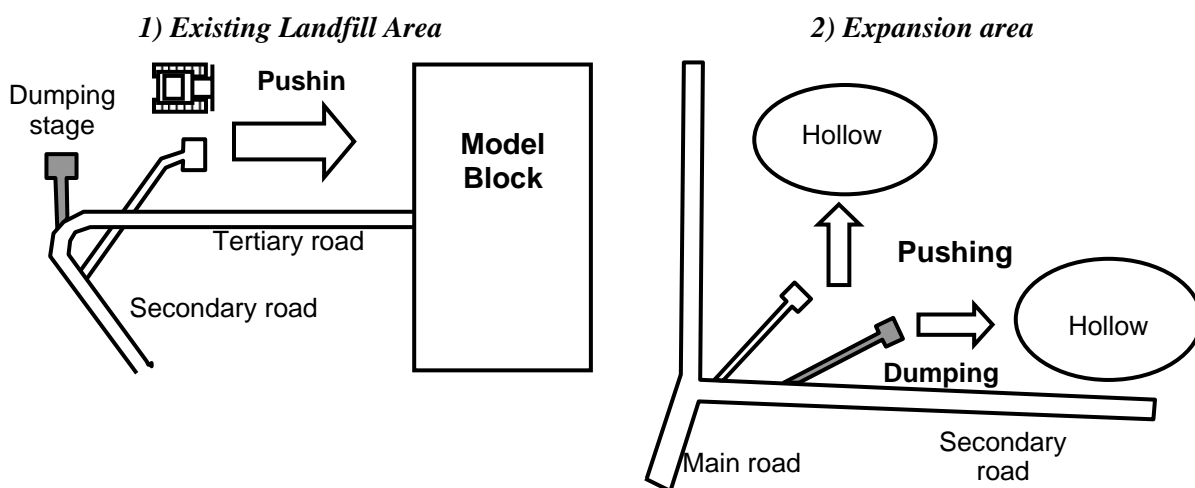


Figure 10-8: Landfill Work in Each Working Area

- PPWM requires at least the following personnel to be stationed at the working area in order to make sure of working area separation

PPWM staff:	1
Assistant in the unloading area:	2
Assistant in the compaction area:	1
Police:	1

- PPWM requires at lease the following heavy vehicles for a sustainable working area separation work

Bulldozer:	2
Wheel loader:	1