SMC Disposal Site before Pilot Project (September 2003)

SMC Disposal Sit after Pilot Project (March 2004)

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Discharge of Waste
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Collection
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Recycling
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Recycling Shop

Recycling
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SMC Disposal Site

Final Disposal
SMC Disposal Site

Final Disposal
SMC Disposal Site

Sorting of Waste
SMC Disposal Site

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NGO Activities: PSE
Informal Education Program for Waste Picker Children

NGO Activities: VCAO
Vocational School

NGO Activities: World Vision Cambodia
Informal Education Program for Waste Picker Children

NGO Activities: CSARO
Compost Production

Illegal Dumping

Illegal Dumping

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Collecting waste from target households

WACS:
Weighing waste collected from households

WACS:
Sorting waste to investigate the composition

WACS:
Sorting waste to investigate the composition

POS
Interview Survey

POS
Interview Survey

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SES
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Medical Institution Survey

Factory Survey

Medical Institution Survey

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Recycling Survey
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Compost Market Survey

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Field Trip
PR Field Trial Farmland

Field Trip
PR Field Trial Farmland

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EIA Survey

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Abbreviations

A/P	Action plan
BTB	Sangkat Boeung Trabek
C/P	Counterpart
CDRI	Cambodia Resource Development Institute
DF/R	Draft final report
DKDS	Dang Kor Disposal Site
DOE	Department of Environment
DPWT	Department of Public Works and Transportation
EIA	Environment Impact Assessment
FAO	Food and Agriculture Organization
F/S	Feasibility Study
F/R	Final report
HW	Hazardous Waste
HIW	Hazardous industrial waste
ICB	Institutional Capacity Building
IC/R	Inception report
IT/R	Interim report
IEE	Initial Environment Examination
IW	Industrial waste
IWM	Industrial waste management
JICA	Japan International Cooperation Agency
M/M	Minutes of meetings
MOE	Ministry of Environment
MOEYS	Ministry of Education, Youth and Sport
MOH	Ministry of Health
M/P	Master plan
MPP	Municipality of Phnom Penh
MSW	Municipal Solid waste
NHIW	Non-hazardous industrial waste
NIP	Neighbourhood Improvement Program
NORAD	Norwegian Agency for Development Cooperation
OJT	On the Job Training
O&M	Operation and Management
PP	Pilot project
PPWM	Phnom Penh Waste Management
P/R	Progress report
POS	Public opinion survey
SES	Social Environment Survey
SHG	Self-Help Group
SMC	Stung Mean Chey
SMCDS	Stung Mean Chey Disposal Site
S/W	Scope of work
SWM	Solid Waste Management
T&M	Time and Motion
VDC	Village Development Committee
WACS	Waste Amount and Composition Survey
WHO	World Health Organization

Chapter 1

Introduction

1 Outline of the Study

1.1 Background

The Municipality of Phnom Penh (MPP) is the capital of Cambodia having a population of 1.2 million in 2003 (estimated) and an area of 374 km^2. Municipal solid waste management (MSWM) in the MPP has been under the jurisdiction of the Department of Public Works and Transport (DPWT). The MSWM services had been provided by the municipal cleansing section under DPWT until June 1994. Since then, due to the extremely limited capability for MSWM, the MPP entrusted its MSWM service to mainly private contractors with franchise agreements, which allows the monopoly service. However, the service provider has been changed six times mainly due to financial difficulty.

Under such circumstances, the Institutional Capacity Building and Neighborhood Improvement Program (ICB & NIP by NORAD) was conducted from May 1997 to March 2002, which is part of the ADB supported drainage component under the Phnom Penh Water Supply and Drainage Project and co-financed by Norwegian Agency for Development Cooperation (NORAD).

According to the proposal given in the ICB & NIP by NORAD, the MPP established the Phnom Penh Waste Management Authority (PPWM) by merging the Cleansing Authority of Phnom Penh (CAP) and the Wastewater Authority of Phnom Penh (WAP) in 2001. The monopoly situation was weakened when PPWM commenced waste collection services in the NIP area and also took over operation of the Stung Mean Chey disposal site (SMCDS). The contract made between MPP and the private company (CINTRI), however, limits the PPWM collection service area to only the NIP area, which is less than 2% of the MPP population.

Waste collection has generally improved in Phnom Penh by the current private company. However, many areas of the city are still without an adequate waste collection service and many tons of wastes are dumped into rivers and ponds, burned or left uncollected to be scattered by animals, block drains and create unsanitary conditions. Waste collection is especially weak in outlying areas and in many of the cities unplanned settlements that are home for thousands of the cities poorest families.

The SMCDS is the only disposal site in the MPP where unregulated landfill operation has continued for 38 years, since 1965. Because the municipality land plot is very limited (only 6.8 ha) and waste is piled up to a height of more than 5 m on average, operation of the landfill is getting more and more difficult. The remaining service life of the landfill is very little within the municipal land (less than two years) and the residential area is approaching less than 100 m away from the site due to rapid urbanization. The construction of a new disposal site is urgently needed. The site is a typical open dump, where more than 500 waste pickers (WPs) are working regularly without any rules or control. This poses a seriously negative impact on the surrounding environment, such as air pollution by smoke caused by fire, waste scattering, offensive odor, surface and underground water contamination, etc.

In order to overcome the aforementioned difficulties with MSWM in the MPP, a comprehensive plan of countermeasures including both soft and hard components is required.

GOC requested the Government of Japan to carry out a development study in 2000. In response to this request, JICA's preliminary study team was sent to Cambodia and the Scope of Work (S/W) was signed by both governments on 24 October 2002. Subsequently, JICA selected Kokusai Kogyo Co., Ltd. as the consultant to conduct this study.

1.2 Outline of the Study

The Study commenced in February 2003, scheduled to be carried out over a 16-month period according to the S/W. The study period was divided into two phases. The study team prepared the master plan (hereinafter referred to as "M/P") in Phase 1 based on the understanding of present SWM and the forecast of future waste generation, etc. In Phase 2, the study team conducted a feasibility study (hereinafter referred to as "F/S") on the priority projects selected in the master plan, which were the Dang Kor disposal site development project, the waste collection service expansion project and SMC disposal site closure project. In addition to these studies, the study team conducted several pilot projects, including the improvement of SMC disposal site, improvement of the collection system, development and promotion of the urban waste compost market, and development of a data management system for SWM.

Regarding the new disposal site development project, MPP held a public hearing twice in the second phase based on the results of the preliminary design and EIA study prepared by the study team, considering the limited remaining capacity of the SMCDS and promoting the project. Although MPP started to acquire the land according to the development plan prepared by the study team, the proposed area was not secured because of a sudden soaring of land prices along national route 303. This might have been due to the fact that the proposed area was identified through the public hearing, and the cost for land acquisition exceeded the budget authorized by the central government. Therefore, MPP changed the plan and acquired 20 ha of land about 800m to the west of national route 303, adjacent to the 11 ha of land MPP had already acquired, securing 31.4 ha of land in all. Consequently, the development plan should be amended according to the land acquired.

Although CINTRI, which was a private service provider, had the right to provide collection services to the whole city according to the contract agreement signed between MPP and CINTRI, the master plan prepared in the first phase of the study proposed that the MPP/PPWM would provide the waste collection service to the three semi-urbanized Khans and CINTRI to the four urban Khans. However, the proposed area demarcation was not agreed to by CINTRI. Therefore, the master plan and the F/S on waste collection should be modified based on a mutual agreement between MPP and CINTRI.

Furthermore, the lack of experience and weak organization of the Phnom Penh Waste Management Authority (herein after referred to as PPWM) and the Department of Environment (hereinafter referred to as "DOE") of MPP were recognized through the study. It was reconfirmed that the capacity development of PPWM and DOE as the executing agencies of SWM would be necessary.

Accordingly, on February 4, 2004 MPP requested JICA to expand the study period, aiming to revise the plan of new disposal site development and expansion of the waste collection service, strengthen the capacity of PPWM and disseminate the results of the study. JICA approved this request and decided to expand the study period until March 2005. Therefore, the third phase of the study was conducted to revise the M/S and F/S and develop the capacity of PPWM through continuation of the pilot projects.

The study team reviewed the preliminary design of the new disposal site development project based on the assumption that the soil condition was almost the same as the results of the geological survey conducted in the second phase of the study. This is because the project site is adjacent to the former site and they had the same geographical features. An additional geological survey was to be done in the detailed design stage. MPP held the third public

hearing and built a public consensus of the implementation of the new disposal site development project explaining the revised plan. MPP also obtained the EIA approval from the Ministry of Environment of Cambodia on July 15 2004.

Regarding the waste collection service expansion project, the MPP and CINTRI agreed to eliminate the unserviced and insufficiently serviced areas in cooperation with each other on May 12, 2004 and both parties have continued to identify the unserviced areas. However, both parties did not reach an agreement by the end of February, 2005. Consequently, MPP has requested the study team to finalize the M/P and feasibility study based on the assumption that PPWM would provide the waste collection service to the areas considered to be unserviced areas by the study team on March 3, 2005. Therefore, the study team prepared this final report according to the request mentioned above.

The study team conducted the pilot projects, which included a continuation of the improvement of SMC disposal site, expansion of the waste collection service to the four Sangkats and an education campaign, to strengthen the capacity of PPWM and DOE. In addition to these pilot projects, the study team conducted a group training workshop for the staff of SWM of the provincial cities so that the provincial cities in Cambodia would be able to formulate their own M/P respectively based on the understanding of the results of the study.

1.3 Objectives and Study Area

1.3.1 Objectives

1. To formulate a master plan (hereinafter referred to as “M/P”) for solid waste management in Phnom Penh with a target year of 2015.
2. To conduct a feasibility study (hereinafter referred to as “F/S”) for the selected priority projects.
3. To transfer technology to the counterpart (hereinafter referred to as the C/P”) in the course of the study.

1.3.2 Study Area

The study area includes the entire municipality of Phnom Penh (population: approx, 1.2 million, area: 373.73 km^2).

1.3.3 Wastes covered in the Study

The wastes covered in the study are municipal solid waste, septage (sludge collected from septic tanks), industrial and medical waste. Municipal solid waste means combustible waste, incombustible waste and bulky waste generated in the MPP, and can be divided into five categories by generation source, namely household waste, commercial waste, institutional waste, market waste and street sweeping waste.

The team conducted studies on the composition and amount of septage, and industrial and medical wastes that are disposed of at the final disposal site. However, the team did not fully consider these three categories of waste in the M/P but clarified current conditions, identified issues that need to be resolved and proposed possible solutions.

1.4 Basic Policies of the Study

In ICB/NIP by NORAD, the "Strategic Solid Waste Management Plan and Action Plan" (SSWMPAP), which is the baseline plan of this Study, was formulated. According to the SSWMPAP, it is necessary to prepare an operational plan, which deals with the management and operation of service institutions and the actual work, as the next step in establishing a waste management system in Phnom Penh.

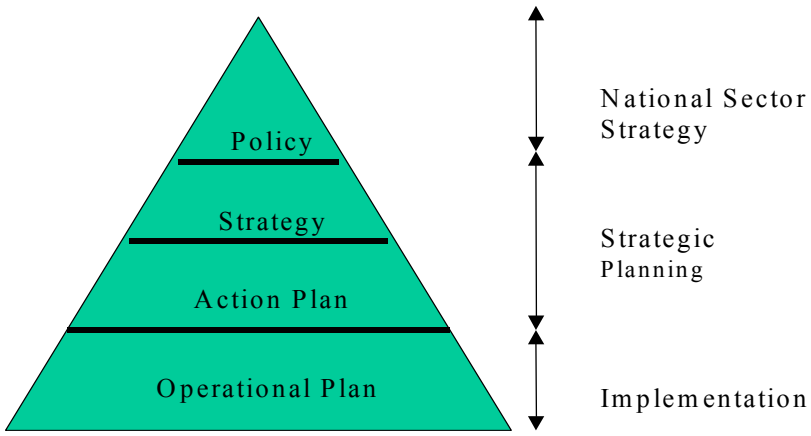


Figure 1-1: Planning Hierarchy

On the basis of the SSWMPAP formulated in the ICB/NIP by NORAD mentioned above, this study was implemented placing particular emphasis on establishing an actual operational plan for solid waste management.

The basic policies of the study were as follows:

Formulation of a practical SWM plan（Practicability）
Promotion of capacity development for main SWM activities（Capacity Building）
Development and application of appropriate technology（Appropriate Technology）
Promotion of public participation（Public participation）
Promotion of consensus building among stakeholders（Consensus）

1.5 Study Schedule

Based on the S/W agreed upon by the Cambodian Government and JICA, the study commenced in February 2003 and the field study was completed in January 2005.

The study was implemented in the following three phases:

Phase 1 : February 2003 － August 2003
Implementation of a study on current conditions of solid waste management and formulation of a master plan

Phase 2 : September 2003 － March 2004
Implementation of a feasibility study for the priority projects

Phase 3 : May 2004 － March 2005
Review of the M/P and the feasibility study and capacity development through continuation of the pilot projects

1.6 Organization of the Study

The study shall be implemented as a joint work by the JICA study team and the C/P.

1.6.1 Members of the study team

Name	Assignment
Mr. Junji Anai	Leader/solid waste management planning
Mr. Susumu Shimura	Deputy leader/institutional management
Mr. Robert Deutch	Collection and transportation planning
Mr. Tamotsu Suzuki	Final disposal/recycling /medical waste/industrial waste
Ms. Keiko Kani	Social consideration/public participation/environmental education
Mr. Takeshi Higo	Waste amount and composition/environmental consideration
Mr. Satoshi Sugimoto	Economic/financial analysis
Mr. Masahiro Ido	Facility planning/cost estimation
Mr. Kunito Ishibashi	Data management system/Web site development
Mr. Masanori Takeishi	Vehicle maintenance planning
Mr. Masahiko Takahashi	Training/administrative coordinator
Mr. Tep Makathy	Chief local assistant (institutional management/collection)
Mr. Saing Hay	Local assistant (Final disposal)
Ms. Kheang Lyhun	Local assistant (Social consideration/public participation/education)

1.6.2 Members of the counterpart personnel

Name	Position
Mr. Moeung Sophan	Head of Public Works Office of DPWT, MPP
Mr. Pumarith	Staff of DPWT
Mr. Samdap	Staff of DPWT
Mr. Heng Lay Orn	Governor of PPWM (2, 2003 - 4, 2004)
Mr. Sao Kunchhune	Governor of PPWM (5, 2004 -)
Mr. Leng Simen	Deputy Governor of PPWM
Mr. Ouch Vann	Deputy Governor of PPWM (2, 2003 – 10, 2004)
Mr. Sam Vicheka	Deputy Governor of PPWM (10, 2004 -)
Mr. Soung Phally	Deputy Governor of PPWM (5, 2004 -)
Mr. Tep Sambath	Staff of Accounting, PPWM
Mr. Khat Orstha	Staff of Accounting, PPWM
Ms. Ly Thavy	Staff of Accounting, PPWM
Ms. Nay Ratha	Staff of Planning, PPWM
Ms. Hem Visal	Staff of Administration, PPWM

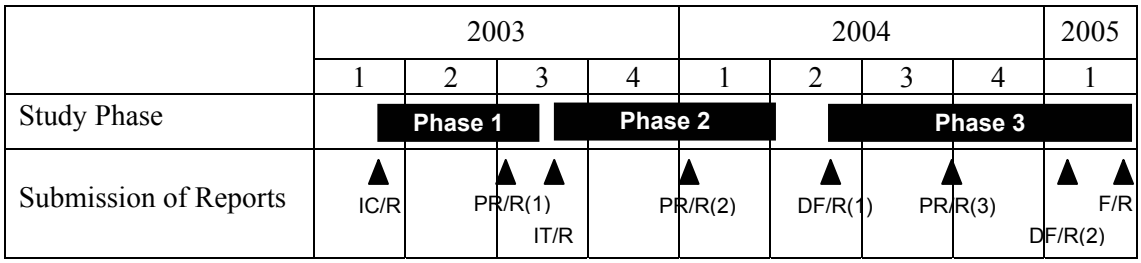
1.7 Transfer of Technology

The study team transferred technology to the C/P by implementing all studies in cooperation with the C/P, and through OJT during implementation of the pilot projects. Moreover, training for the C/P was held in Laos as well as workshops in Cambodia. The details of the technology transfer are discussed in Chapter 5.

1.8 Reports

The study team submitted several reports according to the progress of the study, as shown in the figure below.

Figure 1-2: Reporting Schedule



Symbol	Report	Contents
IC/R	Inception Report	Study contents and schedule
PR/R(1)	Progress Report (1)	Confirmation of the preconditions for M/P, proposal of the pilot projects
IT/R	Interim Report	M/P (Draft), selection of the priority projects
PR/R(3)	Progress Report (2)	Progress of the pilot projects, interim results of the study on the priority projects
DF/R(1)	Draft Final Report (1)	M/P, F/S on the priority project
PR/R(3)	Progress Report (3)	Progress of the pilot projects, confirmation of the precondition for the study on M/P and F/S
DF/R(2)	Draft Final Report (2)	Draft final M/P and F/S
F/R	Final Report	Final version of M/P and F/S

The Final Report consists of the reports listed below. This report is the Main Report of Final Report.

Summary (Japanese, English and Khmer)

Main Report (English)

Supporting Report (English)

Data Book (English)

The study team compiled the report as follows.

Part 1 : Current situation of SWM

Part 2 : SWM Master Plan

Part 3 : Pilot Projects and Capacity Development

Part 4 : Feasibility Study on the Priority Projects

Part 5 : Conclusion and Recommendations

For the convenience of compilation, some detailed data are not shown in the summary report and/or main report. For such data, the reader is requested to refer to the supporting report and/or data book.

1.9 JICA Guideline for Environmental and Social Consideration

JICA decided to apply the "JICA Guideline for Environmental and Social Consideration" to projects and studies adopted in FY 2004.

As this study commenced in FY 2002, the guideline is not applied. However, JICA requested the advisory council of environmental and social consideration to review this study for its completion, and obtained a report from the council.

Although this report reflects the comments given by the council, the study team recommends conducting some matters that cannot be done within the study period in the implementation stage.

Part I

Current Situations

of the Solid Waste Management

Chapter 2

Profile of the Study Area

2 Profile of the Study Area

2.1 The Study Area

The Study Area covers seven Khans under the jurisdiction of the municipality of Phnom Penh as shown in Table 2-1 and Figure 2-1, representing an area of 373.73 km^2 [1]out of the total area of 25,035km^2 in the Plains region. The population in the study area is approximately 1 million according to the General Population Census of Cambodia 1998.

The municipality consists of seven districts (hereinafter referred to as "Khans"), of which four are considered urban, and the remaining three Khans are considered rural. In the study, these are called the "urban area" and "rural area" respectively. Each district consists of 8-12 sub-districts (hereinafter referred to as "Sangkats"). The total area of the four Khans in the urban area is 27.08 km^2 and that of the three Khans in the rural area is 346.65 km^2. For the purposes of this plan, we will consider both the urban area and the rural area.

The existing dumpsite is located 5 km from the city centre in the Mean Chey district, which is south of the city centre (Central Market) in the rural area. It has been in use since 1965 and covers an area of 6.8 ha as of 2003.

Table 2-1: List of Khans in the Study Area

Khans (Districts)	Area (Km^2)		No. of Sangkats
	Total	Land	
Chamkar Mon	9.59	9.26	12
Daun Penh	7.34	5.39	11
Prampir Makkara	2.2	2.14	8
Tuol Kork	7.95	7.82	10
Total of Urban Area	27.08	24.61	41
Dang kor	187.91	181.69	15
Mean Chey	50.86	40.18	8
Ruessey Kaev	107.88	88.33	12
Rural Area Total	346.65	310.2	35
Grand Total	373.73	334.81	76

[1] There are two area estimates. One is 373.73 km^2 and the other is 375km^2. The former is the area estimated on the flat level and the latter is a spherical surface.

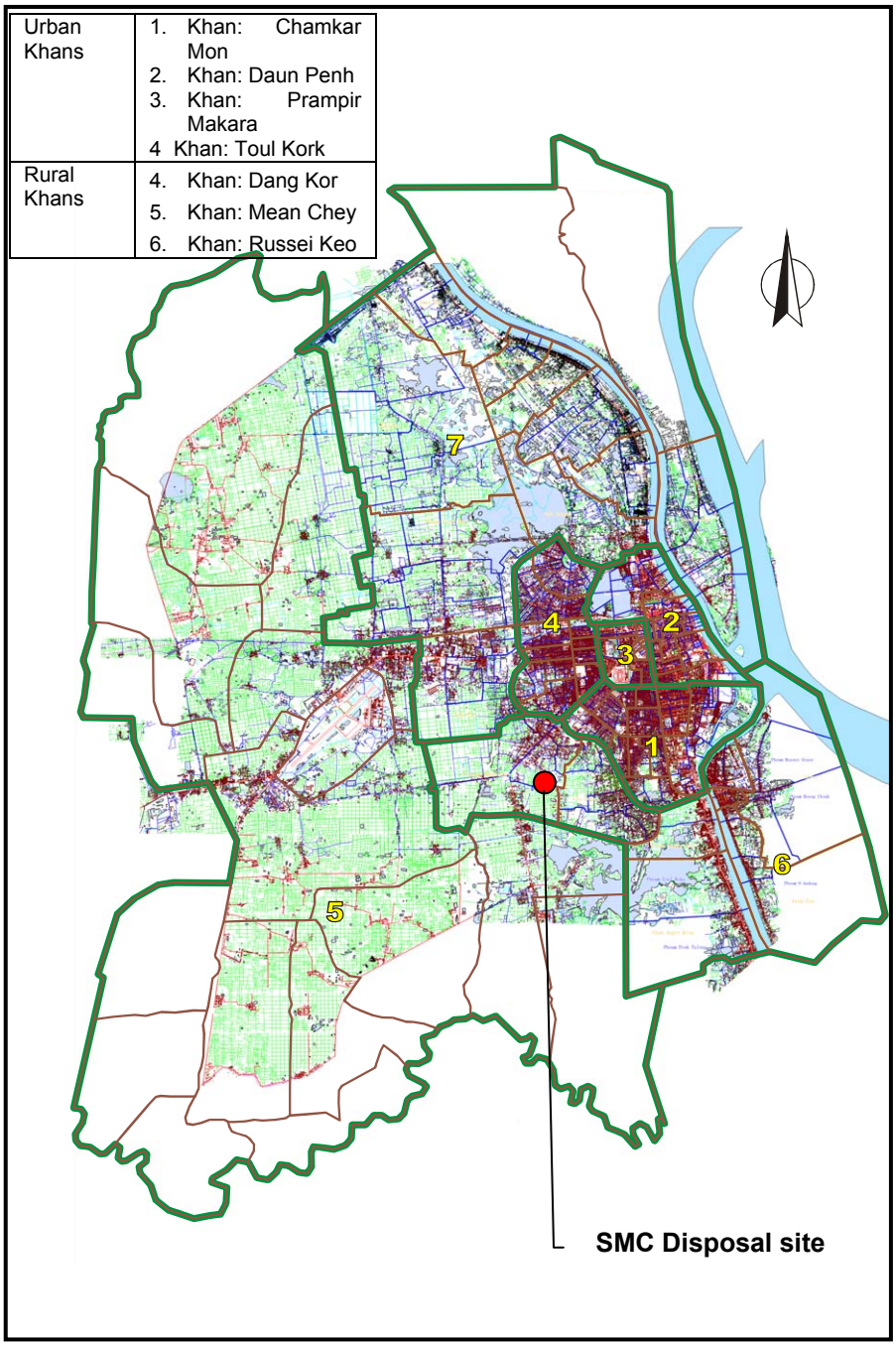


Figure 2-1: Study Area

2.2 Natural Conditions

a. Cambodia – Geography and Climate

a.1 Geography

Cambodia has a land area of 181,035 square kilometers in the southwestern part of the Indochina peninsula, about 20% of which is used for agriculture. It lies completely in the tropics with its southernmost points slightly more than 10° above the Equator. The country's capital city is Phnom Penh. International borders are shared with Thailand and the Lao

People's Democratic Republic on the west and on the north, and the Socialist Republic of Viet Nam on the east and southeast.

In comparison with its neighbors, Cambodia is a geographically compact country administratively composed of 20 provinces (three of which have relatively short maritime boundaries), 4 municipalities, 183 districts, and 1,609 communes. The country has a coastline of 440 km and extensive mangrove forests, some of which are relatively undisturbed.

The dominant features of the Cambodian landscape are the large plains, the almost centrally located Tonle Sap (Great Lake) and the Bassak River, and the Mekong River system, which crosses the country from the north to the south. The Mekong River is the largest river in Cambodia, and dominates the hydrology of the country. The river originates in mainland China and flows through Myanmar, Laos, and Thailand before entering Cambodia. In Phnom Penh, it converges with the Bassac River from the south and the Tonle Sap River, linking with the "Great Lake" Tonle Sap, from the northwest, and continues further southwestward to its lower delta in Viet Nam and to the South China Sea.

The section of the Mekong River passing through Cambodia lies within the tropical wet and dry zone. It has a pronounced dry season during the northern hemisphere winter, with about 80% of the annual rainfall occurring during the southwest monsoon from May to October. The Mekong River's average annual flow at Kracheh is estimated as 93% of the total Mekong run-off discharge of 1,250 m^3/s to a maximum of 66,700m^3/s.

a.2 Climate

Cambodia's climate, like that of the rest of Southeast Asia, is dominated by the monsoons, which are known as tropical wet and dry because of the distinctly marked seasonal differences. In summer, moisture-laden air of the southeast monsoon is drawn landward from the Indian Ocean and Gulf of Thailand. The southwest monsoon lasts from mid-May to mid-September or to early October, and the northeast monsoon flow of drier and cooler air lasts from early November to March. Then hotter air prevails in April and early May. The southern third of the country has a two-month dry season; the northern two-thirds, a four-month one. Temperatures are fairly uniform throughout the Tonle Sap Basin area, with only small variations from the average annual mean of around 25°C. The maximum mean is about 28°C and the minimum mean, about 22°C. Maximum temperatures of higher than 32°C, however, are common just before the start of the rainy season; they may rise to more than 38°C. Minimum temperatures rarely fall below 10°C. January is the coldest month, and April is the warmest. Typhoons, or tropical cyclones, that often devastate coastal Viet Nam rarely cause damage in Cambodia.

The total annual rainfall average is between 1,000 and 1,500 millimeters (mm), with the heaviest fall in the southeast. Rainfall from April to September in the Tonle Sap Basin-Mekong Lowlands area averages 1,300 to 1,900 mm annually, but the amount varies considerably from year to year. Rainfall around the basin increases with elevation. It is heavier in the southwest, which receives from 2,500 to more than 5,000 mm of precipitation annually as the southwest monsoon reaches the coast. This area of greatest rainfall, however, drains mostly to the sea; only a small quantity goes into the rivers flowing into the basin. The relative humidity is high at night throughout the year; usually it exceeds 90%. During the dry season, humidity averages about 50% or slightly lower, but it may remain about 60% in the rainy period.

b. Phnom Penh

b.1 Location and area

The Municipality of Phnom Penh, the capital of Cambodia, covers an area of approximately 290 km^2 within a longitude between 105° 45'E and 105° 55'E and a latitude between 12° 27'N and 12° 40'N, where the Mekong, Tonle Sap and Bassac Rivers meet and branch off. The land is very flat and low, ranging from 4m to 14m above sea level (asl), with most of the urban area being 7-10 m asl. The maximum water level of the Mekong River is 9.96 m asl, as recorded in 1961.

b.2 Climate

Phnom Penh is warm throughout the year; the yearly average temperature is 28 degrees centigrade. Although the yearly rainfall average is about 1300 mm, most comes down in the rainy season, which lasts from May to November.

Table 2-2: Temperature in Phnom Penh

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave.
Max.	31.1	32.6	34.3	34.9	34.4	33.2	32.4	32.1	31.5	30.9	30.6	30.4	32.4
Ave.	26.1	27.5	29.2	30.2	29.9	29.4	28.5	28.6	27.8	27.3	26.6	25.9	28.1
Min.	21.1	22.3	24	25.4	25.4	25.4	24.6	25.1	24	23.8	22.7	21.3	23.8

Source: Department of Meteorology

Table 2-3: Rainfall in Phnom Penh

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Max.	15	0	164	181	235	305	284	312	474	338	346	24	1,639
Ave.	3	0	23	61	125	125	160	181	304	219	119	6	1,327
Min.	0	0	0	0	25	38	75	93	174	98	2	0	1,092

Source: Department of Meteorology

b.3 Geographical and Geological Conditions

The geological features of the Study Area are:

- The city lies on a flat, alluvial plain at the confluence of the Mekong River, Tonle Sap River and Bassac River.
- The riverbank is composed of sand, silt and clay.
- The urbanized area has been constructed on reclaimed land using sediment from the river.
- The swampy areas in and around the city function as retarding basins during the flood season.

These physical features result in the general tendency of urban development as summarized below:

- The soils underlying the urbanized area are generally soft and their bearing capacities are relatively low. Accordingly, construction of high-rise building requires large-scale foundation works. The poor bearing capacity of the subsoil also results in a shorter life period of pavement.

- Careful hydrological consideration is needed to reclaim the lakes and swampy areas in and around the city because it may result in an unfavorable effect on flooding and/or inundation.
- Development of the city is directed towards the west, and the eastside of the present urbanized area is bounded by the Mekong and other rivers. The ground elevation in the western suburbs is generally higher, and the area has less chance of flooding.

2.3 Social Conditions

2.3.1 Administration

a. Administrative Structure

Administratively, Cambodia is divided into 20 provinces (Khett) and four municipalities (Krong). Provinces are divided into districts (Srok), and districts into sub-districts called communes (Khum). Municipalities are divided into districts (Khan) and districts into sub-districts called communes (Sangkat), which are the smallest administrative unit. Sangkats are further divided into villages (Phum), and in each village a village chief is appointed.

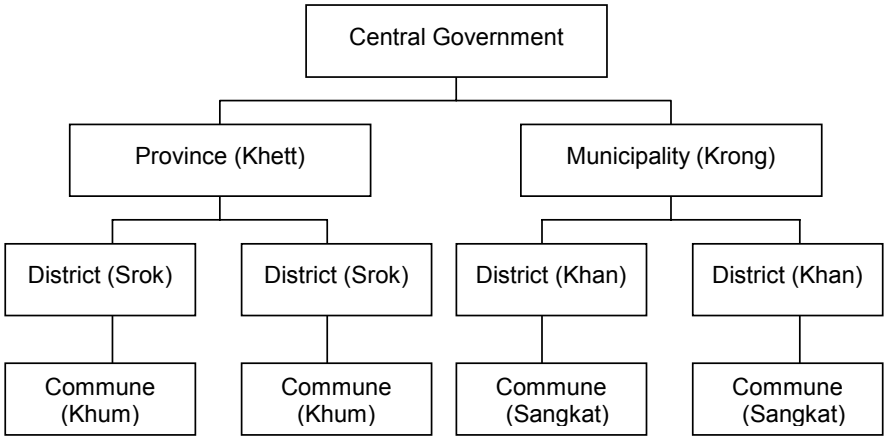
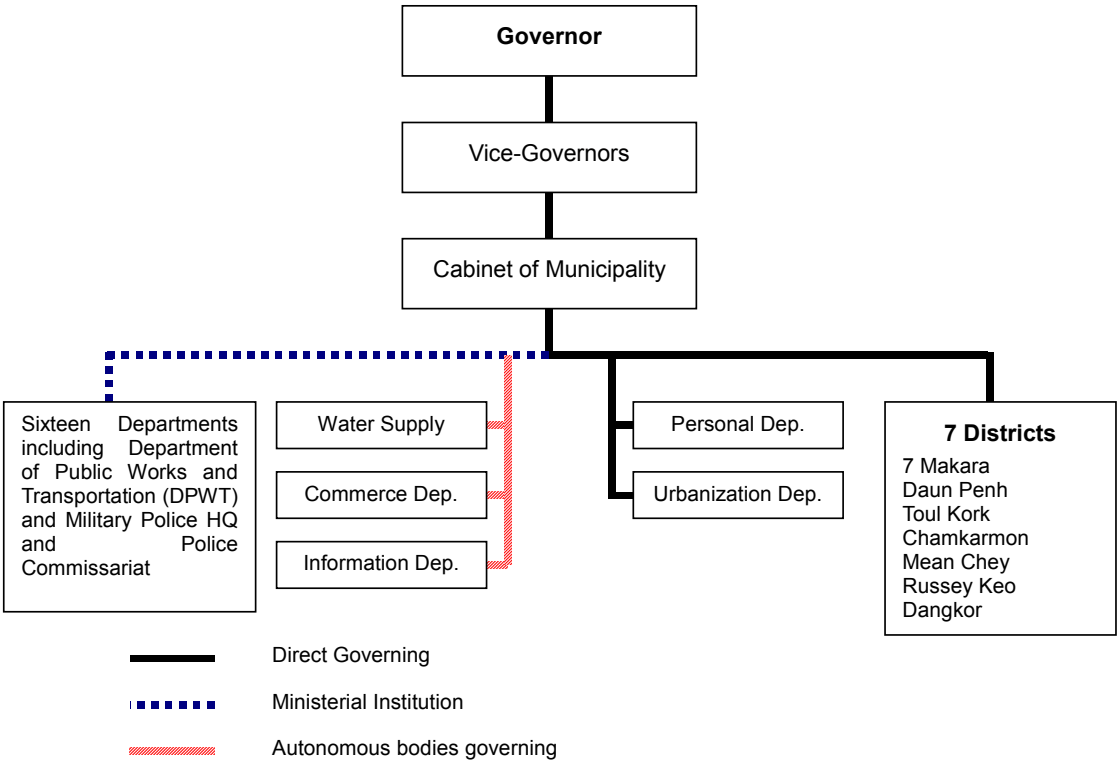


Figure 2-2: Local Government Structure

The administrative structure of MPP is shown in Figure 2-3 (the detailed organization chart is shown in Fig. 3-4). Most departments such as the Department of Public Works and Transportation are directed by ministries in charge, while seven district offices are directly governed by MPP.



Source: Web page of Municipality of Phnom Penh

Figure 2-3: Organization Chart of Phnom Penh Municipality

b. Decentralization

As one of the critical factors for the achievement of good governance, the Cambodian government has promoted the decentralization process, with support from international organizations and donor countries since the SEILA program was initiated by UNCDF/UNDP in 1996. The SEILA program aimed at building the capacity of local governments (Sangakt/Village level) through the planning/management of small-scale community-based projects such as the improvement of roads and construction of drainage systems, by newly established Commune Development Committees (CDCs) and Village Development Committees (VDCs) in six selected provinces.

With the successful result of the SEILA program, the Cambodian government decided to expand the SEILA program nationwide, and promulgated the Law on Commune Administration in 2001. The first Commune Council election was conducted in February 2002. In the case of the MPP, first each VDC formulates a village development plan, and then the newly elected Commune Council in each Sangkat collects the village development plans, formulates the Commune Development Plan, and submits it to the MPP.

2.3.2 Community Structure

a. Features of traditional communities in Cambodia

Traditionally, the basic unit of the Cambodian (Khmer) society is the nuclear family, consisting of a husband and a wife and their unmarried children. A large grouping, the personal kindred that includes a nuclear family, grandchildren, grandparents, uncles, aunts, first cousins, nephews, and nieces, may be included in the household. Although traditionally households in the rural areas have the custom of borrowing/lending labor force among each

other during the busiest farming season, there have been no continuous and fixed organizations or associations in the community.

Temples still have important roles for Cambodian people, although the residences of Buddhist temple supporters are not always located in the same village of the temple. There are some new trends, in which some local NGOs use Buddhist ideas in their efforts to rebuild and develop Cambodian Society.

b. Roles of village chief

After People's Republic of Kampuchea (PRK) gained control of Cambodia, the village chiefs that were appointed by PRK became more powerful than their predecessors, as the central government reached more closely into daily life than in the prewar years. Village chiefs were responsible for control of the population at the local level during a time of civil war. Even though they are still in charge of household data at the local level and some of them are criticized for their politically biased behaviors, they are playing an important role as community leaders. In the target villages of the Social Environment Survey, village chiefs often give advice to villagers and have the confidence of local residents. Groups of houses, which constitute a village, have their own group leaders. They are also playing an important role as a community leader.

2.3.3 Public Education

Inadequately qualified human resources is one of the most serious bottlenecks for the development of Cambodian society, and the improvement of the education sector is one of the most important problems by which the Government is confronted. Even though the government has made a considerable effort, the education sector is still facing a number of serious problems. The Constitution states that the State shall provide primary and secondary education to all citizens in public schools, but there is no law for compulsory education. Although the school enrollment fee was abolished at the primary level in 2001, students are still charged a small daily fee by teachers and sometimes required to pay for school materials. The net enrollment ratio at the primary level in 1998 was still low at 78%. Moreover, the net enrollment ratio at the lower secondary level was extremely low (11%), the lowest in the region, and this will worsen the competitiveness of the country in the future. The high drop out and repetition rate and low access to vocational and higher education, in particular for girls, are also serious problems.

Although the result of the Socio-Economic Survey 1999 stated that the adult literacy rate was 71.2% (87.3% in MPP), the other survey by the Ministry of Education, Youth and Sport revealed that only 37.1% of adults (aged 15 years and above) were literate, with 26.6% classed as semi-literate and 36.3% as completely illiterate.

2.3.4 Public Health

a. Present Conditions

Cambodia’s health status is among the poorest in the region, due to the poor access and quality of the public health services. Cambodia was the only country in the region that

showed an increase in the under-five mortality rate by 2 percentage points (from 115 to 135 per 1,000 live births) between 1990 and 2001[2]. The figure was the worst in the region.

Regarding diseases, infectious diseases still constitute the major health issues. According to the National Health Statistics Report 1998, the main diagnoses for outpatients are acute respiratory infection (18.8%), diarrhea (11.4%), and malaria (4.1%). The main causes of hospital mortality are malaria (19.2%), acute respiratory infection (8.9%), and tuberculosis (6.9%).

b. Public Health System

The Ministry of Health (MOH) initiated health sector reform in 1996 to improve the access and quality of health services at the district level. Operational District Health Offices exercise jurisdiction over the operational districts, which were established to oversee 10-15 health centers. The health sector reform aimed at establishing the health centers at approximately one per 10,000 people, 935 throughout the country in total. At present, 446 health centers have been constructed and 53 have been renovated. The referral hospitals were established as the central hospital in each operational district. In addition, there are 8 national hospitals such as Calmette Hospital and provincial hospitals for the nation- and province-wide health system.

2.3.5 Customs, Language and Religion

Cambodia is a multiracial nation, and the customs, language and religion are different in different ethnic groups, i.e. Khmer, Cham, Chinese, Vietnamese and hill-tribes called Khmer Loeu. The constitution guarantees the freedom of belief, while declaring that Buddhism shall be the religion of the State. Khmer is the official language of the country.

2.3.6 Employment

a. Current situation

According to the Socio-Economic Survey 1999, the employment rate of the whole country was 99.4%, but as many as 46% of the work force were unpaid family laborers working for family owned farms or businesses without pay.

By industry, 74.7% of the employed population of the whole country had worked in the primary industry, while in Phnom Pnnh the share of the service sector was 75%. In addition, the share of the manufacturing sector in Phnom Penh had grown during the past several years from 9% to 17%. The garment industry has now become the leading manufacturing sector, thanks to favorable terms of trade with the United States and the European Union, and employed the largest number of workers.

b. Child Labor

The Child Labor issue is one of the most serious problems and a controversial subject. The current Cambodian Labor Law defines the minimum age for employment as 16, except for hazardous occupations, where the minimum age is 18. However, in practice a large number of children are working to support their families.

[2] Human Development Report 2003

2.4 Population[3]

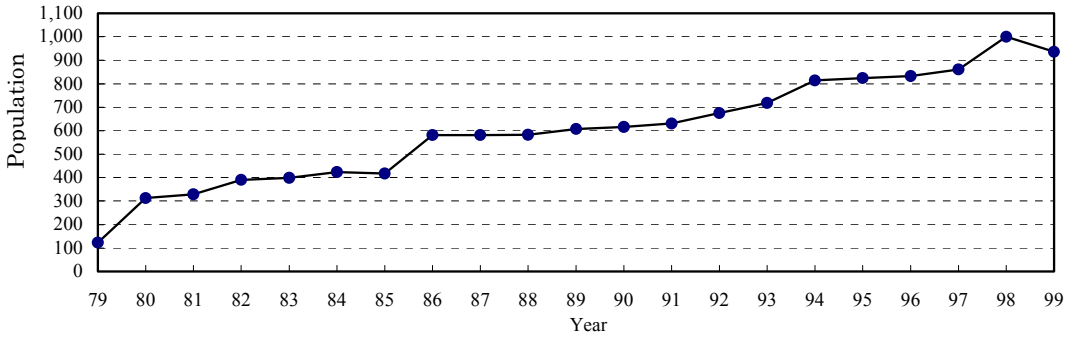
2.4.1 Trend of Population in Census 1998

a. General Trend

The annual growth rate of the population of Cambodia during the period 1981 to 1986 was 2.6%. The population growth for the period 1986 to 1996 was 2.8% and for the period 1996 to 1998, the growth rate was 3.1%. The annual growth of population is increasing every year. The average annual growth rate of the population of Phnom Penh was 6.7% for the period 1980 to 1985, 9.5% for the period 1985 to 1990, 6.7% for the period 1990 to 1995 and 2.7% for the period 1995 to 1999.

In recent years, the annual growth rate of the population has shown a steady increase; 3% in 1997 and 4% in 1999. The first population census undertaken in 1998 indicated a population growth of 11.6% in that year. The difference between the natural population growth indicated above and the census result is about 7.6%. This suggests that the actual population could be about 10% more than the indicated data, including both the people subject to the population survey and others, such as illegal residents, refugees and boat people.

As shown in Figure 2-4, the population in the city is growing faster than that of Cambodia. This result suggests that migration or the number of people returning to the city has been increasing significantly.



Source: Ministry of Planning, Department of Planning of Phnom Penh, Welcome to new Millennium Year 2000

Figure 2-4: Population in Phnom Penh

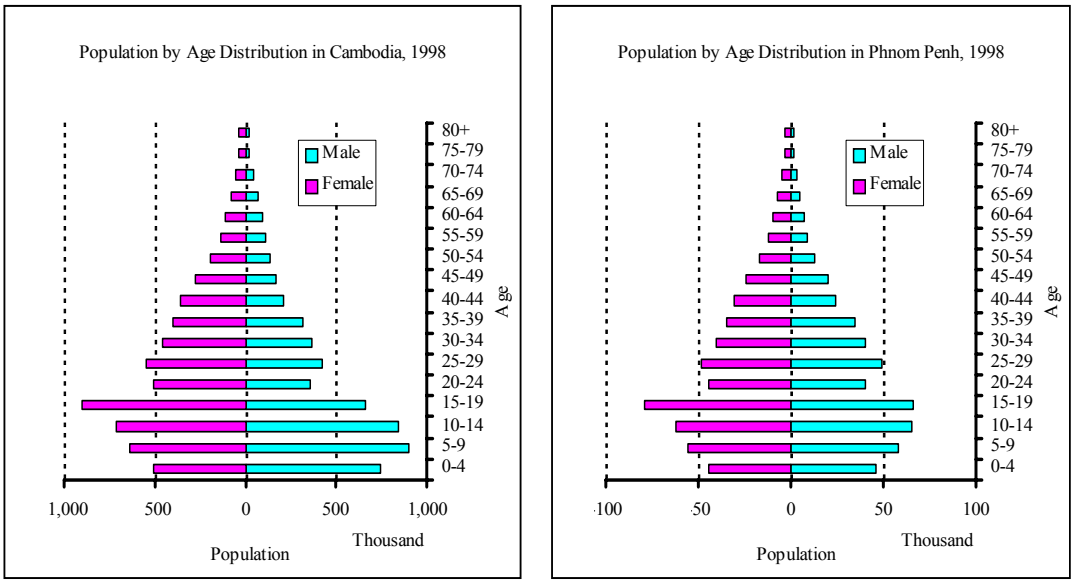
b. Composition by Age Group and Gender

The composition of age structure in Cambodia shows the 5 to 9 year old age group is the largest cohort followed by 10 to14 year olds. This might be attributed to a baby boom reported in the early 1980s and high fertility in the following years of the decade for both gender and age structure. The proportion of 0 to 4 year olds is far less than that of 5 to 9 year olds. The population in each five-year age group over 25 declines substantially as age increases.

Approximately 40% of the population of Cambodia is children below the age of 15. The percentage is lower in Phnom Penh where 32.6% are under the age of 15. The proportion of

[3] Data are quoted from the report of the Study on Transport Master Plan in the Phnom Penh: Nov. 2001 JICA

female children at 40.4% is less than that of male children at 45.4%. The economically productive age group (15 to 64 year olds) forms 53.7% of the population, and the elderly group (65 and over) forms 3.5%. People more than 18 years old constitute nearly 50% of the total population, as shown in Figure 2-5.



Source: General Population Census of Cambodia 1998, Ministry of Planning

Figure 2-5: Distribution of Population by Age Group and Gender

c. Households

According to the General Population Census 1998, there are 2,188,663 households in the country. The average household size of normal or regular households in Cambodia works out to 5.2. It is higher in urban areas (5.5) than rural areas (5.1).

In Phnom Penh, the total number of households is 73,678. The average number of persons per household in the urban area is 5.9, while it is 5.6 in the rural area and 5.8 in the whole city.

Table 2-4: Population Density and No. of Households

Khans (Districts)	Population (persons)	No of persons per household	No. of households
Chamkar Mon	187,082	5.8	32,366
Daun Penh	131,913	5.9	22,203
Prampir Makkara	96,192	5.8	16,529
Tuol Kork	154,968	5.9	26,198
Total of Urban Area	**570,155**	**5.9**	**97,296**
Dang kor	92,461	5.3	17,565
Mean Chey	157,112	5.7	27,443
Ruessey Kaev	180,076	5.7	31,374
Total of Rural Area	**429,804**	**5.8**	**76,382**
Grand Total	**999,804**	**5.8**	**173,678**

2.4.2 Population by Khan, Sangkat and Density Distribution

The population and density by district and commune in the city have been calculated using the census in 1998 and a Landsat data map. The population density in the urban area is

25,531 persons/km^2 and 1,841 persons/km^2 in the rural area. The estimated population and density of each commune are shown in the table below.

Table 2-5: Land and population by Khan and Sangkat in 2003

Districts/Communes	Area (Km^2)		Population	Density on
	Total	Land		Land (Km^2)
Chamkar Mon	**9.59**	**9.26**	**208,750**	**22,543**
Tonle Basak	3.16	2.83	48,862	17,266
Boeng Keng Kang Muoy	1.00	1.00	15,812	15,812
Boeng Keng Kang Pir	0.34	0.34	14,001	41,179
Boeng Keng Kang Bei	0.64	0.64	26,363	41,192
Oulampik	0.30	0.30	11,380	37,933
Tuol Svay Prey Muoy	0.56	0.56	15,334	27,382
Tuol Svay Prey Pir	0.38	0.38	13,459	35,418
Tumnob Tuek	0.82	0.82	15,060	18,366
Tuol Tumpung Pir	0.45	0.45	9,154	20,342
Tuol Tumpung Muoy	0.59	0.59	11,102	18,817
Boeng Traback	0.49	0.49	10,376	21,176
Phsar Daem Thkov	0.86	0.86	17,847	20,752
Daun Penh	**7.34**	**5.39**	**137,186**	**25,452**
Phsar Thmei Muoy	0.18	0.18	7,933	44,072
Phsar Thmei Pir	0.11	0.11	8,278	75,255
Phsar Thmei Bei	0.34	0.34	14,012	41,212
Boeng Reang	0.38	0.38	8,467	22,282
Phsar Kandal Muoy	0.41	0.27	11,591	42,930
Phsar Kandal Pir	0.15	0.15	8,216	54,773
Chakto Mukh	1.11	0.86	12,911	15,013
Chey Chumneah	0.77	0.5	13,065	26,130
Phsar Chas	0.10	0.10	8,423	84,230
Srash Chak	3.15	1.95	35,235	18,069
Voat Phnom	0.64	0.55	9,055	16,464
Prampir Makara	**2.20**	**2.14**	**104,013**	**48,604**
Ou Ruessey Muoy	0.08	0.08	9,715	121,438
Ou Ruessey Pir	0.08	0.08	11,421	142,763
Ou Ruessey Bei	0.05	0.05	9,074	181,480
Ou Ruessey Buon	0.10	0.10	9,719	97,190
Monourom	0.16	0.16	13,827	86,419
Mittapheap	0.40	0.40	12,526	31,315
Veal Vong	0.96	0.91	24,165	26,555
Boeng Prolit	0.37	0.36	13,566	37,683
Tuol Kork	**7.95**	**7.82**	**178,373**	**22,810**
Phsar Depou Muoy	0.32	0.32	11,414	35,669
Phsar Depou Pir	0.20	0.20	10,903	54,515
Phsar Depou Bei	0.30	0.30	10,856	36,187
Tuck L'ak Muoy	0.91	0.89	14,494	16,285
Tuck L'ak Pir	0.44	0.44	12,164	27,645
Tuck L'ak Bei	1.13	1.11	18,409	16,585
Boeng Kak Mouy	1.60	1.60	23,150	14,469
Boeng Kak Pir	1.69	1.69	31,617	18,708
Phsar Daeum Kor	0.47	0.47	18,580	39,532
Boeng Salang	0.89	0.8	26,786	33,483
Total of Urban Area	**27.08**	**24.61**	**628,322**	**25,531**
Dang kor	**187.91**	**181.69**	**114,333**	**629**
Dang kor	13.83	11.97	12,020	1,004
Trapeang Krasang	9.05	9.05	4,107	454
Kouk Roka	32.67	30.4	5,625	185
Phleung Chheh Rotch	9.63	9.61	4,961	516
Chaom Chau	22.6	22.6	26,911	1,191
Kakab	8.88	8.88	20,907	2,354
Pong Tuck	11.14	11.14	7,580	680
Prey Veaeng	9.07	9.02	3,234	359
Samraong Kraom	12.19	12.19	4,674	383
Prey Sar	13.23	13.15	6,152	468
Krang Thnong	6.60	6.60	3,312	502

Districts/Communes	Area (Km^2)		Population	Density on
	Total	Land		Land (Km^2)
Krang Pongro	6.96	6.53	2,237	343
Prateah Lang	8.42	8.32	4,899	589
Sak Sampov	5.86	5.61	2,061	367
Cheung Ack	13.24	12.08	5,653	468
(Airport Area)	4.54	4.54	-	-
Mean Chey	**50.86**	**40.18**	**210,027**	**5,227**
Strueng Mean Chey	12.0	11.65	51,421	4,414
Boeng Tumpun	4.43	4.04	45,316	11,217
Preack Pra	8.39	6.46	13,537	2,096
Chbar Ampov Muoy	0.49	0.41	12,053	29,398
Chbar Ampov Pir	1.32	0.90	28,907	32,119
Chak Angae Leu	3.09	1.99	18,749	9,422
Chak Angae Kraom	9.53	6.78	24,264	3,579
Nirouth	11.61	7.95	15,780	1,985
Russei Keo	**107.88**	**88.33**	**246,732**	**2,793**
Khmuonh	19.91	18.69	9,235	494
Toul Sankae	2.76	2.52	30,773	12,212
Svay Pak	3.97	0.74	14,554	19,668
Kiloumaetr Lekh Prammuoy	5.64	4.92	21,663	4,403
Phnom Penh Thmei	20.55	18.58	25,844	1,391
Ruessey Kaev	5.18	3.99	29,250	7,331
Tuek Thla	6.74	6.74	51,719	7,673
Praek Lieab	11.96	8.56	13,801	1,612
Praek Ta Sek	15.11	12.79	5,396	422
Chrouy Changva	9.62	5.14	20,232	3,936
Chrang Chamreh Muoy	2.30	1.88	8,630	4,590
Chrang Chamreh Pir	4.14	3.78	15,635	4,136
Rural Area Total	**346.65**	**310.20**	**571,092**	**1,841**
Grand Total	**373.73**	**334.81**	**1,199,414**	**3,582**

2.5 Urban Structure

2.5.1 General Situation

Administratively, the city is divided into seven Khans. Of these, four Khans (Daum Penh, Chamkar Mon, Toul Kork, and Prampir Makara) are mainly urban in nature with a total area of 27.08[4] km^2 and a population of 570,155[5]. The majority of government and administrative buildings are located here, especially in Khan Daun Penh and Chamkar Mon. The remaining three Khans are mainly rural or peri-urban in nature with a total area of 346.65 km^2 and population of 429,649. The housing stock in high-density downtown areas mainly consists of three to six older buildings constructed in the colonial period, typically with a "Chinese shophouse" configuration at the street level and walk-up flats on the upper floors. These are 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 shophouses and detached or semi-detached buildings from the postcolonial periods. A number of unplanned settlements (squatter areas) are 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, shophouses, detached and semi-detached all represented.

[4] According to BUA July 2003, the area of urban area is estimated as 27.19km^2 and rural is 348.30km^2 considering a spherical surface.
[5] Population Census 1998

Solid waste collection services are mainly limited to the urban areas and some nearby peri-urban areas. The urban population served is estimated at about 93.5% of the total, while coverage in the rural and peri-urban areas is estimated at about 41.0% of the total. The overall coverage is estimated at 68.5%.

2.5.2 Land Use[6]

a. Present Land Use

The present land use map is shown in Figure 2-6. The Study Area can be classified into two areas. One is the urban area, and the other is the rural area. The urban area is characterized as the center of politics, commerce, business and education. Socioeconomic activities are concentrated in this area. Furthermore, the urban area is expanding to the neighboring Khans. The present land use is summarized in Table 2-6.

Table 2-6: Present Land Use (as of 2000)

Land Use	Urban Area		Rural Area		Study Area	
	ha	%	ha	%	ha	%
Residential area	1,314	48.5	8,307.5	20.2	9,621.5	21,9
Commercial area	792	29.3	649.5	1.6	1,441.5	3.2
Industrial area	80	3.0	2,059	5.0	2,139.0	4.9
Institutional area	192	7.1	636	1.6	828.0	1.9
Agricultural area	14	0.5	18,627	45.2	18,641.0	42.5
Park & Open Space	36	1.3	712	1.7	748.0	1.7
Swamp area	-	-	5,657	13.7	5,657.0	12.9
Water Surface	280	10.3	4,536	11.0	4,816.0	11.0
Total Area	2,708	100.0	41,184	100.0	43,892.0	100.0

Source: Transport Master Plan JICA, 2001

[6] Quoted from the report of the Study on the Transport Master Plan of the Phnom Penh: Nov. 2001 JICA

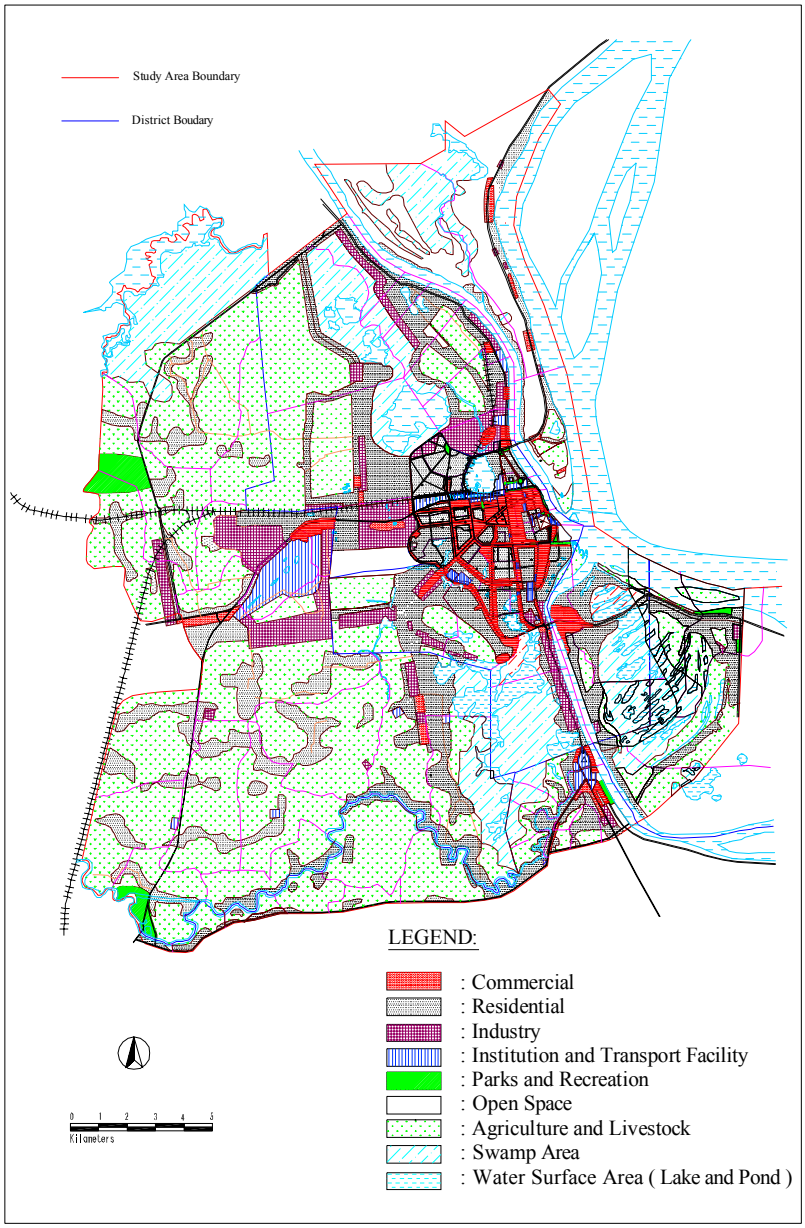


Figure 2-6: Present Land Use

b. Future Land Use Plan

The future land use plan for the municipality of Phnom Penh was prepared in 1999 under the Study on Drainage Improvement and Flood Control in the Municipality of Phnom Penh conducted by JICA

Furthermore, the Bureau of Urban Affairs, MPP and the team for the transport study conducted by JICA in 2001 had reviewed and discussed it. As of 2003, the following is acknowledged as a latest land use plan.

c. Policy and Land Use Plan for the Urbanized Area

The future land use plan for the municipality of Phnom Penh was prepared in 1999 under the Study on Drainage Improvement and Flood Control in the Municipality of Phnom Penh conducted by JICA.

The latest development policies for the urbanized area formulated by BAU, MPP and the French Team are as follows:

- To preserve urban landscape, cultural heritage and the environment
- To ease the concentration of population in the urbanized area by regulating the building height

The urbanized area is divided into the following four zones (Figure 2-7).

- The low-rise zone of buildings up to three-stories for the historical area
- The mid-rise zone of walk-up type buildings for the central commercial area
- The high-rise zone with moderate height buildings for the office and commercial area
- The no designation zone for others

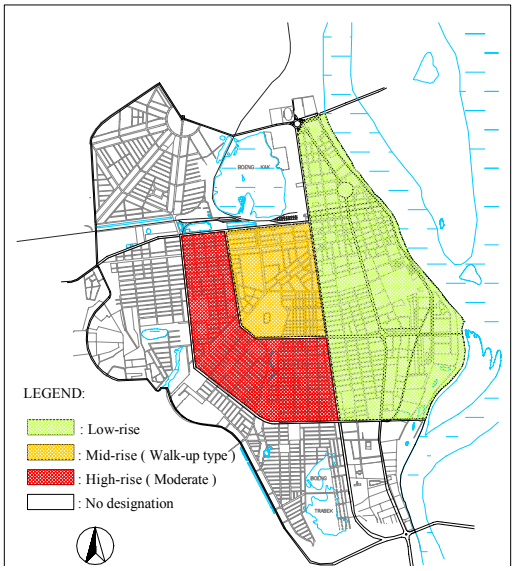


Figure 2-7: Height Limitation of Building in the Urbanized Area Proposed by BAU, MPP and French Team

2.6 Economic Conditions

2.6.1 National Economy

The GDP in Cambodia grew by an annual average of 10.6% during 1994-2000. The latest economic outlook done by the World Bank indicated that economic gorwth in 2001 was estimated at 6.3%, driven by the expanding tourism sector and robust garment exports. The per capita GDP, on the other hand, is about 920 thoudsand riels or 238 US dollars in 2000. Its average annual growth during 1994-2000 is 5.7%.

As to GDP by sector, the tertiary (services) industry occupies the biggest share, accounting for 39%, followed by the primary industry of approximately 37% in 2000. The share of secondary industry is about 24%. However, the share of secondary industry has been steadily increasing since 1990s from 13 % in 1993 to 24 % in 2000.

2.6.2 Regional Economy

According to the latest socio-economic survey in 1993-94, the average monthly household income in Phnom Penh is about 535 thousand riels or 208 US dollars while the average household expenditure is about 781 thousand riels or 304 US dollars per month. The above average income in Phnom Penh is more than three-fold of the national average income of about 169 thousand riels or 66 US dollars per month. These figures clearly indicate that Cambodia is among the poorest countries in Asia. It should also be noted that there is a big difference in income between urban and rural housholds.

2.6.3 National and MPP Budgets and their Allocations

a. National Budget

Revenue mobilization has been the key element of Cambodia's fiscal policies. The government revenue accounted for only 9% of the GDP in 1998, reflecting deficiencies in tax

and customs administration, the narrow tax base, inadequate non-tax revenues and a persistent culture of non-compliance (National Poverty Reduction Strategy 2003-2005). The Government of Cambodia (GOC) is currently conducting the restructure of taxation and revenue collection systems to broaden its revenue bases. Such measures include the transfer of non-tax proceeds from management of forest and other public resources to the budget, the enhanncement of tax administration and the reduction of losses in the form of exemptions. Additional tax reforms including the introduction of value-added tax (VAT) have already been implemented since January 1999. The latest Public Investment Plan 2002-2004 set the revenue target at 13.5% of the GDP in 2005.

b. Regional Budget of MPP

As to the revenue and expenditure of the Municipality of Phnon Penh (MPP), the user charge is the biggest source of revenue, accounting for about three forths of the total revenue in MPP, while income from tax (assessment) covers about 20%. The total revenue of MPP reached 19,646 million riels (approximately 4.9 million US dollars). The per capita revenue in MPP was estimated to be around 5 US dollars. Meanwhile, the total expnditure of MPP is about 17,500 million riels (4.3 million dollars), 60%, of which is spent on materials and supplies followed by 30% on equipment expenses. The total expenditure for public cleansing services is about 243 million riels, accounting for only about 1.4% of the total MPP expenditure.

The table below shows the revenue and expenditure of MPP in 1995 and 2000.

Table 2-7: Revenue and Expenditure of MPP (1995 and 2000)

(Unit: 1,000 Riels)

Source	1995		2000	
	Budgeted	Actual	Budgeted	Actual
Revenue				
Assessment	3,000,000	3,350,576	200,000	215,370
License	250,000	237,812	3,473,000	3,986,242
Loan	0	0	0	0
Grant	0	0	0	0
User Charges	2,958,000	3,148,252	6,917,000	14,937,921
Fine	800,000	1,064,012	0	0
Others	5,000	5,654	110,000	506,827
Total Revenue	**7,013,000**	**7,806,306**	**10,700,000**	**19,646,360**
Expenditure				
Remuneration	8,852,000	8,254,765	1,130,000	1,051,165
Materials & Supplies	8,351,400	8,258,158	10,678,000	10,670,285
Equipment	991,956	991,941	5,537,000	5,536,992
Public Cleansing	0	0	245,000	242,849
Total Expenditure	**18,195,356**	**17,504,864**	**17,590,000**	**17,501,291**

2.7 National Policies relevant to SWM

2.7.1 Socio-Economic Development Plan (2001 – 2005)

The Second Socio-Economic Development Plan 2001 – 2005 (SEDPII) presents the development objectives, strategies and policies of the Government. The strategies are:

- To foster broad-based sustainable economic growth with equity, with the private sector playing the leading role (in concrete terms, to maintain an economic growth of 6-7% per year)
- To promote social and cultural development by improving the access of the poor to education, health, water and sanitation, power, credit, markets, information and appropriate technology
- To promote the sustainable management and use of natural resources and the environment
- To improve the governance environment through effective implementation of the Governance Action Plan (GAP)

While the Government's strategy for meeting the objective of economic growth is mainly focused on agricultural and rural development, relevant specific strategies pertaining to our study include:

- Improving the efficiency and effectiveness of the public sector through civil service reform and public enterprise reform
- Enhancing private sector development by improving the physical infrastructure and developing the legal and regulatory frameworks within which business enterprises operate
- Empowering the poor to participate in, and thus benefit from, the growth process by improving their access to productive assets, health and education services, appropriate technology, and credit

2.7.2 Public Investment Program (2003 – 2005)

The PIP is the instrument through which the Government allocates capital investments in the public sector to compensate for areas of market failure and contribute to an enabling environment for the growth of private investment. With respect to water supply and sanitation (including SWM), it states: "the Government will yield managerial autonomy to utilities with a view to achieving financial independence enabling them to finance their own maintenance and investment programs". Presumably this would also apply to the Phnom Penh Waste Management authority (PPWM).

The PIP mentions about urban and industrial pollution, and recommends specific actions aimed at strengthening legislation, monitoring and enforcement, improving SWM and studying the composting and recycling of waste. However, the PIP lacks a more comprehensive SWM strategy that takes into account the Government's socio-economic priorities, such as improving the effectiveness of public services, public-private partnership arrangements, poverty alleviation, resource recovery and pollution prevention.

The current PIP includes only one SWM project, namely a new sanitary landfill. The project is estimated to require $12.3 million, but no donors or development banks have expressed any interest in this project so far. The reason is believed to be that it is necessary to view this substantial investment in the larger context of a strategic SWM plan like a SWM master plan, and to see how this landfill will enhance the SWM services and what impact it will have on the SEDP development objectives and priorities.

2.7.3 National Environmental Action Plan (1998 – 2002)

The National Environmental Action Plan (NEAP) is formulated to guide the integration of environmental concerns into national and local development policies, economic decision-making, and investment planning.

The first NEAP identifies urban waste management as one of the emerging environmental challenges for Cambodia. It proposes a program to improve solid waste management as follows:

a. Phase I (Years 1 – 2):

a.1 Objective

To improve the disposal of residential and commercial solid waste to minimize adverse public health and environmental impacts.

a.2 Activities to be supported

1. Preparing environmental and sanitation standards for residential and commercial waste, and special waste (including industrial and hospital waste).
2. Preparing a framework for privatizing waste collection and disposal in major cities, including clarifying the roles of the Government and the private sector, and preparing guidelines on the structure of tariffs.

b. Phase I (Years 1 – 2):

b.1 Objective

To improve the disposal of residential and commercial solid waste to minimize adverse public health and environmental impacts.

b.2 Activities to be supported

1. Upgrading open dumps in Phnom Penh to reduce the risk of adverse public health and environmental impacts
2. Conducting topographic, soil and geophysical surveys and community consultations to identify a potential site in Phnom Penh for a sanitary landfill
3. Constructing a sanitary landfill with at least a 10-year capacity, which also has a low-cost pilot composting facility, in Phnom Penh
4. Constructing a medical waste treatment facility in Phnom Penh
5. Training municipal staff in SWM and hospital staff in medical waste management
6. Launching a public information campaign on appropriate waste disposal in Phnom Penh, Siem Reap and Sohanoukville

Though the MOE, MPP and other responsible organizations have made efforts to implement the above plan according to the proposed schedule, it has been delayed.

It is sure that our study will contribute to facilitating the implementation of SWM plans proposed in the NEAP.

2.7.4 Waste Management Program in Cambodia 2002 - 2006

The Waste Management Program in Cambodia 2002 – 2006 (WMP) sets the following key principles to establish sustainable liquid and solid waste management in Cambodia:

1. *Political will and financial affordability are prerequisites for adequate management.*
2. *Health, economy and environment are equally important factors*.
3. *Stepwise approaches are essential to explore alternatives and integrated solutions.*
4. *National and Local Governments are to take responsibility in creating an enabling environment for sustainable solutions.*
5. *Commitment and involvement of all stakeholders has to be assured from the beginning.*
6. *Public and private partnership and other new financial mechanisms are to be explored.*
7. *Linking wastewater management systems to other sectors, e.g. industry, agriculture, etc.*
8. *Sustainable solutions for waste management will be built upon pollution prevention and low-cost technologies.*

Based on the above key principles, the WMP proposes the following improvements to establish sustainable SWM:

- To set up waste inventories throughout the country to assess the actual and potential impact of waste on the living environment in provinces and cities
- To review and develop guidelines and standards relevant to waste management in accordance with national and local requirements
- To enforce all pollution sources to implement the guidelines and standards relevant to waste management as well as to raise their awareness of proper waste management
- To disseminate the waste management guidelines and standards to all stakeholders, including local communities, NGOs, etc.
- To promote the 3Rs (Reduce, Reuse and Recycle)
- To promote cleaner production to minimize or eliminate the use of toxic or hazardous wastes from industries.

To set up an emergency response plan for accidents in toxic/hazardous waste management

- To determine appropriate technologies for waste disposal, i.e. storage, discharge, collection, transportation, recycling, treatment and final disposal (landfill)
- To encourage waste separation for the effective reuse, recycling and disposal of waste
- To cooperate and co-ordinate with inter-ministries and relevant agencies including international organizations and NGOs in waste management and planning

2.7.5 Second Environmental Strategic Plan 2001 – 2003

The Second Environmental Strategic Plan 2001 – 2003 (ESPII) confirms the ministry roles for environmental protection and natural resource conservation keeping as the guarantor of environmentally sustainable development in the present and future in close collaboration and coordination with the line-ministries, the public, international organizations and NGOs. The ESPII consists of the following three phases:

Phase 1:

The first ESPI is checked and reevaluated.

Phase 2:

A meeting is held to promote the ministry mission statement, long-term goals, and strategies.

Phase 3:

Individual departments arrange a mission statement, long-term goals, prioritized activities and a work plan according to the Strategic Plan Office's guidelines for compiling the MOE strategic plan and submit them to the Minister for the Environment for approval.

Chapter 3

Findings through Field Investigations

3 Findings through Field Investigations

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

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 the findings are discussed together in the subsequent section.

3.1.1 Waste Amount Survey

a. Objective

The objective of the Waste Amount Survey is to determine 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 rates 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.

b. Results

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

Table 3-1: 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

3.1.2 Waste Composition Survey

a. 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.

b. Result

b.1 Specific gravity and physical composition

Table 3-2 to Table 3-4 エラー! 参照元が見つかりません。show the results of the specific gravity and physical composition of the waste.

b.2 Three contents[1] and chemical analysis

The results of the three contents and chemical analysis of the wastes are shown in the supporting report.

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

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

[1] 3 Contents: Combustible, moisture and ash contents

Table 3-3: Results of Waste Composition Survey (2/3)

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 3-4: Results of Waste Composition Survey (3/3)

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

3.1.3 Findings

a. Waste amount survey

a.1 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%)

b. Waste composition survey

b.1 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 has spread rapidly, and they are consumed at the same level as developed countries. Plastic waste will be an obstacle in regard to proper management of the final disposal site. Therefore, countermeasures should be considered.

b.2 Household waste

Kitchen waste is the most dominant constituent, which accounts for 63.3% of the total waste composition. 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 a much greater share 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 a greater amount of other types of wastes than kitchen waste 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.

b.3 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 a high percentage of paper waste accounting for 29.5% and 22.7% in total, respectively.
- Street sweeping waste contains 58.0 % ceramic and stone waste, and 25.1% grass and wood waste in total respectively.
- The ratio of carbon and nitrogen contained in the waste of households, restaurants and markets were analyzed. These results indicate the conditions of these wastes are

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.

3.2 Time and Motion Survey (Rainy and Dry Season)

3.2.1 Objective of the Survey

One of the most important issues of solid waste management is to achieve a cost effective and efficient municipal solid waste collection service. There are two significant and essential factors which are considered to improve the solid waste collection service efficiency.

- Maximum use of vehicle capacity
- Maximum use of legal working hours

Besides these relevant factors, others such as, route selection, public participation, general conditions of physical infrastructure and equipment, also impact service efficiency.

The objective of this study was to obtain the following information on the current collection and haulage system for solid waste management in Phnom Penh:

- 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 labour inputs required for each task.

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

3.2.2 Method of the Survey

The details of the method are described in Annex 2 of the Supporting Report.

3.2.3 Results of the Survey

The results of the survey are shown in Annex 2 of the Supporting Report.

3.2.4 Findings of the Survey

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^3 size), it was common to find waste overflowing the container and scattered on the ground, apparently because the 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 odor 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 were 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.

3.3 Public Opinion Survey (POS)

3.3.1 Objective of the Survey

There are no easy solutions to the problems related to Solid Waste Management (SWM). The SWM system should be formulated based on a precise grasp of natural and socioeconomic conditions, the state of the present SWM system and the lifestyle of local residents along with the opinions of all the people in the target area. In addition, the MSWM system should include a mechanism that increases people's awareness and promotes public participation, because active public involvement is indispensable for a sustainable MSWM system.

An effective method for obtaining a precise grasp of the opinions of local residents is a Public Opinion Survey (POS). In particular, a POS can give us essential information for formulating the M/P, such as the way people discharge wastes in their daily lives and the level of waste tariff people are willing to pay. In addition, a POS can show us the level of people's environmental awareness and give us a hint about acceptable approaches for local people to improve the SWM system.

Therefore, the team decided to conduct a POS, targeting all the households and business establishments in MPP, in order to obtain the basic information, which is summarized in the following paragraphs. At present, in MPP, almost all the areas of the four urban Khans are

covered by the waste collection service, while many parts of the three rural Khans are left without a collection service. In the POS, the team aimed at gathering opinions of the people in the urban area on the current collection service, as well as asking the people in the rural area without a collection service how much they need waste collection services and are willing to pay for the services.

(1) Household Survey

1) In the urban area where a waste collection service is already provided
   - Generation and recycling of waste at the source
   - Way of storing and discharging waste.
   - Awareness of environmental issues, in particular SWM

2) In the rural area where there is no collection service available at present
   - Generation and recycling of waste at the source
   - Awareness of environmental issues, in particular SWM
   - Need of waste collection service and willingness to pay

(2) Business Establishments Survey

- Generation and recycling of waste at the source
- Way of storing and discharging waste
- Awareness of environmental issues in particular MSWM

The results of the survey were reflected in the draft of M/P, aiming at increasing people's environmental awareness, improving waste collection services, examining the introduction of separate waste collection and reducing waste amount.

3.3.2 Method of the Survey

a. 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 total, there were 500 samples, of which 400 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 the survey is as follows:

1. Method of Survey: Interview
2. Target of Survey: (1) Households - 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 establishments - all the business establishments in the urban area including shops, restaurants, hotels, offices, and markets.
3. Number of samples: (1) Households - 400 valid samples
   (300 samples were allocated to the urban area and 100 to the rural

area without the collection service)
(2) Business establishments – 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) Method 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.

b. Preparation of Questionnaire and Show Card

b.1 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 concepts of the questions are explained in Annex 3 of the Supporting Report and the questionnaire used in the survey is shown in Data 3 of the Databook.

b.2 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 the 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.

c. Sampling

c.1 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.

c.2 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 3-5: 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
	570,155	**570,155**	**100%**	**41**	**300**

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
	429,649	**321,756**	**100%**	**22**	**100**

c.3 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 Annex 3 of the Supporting Report.
- Select samples randomly in each category.

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

Table 3-6: Allocation of Samples for the Business Establishment Survey

Business Establishment	No. of Samples
Shop	
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
Jewelly	1
Other retail (Bakery, watch, art)	4
Other service (Shoe repair…)	3
Sub-total	**22**
Office	
Government office/institution/	5
NGO/ Company Office	15
Sub-total	**20**
Restaurant	
Bar	1
Coffee Shop	2
Roadside Café	1
Restaurant	6
Street Stall/Eating Place	10
Sub-total	**20**
Hotel	
Local Hotel	8
International Hotel	3
Guest house	9
Sub-total	**20**
Market	
Grocery	7
Clothes/Footwear/Bag	9
Others	4
Sub-total	**20**
TOTAL	**102**

d. Execution of Survey

d.1 Recruitment of Interviewers

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

d.2 Sample Survey

The research was carried out in the way described in Annex 3 in the Supporting Report in order to keep the quality of the survey. Fieldwork was conducted from April 21 to May 5, 2003.

3.3.3 Results of the Survey

The results of all the questions in the questionnaire are shown in Annex 3 in the Supporting Report.

3.3.4 Findings of the Survey

a. 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.

b. 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.

c. Opinion about the current collection service

In total, 80% of the household respondents and 60% of the 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.

d. Recycling

Glass bottles and aluminum cans are the two main items of recycling. Papers and cardboard are rarely collected separately and recycled. At present, people in the MPP store recyclables at home for several months before a buyer comes 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.

3.4 Social Environmental Survey in and around the Final Disposal site

As the situation of the Stung Mean Chey disposal site is getting worse, it has become an urgent issue for the MPP and PPWM to improve the operation and management of the dumpsite. A lot of people are living around the disposal site, while hundreds of waste pickers are working at the disposal site. Therefore, it is necessary for the MPP to grasp the socio-environmental situation in and around the final disposal site before finalizing the disposal site improvement plan, in order avoid or mitigate the possible negative impacts of the improvement plan on these people.

The Social Environmental Survey (SES) is divided into two parts: (1) a survey of local residents living around the disposal site and (2) a survey of waste pickers working at the disposal site. Therefore, the results of the survey are summarized separately.

3.4.1 Objective of the Survey

a. Local Resident Survey

The main purpose of the local resident survey is to obtain the opinions of people who are living around the disposal site about the current situation of the site and its impact on their living conditions and surrounding environment. The results of the survey were reflected in the draft of the Master Plan on municipal solid waste management.

b. Waste Picker Survey

The goal of the waste picker survey is to avoid or mitigate the negative impact of the operation and management improvement plan for the disposal site on the weak such as waste pickers.

PPWM has to improve its operation by introducing the sanitary landfill method as soon as possible in order to prevent the disposal site from further polluting the surrounding areas. One of the biggest obstacles for PPWM in introducing the sanitary landfill operation is the existence of waste pickers. At present, a large number of waste pickers are working around heavy vehicles such as collection vehicles and bulldozers, which would make it extremely difficult for PPWM to implement the improvement plan.

One possible solution is to eliminate waste pickers from the disposal site. Considering the huge economic discrepancy between Phnom Penh and rural areas, more migration from rural areas to Phnom Penh is expected and there would be a continuous supply of waste pickers. It is, therefore, an unrealistic measure to eliminate waste pickers from the disposal site right now. The only option left for PPWM is to find an effective method for conducting the sanitary landfill operation with the existence of waste pickers.

The biggest problem for PPWM in working with waste pickers is the absence of order. At present, waste pickers are out of PPWM's control, flocking together around collection vehicles. This results in not only incomplete landfill operation but also the frequent occurrence of accidents. The control of waste pickers by introducing some kinds of rules is a precondition for PPWM to start sanitary landfill operation. However, it is impossible to implement rules at the disposal site without the consensus and cooperation of the waste pickers. Therefore, it is necessary to know the details of the working conditions of waste pickers and their opinion about current conditions and possible solutions in order to establish acceptable rules both for PPWM and waste pickers.

The waste picker survey aimed to obtain information on the problems they face while working at the dumpsite and opinions about acceptable solutions through a series of focus group meetings and an interview survey. In particular, the team aimed to reach some kind of consensus with waste pickers about the introduction of rules at the disposal site at the end of the meetings. Additional observation surveys along with a reference survey were conducted to obtain the details of the current situation, in particular about child waste pickers. This is because a large number of child waste pickers are working at the disposal site, which would make it more difficult for PPWM to establish appropriate rules and to put them into practice. The results of these surveys were reflected in the draft of the M/P, in particular the improvement plan for the dumpsite.

3.4.2 Method of the Survey

a. 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. However, 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.

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.

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.1 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.

a.1.1. 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.1.2. 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

a.2 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.

a.2.1. 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

a.2.2. 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

a.2.3. 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

b. Selection of meeting participants and interviewees

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

b.1 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.2 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 families
- 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.

c. Preparation of Questionnaire and Show Card

c.1 Questionnaire

The concepts of the questionnaire are explained in Annex 4 of the Supporting Report, and the questionnaire used in the survey is shown in Data 4 of the Databook.

c.2 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.

d. 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 20th and 21st of May, 2003. The entire discussion was facilitated by a facilitator. Two additional meetings for waste pickers were arranged on the 4th and 6th of June.

The interview survey for both local residents and waste pickers was conducted by three research assistants from the 21st to the 23rd 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 29th of May and the 9th of June.

3.4.3 Results of the Survey

The results of all the questions in the questionnaire are shown in Annex 4 in the Supporting Report.

3.4.4 Findings of the Survey

a. 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 either MPP or 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 depos 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.

b. 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 recyclables at the disposal site. Since many of the 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 kind 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.

3.5 Cleansing Workers Survey

3.5.1 Objectives

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.

3.5.2 Method of the Survey

a. Target Group

The main target group for this study was garbage collectors, truck drivers, street sweepers and supervisors who are staff of CINTRI, along with garbage collectors of a smaller group of cleansing workers who are known as members of "Self Help Groups".

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 SHGs. 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 case some data was invalidated.

b. Survey Preparation

b.1 Questionnaire

After doing an interview with CINTRI management to obtain information on the number and type of staff members employed by the company, a questionnaire was prepared. The contents of the questionnaire are shown below. The details of the questionnaire are shown in Data 5 of the Databook.

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

b.2 Permission from CINTRI

The team requested permission from CINTRI to conduct interviews with its staff.

c. Execution of the Survey, Data Compilation and Analysis

Two researchers conducted field interviews with workers from May 15 to 30. The details are shown in Annex 5 of the Supporting Book.

3.5.3 Results of the Survey

The results of the survey are shown in Annex 5 of the Supporting Book.

3.5.4 Findings of the Survey

This survey was carried out from May 15 to 30. Garbage collection workers, drivers, street sweepers and supervisors working for the private service provider, CINTRI were interviewed to establish data on salary and living and working conditions. The primary collection workers called Self-Help Group (SHG) members were also interviewed. These workers have formed groups that function as worker cooperatives to provided contracted services to PPWM or CINTRI for manual waste collection with pushcarts in areas where access is difficult for the standard collection vehicles.

Street sweepers received the lowest salaries of all workers interviewed. The average salary was reported to be about $35.00. Collection workers reported monthly salaries of roughly $44 dollars per month. Drivers and supervisors report $62.50 and $130.00 per month respectively. In addition to salaries, all staff members receive a uniform, basic medical insurance, holiday pay and a meal allowance. Most CINTRI staff reported that they work about 8.5 hours per day; however, when lunch and other breaks are subtracted, the actual work time was found to be approximately 7.5 hours per day.

Salary levels for SHG members were found to be higher at $55 per month; however, they lacked the benefit package (holiday, medical, etc…) provided to workers in the private sector. SHG members are encouraged to sort waste to remove recyclables during collection. Sale of these items provides additional income for SHG members. CINTRI rules prohibit their staff from collecting materials, although a number of staff report that they do occasional collect items for sale. Interviews with sweepers and waste collectors revealed that in almost all cases additional family members must work to provide additional income to help the family survive.

Information on salary levels and employee benefits was later used in preparation of the cost estimated for the SWM master plan.

Most workers interviewed indicated that they are concerned about health hazards related to their work. A number of health problems were reported by workers, with headaches, fever and respiratory problems being the most common. Most workers use some sort of safety equipment, but the employer provides only about 67% of the equipment used. Provision of appropriate safety equipment will be an important consideration for future SWM planning.

3.6 Medical Institutions Survey

3.6.1 Objectives and Definitions

a. Objectives of the Study

Medical waste requires appropriate treatment and disposal based on its physical, chemical and pathological properties. For example, as this waste is handled carelessly, medical staff sometimes injure themselves with sharps. Moreover, when medical waste is disposed of together with general waste, the toxic chemicals and pathogens that it contains may have a grave impact, whether directly on the staff in charge of collection and landfill work, or indirectly on the surrounding environment and the residents living near the disposal sites. Adequate care needs to be taken in its treatment and disposal.

This survey for medical institutions aims to elucidate how infectious, hazardous and general waste generated by medical institutions in the Phnom Penh city is handled, treated and disposed of. The results of this study should also be useful for the establishment of the future medical waste management system necessary in the Phnom Penh city.

b. Definition of Waste Generated in Medical Institutions

The WHO (World Health Organization) defines the waste generated in a medical institution as "health-care waste". In this questionnaire, it is divided into two; i.e. medical waste (hazardous healthcare waste or healthcare risk waste) and general waste (non-risk healthcare waste).

Medical waste in this questionnaire is **hazardous healthcare waste** of WHO classification. A detailed classification of medical waste is summarized in the table below.

Table 3-7: Classification of Medical Waste

Waste Category	Description and examples
1. Infectious waste	Waste suspected to contain pathogens e.g. laboratory culture; waste from isolation wards; tissues, materials, or equipment that have been in contact with infected patients; excreta
2. Pathological waste	Human tissues or fluids e.g. body parts; blood and other body fluids; fetuses
3. Sharps	Sharp waste e.g. needles; infusion sets; scalpels; knives; blades; broken glass
4. Pharmaceutical waste	Waste containing pharmaceuticals e.g. pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals (bottles, boxes)
5. Genotoxic waste	Waste containing substances with genotoxic properties e.g. waste containing cytostatic drugs (often used in cancer therapy); genotoxic chemicals
6. Chemical waste	Waste containing chemical substances e.g. laboratory reagents; film developer; disinfectants that are expired or no longer needed; solvents
7. Wastes with high content of heavy metals	Batteries; broken thermometers; blood-pressure gauges; etc.
8. Pressurized containers	Gas cylinders; gas cartridges; aerosol cans
9. Radioactive waste	Waste containing radioactive substances e.g. unused liquids from radiotherapy or laboratory research; contaminated glassware, packages, or absorbent paper; urine and excreta from patient treated or tested with unsealed radionuclide; sealed sources

（Source） Safe management of wastes from health-care activities, WHO Geneva, 1999

General waste in this questionnaire is **non-risk healthcare waste** of WHO classification. It comes mostly from the administrative and housekeeping functions of medical institutions and may also include waste generated during the maintenance of medical institutions.

3.6.2 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 3-8: Number of Present Medical Institutions and the Survey Coverage

Category of Institution	Whole Area*1	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	
Total	870	41	

(Source) Ministry of Health

Forty-one medical institutions in Phnom Penh City were selected for the survey (see Table 3-9). The survey is based largely on information collected directly from resource persons, directors or those 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:

- Interviews with resource persons, directors or persons 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 3-9: 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
Total	41	3,114	100.0	-	-	-

3.6.3 Results of the Survey

The results of all the questions in the questionnaire are shown in Annex 6 in the Supporting Report.

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 a larger volume of medical waste than the other cities and provinces. The findings of the survey that we conducted in May and June 2003 are described in the following.

a. Waste Generation

a.1 Waste Unit Generation Rate

a.1.1. Medical Waste

The medical waste generation rate in Phnom Penh was calculated for hospitals, polyclinics, clinics and health care centers. The rate can be obtained by dividing the waste amount (i) by the number of beds 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 the medical waste generation rate in Phnom Penh City is still lower if compared with other countries in the world.

Table 3-10: 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 3-11: 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 3-12: 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[1)]	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)[2)]		0.77
Turkey (Mersin)[2)]		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.1.2. General Waste

The general waste generation rate from hospitals, polyclinics, clinics and healthcare centers in Phnom Penh City are shown in the table below. As in the case of medical waste, the generation unit of general waste was calculated in 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 3-13: 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 3-14: 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

a.2 Waste Generation Amount

a.2.1. Medical Waste

The figure below shows the process of estimating the medical waste generation amount from all the medical institutions in the city, taking the example of hospitals. The solid 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 Table 3-8.

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.

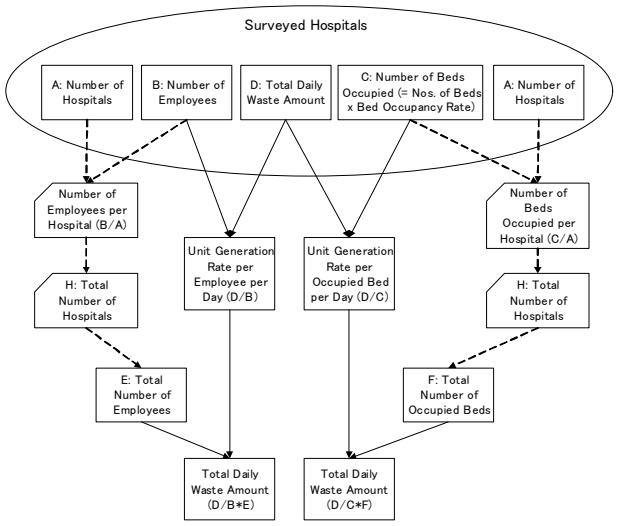


Figure 3-1: Waste Amount Estimation Process

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 many more clinics than health centers in the city, the team assumed that the six health centers that were surveyed were all the health centers existing in the city and all the rest (816) were 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 may be an 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 lead to a wrong estimation because it does not take the scale variation of institutions into account. The team recommends the Cambodian side to gather information on medical institutions to allow more precise estimation.

Table 3-15: Medical Waste Generation Amount in Phnom Penh

Generation Source	Studied Medical Institutions		All Medical Institutions in 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

a.2.2. General Waste

The table below shows the estimated general waste generation amount from all the medical institutions in the entire city. The estimation method taken was the same as 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. Hospitals are the major generation source, followed by clinics, poly-clinics and health centers.

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

Table 3-16: General Waste Generation Amount in Phnom Penh

Generation Source	Studied Medical Institutions		All Medical Institutions in 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

a.3 Generation Forecast

The 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, and was thus calculated with the increase in the total number of beds proportional to the population increase. As shown in the following table, 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.

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

Table 3-17: Generation Amount Forecast

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.

b. Observations on Medical Waste Management

b.1 Medical Waste

b.1.1. 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 secondary 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.

b.1.2. Incineration of Medical Waste

Nineteen of the 41 medical institutions surveyed dispose of some of the medical waste with the incinerators. The table below shows the proportion of incinerated medical waste to the total medical waste amount. The medical waste amount incinerated by the 19 institutions

accounted for 59% of the total generation (See Table 3-18).

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

Table 3-18: 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 undergo incineration, or any other comparative treatment measures. As a result, not a small quantity of medial waste, which threatens human health, is disposed of without due attention.

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

b.1.3. Waste Discharge

Most medical institutions in Phnom Penh store waste separately. 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.

b.1.4. Collection

Waste collection is normally done by the private company, CINTRI, 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 a small amount of institutions transport wastes to Wat Preah Put (local name of pagoda) for burning.

b.1.5. In-house Collection System

In-house collection 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 plastic bags of different colors. The workers collect the primary bins or containers of medical waste, which is mixed with solid wastes from other rooms and buildings, to store in secondary containers or in 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 are not covered or locked. The collection system differs from one facility to another and in many cases waste is stored in a central collection point.

b.2 General Waste

The system for collecting general waste within the hospitals, polyclinics, clinics, and health centers is similar to medical waste collection. As reported earlier, general waste is usually 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.

c. Financial Observation

One hundred percent of the surveyed medical institutions in Phnom Penh pay a collection fee for medical waste as well as general waste. Their payment ranges from 5-100 USD for hospitals, 5-50 USD for polyclinics, and 5-20 USD for clinics and health centers.

Thirty-seven of the institutions stated their satisfaction with the waste collection and disposal services. The reasons for dissatisfaction of the remaining four medical institutions are that waste is not separated in different bins, the collection workers improperly load the waste into the truck allowing the refuse to fall down on the street, and the collection and disposal fees are expensive. Six of the medical institutions surveyed, including two hospitals, two polyclinics, one clinic and one health center, complained about the waste collection procedure in the year 2002. Even so, they are still willing to pay the fee corresponding to appropriate collection, treatment and disposal of medical waste.

d. 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 follows:

- The separation of medical waste is not adequate. Although it is often separated from general waste, in the end they are disposed of together.
- One reason for this is that neither the staff of the medical institutions nor the waste collection workers are fully aware of the possible risks posed by medical waste.
- The second, and probably fundamental, reason is that there are no or only a few facilities that can appropriately treat medical waste in the city. This makes the medical staff and the collection workers reluctant to strictly separate medical waste.

The leadership of the responsible authorities including the Ministry of Health and MPP in the development of a medical waste management system, particularly in raising public awareness of health risks, should be urgently strengthened.

3.7 Factory Survey

3.7.1 Objectives and Waste Flow

a. Objectives

The objectives of the survey are:

1. To obtain basic data for the estimation of current industrial (factory) waste (IW) generation and the forecast of future IW generation in order to formulate an IW management master plan (M/P);
2. To identify current IW management at generation sources, i.e. **on-site**: storage, reuse, recycling, waste exchange, treatment and disposal, and **off-site**: collection/transportation, reuse, recycling, waste exchange, treatment and disposal;
3. To research needs of reuse/recycling of IW according to the categories of industries and/or industrial wastes (IWs); and
4. To get the opinions of factories (generation sources) regarding IW management and the improvement of waste management.
5. To use the result of this survey for the formulation of a SWM master plan for Phnom Penh

b. Waste flow

Through this factory survey, the generation amount, on-site reuse/recycling and treatment/disposal amount, collection/transportation amount, and off-site reuse/recycling and treatment/disposal amount should be understood. An IW flow should then be developed as shown in the following figure.

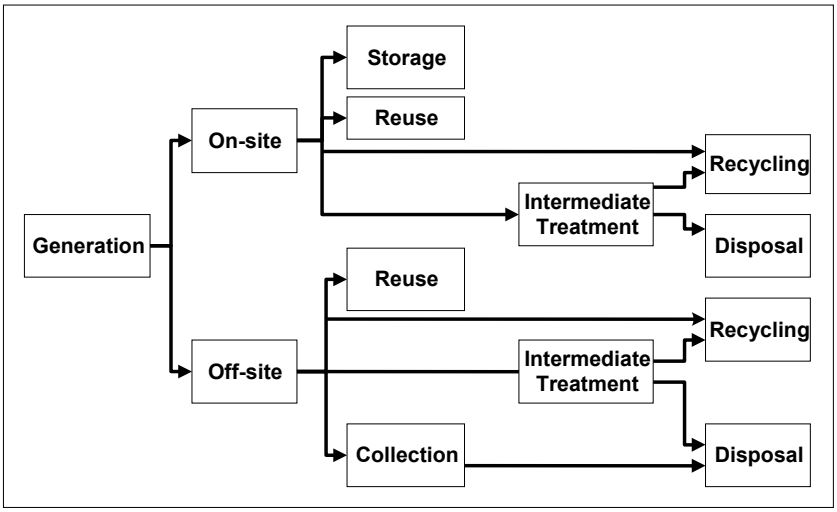


Figure 3-2: IW Flow

c. Work Flow

The factory survey followed the procedure illustrated below.

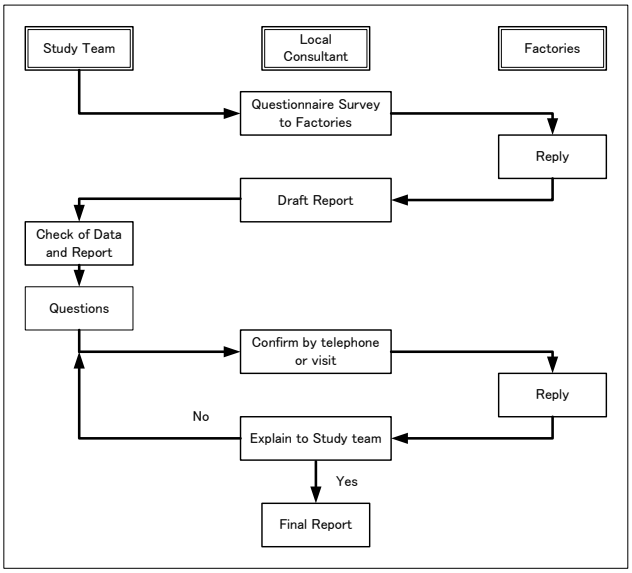


Figure 3-3: Flow Chart of Factory Survey

3.7.2 Method of the Survey

a. Preparation of the Survey

a.1 Classification of IW

In this factory survey, IW was divided into two types: non-hazardous and 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 3-19: 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 3-20: Hazardous Industrial Waste (HIW)

Type of Hazardous Industrial Waste	HIW Code	Example of Hazardous Industrial Waste
Inorganic acid	HW01	Sulfuric acid (H_2SO_4), Hydrochloric acid (HCl), Nitric acid (HNO_3), Phosphoric acid (H_3PO_4), Other inorganic acids
Organic acid	HW02	Acetic acid (CH_3COOH), Formic acid (HCOOH), Other organic acids
Alkalis	HW03	Caustic soda (NaOH), Ammonia (NH_3), Sodium carbonate (Na_2CO_3), Other alkaline materials
Toxic-Metal Compounds	HW04	Salts (Hg, As, Cd, Pb, Cr, etc)
Inorganic Compounds	HW05	Plating wastes, Cyanides, Picking waste, Sulphide, etc.

Type of Hazardous Industrial Waste	HIW Code	Example of Hazardous Industrial Waste
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

a.2 Preparation of Survey Sheet

The survey should clarify current generation, reuse/recycling and treatment/disposal. The content of the questionnaire of the survey is divided into two parts: (1) general information and (2) IW management. The details are explained in Annex 7 of the Supporting Report.

a.3 List of Factories

The Ministry of Industry (MOI), Mines and Energy publicized the list of factories 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 in each industrial sector in Phnom Penh, together with the 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 3-21: 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	G03	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

b. Method of the Survey

The methodology for preparation of the factory survey is as follows:

- Selection of samples taking into account the type of factory and the number of employees
- Distribution of the questionnaire to the factories to be interviewed and appointment making for interviews
- Interviewing the owner or representative of the factories
- Analyzing the survey results

The number of factories surveyed in each industrial sector is shown in the table below. The team tried to cover factories with a large number of employees, but not all the factories that the team planned to visit accepted 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 3-22: Factories Selected for Factory Survey

Category Code	All Factories in Phnom Penh				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%

3.7.3 Results of the Survey

The results of all the questions used in the factory survey are shown in Annex G.

3.7.4 Findings of the Survey

a. Current Industrial Waste Management (IWM)

a.1 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.

a.2 Storage, Intermediate Treatment and Reuse/Recycling

Eighteen of the 32 factories (56%) store waste within the factories. The reason for 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 the factories (30 out of 32) answered that they do not have any such plans.

Therefore, it is considered that it is not popular for factories to reuse/recycle or treat waste on-site, and they are not well motivated to do so.

a.3 Collection, Off-site Treatment and Reuse/Recycling, Disposal

It is interesting to know that as many as 24 factories receive the collection service of Sarom Trading, which is a company that collects, transport and treats HW. It can be presumed that the factories using Sarom Trading generate HW. It should be noted that the factories using CINTRI do not necessarily generate only non-HIW, and there is a 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 the off-site treatment or reuse/recycling of waste. The factories' lack of interest in the fate of the 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 colleted, transported, treated and disposed of.

b. 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.

c. Financial Matters

Replies about off-site disposal costs 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 the total waste generation amount of the factory and the off-site disposal cost regardless of the type of waste. As the table shows, the 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 the unit cost varies from factory to factory within the same industrial sector.

Table 3-23: 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	-	-

d. Evaluation of the Present IW system

About half of the factories surveyed (47%) said that the present IWM has problems.

One of the major problems they have is that they do not know the difference between hazardous and non-hazardous waste (7 factories). This conforms to the problem of the lack of a clear definition of non-HW and HW, as the team pointed out earlier.

Another major problem expressed by the factories was that the 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 a final disposal site or reuse/recycling market, and "software" such as guidelines and laws for IWM.

e. Waste Generation

e.1 Waste Unit Generation Rate

The unit generation rate of waste from factories in each industrial sector was calculated. The unit generation rate is, in this case, expressed by generation per employee.

It was found that the waste unit generation rate varies according to the industrial sector.

Table 3-24: Waste Unit Generation Rate

Factory Code	Generation Amount (tons/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

e.2 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 the 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, the total IW amount from factories in the whole city was calculated at about 58 tons. The major sources were textile factories (35 tons/day) and leather factories (13 tons/day), accounting for 82% together.

Table 3-25: Generation Amount of IW

Type of Factory	Factories in Phnom Penh	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

f. 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 the waste is discharged outside. CINTRI and Sarom Trading have an equal share of the 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. A 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 clear whether all of what they receive is hazardous. There is no sufficient information to evaluate the waste management activity of this company.

Table 3-26: 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 flow shown below. It should 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.

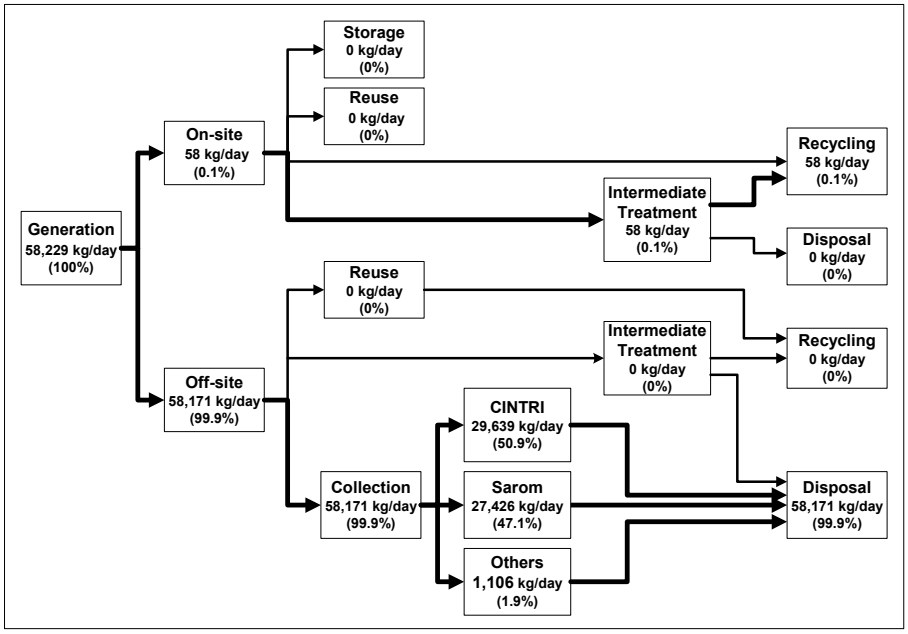


Figure 3-4: Waste Flow of IW (Whole Phnom Penh)

3.8 Recycling Market Survey

3.8.1 Objectives of the Survey

The objectives of the survey are:

- To understand the trends and scale of the present recycling market and analyze future market demands for recycling materials in Phnom Penh.
- To use the results of this survey for the formulation of a SWM master plan for Phnom Penh

3.8.2 Method of the Survey

a. Method of the Survey

The recycling market survey was implemented in the four steps below.

- The samples were randomly selected from a list of companies taken from the Small Industry and Handicraft Office of the Department of Industry, Mines and Energy, which is responsible for giving licenses to recycling companies, and the Department of Commerce of Phnom Penh, which is responsible for giving licenses to waste depots.
- A questionnaire was distributed to companies to be interviewed and appointments for interviewing were made.
- The owners or representatives of the waste recycling companies were interviewed.
- The survey results were analyzed.

b. Surveyed companies

- Twenty private recycling companies, located in different districts of the Municipality of Phnom Penh, were surveyed.
- The 20 companies cover paper recycling, glass recycling, plastic recycling, aluminum recycling, steel recycling, composting and waste depot companies.

Their distribution is shown in Annex 8 of the Supporting Report.

3.8.3 Results of the Survey

The results of the survey are presented in Annex 8 of the Supporting Report.

3.8.4 Findings of the Survey

a. Amount of Materials for Recycling

From the present survey, the team obtained the 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 3-27: 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.

b. 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.

c. Pollution Control and Monitoring

Nineteen 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, may 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 the 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.

3.9 Water Quality Survey (Rainy and Dry Season)

3.9.1 Objectives

The purpose of this work is to obtain data on the water quality of

- Leachate
- Rivers
- Groundwater

around SMCDS

3.9.2 Samples and Sampling Points

There were ten samples in total. The sample number and sampling points and shown below.

Table 3-28: 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

3.9.3 Results

a. Results in dry season

The results of the water quality analysis are shown in the table below.

Table 3-29: 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_5	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^+	mg/l		69	27	76	120	72
14	K^+	mg/l		17	6.5	17	16	16
15	SO_4^-	mg/l	<500	68	27	930	220	340
16	Cl^-	mg/l		3,100	130	5,700	4,000	8,600
17	HCO_3^-	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 3-30: 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_5	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^+	mg/l		65	70	44	<0.1	4.6
14	K^+	mg/l		12	0.22	<0.1	17	2.8
15	SO_4^-	mg/l		31	21	35	46	530
16	Cl^-	mg/l		900	230	36	9.9	79
17	HCO_3^-	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

No	Parameters	Unit	Standard for in public**	Sample No.				
				MW1	MW2	MW3	NR1	NR2
21	Lead	μg/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	μg/l	<50	<5	<5	<5	<5	<5
24	Arsenic	μg/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	μg/l	<0.5	14***	7***	3***	2***	12***
31	PCB	μg/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)

b. Results in Rainy Season

The results of the water quality analysis are shown in the table below.

Table 3-31: 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	μS/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		$5.7x10^4$	$1.8x10^5$	$2.6x10^4$	$2.6x10^4$	$1.2x10^5$
9	BOD_5	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^+	mg/l		0.19	<0.1	1.0	1.1	0.96
14	K^+	mg/l		0.26	0.11	1.1	0.65	1.0
15	SO_4^-	mg/l	<500	33	14	26	9.4	1.4
16	Cl^-	mg/l		340	77	6,500	4,000	4,200
17	HCO_3^-	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	μg/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 3-32: 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	^{o}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	$1.3x10^{2}$	$5.1x10^{2}$
9	BOD_5	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^{+}	mg/l		0.33	0.37	0.24	<0.05	0.05
14	K^{+}	mg/l		<0.1	<0.1	<0.1	<0.1	<0.1
15	SO_4^{-}	mg/l		4.5	19	24	8.3	6.0
16	Cl^{-}	mg/l		99	190	83	5.4	6.9
17	HCO_3^{-}	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	μ g/l	<1	<50***	<50***	<50***	<50***	<50***
20	Cyanide	μ g/l	<0.005****	<1	<1	<1	<1	<1
21	Lead	μ 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	μ g/l	<50	<5	<5	<5	<5	<5
24	Arsenic	μ g/l	<10	<10	<10	<10	<10	<10
25	Copper	mg/l		<0.2	<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	μ g/l	<0.5	<5***	<5***	<5***	<5***	<5***
31	PCB	μ 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)

3.9.4 Findings

a. Findings in dry season

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.

a.1 Leachate, leachate drained canal and a pond

Table 3-29 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_5, COD, SS, Cl^-, HCO_3^-, 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.

a.2 Groundwater and Natural Rivers

Table 3-30 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.

a.3 Data reliability

Data marked *** are questionable or even minimum quantitative limits are higher than the standard of Cambodia. Countermeasures are required. (See 3.9.6 Conclusions)

b. Findings in rainy season

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.

b.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_5, COD and SS also exceeded the effluent standard in Cambodia.

b.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_5 and SS.

b.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 3.9.6 Conclusions)

3.9.5 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 μ g/l for cyanide seems to be too low compared with that of developed countries such as Japan, and the 0 μ 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.

Secondary, 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 3.9.5 a. Findings in dry season” and “3.9.6 b. Findings 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.

3.10 Septage Sludge Survey

3.10.1 Objectives

At SMCDS, septage sludge treatment facilities were constructed by DPWT in 2002 as part of the NORAD project. In this system, waste water is filtrated through a sand filter and organic matters are biologically decomposed through layers of waste. This type of method is approved by MOE for the treatment of septage sludge.

Since there is little information on septage sludge brought in the disposal site, PPWM requested the study team to make a survey on septage sludge. The survey contained the following items.

- List of septage sludge collection vehicle.
- Collection amount of septage sludge (disposal amount at SMCDS)
- Characteristics of septage sludge (Physical/Chemical)
- Type of septic tank

3.10.2 Method of the Survey

Some data were obtained from the department of sludge waste operation, PPWM. A telephone survey was also arranged to make a interview with private collection companies.

3.10.3 Results of the Survey

a. List of Septage Sludge Collection Vehicles

In Phnom Penh, there are 14 septage collection vehicles in total, three owned by PPWM and 11 by private companies.

Collection vehicles of PPWM visit one or two places per day to collect septage sludge, while private collection vehicles collect sludge from 2-3 tanks per week. The collection is arranged at the request of customers by phone. According to the data of the SMCDS, the daily average number of collection vehicles that bring septage sludge into the disposal site is only one or

two. In some cases, there are no private collection vehicles recorded. Therefore, it is assumed that private collection vehicles might bring septage sludge somewhere else.

The collection fee for $4m^3$ of septage sludge is around US$25, and the disposal fee at SMCDS is US$5 ($4m^3$). Septage sludge collection vehicles available at present in Phnom Penh are shown in the list below.

Table 3-33: septage sludge Collection Vehicles

Owner		Capacity of Collection vehicle (m^3)	Capacity of Water tank*1 (m^3)	Unit	Other
PPWM		5.0	---	3	Donated by NORAD
Private	A	3.8	1.0	2	---
		3.5	1.0	1	
	B	3.8	1.0	2	
	C	3.0	1.0	1	
	D	3.0	0.5	1	
	E	3.0	1.0	1	
	F	3.0	1.0	1	
	G	3.0	1.0	1	
	H	3.0	1.0	1	
			Total	14	

*1 : Volume of waste used for the cleansing of septage tank

PPWM Vacuum truck 5.0 m^3

Discharge of Septage Sludge

b. Collection Amount of Septage Sludge

A septage sludge collection vehicle has a water tank for cleaning the septage tank and the volume of water varies each time. This brings about a large error in the weight of septage sludge measured by the weighbridge. Therefore, the amount of septage sludge brought into the SMCDS is not measured by the weighbridge but by observation. The amount of septage sludge brought into the SMCDS in the last two years is shown in the following table. The daily average amount in 2002 and 2003 is $9.2m^3$ and $5.8m^3$ respectively.

Table 3-34: Monthly Amount of Septage Sludge at SMCDS

Date	Month (m3/month)						Total Amount (m3/year)	Ave. Daily Amount (m3/day)
2002	Jan	Feb	Mar	Apr	May	Jun	3,372.4	9.2
	55.8	362.6	691.0	186.0	245.0	520.0		
	Jul	Aug	Sep	Oct	Nov	Dec		
	241.0	243.0	70.0	339.0	269.0	150.0		
2003	Jan	Feb	Mar	Apr	May	Jun	2,116.5	5.8
	52.0	83.0	221.0	361.0	289.0	157.0		

	Jul	Aug	Sep	Oct	Nov	Dec		
	222.0	126.0	112.0	230.0	143.5	120.0		

c. Characteristics of Septage Sludge (Physical/Chemical Property)

There are no data available about the characteristics of septage sludge. The physical and chemical properties of septage sludge obtained from ordinal septage tanks in Japan are shown below as a reference.

Table 3-35: Characteristics of Septage Sludge in Japan

item		Human waste	septage sludge
pH	(---)	8.3	7.3
BOD	(mg/l)	12,000	5,600
COD	(mg/l)	6,800	4,700
Suspended solids	(mg/l)	14,000	12,000
Evaporation residue	(mg/l)	27,000	13,000
Total Nitrogen	(mg/l)	3,900	980
Total Phosphorus	(mg/l)	580	170
Chlorine ion	(mg/l)	3,200	520

d. Type of Septic Tank

There are no data available about the following items in Phnom Penh city.

1) Number of septage tanks installed in Phnom Penh city
2) Distribution of septage tanks in each district
3) Population using septage tanks by Sangkat
4) Type of waste septage tanks (with or without certification systems)

Regarding the type of septage tank, both the single type and combined type of sewage treatment systems are available in Phnom Penh.

3.10.4 Findings

The result showed that the management of septage sludge in Phnom Penh is far from a satisfactory level. From the small amount of septage sludge brought in the SMCDS, the team gathered that:

- Sewage treatment systems are not managed properly at all; and
- Some septage sludge is dumped illegally somewhere, rather than brought to the SMCDS.

In either case, serious pollution problems might arise.

The necessary items PPWM should implement for proper septage sludge management are summarized below.

- PPWM studies and understands the current situation of septage disposal and the use of septic tanks in the city.
- PPWM formulates a septage management plan and an action plan, which is in line with public and private sector partnership and should include a plan for the development of a new septage treatment and disposal facility. In addition, MPP

allocates a budget for the implementation of the action plan, and PPWM puts it into action involving the private sector.

- Even though the total number of septage tanks in the city is not known, it is clear that the capacity of the current septage collection system is too limited to collect all the septage sludge generated in the city.
- The septage sludge treatment systems at the SMCDS are simple and effective. It is better for PPWM to consider their continuous use.
- PPWM sets a guideline for the appropriate management of septic tanks.

[Trial calculation of septage sludge generation amount]

- Here are the preconditions for the calculation of septage sludge generation amount.

1) Population in Phnom Penh:	1,200,000
2) Population that use sewage treatment systems:	360,000(30%2 of total population)
3) Type of sewage treatment systems:	Single type
4) Frequency of tank cleansing:	Once a year (same as the Japanese regulation)
5) Generation unit of eptage sludge:	0.85 liter/person/day (assumed from the case in Japan)

The daily generation amount of septage sludge is expected at 306m^3/day as shown below.

$$\frac{360000\,persons \times 0.85 liter/day}{1000 liter/m^3} = 306 m^3/day$$

The result is around 50 times as large as the current collection amount. It is obvious that the capacity of the septage sludge treatment facilities is too small to treat all the septage sludge generated in Phnom Penh. It is necessary for MPP/PPWM to prepare for the construction plan of new septage sludge treatment facilities as soon as possible.

3.11 Other Studies

The team conducted the following additional surveys with C/P and research assistants in order to obtain the waste flow, which is necessary to formulate the M/P.

- Interview survey with waste depots along the access road to the SMC disposal site
- Interview survey with waste pickers working in the city (on the streets)
- Interview survey with waste pickers working at the disposal site
- Interview survey with slaughter houses

[2] The septic tank diffusion rate in Metro Manila, Philippine is 13%. Seminar on Japanese Experiences in Industrial Pollution Control, 2004)

3.11.1 Interview survey with waste depots along the access road to the SMC disposal site

a. Objectives

At the disposal site, waste pickers sell a part of or all the collected items to waste buyers, who come to the disposal site to buy recyclables. According to the observation, most of the buyers come from waste depots which are located on the both sides of the access road to the disposal site. Therefore, the interview survey on the types of waste and their amounts of dealings was conducted, aiming at estimating the amount of materials that were recovered from the disposal site.

Since waste buyers of organic waste, which is reused as pig feed, are from other areas, the data on organic waste could not be obtained.

b. Method of the Survey

In total, there are 16 waste depots along the access road, and the team and C/P visited all the depots to ask for their cooperation in the interview survey. All but three agreed to do the interview survey. The reasons for the refusal were the absence of the owners (2 depots) and the smallness in size (1 depot).

Waste Depot

Plastic sheet (Sorting and Drying)

c. Results and Findings of the Survey

c.1 Types of recyclables

The types of recyclables that the 13 waste depots were dealing in are shown below. Eleven of them were dealing in multiple, at most eight, types of recyclables. The main items of recyclables were paper and metals, and more than 70% of the waste depots were dealing in these two items.

Table 3-36: Types of recyclables dealt by waste depots in SMC

Waste depot	Material										
	Paper	Plastic		Textile	Rubber	Metal			Glass		Total
	Mix	PET	Others			Aluminum	Iron	Others	Bottles	Others	
	RW01-1	RW02-1	RW02-2	RW03	RW05	RW06-1	RW06-2	RW06-3	RW07-1	RW07-2	
1	x	x	x		x	x	x				6
2	x		x				x				3
3	x	x			x	x	x	x	x	x	8
4		x									1
5	x	x			x	x	x	x	x		7
6	x	x	x		x	x	x	x	x		8

7	x		x	x							3
8				x	x	x	x	x	x		6
9						x	x		x		3
10			x								1
11	x	x		x		x	x	x	x		7
12	x	x			x	x	x				5
13	x		x	x		x	x	x			6
Total	9	7	6	4	6	9	10	6	6	1	64
	69%	54%	46%	31%	46%	69%	77%	46%	46%	8%	

c.2 Amount of Materials Recycled

The daily total amount of dealings by the 13 waste depots was 16.2 tons/day. The breakdown of sources of recyclables shows that 9.2 tons/day of recyclables (57%) were brought from factories, while 7.0 tons/day (43%) was sold by waste pickers. The result of the survey revealed that a large amount of recyclables are brought from factories.

According to the result, waste pickers sold all the types of recyclables except textile.

The total daily amount of materials recovered from the disposal site through the waste depots along the access road was estimated as 8.6 tons, as shown in the equation below. It has to be noted that the amount did not include organic waste.

$$7ton/day \times \frac{16}{13} = 8.6ton/day$$

Table 3-37: Amount of Material Recycled (13 depots)

Type of Waste		Purchase (kg/day)		Total	
		Factory	Waste picker	kg/day	%
RW01-1	Paper mix	5,250	1,450	6,700	41%
RW02-1	Plastic PET	550	310	860	5%
RW02-2	Plastic others	750	2,600	3,350	7%
RW03	Textile	2,060	-	2,060	13%
RW05	Rubber	200	525	725	4%
RW06-1	Aluminum	20	230	250	2%
RW06-2	Iron	375	755	1,130	7%
RW06-3	Other Metals	-	73	73	0%
RW07-1	Glass Bottles	-	83	83	1%
RW07-2	Glass Others	-	1,000	1,000	6%
Grand total		9,205	7,026	16,231	100%
		57%	43%	100%	---

c.3 Buying and Selling Rate of Recyclables

The buying and selling rates of recyclables, which were obtained from the interview survey, are shown in Table 3-38 and Table 3-39. One depot refused to answer to the question about the buying and selling rate, while another depot refused to answer the rate of some items.

The daily buying and selling amounts of the depots along the access road were estimated at US$ 1,480 and US$ 1,910 respectively. The total value of recyclables that waste pickers brought was estimated at US$ 920 per day.

Table 3-38: Buying Rate

Type of Waste	Ans.	Buy Price (Riel/kg) (13 waste depots)	16 waste depots	Total Buy Price (US$)

		Ave.	Max.	Min.	Amount (kg/day)	Ave. price x Amount / 4000
RW01-1	9	156	300	100	8,200	320
RW02-1	7	429	600	100	1,100	120
RW02-2	6	460	700	100	4,100	470
RW03	4	138	300	10	2,500	90
RW05	6	460	500	400	900	100
RW06-1	9	2,733	3,500	100	300	210
RW06-2	10	105	200	50	1,400	40
RW06-3	6	3,160	3,500	3,000	100	80
RW07-1	6	1,605	2,000	25	100	40
RW07-2	1	20	20	20	1,200	10
Total	64	984	---	---	19,900	1,480

Table 3-39: Selling Rate

Type of Waste	Ans.	Sell Price (Riel/kg) (13 waste depots)			16 waste depots	Total Sell Price (US$)
		Ave.	Max.	Min.	Amount (kg/day)	Ave. price x Amount / 4000
RW01-1	9	210	320	150	8,200	430
RW02-1	7	524	700	120	1,100	140
RW02-2	6	580	800	300	4,100	590
RW03	4	315	640	20	2,500	200
RW05	6	580	650	500	900	130
RW06-1	9	3,083	3,800	150	300	230
RW06-2	10	150	250	100	1,400	50
RW06-3	6	3,620	4,000	3,500	100	90
RW07-1	6	1,758	2,400	33	100	40
RW07-2	1	40	40	40	1,200	10
Total	64	1,136	---	---	19,900	1,910

c.4 Treatment of Waste

All the 13 waste depots somehow treated the recyclables they bought. The treatment methods that 12 waste depots answered are summarized below.

The treatment methods that most of the depots applied are drying and sorting. Some depots replied that they sometimes burned covered copper wires.

Table 3-40: Treatment Method of Waste (13 waste depots)

Type of Waste	Treatment Method								
	a, b, e, f	a, b, f	a. b. f	b, c, f	b, f	c, f	e. f	f	Total
RW01-1				1	1	1		5	8
RW02-1	1	1		1				3	6
RW02-2		1	1			1		2	5
RW03							1	3	4
RW05		1		1				3	5
RW06-1				1				7	8
RW06-2				1		1		7	9
RW06-3				1				4	5
RW07-1				1				4	5
RW07-2				1					1
Total	1	3	1	8	1	3	1	38	56

Legend

a. Dewatering	d. Incineration	h. Chemical treatment
b. Drying	e. Crushing	i. Biological treatment
c. Volume reduction	f. Sorting	j. Others

(Baling, Pressing etc.) g. Reutilization k. Not treat

c.5 Destination of Materials Recycled

The question about the destination of materials recovered from the disposal site was answered by 12 waste depots. The result is summarized below. Only 11% of the materials recovered was sold domestically, while the remaining was exported to Vietnam and Thailand. All the items were exported to Vietnam, while only metals and glass were exported to Thailand. One of interviewees replied that there was more demand for recyclables in Vietnam and Thailand because the Vietnamese and Thai economies were more developed than the Cambodian economy.

Table 3-41: Destination of Recyclables (13 depots)

Type of Waste	Customers of Waste depot				
	Cambodia		Thailand	Vietnam	Total
	Final user	Waste depot			
Answer	50	600	---	5,750	6,400
RW01-1	---	400	---	360	760
RW02-1	---	100	---	1,100	1,200
RW02-2	---	110	---	3600	3,710
RW03	10	15	---	500	525
RW05	12	5	150	63	230
RW06-1	160	50	600	270	1,080
RW06-2	2		50	11	63
RW06-3	6	5	---	22	33
RW07-1	---	---	---	1,000	1,000
RW07-2	240	1,285	800	12,676	15,001
Total	2%	9%	5%	84%	100%

3.11.2 Interview Survey with Waste pickers in the City

a. Objectives

In the Phnom Penh city, a lot of waste pickers are often seen carrying waste by muscle-powered vehicles. They are collecting recyclables from household, offices, markets and factories.

The interview survey was conducted with the purpose of obtaining the data of recyclables diverted from the waste flow before reaching to the final disposal site and the income of waste pickers.

b. Method of the Survey

Two research assistants selected waste pickers randomly on the streets and asked questions about monthly income by selling recyclables, items they collect and their volume, based on the questionnaire sheet.

The number of interviewees was 54, and none of them belonged to any organizations; they all were working independently.

Waste Discharge in Town

Waste Picking in Town

c. Results and Finding of the Survey

c.1 Monthly Income

The result of the question about monthly income is shown below.

The average monthly income was US$ 43, while the maximum and minimum incomes were US$ 150 and US$ 10 respectively. Since the team did not ask about job status (full-time or part-time) and age, it is not certain whether they have other sources of income or not.

Table 3-42: Monthly Income (54 Waste pickers)

No of Waste Pickers	Monthly Income (US$/month)		
	Average	Maximum	Minimum
54	43	150	10

c.2 Types of Material Collected

The types of recyclables that interviewees were usually collecting are summarized in Table 3-43.

The average number of types interviewees collected was 6.5. It can be said that they collected any type of recyclables. The minimum and maximum numbers of types were 4 and 11 respectively. They collected various types of plastic, but the main items were plastic bottles and color plastic.

Table 3-43: Type of Recyclables Collected (54 waste pickers)

Type of Waste		Answer	
		Nos.	%
Paper	Paper mix	24	44%
	Cardboard	53	98%
Plastics	Ozone bottles (PET)	22	41%
	Plastic Bottles (Reuse and White)	50	93%
	Crack plastic bag	5	9%
	Soft plastic bag	10	19%
	Color Plastic	48	89%
Metal	Aluminum (cans, pots, other	52	96%
	Steel Cans	2	4%
	Steel (car parts, rebar, roofing, etc..)	34	63%
Glass Bottles (reuse)		48	89%
Cloth		3	6%
Total		351	---

c.3 Amount of Recyclables Collected

The average amount of recyclables by type is shown in Table 3-44. According to the result, each interviewee collected 29.5 kg of recyclables on the average, and the main items were paper and metal.

Table 3-44: Amount of Materials Collected (Waste pickers at Town)

Type of Waste		Amount	
		kg/person/day.	%
Paper	Paper mix	2.5	8.5%
	Cardboard	11.0	37.3%
Plastics	Ozone bottles (PET)	0.1	0.3%
	Plastic Bottles (Reuse and White)	1.6	5.4%
	Crack plastic bag	0.2	0.7%
	Soft plastic bag	0.6	2.0%
	Color Plastic	4.2	14.2%
Metal	Aluminum (cans, pots, other	1.7	5.8%
	Steel Cans	0.3	1.0%
	Steel (car parts, rebar, roofing, etc..)	7.1	24.1%
Glass Bottles (reuse)		0.2	0.7%
Cloth		0.0	0.0%
Total		29.5	100.0%

c.4 Income and Amount of Recyclables

The relation of the income and the amount of collected recyclables is shown below.

The income was correlated with the amount of materials collected, but there were some cases in which the income was high regardless of the amount and vice versa.

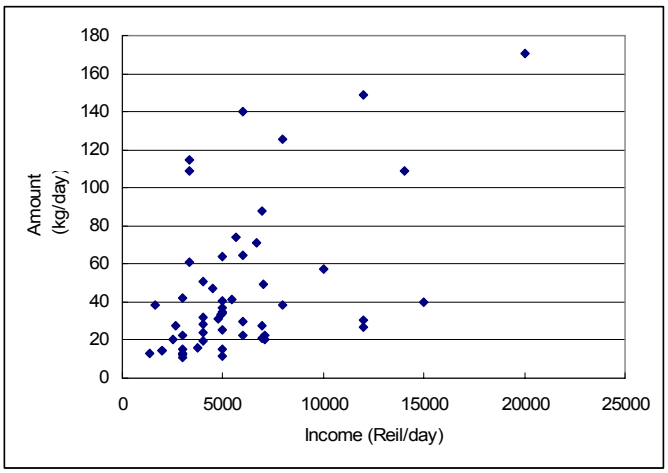


Figure 3-5: Income and Amount of Material Collected (Waste picker at Town)

3.11.3 Interview Survey with Waste Pickers Working at the SMC Disposal Site

a. Objectives

The main purpose of the survey is to know the working and living conditions of waste pickers who were working at the SMC disposal site, as a part of the social environment survey. In this section, the types of waste collected and their amount are summarized.

b. Method of the Survey

Three research assistants conducted an observation survey for six days (counting the number of waste pickers at the disposal site) and an interview survey with 54 randomly selected waste pickers.

c. Results and Finding of the Survey

c.1 Number of waste pickers at dumpsite (Observation survey)

The numbers of waste pickers obtained from the observation are shown in Table 3-45. According to the result of the survey, the average number of waste pickers who are working at the disposal site was 460; the number of adults and children are 328 and 132, respectively. Since a large number of part-time waste pickers and children worked during the weekend, the average number increased to more than 500 during the weekend.

Table 3-45: Number of Waste Pickers at SMC dump site

Date			Weather	No of Waste pickers		
				Adults	Children	Total
29-May	Thursday	PM	sunny	298	103	401
30-May	Friday	AM	sunny	290	112	402
		PM	sunny	233	124	357
2-Jun*1	Monday	AM	sunny	378	169	547
		PM	sunny-rain	360	161	521
3-Jun	Tuesday	AM	sunny	345	98	443
4-Jun	Wednesday	PM	cloudy-rain	381	116	497
5-Jun*2	Thursday	AM	sunny	369	144	513
		PM	sunny	296	165	461
Average				328	132	460

*1: Holiday
*2: School was closed

Waste Picker

Waste Buyer

c.2 Type of Recycle Materials

The items of waste that waste pickers collected at the disposal site were summarized in the table below.

The average number of items that one waste picker collected was 5.6, and the result showed that waste pickers at the disposal site collected any types of recyclables. The minimum and maximum number of items that one waste picker collected were 2 and 10 respectively.

Nine waste pickers out of 54 collected organic waste. The organic waste recovered from the disposal site was reused as feed for livestock such as pigs.

Table 3-46: Type of Recycle Materials (Waste picker at SMC dump site)

Type of Waste		Answer	
		Nos.	%
Paper	Paper	11	20%
	Cardboard	23	43%
Plastic	Plastic bottle	38	70%
	Soft plastics	43	80%
	Hard plastics	37	69%
Metal	Aluminum can	42	78%
	Steel can	38	70%
	Steel	24	44%
Glass bottle		30	56%
Cloth		1	2%
Organic waste		9	17%
Others		5	9%
Total		301	---

c.3 Amount of Recycle Materials

The average amount of waste collected by type and per one waste picker was estimated from the result of the interview survey, as shown in Table 3-47.

The average amount of waste was 28.1kg/person, and the main items of recycle materials were soft plastic and cardboard.

Table 3-47: Amount of Recycle Materials (Waste pickers at SMC dump site)

Type of Waste		Amount	
		kg/person/day	Total Amount
Paper	Paper	1.3	4.6%
	Cardboard	4.8	17.1%
Plastic	Plastic bottle	0.1	0.4%
	Soft plastics	8.6	30.7%
	Hard plastics	3.1	11.0%
Metal	Aluminum can	0.1	0.4%
	Steel can	0.2	0.7%
	Steel	2.4	8.5%
Glass bottle		2.0	7.1%
Cloth		0.0	0.0%
Organic waste		2.4	8.5%
Others *1		3.1	11.0%
Total		28.1	100.0%

*1: Others: Electric wire, Bag, Shoes

c.4 Total Amount of Recycle Materials

The total amount of recycle materials that were recovered from the disposal site was calculated due to the average amount per person and the average number of waste pickers at the disposal site, as shown in Table 3-48.

According to the result, the average daily amount of waste recovered from the disposal site was around 12.9 tons and different from that of another survey on waste depot around SMCDS. The difference could result from the ignorance of the difference in collection amount between adults and children, and full-time and part-time waste pickers.

Table 3-48: Total Amount of Recycle Materials
(Waste pickers at SMC dump site)

Type of Waste		Amount (kg/day)
Paper	Paper	598
	Cardboard	2,208
Plastic	Plastic bottle	46
	Soft plastics	3,956
	Hard plastics	1,426
Metal	Aluminum can	46
	Steel can	92
	Steel	1,104
Glass bottle		920
Cloth		9
Organic waste		1,104
Others *1		1,426
Total		12,935

c.5 Income and collection amount

The relationship between income and collection amount is shown below.

The relationship shows a similar trend of the survey on waste pickers on the streets. Since many of the valuable wastes are already picked up before they reach to the disposal site, the value of waste there tends to be equalized, and as a result the correlation between the income and collection amount at the disposal site becomes stronger than that of on the street. On the other hand, the competition on the street is more intense than at the disposal site, which would result in a larger income gap among waste pickers.

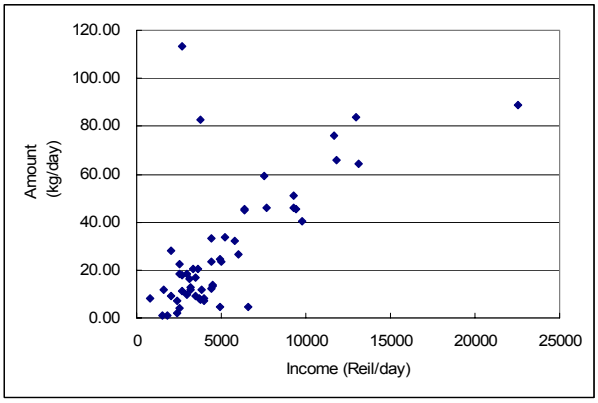


Figure 3-6: Income and Collection Amount (Waste picker at SMC dump site)

3.11.4 Interview survey with slaughter houses

a. Objectives

The main purpose of the survey was to know the current situation of waste management at slaughter houses.

b. Method of the Survey

The samples were selected randomly from the list of slaughter houses that was obtained from Ministry of Agriculture. A team member and a C/P visited selected slaughter houses and conducted an interview.

The outline of slaughter houses in Phnom Penh is shown in the table below. The total number of slaughter houses on the list in Phnom Penh is 37, with two slaughter houses located in the urban Khan and the others located in rural Khans. Two slaughter houses deal with both pigs and cows, while 12 houses and 23 houses deal with only cows and pigs, respectively.

Table 3-49: General Information of Slaughter House

District / Khan	Business form	Type of Slaughter House			
		Cow	Pig	Pig + Cow	Total
Toul Kork	Business			1	1
	Family		1		1
Dang Kor	Family	6	6		12
Mean Chey	Business		3	1	4
	Family	1	2		3
Russei Keo	Business	1	2		3
	Family	4	9		13
Total		12	23	2	37

Source: Ministry of Agriculture, Office of Animal Health and Production

c. Results and Findings of the Survey

c.1 Target

The type and form of slaughter houses surveyed are summarized below.

Table 3-50: Slaughter houses surveyed

District / Khan	Business form	Type of Slaughter House			
		Cow	Pig	Pig+Cow	Total
Toul Kork	Business organization			1	1
Mean Chey	Business organization		2		2
Russei Keo	Business organization	1			1
Total		1	2	1	4

c.2 Results of the Survey

The result is summarized in the table below.

Table 3-51: Results of Slaughter House Survey

Information		1	2	3	4
		Toul Kork	Mean Chey 1	Mean Chey 2	Russei Koe
		Pig + Cow	Pig	Pig	Cow
1	Form of Business	Business	Business	Business	Business
2	Employees (total)	20	20	70 (10 slaughter house)	30
3	Numbers of Pig/Cow (nos./day)	Pig: 40, Cow: 20	Pig: 30	Pig: 200	Cow: 20
4	Purchase	Cambodia	Thailand	Cambodia	Cambodia
5	Consumer	Market at PP	Market at PP	Market at PP	Market at PP
6	Working time	0:00 – 5:00	0:00 – 8:00	20:00 – 6:50	23:00 – 7:00
7	Waste generation amount	1 truck/day	250 liters/day	Do not know	1 ton truck/day
8	Discharge place	SMC dump site	SMC dump site	SMC dump site	SMC dump site
9	Disposal cost	20,000 Riel/month	10,000 Riel/day	100,000 Riel/month	600,000 Riel/month
10	Waste Collector	Contractor (private company)	Contractor (private company)	Contractor (private company)	Contractor (private company)
11	Others	Around 80 pigs are always kept alive as stock. Vegetables are bought at the market as a feed, and organic waste is not used. Waste is mainly the residue of waste water from floor cleansing Bones are received by buyers from Vietnam.	Around 50 pigs are always kept alive as stock (tied with a rope). Meat is sold with bone (there is no waste of bone). Waste is mainly the residue of waste water from floor cleansing.	Business form is a union, consisting of 10 business establishments. The largest slaughter house in Cambodia. Waste is mainly the residue of waste water from floor cleansing. Meat is sold with bone (there is no waste of bone). Every day, 200 pigs are received and all the received pig are sloughed on the same day of receipt. (There is no stock of pigs.)	80 pigs, which are equivalent to the number of slaughtered pigs of 4 days, are received at one time. Skin is sold. Large size bone is incinerated inside its premise, and ashes are discharged to a river. Waste is mainly the residue of waste water from floor cleansing including greaves. Waste is transported in a large size bin

c.3 Type of Waste

According to the result of the survey, the main waste from slaughter houses is a residue of waste water from floor cleansing. It contains a lot of moisture as well as fur and greaves. Most slaughter houses export bone waste to Vietnam or supply meat with bone to markets, and as a result they do not discharge bone waste. However, some slaughter houses incinerate large-sized bone and discharge ashes into public water.

Waste discharged from slaughter houses is not hazardous, even though it is perishable. Bone waste can be recycled with proper drying and crushing methods. Therefore, it is necessary for the government to tighten control and to give technical guidance to these houses.

Truck for Waste Collection

Slaughter Waste

c.4 Waste Amount

The result of the survey shows the slaughter waste generation amount per one pig is around 8 liters. However, the team could not obtain enough data to estimate the waste generation amount per one cow. Due to the generation of greaves, the slaughter waste generation amount per one cow is assumed to be larger than that per one pig.

The data on waste amount from slaughter houses obtained by the weighbridge are shown in the table below.

Table 3-52: Daily Amount of Slaughter House Waste in the SMCDS

	Aug	Sep	Oct	Nov	Dec	Average
Amount (ton/day)	6.5	7.1	7.4	8.5	7.9	7.5

The number of pigs and cows that are consumed daily in Phnom Penh can be calculated in the following equation on the preconditions that the waste generation amount from the slaughter of pigs and cows is same and its density is 1.0.

$$\frac{7.5 ton/day}{0.008 kg/farm\ animal} = 938\ farm\ animal/day$$

d. Future Waste Management of Slaughter House

The survey of slaughter houses revealed that there is not enough data and information on slaughter houses.

It is necessary for the government to grasp the current situation of waste management in cooperation with organizations concerned, while providing necessary information on proper treatment methods and technical assistant.

Chapter 4

Current SWM Conditions

4 Current SWM Conditions

4.1 Current SWM Conditions

4.1.1 Current Waste Flow

a. Household Waste

From the results of the waste amount and composition survey (WACS) in the dry season, the average weight was calculated in accordance with the population by income level in the target area as shown below.

Table 4-1: Population by Income Level & Household Waste Discharge Ratio

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

The waste discharge ratio in the target area is summarized in the following tables. The average discharge ratio of household waste is lower than other economically comparable countries: 487 g/person/day in Phnom Penh city (weight average by population in accordance with the income level).

b. Commercial, Market, School, Street Sweeping, Hotel and Office

The total waste generation amounts of categories other than household waste were calculated by multiplying the discharge ratio of each category by the number of units of that category. All results of these amounts were then summed to get the total waste discharge amounts as shown in the following table.

Table 4-2: Waste Discharge Amount in Phnom Penh City (2003)

Generation Source	Unit	Number of Generation Sources	Generation Ratio			Daily Generation Amount (tons/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

c. Factory Waste

The results of the industrial waste flow estimated by the factory survey are shown below.

Table 4-3: Industrial Waste Flow in Phnom Penh City (2003)

Waste Flow Component	Discharge Ratio (g/employee/day)	Waste Amount (tons/day)	No. of Generation Sources
Waste Generation Amount	334..8	58.2	173,942
Recycling by On-site	---	0.1	---
Final Disposal Amount	---	58.1	---

d. Medical Waste

The results of the medical waste flow estimated by the medical institution survey are shown below.

Table 4-4: Waste Flow of Medical Institution in Phnom Penh City (2003)

Waste Flow Component		Discharge Ratio (g/bed/day)	Waste Amount (tons/day)	No. of Generation Sources
General waste	Waste Generation Amount	1,999	9.7	4,862*1
	Final Disposal Amount	---	9.7	---
Medical waste	Waste Generation	198	1.0	4,862*1
	Intermediate Treatment Amount	---	0.4	---
	Final Disposal Amount	---	0.5*2	---

*1: The number of beds actually used, acquired by multiplying the number of beds by the bed occupation rate (36.9%)
*2: includes 0.1 ton/day of ash

e. Description of waste generation amounts

Table 4-5 shows the waste generation amounts, percentages and description of the waste flow.

Table 4-5: Waste generation amounts

Categories			Amount, %		Description
1. Household waste amount			584.1 tons/day		Calculated amount based on WACS results
	(1) Collection area		43.8 %		Set by the population census data of Cambodia and the interview survey of CINTRI (the proportion against the population)
		Area	Urban	Rural	
		1) Self disposal	2%	2%	
		2) Illegal dumping	2%	2%	
		3) Recycling（composting）	6%	6%	
		4)Discharge to collection service	90%	90%	
	(2) Non-Collection area		15.5%		
		Area	Urban	Rural	Calculated amount based on POS results "Recycling" represents composting
		1) Self disposal	5%	63%	
		2) Illegal dumping	5%	26%	
		3) Recycling（composting）	2%	7%	
		4) Transfer to collected area	88%	4%	
2.Commercial waste amount			343.7 tons/day		Calculated amount based on WACS results Commercial waste amount is not separated between collected area and uncollected area as it covers almost all of the study area
	(1) Restaurant		46.2 tons/day		
	(2) Shop other than restaurant		150.9 tons/day		
	(3) Market		94.3 tons/day		
	(4) School		7.7 tons/day		
	(5) Street sweeping		3.0 tons/day		
	(6) Hotel		3.1 tons/day		
	(7) Office		1.3 tons/day		
	(8) Others resource		37.2 tons/day		
3. Septic tank sludge brought in disposal site			5.8 m^3/day (=5.8 ton/day)		Estimated by the amount of collection vehicles which brought it to disposal site from Jan. to Dec. 2003（as 100% capacity loaded）
4. Recycling at SMC（by waste picker）			18.3 tons/day		Calculated amount based on waste picker interview results and SMC waste depot survey results
5. Recycling market handling amount			34.6 tons/day (Composting facility 14.0 tons/day)		Estimated amount based on the recycling market survey results
6. Amount collected by street waste pickers			Collection area 3.0 % Non-collection area 2.0% (percentage against the population)		Estimated amount based on the interview survey of collection workers and street waste pickers
7. Factory waste			29.7 tons/day （final disposal amount）		Calculated amount based on the factory survey results
8. Medical waste			9.7 tons/day (final disposal amount)		Calculated amount based on medical institution survey results
9. Incoming waste proportion to SMC	CINTRI		91.4 %		Data of weighbridge (08/2003-12/2003)
	PPWM/MPP		3.1%		
	Private（Market）		5.5 %		
10. Incoming waste amount to SMC			686.9 tons/day		Calculated by following formula: Final Disposal Amount = Collected Waste Amount + Other Wastes - Recycled Waste Amount by waste pickers at SMC dump site

f. Waste Flow

The other part of the waste flow was estimated from the results of the WACS, the POS, and the other field survey. The results of the estimation are summarized in the table below.

Table 4-6: Waste Flow Components in the Target Area

Waste Flow Components		Waste Amount (tons/day)
Waste Generation Amount		927.8
Recycling by Discharge Source		46.1
Self-Disposed Amount		142.4
Illegally Dumped Waste Amount		70.4
Discharge Amount		668.9
Recycling by Street Waste Pickers		21.4
Waste Collection Amount		647.5
Injected Waste to Compost Plant		10.3
Compost		1.1
Recycling by Scavengers at Dumpsite		18.3
Other waste	Industrial Waste	29.7
	Medical Waste	9.7
Final Disposal Amount		668.6

The following figure presents the waste flow in Phnom Penh city.

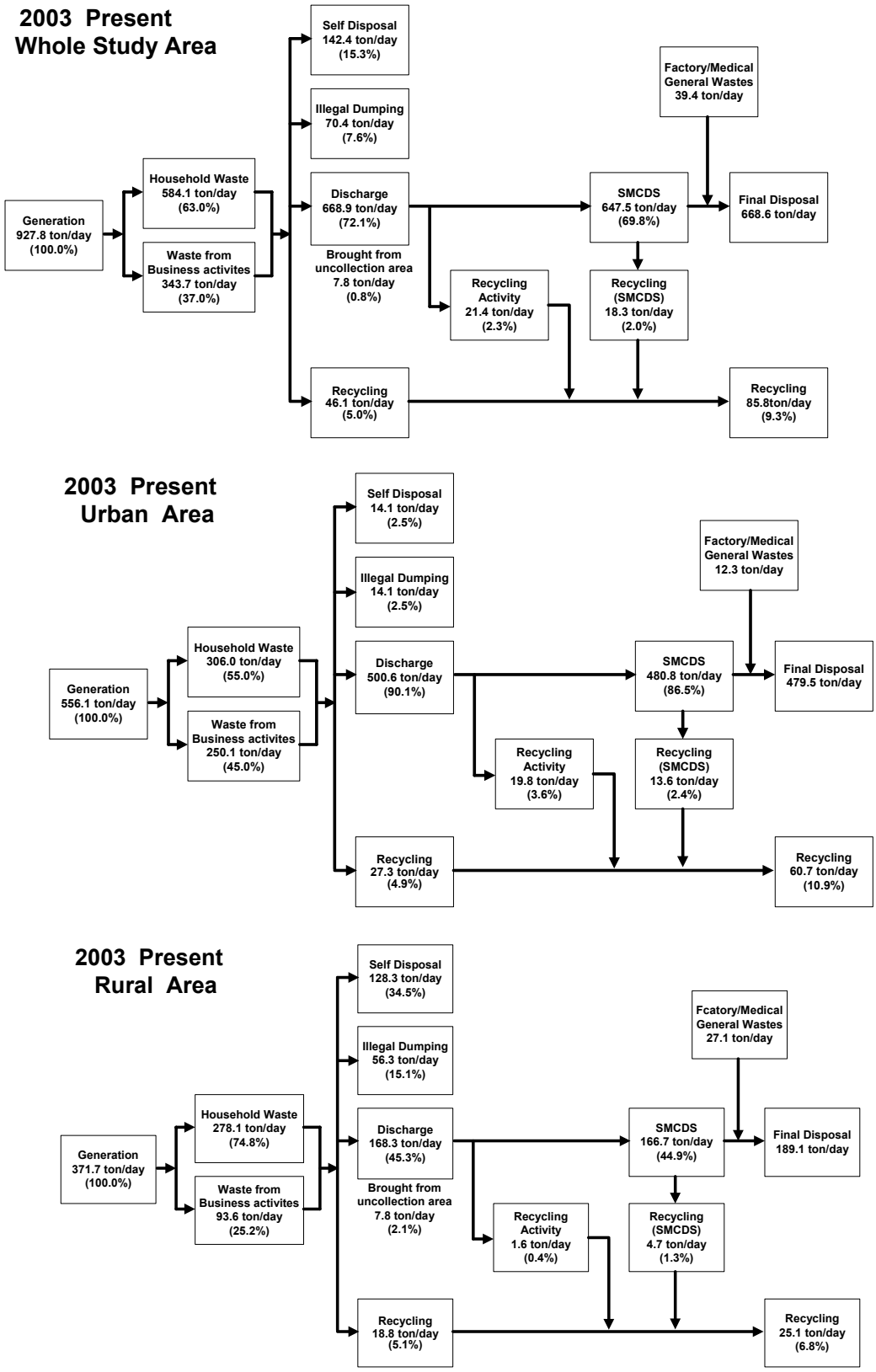


Figure 4-1: Waste Flow in 2003

4.1.2 Technical System

a. Discharge and Storage

a.1 Rules governing discharge and storage of waste

Present rules concerning the discharge of household waste are contained in a sub-decree from the Council of Ministers dated 10 August 1994 and a Municipal announcement dated 23 June 1999 (see the text box below). These decrees and directives cover penalties for littering and require residents to place waste in plastic bags or waste bins and discharge directly into collection vehicles only. If they miss the vehicle, residents must return waste to their premises. Residents are also required to keep the area in front of their properties clean.

Waste Discharge Rule (Unofficial Translation)

Sub-decree N0. 43 GnRk. Dated 10/08/1994 by Co-Prime-Ministers (Hun Sen and Ranarith) on **"Social Order in PP Municipality":**

- Article 4: Those who throw garbage outside the waste heaps or public bins, recommended by local authorities, will be punished with a 2,000 Riel fine. They will be punished up to two, three, or four times, according to the actual violation, if they do not abide by the rules.
- Article 5: Those who throw away dead animals will be punished with a 5,000 Riel fine. If they do not abide by the rule, (second offence) they will be punished up to 10,000 Riels.
- Article 6: Those who discharge wastes, construction wastes, and/or dead animals in wells, drainage, and/or canals will be punished with a 10,000 Riel fine. If they do not abide by the rule, it will be double (20,000 Riels).
- Article 12: Those who sell goods/foods (permanent stalls) in a disorderly way in prohibited-public areas will be given a primary warning. If they do not abide by the warning, they will be punished with a 10,000 Riel fine.
- Article 13: Individual food sellers or mobile food hawkers in prohibited-public areas will be given a preliminary warning. If they do not abide by the warning, they will be punished with a 2,000 Riel fine.

Waste Discharge Rule (Unofficial Translation)

Announcement (MPP, No. 62 sCN>s) dated 23/06/1999 by H.E Trak Thai Sreang on "The time for waste discharging and transporting to dump site".

MPP is pleased to announce to all ministries, agencies industries, manufacturing, companies, shops, and PP citizens and P.S.B.K to be aware that: in order to achieve betterment for PP municipality, MPP would like to instruct as below:

1- All households and shops MUST pack waste properly in bags and waste bins and carry it to collection vehicles at 16:00.
2- Do not leave waste bags on the street after the collection vehicles have passed. If waste bags cannot be collected by vehicle, they MUST be returned to the house and discharged the next day.
3- The owner of each plot of land MUST clean the area in front of it everyday.
4- The owner of construction sites MUST keep solid waste generated from the civil work properly in the area of construction site that is fenced.
5- The waste transport MUST operate everyday from 16:30-05.00am
6- P.S.B.K MUST carry out regular waste collection according to a fixed time and place.
7- The district municipal must inform its citizens not to throw waste in the public garden.
8- Sellers along gardens and visitors MUST keep waste in plastic bags or bins properly in one place.

a.2 Discharge and Storage

Although Phnom Penh Municipality has issued rules for waste discharge, not all waste discharge is practiced according to these rules. Much of the waste is discharged in an uncontrolled manner making waste collection difficult to manage and affecting the efficiency of the collection system.

The common practice for storage of household waste in Phnom Penh is to place waste in a plastic bag (obtained from market purchases). Houses generally have limited storage space and the waste tends to putrefy quickly in the tropical climate, so waste is usually discharged daily from the household, often without regard to the collection day or time. Some households use open baskets (normally 60-80 liters in size) or larger woven plastic sacks (50kg. rice or cement bags) for waste storage. A limited number of households use 80 –100 liter "wheelie" bins, which are available in the market.

Businesses and larger waste producers often use woven bamboo baskets (100-120 liter) to store loose waste until the collection time. Businesses located on the principal roads receive daily collection services.

At present, there is very limited storage of waste in large bins or containers at the point of waste generation in Phnom Penh because there is limited capacity for mechanized handling of waste bins. The main service provider (CINTRI) has only four aging Kamaz vehicles ($20m^3$ capacity, compaction mechanisms are not working) capable of loading 0.6 m^3 containers. These open top containers can be seen at a number of locations throughout the city, but because of the limited capacity to load these containers, often the collection method is to dump the waste on the ground and then workers shovel the waste into a compactor truck.

The other major method of post-producer waste storage is illegal garbage heaps. Because residents and businesses tend to discharge waste daily, regardless of the collection schedule, waste heaps on the sidewalk, on unused land or even in the middle of the street are common in the many parts of Phnom Penh. (In many areas the collection time is not fixed or the service is irregular, leaving residents little alternative but the illegal dumping of waste.) During a recent survey (December 2003) of Sangkat chiefs by the JICA study team, 24 out of 76 chiefs reported waste heaps within their Sangkats.

Waste stored in heaps is often scattered by waste pickers who open the bags and sort through the garbage looking for recyclable materials, or by dogs scavenging for food waste. This results in considerable littering of streets and public areas. This practice also slows down the eventual collection process when the crews must first shovel the waste and then sweep up the ground.

A number of 100-liter steel bins made from half oil drums have been placed along some of the major roads for temporary storage of waste to be used by the public until the collection vehicle arrives. This has reduced littering and improved the cleanliness and appearance of these areas considerably. However, as there are too few drums, those that are in place tend to overflow with waste, and the drums become collection points where people throw their household waste. It is also common to see the collection crews empty the drums on the street and then shovel waste into compactor trucks, perhaps because the drums are too heavy to lift, or lack handles. This method of manual loading of the trucks is very slow and drums have a short service life (about 18 – 24 months).

Rather than store waste or illegally dump it, some households burn their excess waste in the streets, especially tree leaves and garden waste, but it is often mixed with plastic and household waste. This practice creates health risks and environmental problems. The smoke

from burning organic garbage with plastic waste can create a chemical called dioxin, which is carcinogenic. Burning waste can also cause other environmental health problems such as asthma, bronchitis and eye infections. The smell and smoke from burning household waste is foul and obnoxious.

The lack of a workable storage system at the source of waste generation coupled with the irregular waste collection is considered the most serious shortcoming to the present waste collection system in Phnom Penh.

b. Collection and Transport

The main service provider, 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. Details of the CINTRI fleet are shown in the table below.

Table 4-7: CINTRI Fleet

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^3 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^3 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^3 capacity, long frame, 4-5 trips per day (day-time operation only)	
Isuzu 4.5 ton	2 vehicles	21, 22	4 m^3 capacity, roll-top box, 4-5 trips per day (day-time operation only)	
Daelus 6 ton	1 vehicle	53	4 m^3 capacity open top dump truck, 4 trips per day	
Daelus 7 ton	1 vehicle	28	6 m^3 capacity compactor truck, 4 trips per day	
Amaz 9 ton	1 vehicle	59	6 m^3 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 m^3 capacity, 4-5 trips per day (24 hr. per day operation)	
Kama 11 ton	4 vehicles	52, 59, 61, 93	20 m^3 capacity, 2 trips per day, side load arm, compaction not working	

PPWM operates a single 1993 Daewoo 11 ton ($18m^3$) compactor vehicle to service the secondary collection needs of the NIP area. This vehicle is based within the NIP Waste Recycling Development Center where it is used in conjunction with six, 3-wheeled steels bins ($2.5\ m^3$ capacity). These bins serve as temporary waste storage within the center until they are tipped into the compactor truck with the assistance of the truck's steel winch cable.

PPWM also operates a single 1994 Boxer 4.5 ($4m^3$) ton for occasional collection activities in other areas.

The main collection systems used in Phnom Penh are as follows:

- *Curbside and Bell collection*. These are actually two different collection methods, but they are practiced interchangeably in Phnom Penh. The activity consists of a 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 it to the vehicle while the crew loads the waste that has been deposited on the curbside. This is the most common type of collection in Phnom Penh.
- *Heap collection*. This collection method consists of uncontrolled dumping of waste on the ground. In some areas, unused land has become heap sites where waste will remain for several days. Where the municipal open-air markets have waste collection areas, these often become heap collection sites for waste from nearby residences. Elsewhere, residents or market vendors start dumping waste in the middle of the street every evening and crews arrive in the early morning to collect the waste. When collection crews arrive, they must manually load the waste from the ground into the vehicles. Not only are the heaps unsightly and unhygienic, but the loading process is slow and results in a lot of littering. Heap collection is similar to a communal collection point but lacks any kind of site improvements or pollution control.
- *Container collection*. This is normally the mechanical loading of waste containers but in Phnom Penh, it also includes the manual loading of smaller public bins (100 liter). Because of lack of container handling vehicles, currently there is very little larger container collection taking place in Phnom Penh, only the limited use of $0.6m^3$ at some hospitals and markets, and the use of $2.5m^3$ containers at the NIP waste recycling center mentioned above.
- *Primary/Secondary collection.* This is actually a combination of the 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 as mentioned above; other areas use the heap method for transfer. This method is appropriate where the population density is fairly high and roads are not appropriate for the larger vehicles.
- *Communal collection point*. This method usually involves residents bringing their own waste to a designated site where some sort of waste enclosure or container has been placed to retain the waste. Although not common in Phnom Penh, this is a common low-cost collection method in other developing countries. This method is often considered as dirty and old fashioned; however, with proper equipment, regular collection pick-ups and community participation, it can be fairly clean and sanitary.

Despite improvements in the collection service, it is estimated that almost 40%[1] of the population still lack regular or adequate collection services. One reason for this situation is the relative lack of alternative waste collection systems. There is currently an almost complete reliance on a heavy vehicle based collection systems. However, many areas lack adequate roads for the heavy trucks, and many unplanned areas are without service, particularly on the outskirts of the city.

Many areas that do have scheduled collection service suffer from lack of fixed collection times. Residents must wait for the trucks to honk their horns to signal that they are on the street. With irregular collection times, people are not always home or ready to deliver the waste. Consequently, more and more households place their waste outside their houses along the curb or roadside, where it is exposed to the itinerant waste pickers and animal scavengers. The collection job is also made more difficult for the collection workers because they have to shovel loose waste from the ground. This system leads to unacceptably low collection efficiency and too much waste is left on the streets of Phnom Penh.

Flooding during the rainy season also makes the waste wet and more difficult to collect. When the streets are flooded, which is common in some areas during the rainy season, the waste is flushed into the drain inlets where it causes clogging and adds considerably to the flooding problem.

It is also common to find people deliberately dumping their waste into open manholes or drains, thinking that it will be carried away with the rainwater, not understanding the clogging and pollution problem this causes. Dumping of waste in the open canals is also a considerable littering, pollution, flooding and public health problem.

c. Public Area Cleaning

The condition of the road network in Phnom Penh and public littering habits are the major factors affecting the cleanliness of public areas. The majority of roads in Phnom Penh are un-surfaced, in most areas only the principal roads have asphalt paving. Vehicles moving from the un-surfaced roads to the paved roads transfer large qualities of sand and soil to the paved areas that must be swept. There would also appear to be very low awareness about littering among residents in Phnom Penh with waste commonly discharged on the sidewalks and roadway by passages of vehicles and pedestrians who consume food while moving about. This problem is compounded by a lack of public waste bins.

Street sweeping is carried out by CINTRI staff on some 56 km of paved roads, mostly in the urban center of the city. The private company has one mechanical sweeper with a $3m^3$ container; however, some 350 street sweepers do most of the street cleaning manually.

Public gardens and parks are cleaned by a section of DPWT. After cleaning, the waste from these areas is moved to the curbside for pick-up by the private waste contractor.

All public schools are supposed to receive free waste collection until the year 2002 when it is assumed they should start paying a collection fee. However, many schools visited reported irregular waste collection. As a result, much of the waste is burned and there is a high rate of littering.

In the past, there have been some limited campaigns to educate the public about the problems of littering using television spots, posters, banners and education in the schools

[1] From Sangkat Survey, December 2003. Reports from 76 Sangkat chiefs indicated that only 57% of families in their areas receive collection service.

(NORAD/MPP, 2000 and on-going work by CSARO). These campaigns reportedly had limited success because of their small scope and the lack of public waste bins and a generally weak collection service. A sustained education campaign linked with improved service has not been provided.

d. Recycling

Waste recycling by private recyclers is very active. Recycled material amounts to about 86 tons/day. CSARO is sorting 1.5 – 2.0 tons/month recyclable materials at WRDC.

- Recycling is an informal activity using cheap labor in Phnom Penh.
- NGOs such as CSARO carry out recycling although on a limited scale. The recycling system of individual recyclers is well developed.
- Informal recycling by street waste pickers at the source and waste discharge points is especially active. Their recycling is estimated to reach 39.7 tons/day, or 4.3 % of the total waste generated in the city. Their activity is, however, limited to urbanized and populated areas where recycling is efficient, and not active in most parts of the rural area.
- Final users of recycled material are various but their business scale is small. The majority of recovered material is, therefore, exported to Vietnam and Thailand.
- At the SMC disposal site, there are more than 500 waste pickers engaged in resource recovery.

e. Intermediate Treatment

CSARO is producing 2.0 tons/month of compost at the Waste Recycle Development Center (WRDC). COMPED is producing 6.0 tons/month of compost at the SMC disposal site.

- One composting facility (waste handling capacity: about 4 tons/day) is operated by the NGO, CSARO. The product quality of compost is high because selected material is used.
- There is one composting facility run by the NGO, COMPED, at the SMC disposal site (waste handling capacity is reported to be about 13.7 tons/day by the NGO. It receives waste from two markets.
- The promotion of compost is one of the effective ways to raise the waste recycling rate. The evaluation of project feasibility, however, requires market research such as a study on prices of competitive products such as organic fertilizers. It is also necessary to diffuse knowledge to farmers on the effect of soil improvement by using compost and to stimulate demand.
- Major hospitals have small incinerators for treating infectious waste, but the incineration system such as an exhaust facility is not enough to treat hospital waste appropriately.

f. Final Disposal;

- The SMC disposal site is the only disposal site in MPP. The unregulated landfill operation has continued for 38 years, since 1965. The municipality possesses a land plot of only 6.8 ha, which is too small for a city with a population of a million. As a result, waste spreads out of the municipal area to the surrounding private land.

- Since waste is piled up to a height of more than 5 m on average, it is getting difficult for the collection vehicles to access to the working face. Accessibility to the site is particularly poor in the rainy season, when waste disposal must occasionally cease. Improving accessibility and securing a landfill area are urgent issues.
- There is neither a landfill plan nor an operation program pertaining to management and operation of the disposal site. Possibly as a consequence of this, the disposal site has been mismanaged for many years.
- There are only four PPWM staff members assigned to the SMCDS. All the landfill equipment (only two bulldozers) is leased along with a bulldozer operator and a guide for collection vehicles.
- No efforts seem to have been made to reduce the environmental impacts, or to control the working conditions.
- There are more than 500 waste pickers making a living at the site by picking material that they can sell.
- Because of the poor road conditions at the disposal site and the lack of any waste picker controls, accidents happen frequently. Reportedly, there is at least one accidental death every year among the waste pickers.
- MPP is clearly responsible for operation of the disposal site.
- The site is a typical open dump, posing seriously negative impacts on the surrounding environment. Air pollution by smoke caused by fire is particularly serious for not only the surrounding area but also a wide area in the city.
- Incoming vehicles are not controlled. It is not known what kind of waste is disposed of in which part of the landfill. Infectious waste is disposed of without being distinguished from municipal waste.

g. Operation and Maintenance of Vehicles and Equipment

g.1 General

Although an equipment maintenance section was formed when the PPWM established, no staff has been assigned until now. The Deputy Manager (operation) is in charge of all equipment maintenance and management.

g.2 Equipment maintenance

PPWM has only three vacuum trucks for sewage and two waste collection compactors for cleansing works.

Table 4-8: List of the Equipment of PPWM

No.	Type	Donated Year	Manufactured year	Description	Condition (Availability)	Remarks
1.-3.	IVECO Vacuum truck	1998	1998	Sewage	65%	Donated by NORAD
4	DAEWOO Compactor14ton＊	2001	1992	Solid waste	50%	Donated by NORAD
5	KIA Compactor 8ton ＊	2003	1992	Solid waste	50%	Donated by NGO

＊ used vehicle

The two second-hand waste collection compactors are in running condition. Those vehicles are more than ten years old but in good mechanical condition, and their useful life in Cambodia is expected to be 5-7 years. Availability of that equipment is an appropriate level (50-65%) considering their present condition.

PPWM had two landfill vehicles (bulldozers). However, they were second-hand vehicles made in Russia around 1990（no exact record), which were difficult to maintain and needed substantial overhaul and repair. PPWM decided to sell them in early 2003.

At present, PPWM does not have any proper maintenance system, including a maintenance schedule or facilities. As a result, the equipment maintenance works are not done by direct labor but by private workshops at the driver's request.

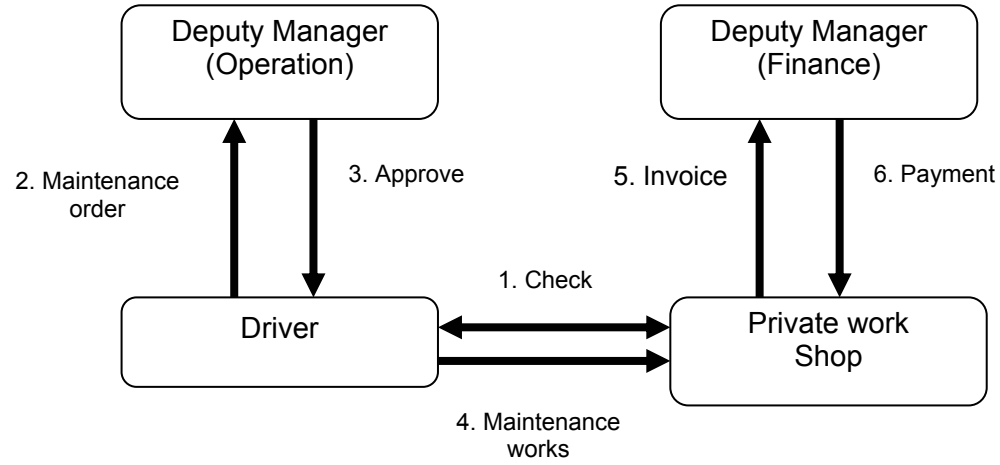


Figure 4-2: Current Maintenance Flow of PPWM

The maintenance expense for maintenance/repair and spare parts is 17% of all expenses, and the average cost of each vehicle is 1,000-1,200US$. This is an appropriate level of cost per vehicle, if all preventative maintenance and necessary works have been done. However, it is difficult to analyze whether maintenance is efficient or not because there are no repair records or periodical data.

Table 4-9: Equipment Maintenance Expenses of PPWM

Year		Total Expense(A)	Maintenance and repair spare parts expense (B)	B/A (%)
2001	$US	122,563	15,702	
	Riel	6,914,000	677,300	
	Total $US	149,290	15,872	10.6
2002	$US	138,725	14,550	
	Riel	81,658,000	5,688,500	
	Total $US	159,140	15,973	10.0

The private company that has the contract with the MPP for waste collection in the city centre has a total of 52 collection vehicles and one sweeping vehicle. The company has its own service workshop but almost all the vehicles are 15 years old or more. They are very difficult to maintain because reliable spare parts are difficult to obtain, especially Korean and Chinese made parts.

As for the present equipment maintenance situation in the country, there are several authorized dealers such as Caterpillar and JCB, which have their own parts section and maintenance and training facilities. They have sufficient capacity with respect to the supply of spare parts (fast moving parts such as preventive maintenance parts) and maintenance skill. However, most maintenance and repair works are done by private workshops or road side maintenance works because it is cheaper than professional workshops. Reliable spare parts are also difficult to get in the country. With authorized dealers, its takes 2-3 weeks if there is no stock and costs almost 3-4 times higher than those sold by private parts shops. Furthermore, most of the local workshops use imitations or rebuilt parts imported from neighboring countries such as Vietnam or Thailand.

In addition, road sweeping machines are not suitable in the country because of the difficulty in obtaining maintenance spare parts, the high maintenance cost (spare parts are very expensive) and the road conditions.

h. Medical SWM

In total, there are 870 medical institutions such as hospitals, polyclinics, clinics and health centers in the MPP. The results of the Medical Institutions Survey revealed that most of the medical institutions that responded to the questionnaire separated medical waste (hazardous health-care waste of WHO classification) from general waste (non-risk health-care waste of WHO classification) and stored them separately. According to the results, the team assumed that most medical institutions recognize the risks posed by medical waste on human health or the environment. However, only large-scale hospitals have incineration facilities and can treat medical waste, which is stored separately from other waste, on site. Other medical institutions have to treat medical waste outside the institutions. Some of them bring their waste to other hospitals with incineration facilities.

On the other hand, judging from its structure, it is unlikely that the incineration facilities at large-scale hospitals can combust medical waste perfectly and treat emission gas (removal of soot and dust) properly. Therefore, it is very difficult to control secondary infection by the emission gas, soot and dust.

At present, unlike general waste, an appropriate collection system for medical waste has not been established, which results in the mixture of medical waste with general waste at some hospitals.

In the study area, the disposal systems for medical waste, from source separation and on site storing and treatment to collection/transportation and treatment/disposal, have not been fully established yet. It is an urgent issue for the government to provide legal and technical support in order to establish the disposal systems for medical waste.

i. Industrial SWM

In Phnom Penh, the textile and garment industries account for 80% and 97% of the total number of factories and employees respectively. Regarding the amount of waste, 82% of the total amount of IW is discharged by these industries.

The current situation of SWM at factories is summarized below.

- Almost all factories separate HIW from non-HIW
- Few factories conduct reuse, recycling, or treatment of waste on-site.

- CINRTI and Sarom Trading Company each collect half of the waste discharged from factories.

Although the team judged that the SWM at factories in Phnom Penh is in general appropriate, some factories cannot distinguish HIW from non-HIW well and discharge HIW mixed with non-HIW because there are no clear standards or regulations for IW treatment and disposal. It is, therefore, necessary for the government to prepare the standards or regulations of IW classification, treatment and disposal.

4.1.3 Institutional System

a. Legal System

a.1 Legislative Hierarchy[2]

The legislative hierarchy and terminology currently in use, although not very precisely established, are described below.

a.2 Constitution

Adopted by the Constituent Assembly and promulgated on September 24, 1993. It is the Supreme Law of the Kingdom of Cambodia and all other laws must be in strict conformity with the Constitution. The initiative to review or to amend the constitution is the prerogative of the King, the Prime Minister, and the President of the National Assembly at the suggestion of 1/4 of the Assembly members. Revisions or amendments can be enacted by a constitutional law passed by the assembly with a 2/3 majority vote.

a.3 Treaties and Conventions

The other source of law is international law which, if it is internalized or considered part of Khmer law, may also be enforced by judges in Khmer courts. International law is a combination of the law of individual nations, customs developed in the course of international business transaction, treaties (agreements between two more independent nations) and the declaration and resolution of international organizations like the United Nations. Before an international treaty is enforced as if it were a national law, it must be ratified by the National Assembly. According to Article 26 of the Constitution, the King is empowered to ratify an international treaty after approval by the National Assembly.

a.3.1. *Chhbab* (Law)

Law voted by the National Assembly; this law is called an organic law if it refers to the creation or the organization of a state institution and its structures, i.e. article 127 provides that provinces, municipalities, districts , *Khan*, *Khum* and *Sangkat* shall be governed in accordance with organic law.

a.3.2. *Reach Kret* (Royal Decree)

Used by the King in the exercise of his constitutional powers, i.e. power of appointments upon proposals by the Council of Ministers and by the Supreme Council of the Magistracy.

a.3.3. *Anu-Kret* (Sub-Decree)

[2] The information of this section is cited from "The Legal System of Cambodia, Cambodian Legal Resources Development Center"

Signed by the Prime Minister and countersigned by the minister(s) in charge of its execution after adoption of the Council of Ministers. The *Anu-Kret* can also be used by the Prime Minister in the framework of his own regulatory executive powers.

a.3.4. Ministerial *Prakas* (Declaration)

Used by members of the government in the framework of their own regulatory powers.

a.3.5. Sechdei Samrech (Decision)

The individual decision of the Prime Minister, a minister or a governor in the framework of his or her own regulatory powers.

a.3.6. *Sarachor* (Circular)

In general, used by the Prime Minister as head of the government, or by minister(s) as officials of the ministry either to explain or clarify certain legal of regulatory measures or to provide instructions.

a.3.7. *Provincial Deka* (Declaration):

Used by provincial governors within the geographical limit of their provinces.

a.4 Law on Environmental Protection and Natural Resource Management

The Law on Environmental Protection and Natural Resource Management (LEPNRM), which was enacted in 1996, is the supreme legal instrument for the environmental management. It codifies the following frameworks for environmental protection and natural resource management:

- Formulation of national and regional environmental plans;
- Execution of environmental impact assessments for new investment projects;
- Natural resource management;
- Protection of the environment from public nuisance;
- Monitoring, record-keeping and inspections;
- Establishment of an environmental endowment fund; and
- Penalties against violation.

Based on the LEPNRM, the following Sub-decrees were prepared:

- Sub-decree on the Environmental Impact Assessment Process (enacted in August 1999);
- Sub-decree on Water Pollution Control (enacted in April 1999);
- Sub-decree on Solid Waste Management (enacted in April 1999); and
- Sub-decree on Air and Noise Pollution Control (drafted in July 2000).

a.5 Sub-decree on Solid Waste Management

a.5.1. Contents

The Sub-decree on Solid Waste Management (SWM) was enacted in April 1999 and established the legal basis for SWM together with the Sub-decree on Water Pollution Control. The Sub-decree on SWM regulates SWM in a proper technical and safe manner to protect human health and the environment. It divides solid waste (SW) into two categories, i.e.

non-hazardous waste (Non-HW) and hazardous waste (HW). The other important contents of the sub-decree are described below.

General and common aspects:

- MOE shall establish guidelines on non-hazardous waste management (Non-HWM) and hazardous waste management (HWM);
- Disposal of SW in public areas or unauthorized areas is strictly prohibited;
- Exportation of SW from Cambodia requires approval from the MOE, the Ministry of Trade and the importing country;
- Importation of SW is strictly prohibited; and
- Penalty: Violators of the Sub-decree shall be fined and punished in accordance with the Law on Environmental Protection and Natural Resource Management.

For non-HWM

- Province and municipal authorities shall establish non-HWM plans for the short, medium and long-terms;
- Province and municipal authorities shall be responsible for non-HWM services according to guidelines issued by MOE;
- The MOE shall monitor the implementation of non-HW disposal (storage, collection, transport, recycling, treatment and final disposal (landfill)); and
- Investment in the construction of non-HW disposal facilities is subject to prior approval by MOE.

For HWM

- The MOE shall issue Ministerial Declarations (*Prakas*) on standards for the quantity of toxins or hazardous substances in HW;
- The owner of HW shall be responsible for its temporary storage and shall submit quarterly reports on it to MOE;
- The owner of HW other than domestic sources shall be responsible for its disposal;
- The disposal of HW from domestic sources (households, markets, etc.) is the competence of the local authorities;
- The transportation or construction of a storage place or landfill for HW from factories and manufacturing sites shall be subject to permit from MOE;
- The owner or responsible person of a storage place or landfill for HW shall submit quarterly reports on it to MOE;
- Investment in treatment or incineration at HW disposal facilities shall be subject to prior approval by MOE;
- The monitoring of packing, storage and disposal of HW is the responsibility of MOE; and
- The MOE shall take samples of HW and analyze them in its laboratory.

a.5.2. Issues

The Team identified the following issues on the Sub-decree on SWM:

- It is general without specific descriptions, and detailed regulations and guidelines have not been well prepared yet.
- No local authority has established a non-HWM plan for the short, medium and long-terms.
- Though the classification of non-HW and HW is reasonable as a broad one, a more detailed classification is necessary for proper SWM, especially for identification of the body (producer) responsible for the disposal of the SW.

- There is a list of HW, but it is neither clear nor sufficient. In addition, there is no information for the identification method of HW.
- Though the disposal of HW from domestic sources is the competence of the local authorities, the domestic sources in the Sub-decree included clinics and hospitals. This might need to be examined.

a.6 MOE Declarations

In order to supplement the Sub-decree on SWM, the MOE has issued the following Ministerial Declarations (*Prakas*):

- Declaration on the Provision of Duties to carry out the Sub-decree on Water Pollution Control and Sub-decree on SWM for Urban and Provincial Environmental Departments, June 2, 1999;
- Declaration on Industrial HWM, May 26, 2000;
- Declaration on the Proceeding of the Department of Environmental Pollution Control, July 27, 2000; and
- Declaration on Industrial Sludge Management, October 9, 2000.

a.7 Guidelines[3]

According to the Cambodia Waste Management Program for 2002 – 2006 published by the Department of Environmental Pollution Control (DEPC) of MOE, the following guidelines have been prepared pursuant to the 1996 Environmental Law and the Sub-decree on SWM:

- Guideline for hospital/clinic waste management;
- Guideline for industrial waste recycling and disposal; and
- Guideline for toxic and hazardous waste movement.

a.8 Enforcement

Chapter 5 in the sub-decree on SWM states that violators of the sub-decree shall be fined and punished according to the Law on Environmental Protection and Natural Resources Management.

According to information from DEPC of MOE, nine factories were fined a total of 44.3 million Riel in 2002. However, enforcement of the law and the sub-decree appear to be insufficient. For example, waste is clearly being disposed of haphazardly in public and private areas, temporary storage of waste in collection areas is below standards, and the dumping of waste at Stung Mean Chey disposal site causes obvious air and water pollution and exposes the waste pickers to great risks and health hazards.

b. Administration and Organization

b.1 Administration

In general, administrative powers and responsibilities concerning urban environmental management in Cambodia are divided imperfectly between line ministries, municipalities and provincial governments. All maintenance, rehabilitation and development works within provincial urban areas are handled by the branch offices of the line ministries.

[3] The information in this section is cited from "the Cambodia Waste Management Program for 2002 – 2006 ".

Although household (non-hazardous) solid waste management has been placed under the jurisdiction of local authorities (municipalities and provincial governments), SWM is under the jurisdiction of several governmental organizations. Some organizations are directly involved in SWM and others are indirectly involved. The MOE is the main responsible body at the national level. The PPWM is the executing authority of SWM in Phnom Penh. The roles and functions of those organizations are presented below.

b.2 National Level

b.2.1. Ministry of Environment

The Ministry of Environment (MOE) is the main responsible body at the national level for the administration of SWM. The MOE is responsible for establishing proper guidelines for SWM, approving and issuing operating and discharge permits for the necessary facilities, new or old, such as storage and transfer stations, recycling and treatment plants and final disposal sites. The MOE is also responsible for monitoring and enforcing compliance with the environmental law and the operating and discharge permits.

The organization chart of MOE is presented in Figure 4-3. The Department of Environmental Pollution Control (DEPC) is the main responsible department for the administration of SWM. The Department of EIA Review and the Provincial Municipal Department of Environment are also responsible for some parts of SWM administration.

DEPC has 76 personnel and consists of seven offices as shown in Figure 4-4. The Office of Solid Waste and Hazardous Substance Management (OSWHSM), which has 14 personnel, is the main office for SWM administration.

b.2.2. Ministry of Health

The Ministry of Health is responsible for the administration of health aspects including SWM in all medical institutions at the national level and the Department of Health of MPP is responsible for it in Phnom Penh. The organization chart of MOH is presented in Figure 4-5. As indicated in the Figure, the Department of Hospital is in charge of SWM in all medical institutions and the department organizes a waste management committee for the development of SWM in all medical institutions.

b.3 Municipality of Phnom Penh

b.3.1. Municipality of Phnom Penh

The organization structure of the Municipality of Phnom Penh (MPP) is presented in Figure 4-6. The governor, the top of MPP, and six vice-governors are appointed by the Government. The five vice-governors other than the first vice-governor share responsibilities on all administrative aspects of the municipality. One of the vice-governors is responsible for public works, tourism and the environment including SWM.

As for the bureaucrat, the chief of cabinet is the top. Under him, there are eight deputy chiefs of cabinet, each of which has his own department for municipal administration. Most departments in the MPP are directed by ministries in charge.

b.3.2. Department of Public Work and Transport

The Department of Public Work and Transport (DPWT) is the responsible body for SWM in MPP through the control of PPWM, the executing authority of SWM in MPP. The organization structure of DPWT is shown in Figure 4-7. One of the four deputy directors is

responsible for the Drainage and Sewerage Division as well as the SWM unit, the body directly responsible for SWM in MPP. The unit, however, has only two staff members and carries out very limited administrative work.

b.3.3. Department of Environment

As DPWT has close relations with the Ministry of Public Work and Transport, the responsibilities and functions of the Department of Environment (DOE) are quite similar to MOE. It is like a branch office of MOE in Phnom Penh as shown in Figure 4-8. There are 78 personnel in total in DOE and The Pollution Control and Education Office, which has 14 staff members, is responsible for SWM.

b.3.4. Phnom Penh Waste Management Authority

MPP established two waste service organizations in February 2001, namely the Cleansing Authority of Phnom Penh (CAP) and the Wastewater Authority of Phnom Penh (WAP). Both were established based on the Government sub-decree of April 1999 regarding the government's public administrative financial policies. The second SEDP (2001-2006) also states that the Government will prioritize "further democratization through the decentralization and delivery of government and public services". The Phnom Penh Water Supply Authority owned by the MPP and the Electricitè du Cambodge (EDC) owned by the State might serve as models for developing public service providers into autonomous and self-financing authorities.

Following the advise made by Inter-Consult (ICI), which conducted "the Strategic SWM Plan and Action Plan, March 2002"under the cooperation program of NORAD, the Municipal Council approved in principle a merger of CAP and WAP into the Phnom Penh Waste Management (PPWM) entity in October 2001 to reduce the administrative costs and increase the operational efficiency. The statue of PPWM was submitted in 2002, but it has not been formally approved as of June 2003.

According to its statute, PPWM has very wide mandates. It may itself deliver SWM services, such as collection and disposal, or contract out these services, and control / monitor the performance of the private service providers. The PPWM mandates are quite similar to those in the franchise agreement with CINTRI. It is contradictory that both PPWM and CINTRI should have the rights to deliver SWM services and collect service fees within the entire city. This conflict must be resolved, presumably by either limiting the scope of one or by dividing the city into separate collection areas for PPWM and CINTRI. This has already taken place to a limited degree, in as much as PPWM is collecting waste and service fees from the NIP SWM pilot area and operating the Stung Mean Chey disposal site.

The organization structure of PPWM is presented in Figure 4-9. There are six departments and 40 personnel in total. PPWM lacks the necessary independence and powers in certain areas to carry out its mandate as described in the statute. The Governor of MPP appoints and determines the remuneration of the management team (Governor and Deputy Governors of PPWM), and is himself the Business Committee Chairman, while the Municipal Cabinet appoints the other Business Committee members.

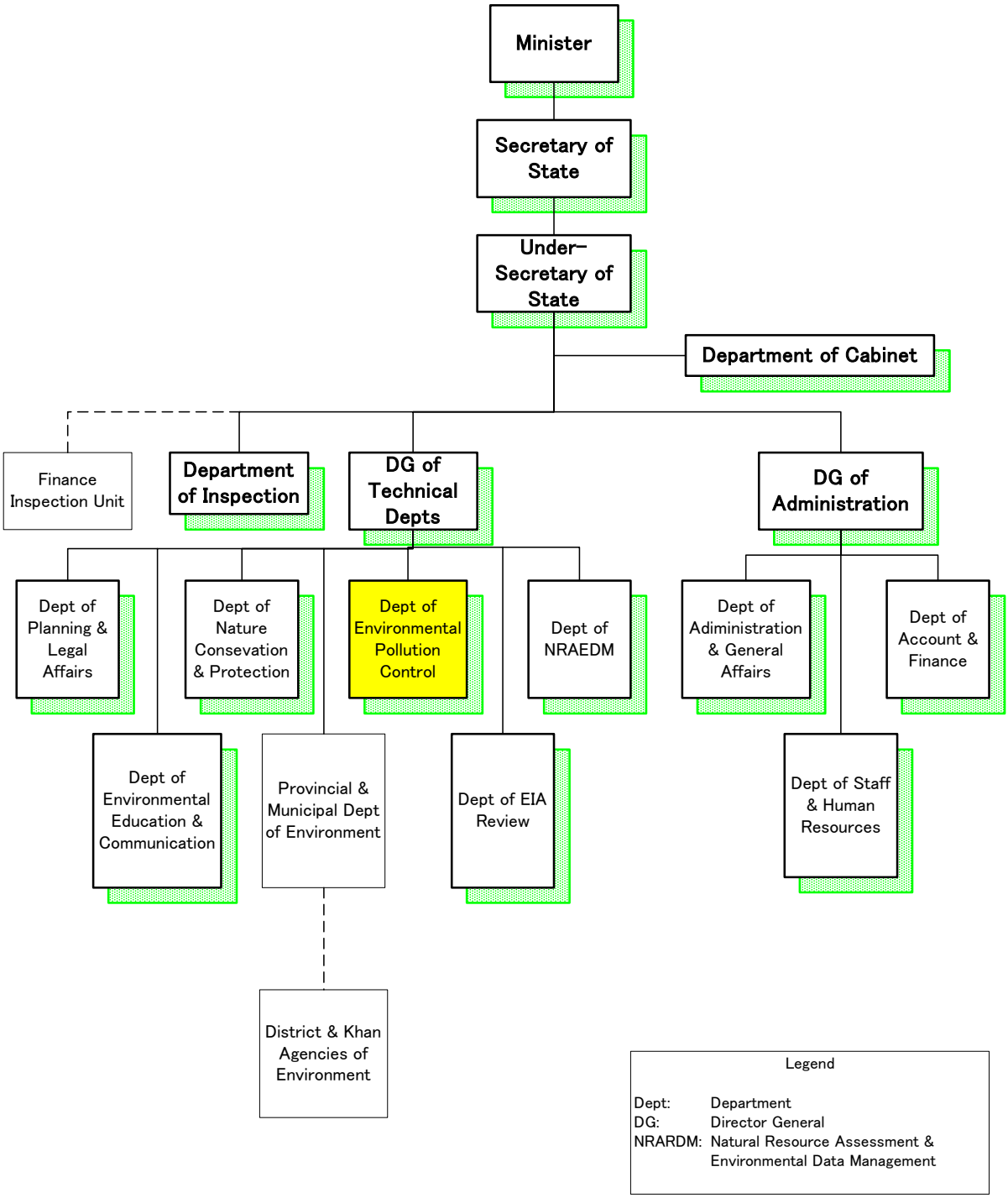


Figure 4-3: Organization Chart of MOE

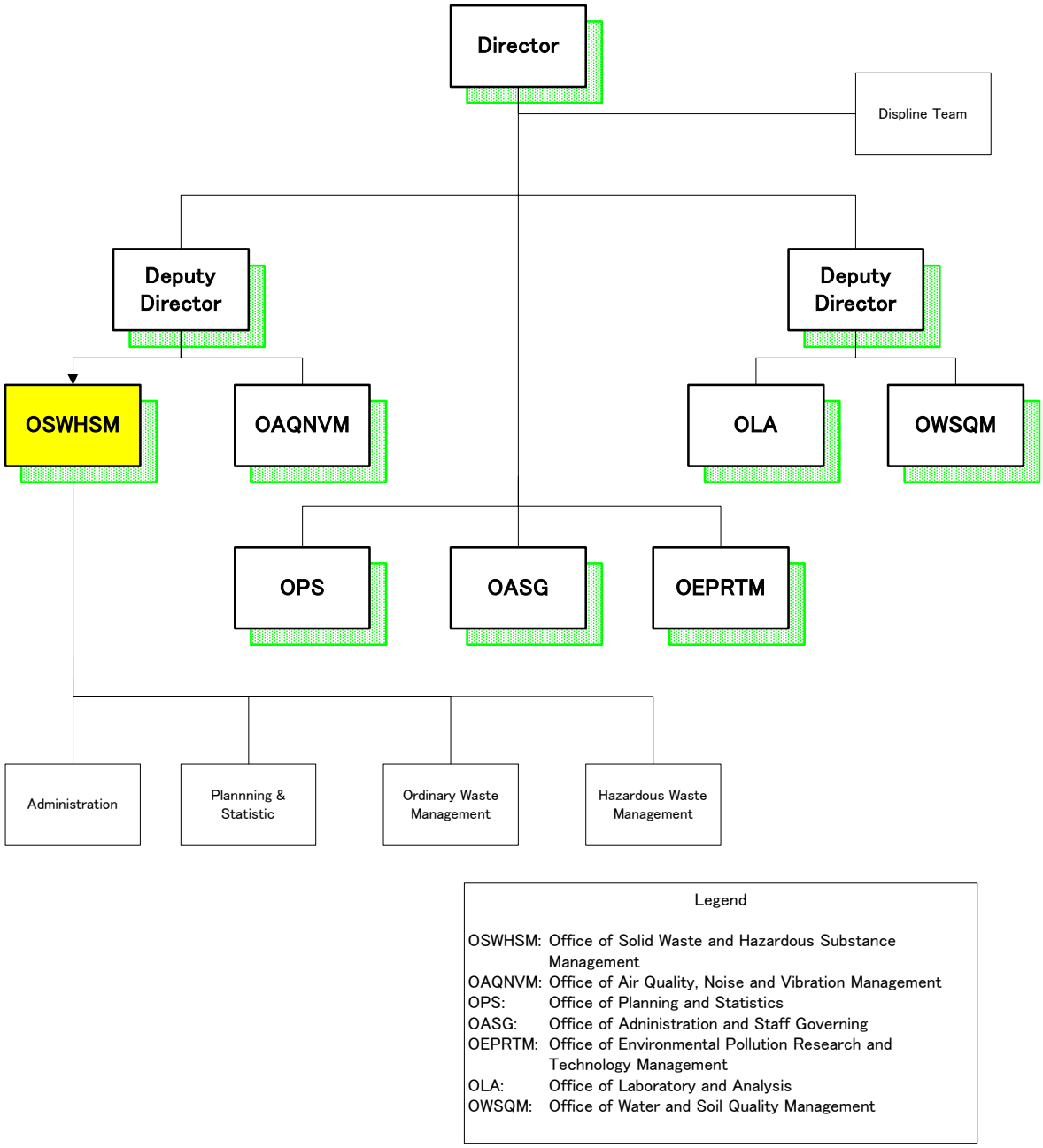


Figure 4-4: Organization Chart of DEPC

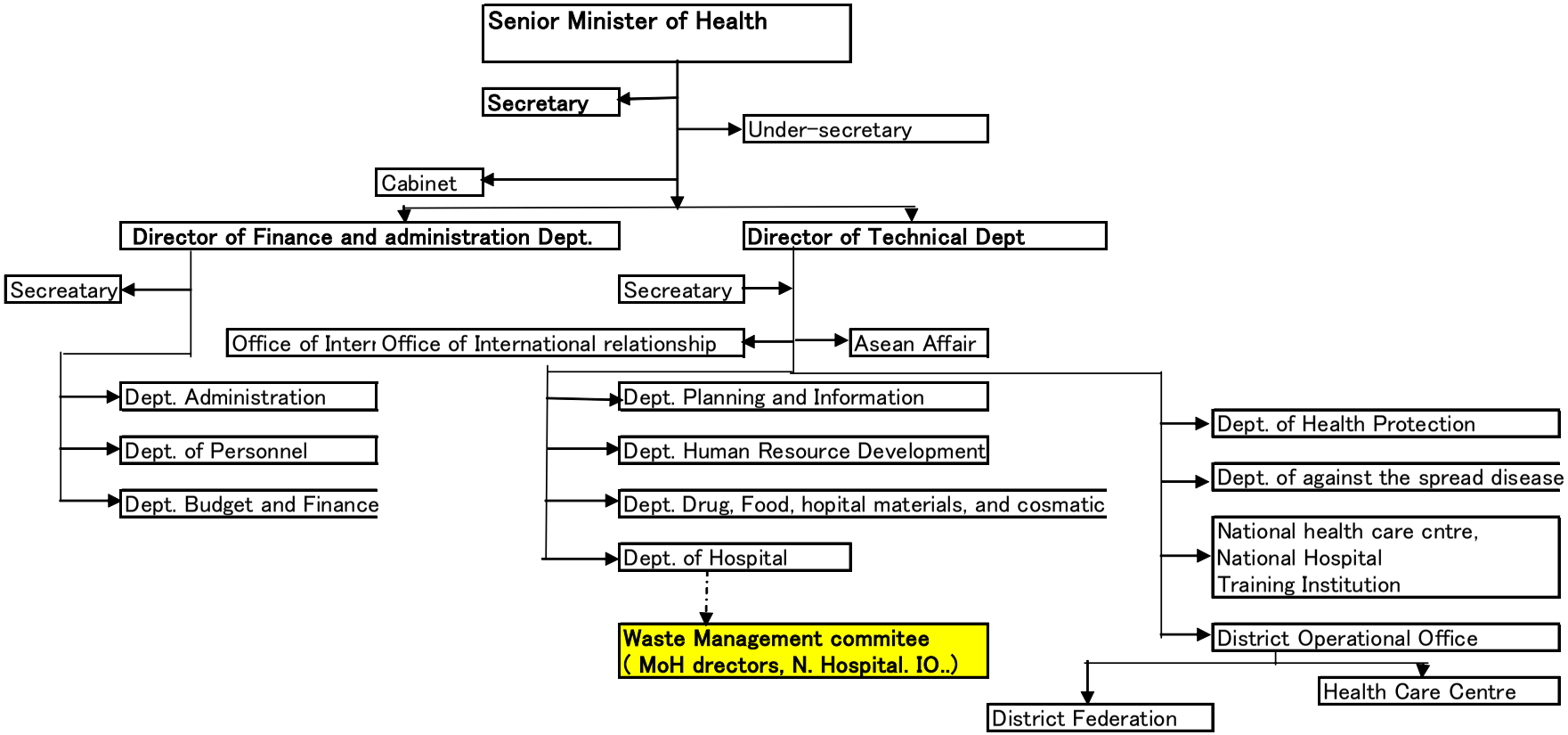


Figure 4-5: Organization Chart of MOH

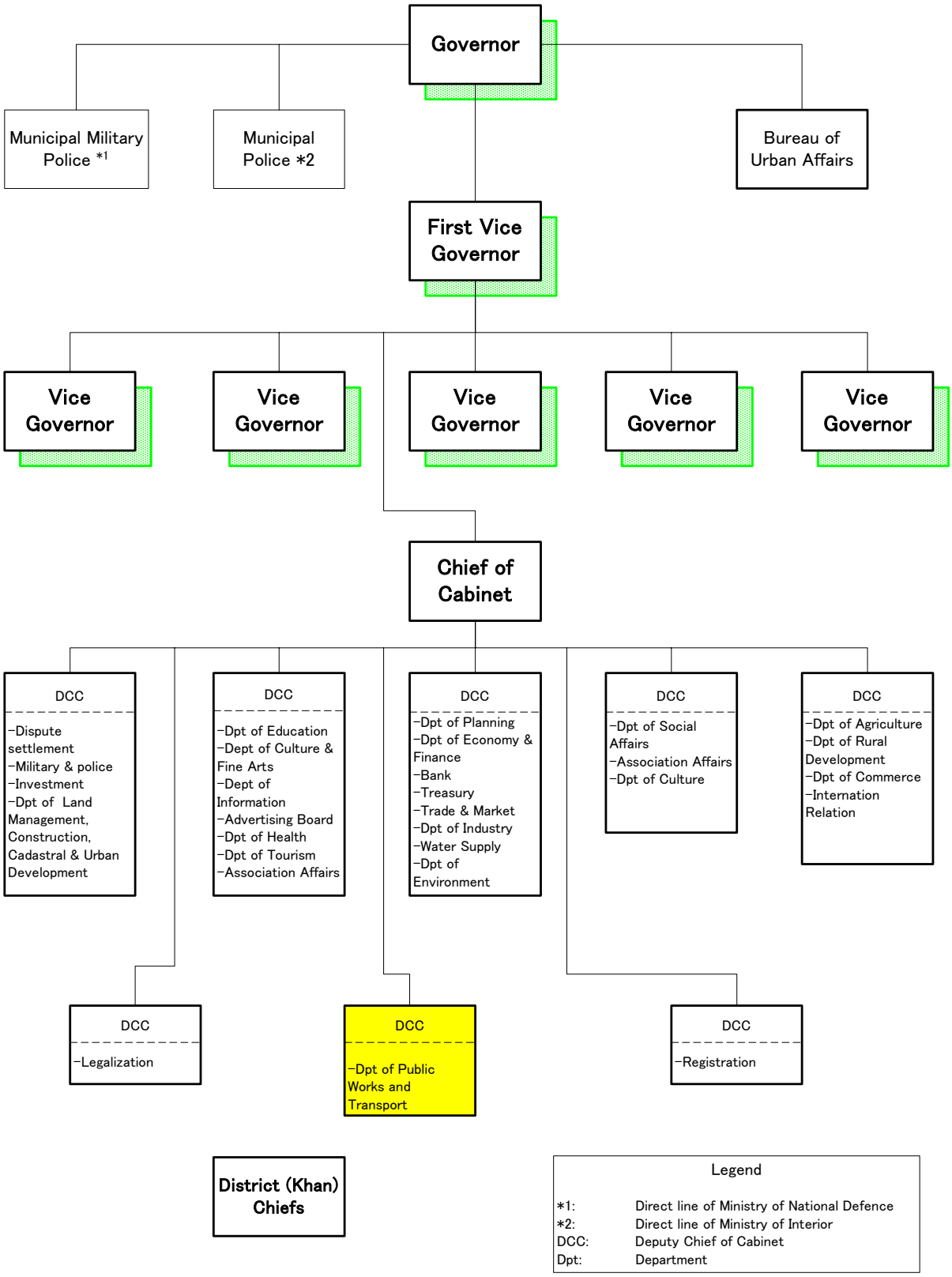


Figure 4-6: Organization Chart of MPP

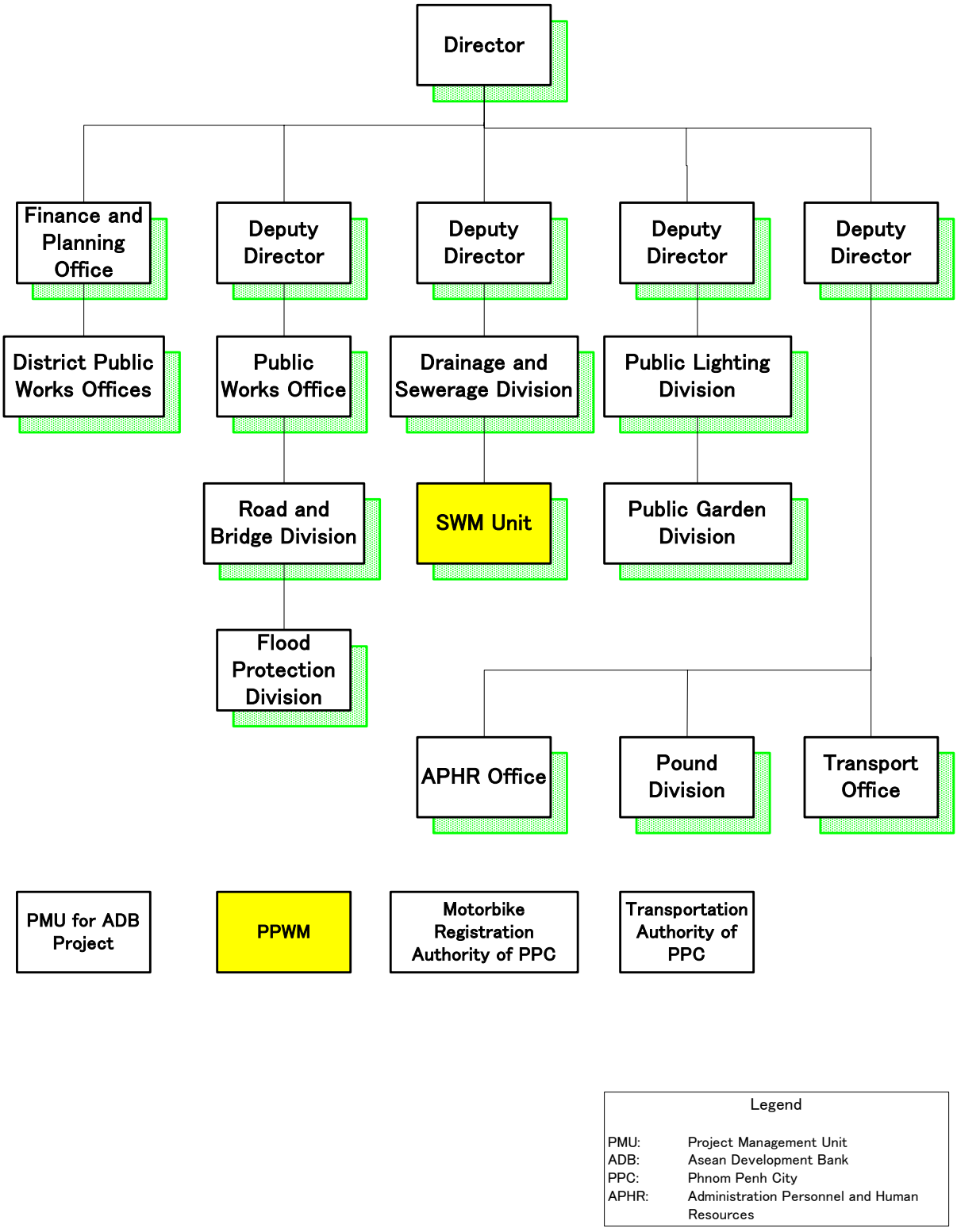


Figure 4-7: Organization Chart of DPWT

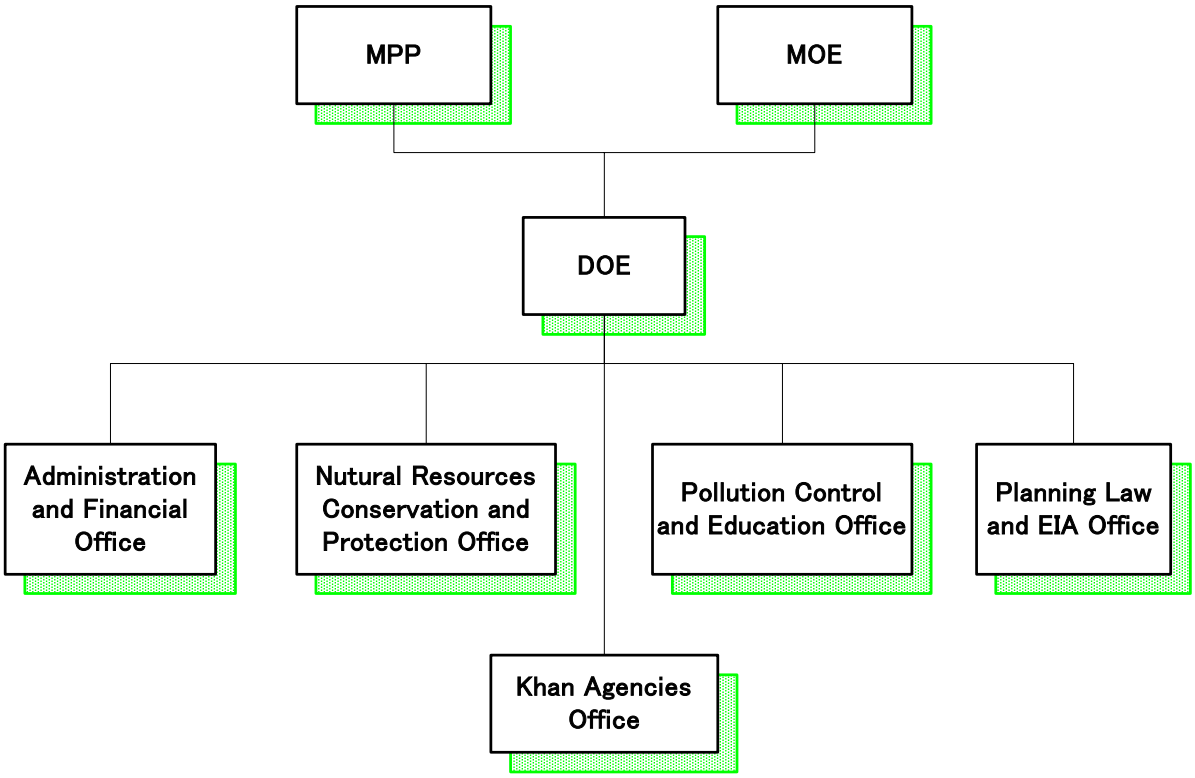


Figure 4-8: Organization Chart of DOE

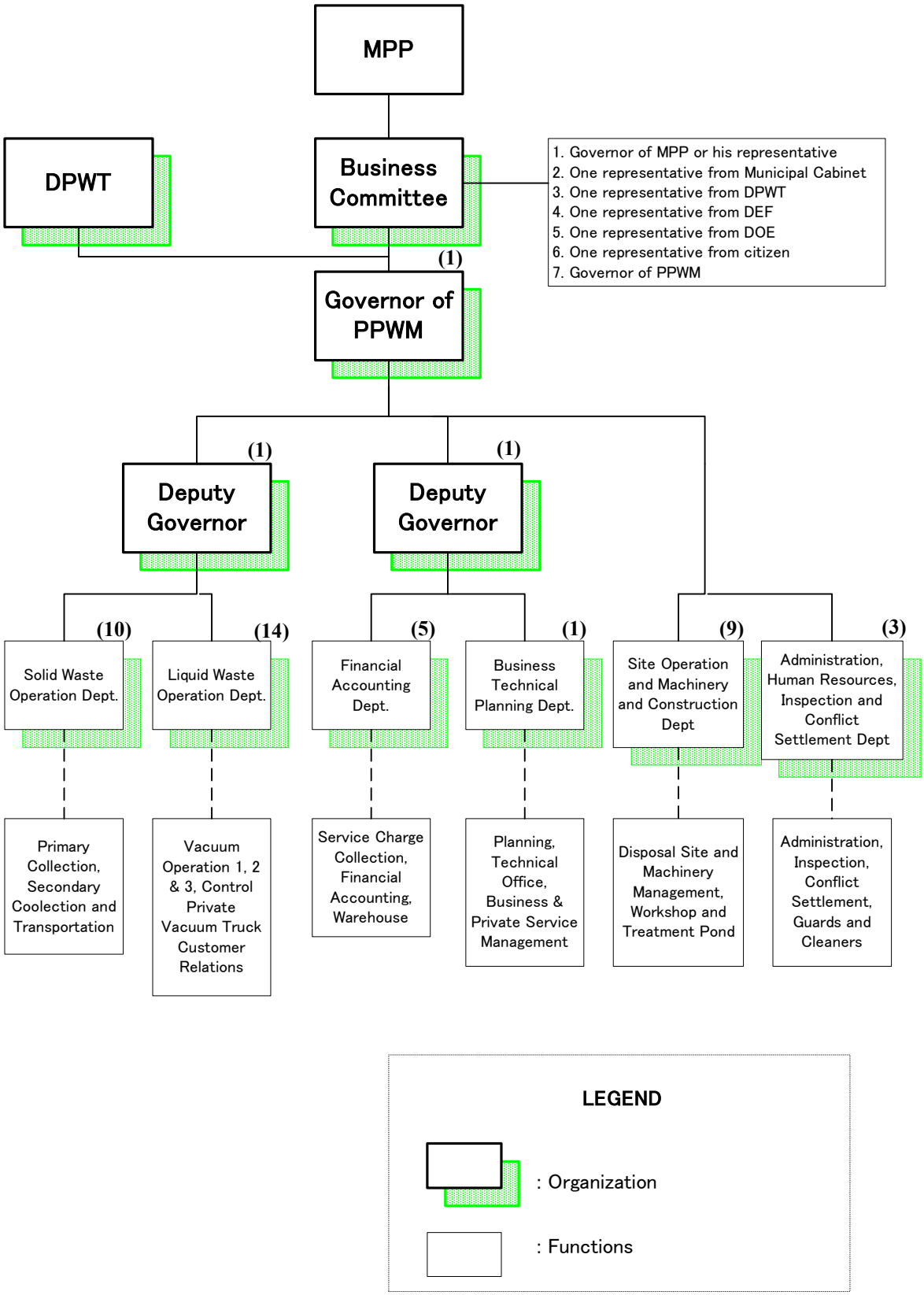


Figure 4-9: Organization Chart of PPWM

c. Public-Private Partnership

c.1 History of Municipal SWM

It is very important to look at the historical development of the Municipal SWM (MSWM[4]) services in Phnom Penh for a better understanding of its SWM system. The Strategic SWM Plan and Action Plan conducted by ICI (INTERCONSUL International) under the technical cooperation of NORAD have well presented the history as described below. For better understanding, the Team has provided a figure showing the immaturity of MSWM administration and frequent changes of private contractors (refer to Figure 4-10).

The Municipal Cleansing Section (MCS) under the DPWT used to provide MSWM services but in June 1994, this division was closed down and a French contractor called Pacific Asia Development (PAD) signed a 50-year franchise agreement with the Municipal Council. All assets, such as trucks, equipment, workshops, etc., and most of the MCS staff were transferred to PAD. The contract with PAD did not last long. In July 1995, the agreement was cancelled, and the individual Khans (Districts) took over collection services for some time. Then in January 1996, a Cambodian company called PPC took over waste collection on a temporary basis. In December 1996, an East German company called ENV received another 50-year franchise agreement, but ENV decided to leave Cambodia after the fighting in July 1997, presumably because it considered the business environment too risky. The Municipal Council then asked a Cambodian company called PSBK Ltd, which had been sub-contractors under ENV, to take over waste collection and dumpsite operation. This arrangement was formalized in January 1998 when the Council entered into another 50-year franchise agreement with PSBK.

These franchise agreements gave the contracted companies the monopoly rights to collect, recycle and dispose of all municipal waste from within the municipality. Stung Mean Chey was the designated disposal site. The contracted companies were also required to collect user fees from households, enterprises, institutions, etc. to recover its operational costs. The contractor compensated MPP for equipment that it leased or took over by paying an annual franchise fee. A nominal deposit was also made, presumably in lieu of a security bond.

The monopoly situation has been broken or weakened since February 2001, when the newly established Cleansing Authority of Phnom Penh (CAP) started secondary waste collection from the NIP SWM pilot area covering about 2,300 households, or 1% of the total population in Phnom Penh. In the same month, CAP also took over operation of the Stung Mean Chey disposal site from PSBK.

In 2001, the Council began discussions with CINTEC Environment Inc. from Canada because PSBK wanted to sell its contractual rights and obligations to this company. In March 2002, the MPP and CINTRI (Cambodia) Ltd., a subsidiary company of CINTEC, made a contract, “Supplement to SW Disposal Agreement Originally Entered into between the MPP and PSBK Development Co.”. Although MPP had been advised to split the service areas into two sections controlled respectively by PPWM and CINTEC, the contract made is a franchise one and limits PPWM collection service area to only the NIP area.

[4] In the Sub-decree of SWM MSW is defined as non-hazardous waste.

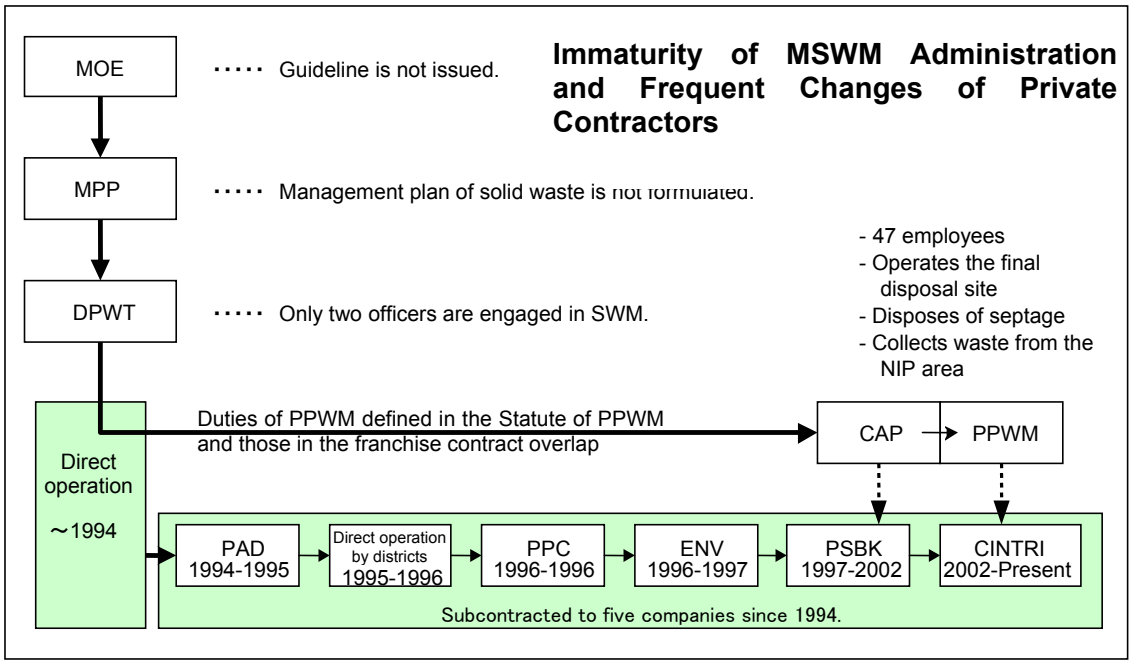


Figure 4-10: History of MSWM in Phnom Penh

c.2 Public-Private Sector Partnership and Contracting System

"A public-private sector partnership is a contractual relationship between a public and a private partner that commits both to providing a SWM service[5]".

The most common public-private partnership arrangements are:

- **Service Contract:** The government awards a service contract to a private firm for delivering SWM services for a specified length of time and in a specified location, based on competitive bidding. The government collects service fees from the users, and pays the firm for its services. This type of contract is the most commonly used contract type. It is normal to divide the collection area into zones and to have three or more contractors compete for services in these zones. In this way, competition is ensured at the bidding stage and during the contract period, because the municipal waste authority can compare service performance and the unit cost of operations for each to the contractors. Phnom Penh is large enough to have three or four private waste collection contractors working in different districts.
- **Operation Contract:** This is a variation of the contracting method describe above. The municipality will contract a firm to provide management and operation of a facility, such as a landfill, while the municipality owns the site, facilities and equipment. The government normally pays the contractor directly, but the contract may also allow the contractor to recover his costs from disposal (tipping) fees collected from the users of the landfill. The disposal fees are subject to approval by the government.
- **Franchise Contract:** After competitive bidding, the government grants a company an exclusive monopoly to provide solid waste services within a specific zone, or zones within the municipality. A franchise agreement can be made for parts of the

[5] "Public Private Partnership for Environmental Facilities. A Self-Help Guide for Local Governments", EPA July 1991.

waste management system, such as primary and/or secondary collection services. The firm collects its own revenues from the waste generators (households, enterprises, institutions, etc.) within the zone, or from sale of recovered resources, compost, etc. The tariffs are normally subject to approval by the government.

- **Concession Contract:** The government contracts a private firm to design, construct and operate a facility owned by the municipality, such as a landfill. There are several variations of this contract form, such as design, build and operate (DBO); build, own and operate (BOO); or build, operate and transfer (BOT), where the contractor may own the facility permanently or for a specified duration before it is transferred to the government. The contractor may be paid an agreed sum by the municipality and/or handling fees (tipping fees at a landfill) paid by the users of the facility.

MPP made the franchise contract with CINTRI for SWM services in Phnom Penh excluding cleansing services in the NIP area and Deumkor Market and operation of current Stung Mean Chey Disposal Site (SMCDS) on March 21, 2002. The contract was amended on December 12, 2002. The First Amending Agreement transfers the construction and operation of the new landfill to MPP with some conditions. The following conditions need attention:

- CINTRI shall be entitled to dispose of all waste collected throughout its territory at the new landfill to be constructed by MPP
- The tipping fee of the new landfill for CINTRI is US$0.75/ton, which is far lower than the sanitary landfill cost (It is in the range of 10 – 15 US$ per to according to the Strategic SWM Plan and Action Plan)
- MPP shall complete and maintain paved public access roads from Phnom Penh to the entrance of the new landfill

c.3 Monitoring and Information Management

It is noticed that the agreement conditions of MPP and CINTRI are rather general and lack specific performance specifications pertaining to the collection and cleaning operations, such as for example frequency of collection and service coverage. This makes it difficult for the MPP/PPWM to monitor and enforce the quality and standard of services. The MPP/PPWM also lacks a department or office with the necessary professional qualifications and competence to monitor and control the contractor's services. As a result, some areas where the roads are inaccessible to the large collection trucks are without adequate services. These areas tend to be the marginal and urban fringe areas, where poorer families that cannot afford the regular collection services live. In addition these un-serviced or under-serviced areas seem to be less profitable for CINTRI.

As described in the history of MSWM in Phnom Penh, all agreements with private firms until now have been made without any competitive bidding, and based only on direct negotiations between the two parties. As the municipality is without a department with the necessary professional competence, the authorities are in a very disadvantaged negotiating position, and have no hard data or studies with which to contest the technical or financial terms of the agreement. Also lacking is any system for specifying and monitoring the efficiency and quality of the services delivered.

Some of these problems could possibly have been avoided or reduced if the MPP/PPWM had an office or department with the necessary professional competence to advise on contracts conditions, and to monitor and supervise the contractor's work.

In order to obtain basic data to monitor and supervise the contractor's work, the Team installed a weighbridge at the entrance of the Stung Mean Chey disposal site. The weighbridge was completed in the end of June, 2003 and commenced operation from the beginning of July. It will provide the following data and information:

- Waste collection and disposal amount by organization, area, vehicle, etc.
- Unit cost for final disposal (US$/ton)
- Unit cost for waste collection if each organization releases their financial data
- Efficiency of waste collection services

d. Capacity Building

The Strategic SWM Plan and Action Plan Project is one output of the NORAD supported Institution Capacity Building and Neighborhood Improvement Program (ICB & NIP), which is part of the ADB supported Drainage component under the Phnom Penh Water Supply and Drainage Project. The project commenced in May 1997 and ended in March 2002. The objectives of the Project for the Institutional Capacity Building are to:

- Improve the proficiency of the professional staff in the DPWT
- Improve the technical skills of the professional staff in DPWT
- Develop skills for using computer assisted design and other relevant computer software among the professional staff in DPWT
- Enhance the overall management capacity of DPWT

The Institutional Capacity Building included the following training programs:

- English training program
- Computer equipment and training
- Provision of human resources and institutional development programs
- Financial management training
- Engineering training

Through implementation of the Project, the capability of DPWT/PPWM has been enhanced to a great extent. It is, however, still insufficient, especially regarding the monitoring and control of SWM in Phnom Penh as the responsible administrative body for such activities.

e. Financial Consideration

As mentioned in the former sections, SWM services are provided with public and private partnership in Phnom Penh. Before getting into details about financial conditions in relation to SWM, the Study here clarifies the current allocation of tasks and roles of the public and private sector in SWM as shown in Table 4-10. In this case, the public sector is represented by DPWT/PPWM while CINTRI represents the private sector.

Table 4-10: Currently Allocated Tasks and Roles of DPWT/PPWM and CINTRI in SWM in Phnom Penh

Tasks/Roles	DPWT/PPWM	CINTRI
1. SW Collection Services	NIP Zone	All of Phnom Penh except NIP Zone
2. Landfill operation	Primary responsible for landfill operation	No obligation
3. Fee collection		
- SW collection fees	NIP Zone	All of Phnom Penh except NIP Zone
- Schedule of fees	Common rates applied.	
- Tipping fee for landfill	To be collected from those who bring SW to landfill	Paying to DPWT/PPWM for tipping fees

*There are some exceptions regarding market waste, which is currently brought into the landfill directly from the market by third parties with payment of tipping fees.

As shown in the table above, SW collection services are mostly provided by CINTRI except the NIP zone while PPWM takes full responsibility for operating the currently operating SMC landfill as well as the collection services in the NIP Zone. Both sides are also required to provide such services by their own financing including the collection of fees from their customers. No budget allocation is currently provided from MPP or the national government to their services.

As to the financial conditions of CINTRI, the Study Team has not been able to obtain any concrete data due to CINTRI's company regulations on confidentiality. As mentioned in the former section, even the contract agreement between MPP and CINTRI does not specify any requirement of providing data or information for monitoring the services of CINTRI. However, CINTRI management answered in the interview by the Study Team that the current income from SW collection fees only covered about 50% of the monthly cost of their service operation due to low collection efficiency while it received the remainder from the capital infusion from its headquarter.

The financial conditions of PPWM, on the other hand, can be identified based on the detailed financial data provided by PPWM. The Study outlines the financial conditions of PPWM below.

e.1 Revenue of PPWM

According to the financial record of PPWM in 2002, its total revenue is about 160 thousand US dollars, of which 110 thousand comes from landfill operation. Taking into account that about 90% of the revenue of landfill operation comes from the payment by CINTRI, the private SW collection service provider, PPWM's SWM service operation largely depends on CINTRI's payment of tipping fees. Table 4-11 below shows the income of PPWM in 2002.

Table 4-11: Revenue of PPWM by sources (2002)

Income	US$	Riel	Total (US$)	AVG (per month)
Landfill	110,900.00	1,400,000.00	111,250.00	9,270.83
Fee collection	12,572.00	72,580,300.00	30,717.08	2,559.76
Septic tank sludge collection	15,253.00	7,562,000.00	17,143.50	1,428.63
ST sludge treatment		115,700.00	28.93	2.41
Total	**138,725.00**	**81,658,000.00**	**159,139.50**	**13,261.63**

*US$ 1 = 4000 Riel

e.2 Expenditure of PPWM

The total expenditure of PPWM in 2002 is about 156 thousand US dollars, a little less than the total income of the same year. Approximately 110 thousand dollars are spent in the landfill operation, which is followed by about 18 thousand US dollars spent for the SW collection service operation. The major expenses in PPWM's SWM operation are fuel, operation of bulldozers at the landfill (probably the rental fee of bulldozers or fees paid to service providers), equipment maintenance and salaries. Table 4-12 below shows the details of PPWM's expenditure in 2002.

Table 4-12: Detailed Expenditure of PPWM (2002)

Expense Item	Total (US$)	AVG (per month)
Salaries	15,700.47	1,308.37
Payment for primary collection	9,830.23	819.19
Fuels	33,888.84	2,824.07
Maintenance & Spare Parts	15,981.93	1,331.83
Construction of access road	1,760.00	146.67
Repair of access road	5,846.50	487.21
Administration expense	1,798.01	149.83
Office supply	970.04	80.84
Payment for cell cards	2,433.38	202.78
Electricity bill	866.08	72.17
Water bill	94.53	7.88
Rental fee of private truck	13,806.25	1,150.52
Interest payment	5,033.25	419.44
Medical expenses	523.75	43.65
Payment of commissions	1,156.75	96.40
Labor cost	2,325.14	193.76
Cash contribution	789.13	65.76
Loan repayment (no interest)	15,174.72	1,264.56
Loan repayment (with interest)	3,000.00	250.00
Operation of bulldozer at dump site	22,500.00	1,875.00
Expenses of business trip	475.00	39.58
Traffic accidents	70.00	5.83
Training expenses	10.00	0.83
Overtime payment	442.63	36.89
Rental fee of truck parking	197.50	16.46
Equipment expenses	37.75	3.15
Septic tank expenses	15.00	1.25
Miscellaneous	1,681.04	140.09
Total	156,407.89	13,033.99

e.3 Financial Issues in PPWM

Although the revenue and expenditure of PPWM seems almost in balance, it is only possible at the risk of human health and environment. The landfill operation, in particular, is forced to be minimized due to limited sources of available funds, which is only about 110 thousand dollars per year in 2002.

Furthermore, the financial balance of PPWM clearly indicated that it could not reserve enough funds not only for developing a new landfill, but also for renewal of any equipment for providing SWM services. Without additional capital allocation from external sources, SWM in Phnom Penh will eventually crumble to further threaten human health and the environment. This is also one of the most critical issues of the government, which has to be responsible for providing fundamental public services equally to all the citizens.

f. Public Education and Cooperation

f.1 Public Education

The Department of Environment Education and Communications of the MOE is in charge of environmental education, along with the Ministry of Education, Youth and Sport. The MOE pins its hope on environmental education in formal education, especially for the younger generation, and on public environmental awareness for the solution of the country's

environmental problems (particularly deforestation; problems associated with floodplains and coastal fisheries; biodiversity conservation; and urban waste management).

However, due to the limited budget, human resources, and educational materials, it is actually very difficult to conduct environmental education. In addition, popular subjects are protection of forests and bio-diversity.

Regarding education to ordinary people, hygiene and sanitation education is widely exercised in various government projects. However, waste management issues, in particular the way of discharging waste and the promotion of reuse/recycling, are not major subjects yet, and MPP/PPWM does not have a program to increase people's awareness at present.

f.2 NGO

In Cambodia, there are many NGOs involved in environment issues, and dozens of them formed the Environment Working Group (EWG) under the NGO Forum, which is an umbrella organization of NGOs. EWG has a regular meeting to exchange and disseminate information and takes a leading role in important issues such as Mekong issues. In addition, it sets environmental education as one of its main activities, organizes workshops to promote environmental education for local NGOs, and organizes events on Earth Day and Tree Planting Day to promote environment awareness.

However, most of the environmental NGOs in Cambodia are concerned about forest protection and biodiversity, rather than urban environment issues. In addition, the targets of NGOs that are working in the field of urban environment issues are mainly the weak such as slum dwellers and waste pickers. These features reflect the interests of donors, i.e. international NGOs, donor countries and international organizations.

In Phnom Penh, the only NGOs specialized in waste management issues are CSACO and COMPED, and CSARO is the only one that conducts environmental education along with sanitary education.

4.2 Assessment of Current SWM Conditions

The current SWM in Phnom Penh has been assessed, and the results are shown in the table below.

Table 4-13: Assessment of Current SWM Conditions in Phnom Penh

Items		Urban area (4 Khans)	Rural (3 Khans)
Technical System	1. Waste generation	• The generation unit of household waste is 487 g/person/day • The proportion of kitchen waste is as high as 63.3%. The proportion of recyclable matters such as metals, paper and bottles is 23.7% all together. Of that, the proportion of plastic is 15.5%, which is strikingly high. Plastic bottles have become popularized and the use of plastic bags has drastically increased; their consumption rate is equal to that of developed countries.	
	2. Waste disposal at source	• 2.5% of waste generated is self disposed and 2.5% is illegally dumped by the generators. These figures are relatively low. • The reason for these low figures is that about 90% of waste generated in areas without collection services is carried to the waste collection area by people.	• As much as 34.5% of waste generated is disposed of by the generators. Illegal dumping is 15.1%, 6 times as much as in the urban area. • The primary reason for the high self-disposal and illegal dumping rates is the low coverage of waste collection

	Items	Urban area (4 Khans)	Rural (3 Khans)
Technical System		• The other reason is that the area is overpopulated (population density: 230.2 persons/ha) and there are only a few vacant lands or gardens, thus self-disposal or illegal dumping is not practically possible based on the study of waste flow.	services. Secondly, the area is not highly populated (population density: 16.5 persons/ha) and there is vacant land and houses with gardens, making self-disposal and illegal dumping possible.
	3. Storage and Discharge	• Plastic bags are widely used to store waste before discharge. • Since there is no discharge rule, the waste is never disappeared from the city because people discharge waste after the collection service done. • Street vendors and cars parked on the sidewalk disturb a cleansing works and the wastes discharged by them are littered on it. • There are waste piles on the sidewalk and carriageway making a mess even in the city center, degrading city beauty and public health. • Sangkats reported there are 57 waste heaps in the four urban Khans. • Some large restaurants, hotels and shops use bins or containers for on-site storage of waste.	• The method of waste storage and discharge varies from place to place. • There are waste piles making a mess in the urbanized or populated areas, degrading city beauty and public health. • Sangkats reported there are six waste heaps in the three rural Khans. • The problem of scattered waste is not serious in the unpopulated areas. • The sanitary and aesthetic problem of waste scattering in vacant land is particularly severe in the areas where people were relocated.
	4. Collection and Transport	• The waste collection rate in terms of population is estimated at 95.0% by adding the waste recycling rate at the source (4.9%) and the waste discharge rate to collection services (90.1%). • Because the collection vehicles are old (in use for 8-25 years) and frequently break down, the collection service is not able to keep to the schedule. As a result, some of the discharged waste is left uncollected. • The loading of waste piled on sidewalks and streets requires manpower, which reduces the collection efficiency. • Waste piled in empty lots that cannot be accessed by collection vehicle is neglected, which is causing considerable deterioration of the surrounding environment. • Most of the population in the four Khans in the urban area enjoys waste collection services. The service does not cover only a limited area. Therefore, the primary target of SWM in cities, i.e. the removal of waste from the living environment, has been generally achieved. • In part of the area, for example the NIP area, former waste pickers were grouped to make a self help group (SHG) and the SHG	• The waste collection rate in terms of population is estimated at 50.4% by adding the waste recycling rate at the source (5.1%) and the waste discharge rate to collection services (45.3%). • Because the collection vehicles are old (8-25 years) and frequently break down, the collection service is not provided at fixed intervals. As a result, the waste discharged by residents is left uncollected. • The reason for the low waste collection service coverage is because there are unpopulated areas and more directly because most parts of the urbanized or populated areas are out of the serviced area. Therefore, the top priority should be given to the provision of collection services to urbanized or populated areas. • In some areas, primary collection has been attempted as in the NIP area, but collection services in the areas where collection vehicles cannot enter are inadequate. Because most parts of the area with no or poor collection services are areas with low accessibility, the method used in the NIP area should be employed to expand collection services.

Items	Urban area (4 Khans)	Rural (3 Khans)
	provides primary collection services. This is a very effective way to expand waste collection services to areas that collection vehicles cannot easily enter. • The NIP area is the only area where PPWM renders waste collection services. The collection efficiency of PPWM is low: it has a compacter truck with the capacity of 18m^3 but collects only 19 tons/day of waste. • A resource recovery system by an informal sector at the source and waste discharge points is efficiently working. Resource recovery at waste discharge points, however, causes problems such as the scattering of waste. In view of waste reduction, recycling and city cleansing, source separation will be preferable. • Except for the NIP area, there is no waste transfer system. Collection vehicles directly go to the SMCDS. The site is within 10 km from anywhere in the city, it seems no transfer station is considered.	• There is no area served by PPWM. The collection service is provided only by a private company, which follows economic principle. Because of the character of the area, the efficiency of the waste collection service cannot be high, and the provision of collection services by the public sector needs to be considered. • There is active resource recovery by the informal sector at the generation source and waste discharge points. • There is no waste transfer system. Waste collected by collection vehicles directly goes to the SMC final disposal site. Since the transport distance from some areas exceeds 20 km, the establishment of a waste transfer system is needed.
5. Road and park cleansing	• Street sweeping services are provided by CINTRI with waste collection fees as the financial source. • Cleansing services are provided to major roads and parks in the city, which heavily contribute to city beauty. • Machinery is used for cleansing services in a limited area. Manual cleansing is the main practice creating jobs.	• Street sweeping services are provided only to the road to the airport by CINTRI with waste collection fees as the financial source. • Manual cleansing is the main practice creating jobs.
	• Cleansing works of public parks are carried out by DPWT, Garden and Park Section • CINTRI hauls its waste to the SMC disposal site.	
6. Intermediate treatment	• One composting facility (compost production capacity: about 4 tons/day) is operated by the NGO, CSARO. The product quality of compost is high because selected material is used, but its market is unstable.	• There is one composting facility run by the NGO, COMPED, at the SMC disposal site (compost production capacity is reported to be about 13.7 tons/day by the NGO, which seems to be overestimated). It receives waste from markets, thus the quality of compost is high, but its market is not stable. According to POS, on-site composting is practiced at some households.
	• The promotion of compost is one of the effective ways to raise the waste recycling rate. The evaluation of project feasibility, however, requires market research such as a study on prices of competitive products such as organic fertilizers. It is also necessary to diffuse knowledge to farmers on the effect of soil improvement by using compost and to stimulate demand. • Major hospitals have small incinerators for treating infectious waste, but they are not fully operated due to financial and technical problems.	

Items	Urban area (4 Khans)	Rural (3 Khans)
7.Recylcing	• The recycling rate of the city is 9.3% (85.8 tons/day) of total waste generation, which is comparable to that in Japan (13.1% in 1999). Recycling systems in the two countries are, however, largely different. In Japan, recycling is done by community groups (5.1%), recycling facilities and machinery, while in Cambodia recycling is an informal activity using cheap labor. • NGOs such as CSARO carry out recycling although on a limited scale. The recycling system of individual recyclers is well developed. • Informal recycling by street waste pickers at the source and waste discharge points is especially active. Their recycling is estimated to reach 67.5 tons/day, or 7.3 % of the total waste generated in the city. • Final users of recycled material are various but their business scale is small. The majority of recovered material is therefore exported to Vietnam and Thailand. • At the SMC disposal site, there are more than 500 waste pickers engaged in resource recovery.	
8. Final disposal	• The SMC disposal site is the only disposal site in MPP. Unregulated landfill operation has continued for 38 years, since 1965. The municipality possesses a land plot of only 6.8 ha, which is too small for a city with a population of million, and waste spreads out of the municipal area to the surrounding private land. Since waste is piled up to a height of more than 5 m on average, it is getting difficult for the collection vehicles to access to the working face. Accessibility to the site is particularly poor in the rainy season, when waste disposal must occasionally cease. Improving accessibility and securing a landfill area are urgent issues. • The site is a typical open dump, posing seriously negative impacts on the surrounding environment. Air pollution by smoke caused by fire is particularly serious for not only the surrounding area but also a wide area in the city. The prevention of fire is therefore also an urgent matter. • Incoming vehicles are not controlled. It is not known what kind of waste is disposed of in which part of the landfill. Infectious hazardous waste is disposed of without being distinguished from municipal waste. • The most problematic matter is that the remaining service life of the site is nearly nil and a residential area is approaching less than 100 m away from the site due to rapid urbanization. Therefore, a new disposal site must be constructed as soon as possible and the existing site must be closed. • More than 500 waste pickers are working without any rules. Their resource recovery activities interfere with landfill operations and put their lives at risk. It is urgently required to segregate the working area of waste pickers and the working area of heavy machinery and waste collection vehicles to realize efficient landfill operation and safe material recovery. • All landfill equipment being used in SMCDS is leased along with a bulldozer operator and a guide for collection vehicles. Since there is a shortage of landfill equipment and fuel due to a financial problem, the landfill operation is not operated sufficiently.	
9.Operation and Maintenance (O&M) of Machinery	• CINTRI's machinery for waste collection, transport, and road cleansing, which have been in use for 8 to 25 years, break down frequently. Although CINTRI's maintenance shops in Beng Kak 1 and Toul Kork are not adequate facilities, CINTRI is somehow able to keep the machinery in working condition. However, CINTRI is not able to keep to the collection schedule. • PPWM does not have the human resources, equipment or facilities to operate and maintain its machinery. When machinery breaks down, the repair work is entrusted to a private service shop. • The landfilling machinery at the disposal site is all rentals, and the rental company carries out the repair work at a small shop set up on-site.	
10. Management of Septage	• Septage generated in the city is collected by three vehicles of PPWM and 11 vehicles of the private sector. • According to records in the year 2003, 5.8 m^3/day of septage was disposed of at the SMC	

Items		Urban area (4 Khans)	Rural (3 Khans)
		disposal site on the average. • Examining these figures, it is highly anticipated that septage collected by the private sector is disposed of out of the SMC disposal site. Appropriate disposal must be strongly instructed. The establishment of the septage disposal system requires a correct understanding of the real situation by studying the number of septic tanks, frequency of emptying the tanks, and other aspects. • Septage is disposed of in the sludge pond constructed on top of the waste layers at the SMC disposal site. As this method is simple but effective, its continuation is one option.	
Institutional System	11. Legal system	There is a Sub-Decree on SWM, established in April 1999, which is the fundamental law on SWM. Since it only sets an overall framework, the following issues should be solved. • Although MOE has issued a ministerial declaration to supplement the Sub-Decree, detailed regulations, standards and guidelines that should have been established based on it have not been well prepared yet. • The Sub-Decree on SWM states that waste is divided into hazardous waste (HW) and non-hazardous waste (non-HW), but does not define or categorize waste. It is hence not practically possible to separate non-HW and HW. Though the classification of non-HW and HW is reasonable as a broad one, a more detailed classification is necessary for proper SWM, especially for identification of the body (producer) responsible for the disposal of the SW. • The Sub-Decree on SWM states that the local authorities are responsible for the disposal of HW from domestic sources. However, the domestic sources in the Sub-decree included clinics and hospitals. This might need to be examined. • The collection, transport or storage of hazardous waste from factories requires the approval of MOE, but the responsibility of supervision is not clearly placed. • The Sub-Decree on SWM stipulates that the municipalities responsible for non-hazardous waste management (non-HW) have to prepare waste management plans. However, no municipalities in the country have developed the plan. The SWM plan for the MPP to be formulated in this study is the first one and the methodology of SWM planning is expected to diffuse to other cities throughout the country. • By-laws on SWM and guidelines on waste discharge and others to ask people for cooperation are necessary for the municipalities to properly carry out SWM. There are, however, no such by-laws or guidelines. • MOE stated that it detected nine cases of breach of the Sub-Decree on SWM and its ministerial declarations and collected 44.23 million Riels of fines in 2002 following the Law on Environmental Protection and Natural Resources Management issued in January 1997. The team considers these cases are only part of the illegal activities. An example is the problem of septage. There is a septage disposal facility on the SMC disposal site. The private septage collection companies, which possess 11 septage collection vehicles (PPWM owns only three), do not deliver septage there. Most of the septage collected by the private sector is presumed to be illegally dumped.	
	12. Administration and Organization	• At the national level, it is clear that SWM is within the jurisdiction of MOE. On the other hand, in MPP, DPWT, DOE and PPWM are involved in SWM and the relationship among the three is not clear. Management of waste disposal and cleansing services in a practical sense are carried out by PPWM under the DPWT. The PPWM Statute was made based on such a situation, but has not been approved as of July 2003 by either the Ministry of Interior, the Ministry of Finance of Economics, or the MOE. On the other hand, Prakas No. 80, which was issued jointly by the Ministry of Interior and the MOE on February 25, 2003, stipulates that a SWM plan should be formulated mainly by the DOE of each municipality. The jurisdiction of SWM in the city should be unified without delay. The immediate approval of the PPWM Statute is expected in view of the clarification of the jurisdiction.	

Items		Urban area (4 Khans)	Rural (3 Khans)
Institutional System		• Waste collection and cleansing work was contracted out to CINTRI, which took over the franchise contract from PSBK in 2002. The contract is valid for 50 years from 1997, and allows CINTRI to do business as a monopoly and to collect fees. If any problems occur such as a breach of contract by CINTRI, there is no other organization that can provide the waste service in place of CINTRI. Avoidance of the monopoly of waste collection and cleansing work is a critical issue. • Since the PPWM Statute has not yet been approved, its presence is very unstable. Moreover, PPWM is weak in terms of property (machinery and facility), human resources (quality and quantity of personnel) and finance. MPP amended the contract between MPP and CINTRI and currently executes waste collection in the NIP area and landfill operation in the SCMDS. • The supervision of waste collection and cleansing works being provided by CINTRI and PPWM in MPP as a whole is hardly done. The system for monitoring and control of the SWM should be established.	
	13. Public-Private Partnership	SSWMPAP[6] strongly pointed out, the 46-year franchise contract on SWM work with the private company has the following problems. • Open and transparent competitive bidding and pricing of the contracted services are not practiced. • The service performance and costs of the private contractor's work are neither contested nor monitored by the responsible organization of MPP. • The contractor is not accountable to the client and customers for the standards and manner in which his service is provided. In addition to the aforementioned problems with the contract, MPP's control and supervision system on SWM is weak as described in the following. • There are no baseline data necessary for SWM, such as data on the rate of population without waste collection services and data on the waste disposal quantity from each generation source, from each district, or of each collection company. Moreover the data collection system is not developed. • Due to a lack of baseline data, the unit cost of each sub-component of SWM (i.e. waste collection, septage collection, final disposal) is not known. • MPP does not control or supervise the private company operating SWM work, and does not even have a unit to do so. It also lacks a function to receive claims from people. As shown above, the compilation of basic data on SWM and the development of a database are urgently needed.	
	14.Capacity Building	• Following the SSWMPAP, several programs were carried out by ADB and NORAD for five years in order to strengthen DPWT and PPWM. Although they are still weak, the development of their present structure owes much to the assistance. • Although the structure of PPWM was developed, its collection service covers only 2.1 % of the population in MPP and the SMC final disposal site they operate is nothing but an open dump. Although PPWM statute stipulates that monitoring the private business company on solid and liquid waste is one of the PPWM's tasks, PPWM does not supervise or control the SWM work in the city carried out by the private company.	

[6] "Strategic Solid Waste Management Plan and Action Plan" by NORAD March, 2003

Items		Urban area (4 Khans)	Rural (3 Khans)
Institutional System		• In conclusion, further development of PPWM's human resources is necessary so that PPWM can operate and control an appropriate and sustainable SWM system for MPP. The acquisition of the know-how on the provision of waste collection and cleansing services and the operation of a sanitary landfill is especially urgent for the existence of the organization. The acquisition of such know-how would provide PPWM or any other organization in MPP responsible for SWM of the know-how on supervision and control of proper SWM works, which are main responsibility of the public sector. Therefore, in regard to the human resources development of PPWM, priority should be placed on the acquisition of the know-how of SWM operation. • On the other hand, the monitoring and control of the collection service and disposal site operation should be the responsibility of an organization other than the implementing body, i.e. PPWM. It is necessary for MPP to establish this as quickly as possible.	
	15. Financial Condition	• The financial base of PPWM is weak as shown by the fact that as high as 70% of revenues depend on the waste disposal fee paid by CINTRI. The total revenue in 2002 was 159,000 dollars and there is no financial support from MPP to PPWM. The repayment of loans and interest amounted to about 22,000 dollars in 2002. The yearly balance of income and expenditure does not have a problem, but no funds are retained to purchase new machinery and vehicles or to improve the final disposal site. Even the budget for the operation and maintenance of existing property is very tight. • The financial condition of MPP is also severe. The total revenue of the year 2002 was 26.6 billion Riel (approximately 6.65 million dollars), which is too tight to subsidize the SWM work of PPWM. • The area where PPWM provides waste collection service is very limited. As of 2003, CINTRI's collection service covers 130,000 households and institutions, while PPWM's service covers only 3,400 (2.1%). Moreover, PPWM's area is mostly residential and the collection fee of more than 3,200 households is less than 1 dollar/month. Even if PPWM collects fee from all the beneficiaries in the area, the income will only amount to 4,300 dollars/month. The average monthly fee collected in 2002 was about 2,560 dollars; thus the fee collection rate is 60% in the NIP area. Accordingly, not only the purchase of new vehicles but also their maintenance is difficult. • The current tariff structure for municipal waste management was determined by an agreement among PPWM, CINTRI and MPP. It should be reviewed in order to prepare for additional expenditure if the development of the new final disposal site and the enforcement of PPWM's SWM service system is to be put into effect. • The tariff structure needs adjustment also from the viewpoint of equality. The households and institutions are broadly categorized depending on the size and/or type, and the waste fee is set for each category. In order to more strictly follow the "beneficiary pays" principle, careful categorization should be considered. • CINTRI has set the fees based on it own studies and sends bills to customers without their agreement, which has resulted in many complaints an unpaid bills. In order to improve the fee collection rate, the fee should be charged based on an agreement made between the CINTRI and the customer. • The city is divided into seven Khans, which are further divided into 76 Sangkats, the smallest administrative division. It is believed that it would be effective to incorporate the Sangkat into the fee collection system. • At present, CINTRI is charging fees by adding it to the electric charges. However, • The disposal fee currently being paid by CINTRI is approximately 0.5 dollars per ton and when the new disposal site is constructed, it will pay 0.75 dollars per ton. However, as a sanitary landfill cannot be properly operated at that cost, it is necessary to reexamine the disposal fee.	

Items		Urban area (4 Khans)	Rural (3 Khans)
		• Considering the severe financial situation of MPP and PPWM, it is apparent that self-financing for the development of a new final disposal site is far beyond their affordability. In light of the provision of public services, the country or the city should be responsible for allocating as much funding as possible, but grant assistance from donor countries or international organizations is inevitable for an appropriate SWM system because of the financial shortage of the country and the city.	
Institutional System	16. Public education and cooperation	• Sustainable SWM cannot be realized without sufficient understanding and cooperation of residents. SWM authorities in developed countries try to raise people's awareness and ask for cooperation in many ways. Such public relations activities are hardly seen in MPP. • It is reported that CINTRI, a monopoly rendering waste collection and cleansing service in MPP, use 100,000 US dollars for PR activities. It does not, however, receive enough cooperation from residents for appropriate waste discharge. • In order to reduce waste scattering and increase the collection efficiency, it is necessary to establish waste discharge rules and promote a public education campaign to disseminate the rules by the joint effort of the MPP and the public. • According to the result of POS, people's awareness of SWM is not high. Many people are concerned with the problem of scattered waste that degrades city beauty, but they are not well aware of the important roles that they should play in waste reduction or recycling. • In order to keep the city clean and to conserve the sanitary environment, people's cooperation is inevitable. The authority has to carry out PR activities actively.	
	17. Hazardous waste management	• The Sub-Decree on SWM sets basic rules for hazardous waste management including infectious waste, but standards or guidelines have not been developed, although they are necessary to practically control and regulate the management of these wastes. • A private disposal site for hazardous waste was approved by MOE and constructed in Khan Ang Snoul by Sarom Trading Company, but its control is insufficient. Main hospitals have incinerators for medical waste but most are not working well because of financial and technical problems. • MOI issued a monitorial order (Prakas), which requires factories to report on their management of hazardous waste and instructs them to properly treat and dispose of it, but the enforcement of this Prakas is weak. • The team studied SWM at 41 medical institutions. It was found that all of them had known that the management system for medical waste was regulated by law. • Personnel working for the medical institutions are aware of a medical waste management system and the risks of infectious or hazardous waste. Most medical institutions take prevention measures against infection, and separately collect and store such waste within the premises. • The number of separation categories of infectious or hazardous waste is small. • Many medical institutions do not report on hazardous waste. This shows a lack of consciousness about the definition, character and identity of hazardous waste. • Many medical institutions replied that the disposal manner of collected infectious or hazardous waste is not satisfactory. Infectious or hazardous waste is separated from municipal waste when collected, and is incinerated or entrusted to contractors for treatment. Some stated that the contractors mix infectious or hazardous waste with municipal waste during collection, and they end up being disposed of together at the landfill. Since no treatment measures are taken at the landfill for infectious or hazardous waste, human health and the environment are threatened. • The medical institutions stated that they are ready to cooperate with the national or local government for the realization of the appropriate medical waste management system. Most of them, however, also answered that they need governmental support financially and technically in order to put the appropriate waste management system into action.	