

## 4 Pilot Projects

### 4.1 Selection of Pilot Projects

#### a. Objectives

The objectives of implementing the pilot project are as follows:

1. To strengthen PPWM's waste management capability
2. To verify the practicability of the Master Plan
3. To execute the operational plan and verify its practicability
4. To demonstrate improvement measures to the authorities and residents concerned with SWM
5. To raise public awareness of SWM and promote public cooperation.
6. To obtain basic data to plan and design the F/S study
7. To strengthen the capacity on SWM of the executing authorities

#### b. Selection of pilot projects

In the discussions with the JICA study team and the C/P, the following five pilot projects were selected. All the PP but PP3 started in the second phase and PP1 and PP2 continued until the end of the third phase. PP3 started in the third phase.

PP1: Improvement of the SMC Disposal Site

PP2: Improvement of the Waste Collection System

PP3: Public Education Campaign

PP4: Development and Promotion of the Municipal Solid Waste Compost Market

PP5: Development of the Data Management System for SWM

### 4.2 Improvement of SMC disposal site

#### 4.2.1 Outline of Improvement Plan

The pilot project of the improvement of the Stung Mean Chey Disposal Site (SMCDS) has been conducted from April 2003. The improvement mainly consists of three elements: (1) construction of facilities, (2) waste picker (WP) management, and (3) improvement of operation. The improvement plan of the SMCDS is summarized in the table below.

Although the further improvement of the leachate collection and treatment system is being conducted from June 2004, the construction of facilities other than it has completed and handed over to PPWM mid-March, 2004.

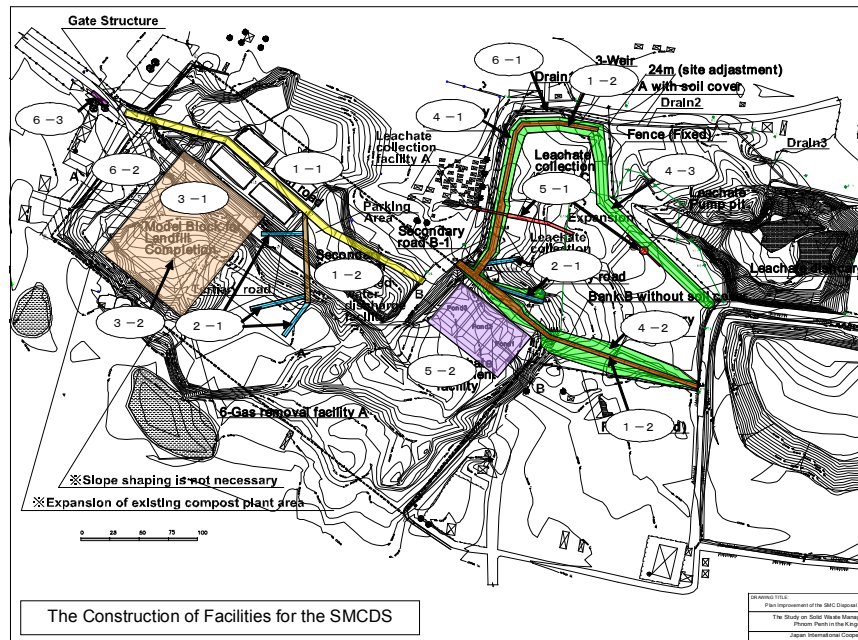
Table 4-1: SMC Disposal Site Improvement Plan and Responsible Bodies

Items	Main Target	Responsible Bodies
<b>1. Construction of Facilities</b>		
1.1 Installation of a weighbridge	Data collection for landfill management	JICA
1.2 Securing of land for expansion	Expansion of the landfill	PPWM
1.3 On-site road	Secure the access	JICA
1.4 Working face	Separation of landfill operation (LO) and waste picking work	JICA
1.5 Model block for landfill completion	Demonstration of sanitary landfill	JICA
1.6 Enclosing bank	Demonstration of sanitary landfill Expansion of the landfill	JICA
1.7 Leachate collection and treatment	Demonstration of sanitary landfill	JICA
1.8 Others	Demonstration of sanitary landfill	JICA
<b>2. Waste Picker Management</b>		
2.1 Registration of WPs	Separation of LO and waste picking work	PPWM and JICA
2.2 Issuance of permission cards	Separation of LO and waste picking work	PPWM and JICA
2.3 Control of the entrance of WPs	Separation of LO and waste picking work	PPWM
2.4 Provision of jackets	To support WPs to organize themselves	PPWM and JICA
2.5 Provision of vaccinations	To establish a reliable relation with WPs and to improve their health conditions	MOH, DOH
<b>3. Improvement of Operation</b>		
3.1 Operation of the weighbridge	Establishment of data base for landfill	PPWM and JICA
3.2 Preparation of operation plan	Demonstration of sanitary landfill	JICA
3.3 Preparation of technical specification	To supervise landfill operation done by the contractor	JICA
3.3 Operation of improved landfill	Demonstration of sanitary landfill	JICA, PPWM

**a. Construction of facilities**

In the pilot project, part of the existing disposal site, which was basically an open dump, was improved, and the landfill area was expanded using the area secured by MPP so that PPWM can continue landfill operations until 2007, when the new disposal site is planned to be opened.

The facility improvement work was conducted by a contractor under the instruction of the study team, based on the facility improvement plan shown in Figure 4-1.



Work Item	
1. On-site Road	
1-1	Main road
1-2	Secondary road
2. Working Face	
2-1	Tertiary road
3. Model Block for Landfill Completion	
3-1	Model block
3-2	Gas removal facility
4. Enclosing Bank	
4-1	Bank A (with soil cover)
4-2	Bank B (without soil cover)

Work Item	
5. Leachate Collection & Treatment Facility	
5-1 Expansion Area A	
(1)	Leachate collection facility
(2)	Leachate pump pit
(3)	Pump
(4)	Leachate discharge pipe
(5)	Gas removal facility
5-2 Exiting Area (southern area)	
(1)	Leachate collection facility
(2)	Leachate pump pit n
(3)	Pump
(4)	Leachate discharge pipe
5-3 Leachate Treatment Facility	
(1)	Pond (1-3 ponds)
(2)	Pumping station
(3)	Treated water discharge pipe
6. Others	
6-1	Fence (Fixed type) and gate
6-2	Expansion of Existing compost plant area
6-3	Weighbridge

Figure 4-1: SMCDs Facility Improvement Plan

**b. Waste picker management**

Based on the results of the interview survey and Focus Group Meeting in the phase one study, it was found that the waste pickers recognized there were serious problems with the current situation in terms of the environment as well as safety such as the frequent occurrence of accidents.

As a result, the study team organized 11 community meetings to explain to the waste pickers the waste picking rules (draft) for the separation of the waste picking area from the landfill operation area in order to prevent accidents and increase landfill efficiency. In the meeting, preliminary registration of the waste pickers was carried out in order to get an idea of the number of waste pickers working at the disposal site and to facilitate registration at the disposal site.

The registration started at the disposal site on November 17, 2003, and 2,907 waste pickers had applied for registration as of January 17, 2004. ID cards (entrance permits) were prepared for the applicants and PPWM distributed them to selected waste pickers working daily at the disposal site. Furthermore, in order to prevent the spread of infectious diseases in the poor working environment, vaccinations against tetanus and hepatitis B were administered to the waste pickers.

### **c. Improvement of operation**

#### **c.1 Landfill operation**

The recording system, which disposal waste amount, the transporters, type and number of collection vehicles incoming to the SMC were recorded by the weighbridge installed in the first phase study was established.

The team prepared the “technical specifications for the operation works of the SMC disposal site” which is necessary for PPWM to entrust a private company with the landfill operation in the SMC disposal site. Therefore, PPWM has been able to manage the landfill operation appropriately by controlling, supervising the contractor according to this specification. After August, 2004 when the contractor was changed, the access road and working faces are being maintained continuously.

The team is now giving a practical training to the PPWM staffs for the purpose of transferring a proper technology of landfill operation with heavy equipment leasing one wheel loader from the middle of September, 2004. Main works using this equipment are maintenance of the access roads to the working face, removal of unloaded waste from the working face, forming and maintain the enclosing dike. This practical training will be continued until the beginning of March, 2005.

The reason why wheel loader was selected is speedy move and widely applicable comparing with the bulldozer being used by the contractor already. The soil for covering waste is available within the site based on the excavation of aged waste done by PPWM and the soil covering of the expanded area was added into this practical training.

#### **c.2 Measures to deal with Waste picker**

A trial was conducted to establish a safe and proper landfill operation system by separating the waste picking area from the landfill operation area (landfill area), aiming to improve the efficiency of the landfill operation carried out by PPWM. Because of a delay in construction work due to disputes with the landowners in the expansion area mentioned below, the trials for landfill operation based on the waste picking rules began from December 29, 2003. However, problems with the landowners such as the obstruction of work continued.

The continuous maintenance system of working face was established as of the beginning of December, 2004, the PPWM tried to separate working faces. However, the gang stars in the landfill often obstructed the separation works as well as organizing works of WPs. Furthermore, the budget of the PPWM could not employ enough number of the guards for the separation work. In January 2005 the PPWM postponed the separation work again.

#### **c.3 Establishment of Regular Monitoring System**

Before the pilot project, MOE/DOE had never conducted the environmental monitoring at the SMC disposal site. The regular environment monitoring by the regulatory organizations is indispensable for the proper pollution control.

On the other hand, in the development plan of the new Dang Kor (DK) disposal site, the team proposed to organize the monitoring committee to control the operation of PPWM. In order to guarantee the regular monitoring by the monitoring committee at the DK disposal site, MOE/DOE should start to prepare for the regular monitoring system now. Therefore, under the pilot project, the team decided to support MOE/DOE to initiate the regular monitoring system at the SMC disposal site.

Due to the lack of the budget, it is almost impossible for MOE/DOE to start the same regular monitoring system as the development plan proposed. The team decided to exclude some monitoring items which are not affordable for MOE and DOE. Even though the newly established regular monitoring system is primitive, MOE and DOE could accumulate knowledge and experience through the regular monitoring which includes such tasks as sampling, analysis, data compiling, and data analysis.

#### 4.2.2 Finding

##### a. Disputes with landowners in the expansion area

On January 13, 2004, a final agreement was made between MPP and some of the landowners to exclude A2 (2.4ha) from the planned expansion area of 6ha (A1+A2+B). The plan was re-examined with the expansion area of the site reduced to 3.6ha. On February 4, 2004, the study team explained the following problems that may occur as a result and the required countermeasures to MPP, and MPP agreed to them on February 14.

##### Problems

1. Although this had occurred before implementation of the pilot project to improve SMC disposal site, leachate from the expansion area and waste water from the surrounding area will be discharged into the A-2 site, which may lead to complaints from the landowners in that site in future.
2. By reducing the expansion area, the originally planned capacity will decrease from 284,000m<sup>3</sup> to 170,000m<sup>3</sup>, which is equivalent to a decrease in landfill capacity of about one year. Therefore, the landfill at the SMC disposal site will receive waste until the end of 2006 rather than the end of 2007.

##### Measures

1. The complaints from the landowner should be dealt with by providing evidence of the conditions prior to implementation of improvement work.
2. Until the new disposal site is constructed, the planned landfill height should be raised.

In waste management, problems occur daily at the site. By dealing with these problems, PPWM gained a lot of experience such as conducting checks with drawings, taking measures as the situation demands, building consensus with concerned parties, etc.



A widely applicable of the wheel loader was verified through maintaining working face and soil covering works. In addition to the above validity, it was verified that the combination with bulldozer and/or excavator could make various works necessary for the landfill operation. Therefore, the operational technology transfer was done through this pilot project.

Regarding the separation of the landfill operation area and the waste picking area, trials with three working areas and two working areas were conducted. The rotation time of 6-7 hours was found to be too long for the waste pickers to accept, but the waste pickers found the rotation time of about 30-40 minutes to be reasonable. Although there is no concrete data, based on observation, the working area separation seemed to increase the efficiency of levelling/compaction work and waste unloading work.

However, because the trial was delayed (Start: December 29, 2003) and site problems with landowners worsened after the trial began, the Study Team did not have sufficient time to carry out the trial. As the result, the study team and PPWM were not able to firmly establish the system of separating the landfill operation from the waste pickers.

Meanwhile, it became clear that there are several problems such as waste pickers who buy waste from collection drivers and kept it to themselves or try to control other waste pickers by force. Such behaviour is a major obstacle to working area separation. Therefore, the team and PPWM took the necessary measures to deal with these waste pickers in cooperation with Sangkat and Phum officials.

Although the trial period was short, it was verified that separation of the working areas makes the working environment for waste pickers safer. Therefore, PPWM is planning to restart a trial from the end of December, 2004.

#### **d. Improvement results**

##### **d.1 Evaluation of improvement results**

In order to evaluate the improvement results, a participatory assessment with neighboring residents and NGO workers was conducted. In this assessment, the participants were taken on a bus tour before implementation of the pilot project, on October 10, 2003, and after, on March 9, 2004, and the results were quantitatively evaluated through a questionnaire comparing conditions beforehand and afterwards. There were 25 participants in the pre-pilot project tour and 20 in the post-pilot project tour.

The questionnaire consisted of 3-10 items each on environmental impacts, operational conditions, and facility function. The participants rated each item on a scale of one to three, one being "unacceptable", two "so-so" and three "acceptable", and the points were tallied. The average rating of environmental impacts before the improvement was 1.27, while after the improvement it was 2.05. As for operational conditions, the rating increased from 1.31 to 2.05 showing that the participants recognized an overall improvement of the disposal site. However, looking at the individual items, the evaluation rating of fire and smoke and the heaps of waste did not reach 2 points revealing that improvement needs to be continued. As for the upgrading of facilities, nearly all members recognized the effect of weighing incoming waste on the weighbridge, and the on-site roads, gas ventilation system, leachate treatment system, wastewater facility, and compost plant were also highly evaluated. On the other hand, the rating for the landfill's working face was below 2 points showing that further improvement is desired

## d.2 Extension of the service life of the disposal site

In this improvement, the capacity of the disposal was increased by 170,000m<sup>3</sup>. Based on the height of the completed model block, the landfill has the capacity to operate until 2006.

## d.3 Introduction of waste picking rules

It was found that by separating the working areas, the landfill operation efficiency significantly increased and the safety of the waste picking work was improved. However, due to the limited personnel and equipments, it was difficult for PPWM to continue the trial by itself. In the third phase, after changing the contractors of the landfill operator, PPWM's capability of managing the working area separation improved enough to resume the trial. At the end of third phase, PPWM tried to start the working area separation by itself in the simple form.

## d.4 Landfill Operation with Wheel Loader

As a validity of wheel loader in the landfill operation was verified, it is recommended to include this equipment into the landfill equipment plan. Therefore, the SMC disposal site may be closed smoothly if the improvement works will be continued.

## d.5 Performance of Leachate Treatment facilities

Generally, leachate is highly contaminated by pollutants especially organic matter. The purpose and function of the leachate treatment facility in SMC disposal site are to improve water quality of the leachate that is collected by the leachate collection facility in order not to pollute the discharge area of public water. To evaluate the performance of the leachate treatment facility, raw water and treated water of the leachate were sampled and water quality was analyzed.

Table 4-2: Analysis Method for Each Parameter

Analysis parameters	PH	BOD5 (mg/L)	COD-Cr (mg/L)	Oil & Grease (mg/L)	SS (mg/L)	Iron (mg/L)	Chloride (mg/L)	Flow (L/sec)
<b>Sampling 1 (26 July 2004)</b>								
Inlet	7.52	380	720	59*	100	2.3	1,900	38
Outlet	NO sampling due to a mechanical problem of pump in the facility							
Proportion (%)	N/A							
<b>Sampling 2 (20 August 2004)</b>								
Inlet	7.57	190	540	11	99	2.3	2,200	41
Outlet	8.26	300	640	7.8	1,100	< 0.3	1,400	
Proportion (%)	109	158	119	71	1111	13	64	
<b>Sampling 3 (10 September 2004)</b>								
Inlet	7.44	320	1,100	9.1	130	0.97	1,700	35
Outlet	8.40	180	570	5.3	375	0.45	1,200	
Proportion (%)	113	56	52	58	288	46	71	
<b>Sampling 4 (22 September 2004)</b>								
Inlet	7.22	360	5,100*	7.5	244	0.53	1,800	30
Outlet	8.76	110	590	4.8	195	< 0.3	1,100	
Proportion (%)	121	31	12	64	80	57	61	
<b>Sampling 5 (28 September 2004)</b>								
Inlet	7.36	410	760	9.7	138	0.52	950	32
Outlet	9.05	160	630	6.0	318	< 0.3	1,100	
Proportion (%)	123	39	83	62	230	58	116	

\*Data are suspected



The following issues should be considered before evaluating the results.

First of all, the results of Sampling 2, dated the 26<sup>th</sup> of July 2004, show a different tendency from the other samplings. This is because the activities of waste pickers in the 3<sup>rd</sup> treatment pond, such as washing used plastic bags, stir the pond and make mixed sediment at the bottom of the pond. As a result, the outlet shows higher concentrations of BOD, COD and ten times higher in the case of SS. Secondly, data marked as \* are questionable.

As an overall evaluation, the facility could improve the water quality of leachate. The facility could improve the water quality of BOD, COD and iron effectively as well as chloride also to a certain extent. The picture (on the right) clearly shows the difference in water quality between the inlet and the outlet. As for SS, it is notable that the concentration of the outlet was higher than the inlet in spite of our expectation that it would decrease after treatment. The reason is that the SS originated from organic matter in the leachate was surely decomposed. However, algae have occurred in the treated leachate instead because of strong sun exposure in Cambodia.



Figure 4-3 The Picture of Samples

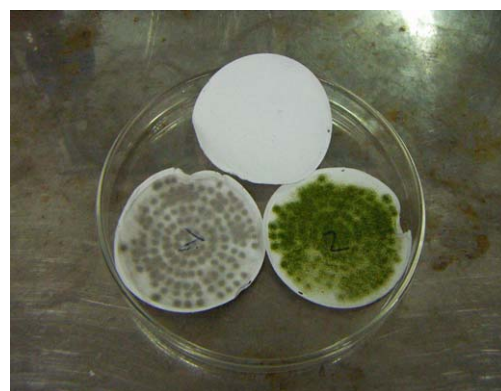


Figure 4-4: Algae grown in the treated leachate

#### 4.2.3 Poor Access and its Problems

To provide a smooth access in the landfill to the users (collection vehicles) is the basic responsibility of the operator of a disposal site, i.e. PPWM. As for the SMCDS, PPWM often fails to provide this principal requirement of landfill operation. The users (collection vehicles) often have to wait for a considerable time, some time more than 6 hours, until they dump their wastes collected due to a vehicle stuck at mud and waste heap. A long queue of collection vehicles brings a considerable loss to the users and this is clearly caused by poor access to and at the working face (unloading area of the waste collected). This situation becomes more serious when it rains.

The Team summarizes the reasons why PPWM could not provide a good access as follows:

1. Lack of landfill equipment for a proper operation of the disposal site. Actually PPWM has no landfill equipment at all. As all landfill equipment belongs to the operation contractor, PPWM could not conduct any physical works to provide a good access without the consent of the contractor.
2. Insufficient budget for the operation of the SMCDS. In fact the current payment (US\$8,500) to the operation contractor is not enough to provide proper landfill

operation. According to the calculation done by the Team the payment could only cover for a D7 class bulldozer rental fee and 12 hours continuous operation<sup>1</sup> cost of it.

3. Improper operation of the operation contractor. This is due to lack of proper instruction and control of PPWM in addition to the insufficient knowledge of the contractor.
4. Lack of daily, weekly and monthly operation plans. Based on the plans, the operation contractor shall construct, maintain and repair of access; i.e. on-site roads and working faces.

#### 4.2.4 Actions to be taken by MPP/PPWM

The Team recommends the PPWM to take the following actions to solve the current problems of the SMCDS:

##### a. Solution of Poor Access

Since provision of a good access to the users is the responsibility of PPWM not of private operation contractor, PPWM needs to take the following measures:

##### a.1 Increase of Income from Users and Raise Payment to the Contractor

For the provision of a good access to the collection vehicles, PPWM shall properly construct, maintain and repair on-site roads and working faces. PPWM shall understand that this work requires a considerable number of landfill equipment and inputs for their operation, i.e. fuel, lubricant, operators, etc.

The Team made a study for minimum requirement for a proper operation of SMCDS including shaping but excluding soil cover and estimated that it requires at least 25,300 US\$/month (This is equivalent to 1.20 US\$/ton if daily disposal amount is 700 ton/day.). PPWM, therefore, needs to negotiate the users, mainly CINTRI, to raise tipping fee to cover minimum cost for proper operation. At the same time PPWM shall make its best effort to provide a good access to users. Otherwise the users will not accept the increase of tipping fee. PPWM shall mind for negotiation that to improve the landfill and provide a good access will bring a considerable benefits to the users. Because the provision of a good access improves the efficiency of the collection vehicles (e.g.: increase the number of trips) and avoids damages of them (e.g.: decrease the maintenance and repair costs).

If PPWM succeeds to increase the tipping fee, it shall increase the payment to the contractor and ask to increase the number of landfill equipment for proper operation.

##### a.2 Plan and Control of Landfill Operation

Even if PPWM secure the budget for proper operation, a good access could not be achieved without proper plan and control of landfill operation as far as PPWM entrusts the landfill operation to the private contractor. PPWM, therefore, needs to make a daily, weekly and monthly plan for proper operation to instruct and control the private contractor. Then based on the plans PPWM shall control and supervise its operation contractor considering the following aspects:

---

<sup>1</sup> Normally a bulldozer does not operate continuously. 12 hours continuous operation, therefore, means 24 hours normal operation.

- Maintain the access (on-site roads and working faces) for collection vehicles higher than the surrounding area in order to avoid impact of the rain water
- Secure drainage of rain water for the on-site roads and working faces
- Conduct frequent maintenance and repair of the access according to the instruction of the PPWM

**b. Control of SMCDS**

The PPWM is the owner of the SMCDS and has responsibility for the following aspects:

- Overall management of the landfill
- Security of the landfill including measure to avoid theft of the property
- Landfill operation planning and instruction of operational works
- Control of the contractor on its landfill operation, the users of the landfill (incoming vehicles), waste pickers, visitors, etc.
- Supervision of landfill operation including watching from the watchtower
- Enforcement of the rule of the SMCDS such as control of open fires, improper operation and dumping, etc.
- Operation of weighbridge and leachate treatment facility
- Provision of electricity and water
- Provision of lights for night operation along the main road and working faces
- Maintenance of on-site roads, model block, enclosing bank, canal, etc.

In order to fulfill the above-mentioned responsibility, PPWM shall establish the Rule of the SMCDS based on the draft rule prepared by the Team.

**c. Excavation and Taking Out of Aged Waste**

There is a plan of taking out of disposed waste (aged waste) of at SMCDS to outside. The Team considered that the plan is very beneficial because it contributes to the extension of the use of SMCDS by providing extra landfill spaces and reduce the landfill operation cost by avoiding mounting up operation of waste. Therefore, the Team recommends PPWM to implement the plan but also request it to pay attentions on the following aspects:

- The excavation work shall be done in accordance with the order as shown in the Figure below. The first excavation area shall be number ① in the Figure. Then ② and ③. The number ④ shall be additional area in case it requires more aged wastes.
- The access road for the excavation site is recommended to apply the route as shown in the Figure. PPWM shall not allow the vehicle hauling aged wastes to use the main road to avoid mix traffic with collection vehicles. The route of the access road shall avoid the bank of leachate treatment ponds.
- PPWM shall not allow the excavation of aged wastes from the model block.

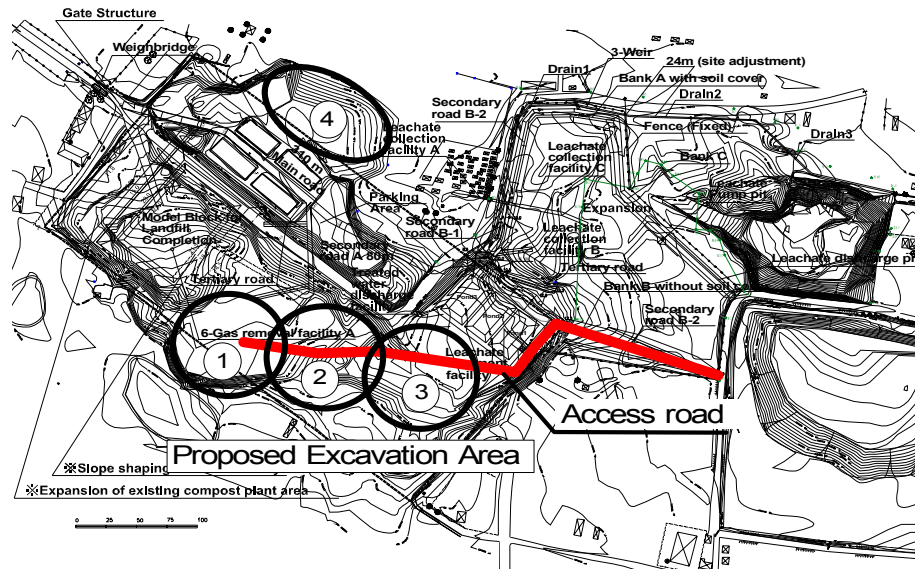


Figure 4-5: Propose Excavation Area of Aged Waste and Access Road

### 4.3 Improvement of Collection System

An improvement of the waste collection needed to realize the M/P is to establish the collection system for unserved or insufficient service area and to strengthen the collection capacity of the MPP/PPWM.

Most of the unserved area and insufficient service area is inaccessible area. The team conducted the pilot project to verify the practicability of the container collection system investing one skip loader truck and 10 of 5 m<sup>3</sup> containers and the fee collection system involving sangkat and phum offices in the 2<sup>nd</sup> phase study.

In the 3<sup>rd</sup> phase study, PPWM has conducted the pilot project to expand collection service to the unserved and insufficient service area by using the existing vehicles. Through his pilot project, PPWM practiced doing every kind of activities required for the service provider instead of CINTRI and continues now.

#### 4.3.1 Introduction of Container Collection System

##### a. Outline of improvement plan

##### a.1 Expansion of waste collection service using containers

Kongkea Pos and Boeung Salang (1 and 2 in Figure 4-6) are typical low income areas in Phnom Penh. There, the collection method combining primary collection by pushcart and secondary collection by container was attempted.

The Neighborhood Improvement Program (NIP) area in Khan Chamkar Mon is 800m east-west and 200m north-south. The northern half is part of Sangkat Bengkengkong 1 and the southern half is part of Bengkengkong 2. In the NIP area where primary collection is established, waste is collected by Self-Help Groups (SHGs) and brought to the recycling center for separation. However, as the recycling center is located near the northern end of the NIP area, the hauling distance from the southern end is long, approximately 1 km, and

low collection efficiency is a problem. Therefore, the study team tried to increase work efficiency by placing containers in the southern section, Bengkengkong 2 to reduce the haulage time of the SHGs. The team also placed containers along the canal running north-south in the eastern part of the NIP area in an attempt to reduce waste heaps and the dumping of waste in the canal.

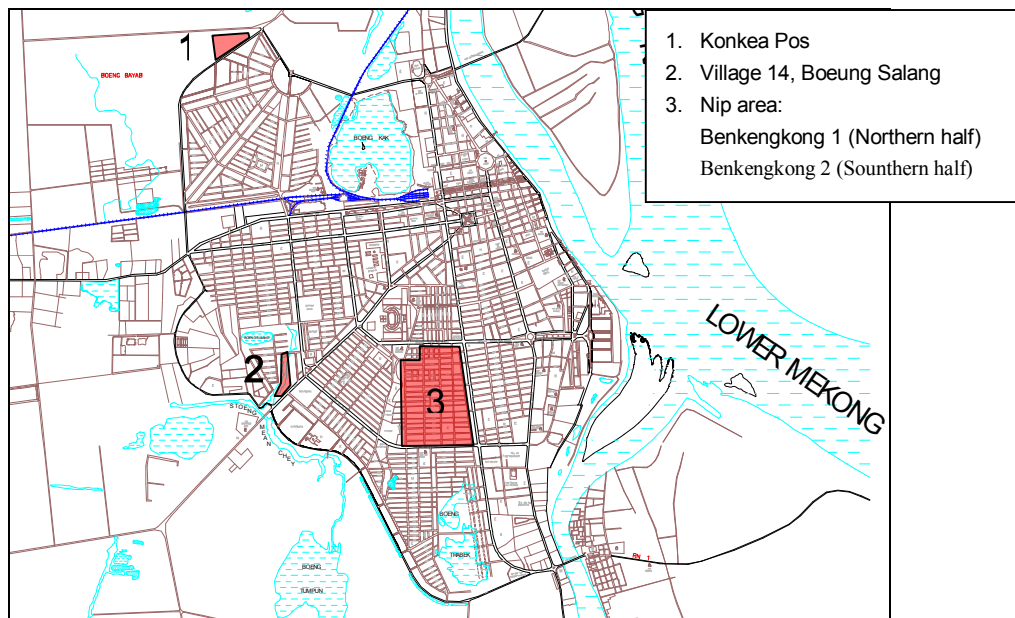


Figure 4-6: Location Map of target Area for Collection Trial

#### a.2 Separate collection

A trial of separate collection dividing compostable waste from non-compostable waste was carried out targeting the 200 households in Bengkengkong 2.

#### a.3 Establishment of fee collection system

A fee collection system by Sangkat was introduced in the Kongkea Pos and Boeung Salang areas where the waste collection service was newly provided.

Table 4-3: Outline of Target Areas of Trials

Target Area	Introduced Collection System	Description of Target Area
Konkea Pos, Sangkat Toul Sangke, Khan Russey Keo	Primary collection + container collection	Part of Sangkat Toul Sangke located on the outskirts of the northwestern part of the four urban khans. The households along route 598 receive CINTRI's waste collection service but the 263 households targeted in this improvement do not receive the service.
Village 14 in Boeung Salang, Khan Toul Kork	Primary collection + container collection	This village is part of Sangkat Boeung Salang adjacent to the new drainage canal. It is necessary to improve the narrow roads in order to carry out primary collection. There are approximately 113 household within the area.
Bengkengkong 1, 2 Khan Chamkar Mon	Primary collection + container collection	About half of the NIP area collection area under control of PPWM is targeted. 2,000 households are targeted.
Bengkengkong 2 Khan Chamkar Mon	Separate collection	One section of the NIP area collection area under PPWM's control. 200 households are targeted.

## **b. Findings**

### **b.1 Establishment of primary collection**

In the Kongkea Pos and Boeung Salang areas, as in many of the unserved areas, the alleyways and passages are narrow and unpaved, which make waste collection by pushcart difficult or impossible. The study team first conducted a survey in the area to measure the layout and width of the alleyways. They then carried out paving work including widening of some of the roads so that pushcarts could pass. The study provided material for the work, such as aggregate and cement, and the residents provided man power.

Table 4-4: Road improvement in the PP area

Target Area	Length of paving(m)
1. Kongkea Pos	884
2. Boeung Salang	528

For primary collection, three former waster pickers were organized into a Self Help Group (SHG) with the cooperation of CSARO, and they provided the collection service to the Kongkea Pos and Boeung Salang areas at a rate of 0.3US\$/household/month by direct contract with PPWM.

According to the questionnaire survey targeting the residents after the start of the trial, a large number of residents were satisfied. The payment rate of the fee, described later, in the first collection was 89% in Kongkea Pos and 82% in Boeung Salang, which is proof of their satisfaction.

### **b.2 Effectiveness of Container Collection**

By placing containers in the unserved area, the waste heaps disappeared and the view and foul odor in the surrounding area were improved. There was also a drastic decline in illegal dumping in the area. Furthermore, in addition to primary collection, there were also residents who directly brought their waste to the containers. Container collection proved to be an effective system for expanding the collection service to unserved areas that are difficult to access.

By placing containers in the NIP area, the hauling distance from the southern area was shortened, thereby reducing the work time of the SHGs. As for recycling, although the SHGs tried to recover valuable materials before loading waste into the containers and gather them at the recycling center, the amount of recovered valuables at the center decreased.

### **b.3 Placement of containers**

As for the placement of containers(5m<sup>3</sup>), based on the discharge rate of 487g/person/day and in consideration of the income level in the target area, one container per 340~440 households was planned. Soon after the collection began, the amount of waste discharged in both Kongkea Pos and Boeung Salang was greater than originally estimated. In Kongkea Pos in particular, one container was not sufficient so a second container was placed as an emergency measure. Three days later it went back to one container. The initial excess of waste was thought to be due to the fact that when the proper discharge site was provided nearby, the residents disposed of all the waste that had collected in their homes at once.

In the NIP area, at first the waste amount was as expected and the container system was going smoothly. However, a couple of weeks after the start of the trial, the waste amount increased and the containers were overflowing. The reason is thought to be because in the areas

surrounding the NIP area, waste is not collected by CINTRI three days a week, on Saturday, Sunday and Monday, and the uncollected waste is brought to the containers in the NIP area by small size trucks and bike carts.

#### **b.4 Problems with the container system and measures**

About two weeks after the start of the trial, the area surrounding the containers was littered with waste. This was due to the fact that the amount of waste transported from outside the target area was greater than expected and some of the residents did not properly place their waste in the container. As an emergency measure, the study team, through PPWM, requested the SHGs to keep the container area clean and requested the Sangkat to try to stop waste from being brought in from outside the target area. As a permanent measure, it is necessary to teach proper discharge practices through public education. Furthermore, container ownership is a problem, and it is necessary to examine community based activities to clean up the container area.

#### **b.5 Effectiveness of separate collection**

The discharged waste was assorted into two kinds, wet and dry. By introducing separate collection, the amount of compostable waste recovered per person per hour at the recycling centre was 7.6 times greater, and the amount of valuables recovered from the dry waste was 6.8 times greater. However, some of the households that used to give all their waste to the SHGs are now selling the valuable materials directly to recycling companies. Although this not desirable for the SHGs, in view of solid waste management as a whole, it can be said that citizens are now taking part in recycling activities.

#### **c. Fee collection system**

Regarding the fee collection system that was introduced, PPWM prepares the bills and the Sangkat collects the fees and pays PPWM. PPWM gives back 10% of the fees collected to the Sangkat to as a service charge.

In order to get the fee collection system started, the study team held a meeting for the Sangkat and community representatives to explain the system and the basis of the fee.

Before starting the collection trial, an explanatory meeting was held for the residents, and the residents understood that those who would receive the service had the make a service agreement with PPWM and pay the fee every month.

The first collection of fees was conducted in January 2004. As seen in the results shown in the table below, it appears that the consensus of most residents has been obtained.

Table 4-5: Results of Fee Collection (January 2004)

Target area	No. of households	Expected amount collected (US\$)	No. of households that paid	Actual amount collected (US\$)
Kongkea Pos	263	294	261(99.2%)	261.0(88.7%)
Boeung Salang	113	125	101(89.3%)	101.6(81.3%)

The average fee collection rate in subsequent half year was 82% as shown in the below figure. Therefore, this verified that the fee collection system with Sangkat was feasible.

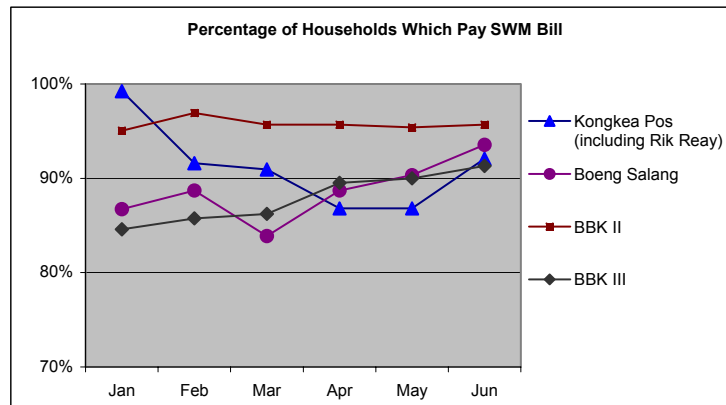


Figure 4-7: Fee collection rate

### 4.3.2 Collection Service Expansion

#### a. Outline of the Pilot Project

PPWM and the team selected 4 candidate sites in which unservices and insufficient service areas were located for the pilot project expanding the service based on the results of the pilot project conducted within the rural 3 Khans in the 2<sup>nd</sup> phase study. Subsequently, PPWM requested CINTRI to agree to conduct the pilot project in these three sites. But CINTRI proposed to exchange 4 Sangkats, where the selected candidates sites were located, for NIP area and Boeung salang area in which PPWM was continuing the pilot project from the 2<sup>nd</sup> phase study. Accordingly, MPP/PPWM agreed the CINTRI's proposal and could implement the pilot project to expanding service area.

#### a.1 Plan of Collection

##### (1) Pilot project area and customers targeted

The area of the pilot project, of which population is 88,902 in 2003 (7.4% of total population) is shown in the Figure 4-8.

The targeted customers will be the one who are receiving CINTRI's collection service as of now. PPWM and the Team collected the customer's data in the 4 Sangkats in cooperate with Sangkat office and Phum. According to the data collected, the targeted number of the customers is 6,314 as shown in the table below. Therefore, it is not confirmed whether these number of customers received the service given by CINTRI as of now.

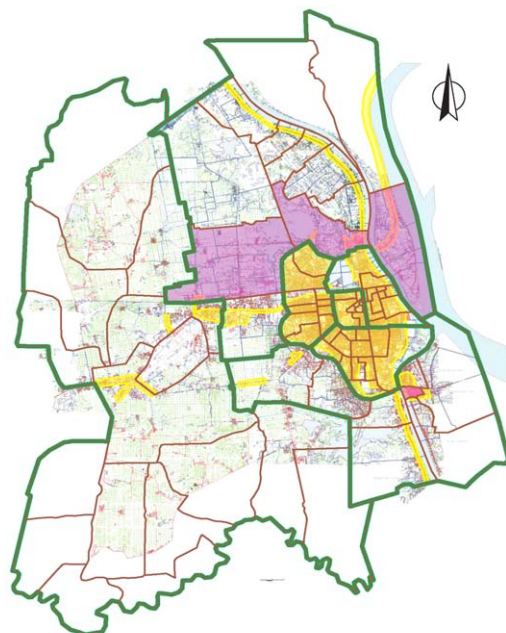


Figure 4-8: Pilot Project Area



Table 4-6: Area and Population of the Project area (in 2003)

Local Authority		Area	Population
Khan	Sangkat	(Km <sup>2</sup> )	(Person)
Mean Chey	Chbar Ampov Muoy	0.49	12,053
Russey Keo	Toul Sankae	2.76	30,773
Russey Keo	Phnom Penh Thmei	20.55	25,844
Russey Keo	Chrouy Changva	9.62	20,232
Total		33.42	88,902

Table 4-7: Number of Customers informed by Sangkats

		Chba Ampov 1	Chroy Changva	Phnom Penh Thmey	Toul Sangke	Total
Households	Total	1245	2465	3168	4159	11037
	Within Service Area	1150	1849	345	2074	5418
Restaurants	Total	9	49	7	17	82
	Within Service Area	9	24	3	10	46
Shops	Total	113	127	59	624	923
	Within Service Area	113	69	20	400	602
Offices	Total	4	2	9	1	16
	Within Service Area	4	2	3	1	10
Accommodation Facilities	Total		50	24	651	725
	Within Service Area		21	10	194	225
Factories	Total		2	18	33	53
	Within Service Area			3	4	7
Markets	Total		2	1	2	5
	Within Service Area			1	1	2
Medical Facilities	Total		1			1
	Within Service Area					-
Schools	Total		13	5	4	22
	Within Service Area			2		2
Public Facilities	Total		3	1		4
	Within Service Area					-
TOTAL	Total					
	Within Service Area					6,314

Upper: Whole sum, Lower: CINTRI service receiver

## (2) Targeted collection amount

Targeted collection amount was estimated based on the number and kind of customers informed by Sangkats.

Table 4-8: Targeted Collection Amount in the Service Area

Customer Type	Chba Ampov I	Chroy Changva	Phnom Penh Thmey	Toul Sangke	4 Sangkats Total
Household	3.22	5.18	0.97	5.81	15.17
Restaurant	0.14	0.77	0.05	0.32	1.28
Shop	0.51	0.31	0.09	1.80	2.71
Office	0.01	0.01	0.01	0.00	0.04
Accommodation Facility	0.00	0.07	0.04	0.68	0.79
Factory	0.06		1.50	2.72	4.28
Market			0.60	3.00	3.60
Medical Facility					
School			0.15		0.15
Public Facility					
Total	3.95	6.34	3.40	14.33	28.02

### (3) Collection vehicles owned by PPWM

PPWM has four types of collection vehicles, 4 Compacter trucks, 1 skip loader and 10 communal containers (5m<sup>3</sup>).



Skip loader truck with 5m<sup>3</sup> container



Compacter truck 4m<sup>3</sup>



Compacter truck 18m<sup>3</sup>



Compacter truck 4.5m<sup>3</sup>

Figure 4-9: Collection Vehicles owned by PPWM

### (4) 1<sup>st</sup> Collection plan

A frequency of collection service is planned as 3 days a week for residential area and everyday for commercial area basically. Assuming the type of vehicles and number of trips, PPWM and the team estimated the maximum collection capacity as Table 4-9. However, the

targeted collection amount is comparatively smaller than this capacity, it considered the breakdown, traffic accident, increased waste in the festival, new customers and expansion of the service area.

Table 4-9: Collection Capacity of PPWM

Area	Vehicle	Vehicle Capacity	Collection Plan	Collection Capacity
		Ton/trip	trip/day	ton/day
Tuol Sangke	Compactor Daewoo (01)	9.6	2	19.2
	Skip Loader (05)	1.2	6	7.2
Chbar Ampov I	Compactor hiroshima (03)	2	3	6
Chroy Changwar	Compactor Laterday (02)	2.7	2	5.4
	Compactor hiroshima (03)	2	1	2
Phnom Penh Thmey	Compactor hiroshima (04)	2	2	4
TOTAL			16	43.8

### (5) Implementation Schedule

According to the agreement with CINTRI, commencement of the service for 4 Sangkats was set on the 15<sup>th</sup> of September, 2004. PPWM had a explanatory meeting with Sangkat and its people, made the service agreement with the customers, employed new driver and workers and trained them before the commencement.

Table 4-10: Implementation Schedule

Items	Jul.	Aug.	Sep.	Oct.
Agreement between MPP and CINTRI		■		
Customer Data Collection	■■■■■■■■■■			
Detail Collection Planning	■■■■■■■■■■			
Agreement with Sangkat		■■■■■■■■■■		
Service agreement with Customers		■■■■■■■■■■	■■■■■■■■■■	
Preparation of the vehicle depot		■■■■■■■■■■		
Preparation of the maintenance facility		■■■■■■■■■■		
Recruit new staffs		■■■■■■■■■■		
Purchase tools and materials		■■■■■■■■■■		
Training staff			■■■■■■■■■■	
Implementation of the collection service			■■■■■■■■■■	■■■■■■■■■■

#### a.2 Action taken by MPP/PPWM

##### (1) Secure the initial fund

PPWM and the team estimated 13,000 US dollar as a initial budget necessary for the first 6 weeks management to provide collection service to the 4 Sangkats. This amount included personnel expenses including new employees, training fee, maintenance cost and fuel etc. PPWM requested to allocate this budget, and MPP supplied this fund by September, 2004.

## (2) Secure the land for vehicle maintenance and depot

PPWM has 5 units of collection vehicles but does not have the maintenance facilities and depot. To provide a reliable collection service, these are indispensable.

Therefore, MPP/PPWM decided to park the collection vehicles in the Waste Pickers Multi Purpose Center (WPMPC) constructed by the JFPR project in the SMC disposal site temporarily for the moment and prepare the facilities in the open space next to the SMC disposal site office.

### b. Findings

#### b.1 Collection amount

PPWM has collected waste as shown in the below table within 2.5 month from September 15, 2004. The reason why the waste collected in Toul Sankea in September was large amount in spite of half month operation, illegal waste heaps were removed through the cleansing campaign conducted at the beginning of the service. And the collection amount in Chroy Changvar and Toul Sangkae facing to the river in November was large because of the water festival.

Collection amount in October was 32.2 ton per day, which exceeds the planned amount by 4 ton and this was equal to 74% of the current collection capacity of PPWM.

Table 4-11: Waste Amount Collected in 4 Sangkats (Weighbridge data)

Sangkat	September, 2004			October, 2004			November, 2004		
	trips	ton/m	ton/day	trips	ton/m	ton/day	trips	ton/m	ton/day
Toul Sangke	121	543.7	36.2	171	649.2	21.6	196	708.8	23.6
Chroy Changvar	38	99.4	6.6	58	158.2	5.3	58	597.7	19.9
Phnom Penh Thmey	14	34.3	2.3	28	65.2	2.2	15	57.5	1.9
Chbar Ampov 1	15	36.5	2.4	33	94.0	3.1	42	108.6	3.6
Total	188	713.9	47.6	290	966.6	32.2	311	1,472.6	49.1

Note: Collection service was started from the 15<sup>th</sup> of September

#### b.2 Management of collection equipment

2 compacter trucks out of 5, which are 18 m<sup>3</sup> and 4.5m<sup>3</sup> compacter trucks, broke down so frequent that the remaining 2 units of 4m<sup>3</sup> compacter trucks covered these troubles. However, it was expected situation because these two compacter trucks were old, but PPWM has been managing the vehicles well without stopping the service.

PPWM equipped all the vehicles with radio for emergency such as breakdown and accident, and established the communication system to give the instruction to change the collection route anytime.

However, the overage vehicles are big size, covering by small vehicle is not effective. Replacement of the collection vehicles is required urgently.

#### b.3 Number of customers and fee collection

The number of customers agreed with PPWM, contracted amount and the fee collected as of the end of November, 2004 are shown in the below table. PPWM explained the cause of low fee collection rate, which was about 58%, why the teamwork between PPWM and Sangkats

was not working smoothly and some customers did not pay the fee. PPWM will launch a public education campaign to raise the fee collection rate in cooperation with Sangkat office in December, 2004.

Table 4-12: Number of Customers, Contract Amount and Collected Amount (End of Nov. 2004)

	Agreement		Fee collected	
	Customers	US\$	Customers	US\$
Toul Sangke	2,301	4,338.50	1,334	2,094.90
Chroy Changvar	305	892.20	65	418.80
Phnom Penh Thmey	193	362.50	22	151.00
Chbar Ampov 1	1,052	1,471.25	811	1,192.50
Total	3,851	7,064.45	2,232	3,857.20

Data source: PPWM record issued on 8 Dec., 2004

#### b.4 Emergency measures

One traffic accident occurred within these 2.5 month operation. 18 m<sup>3</sup> compactor truck touched with a trailer truck on the 16<sup>th</sup> of November, 2004. However, 2 workers got a scratch, the compactor truck was not necessary to be repaired.

In this accident, the driver sent the workers to the hospital according to the emergency manual prepared by the team. Therefore, PPWM warned this driver to fire if he would cause an accident again.

## 4.4 Public Education Campaign

### 4.4.1 Outline of the project

#### a. Goals of the project

The project aimed at cleaning up the city, in particular the waste heaps in a typical residential area mixed with a commercial area with a high population density, by introducing waste discharge rules in cooperation with local authorities and residents. It was imperative for DOE to increase public awareness and promote public participation in order to introduce the discharge rules smoothly. Therefore, enhancing the capabilities of DOE to increase public awareness through PP was also an important purpose of the project.

#### b. Project Sites

Since the center of the city with a high population density has more serious problems, possible target areas were (1) a large-scale housing complex with a few hundred households or a group of apartments which share a common space as waste discharge points, (2) an area mixed with residences and small shops, and (3) a market area.

Based on these criteria, DOE selected several candidate sites, and the team chose a building block in Sangkat Monorom shown in Figure 4-10.

In addition, based on a request by CINTRI, an area in Sangkat Boeung Trabek, a typical residential area with one or two story houses in the suburb of Phnom Penh, was selected as

another project site. Before the pilot project, CINTRI collection workers faced problems caused by large waste heaps at the both sides of the bridge over the canal.

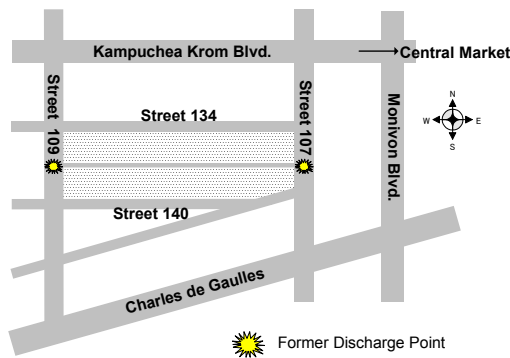


Figure 4-10: Project Site in Sangkat Monorom

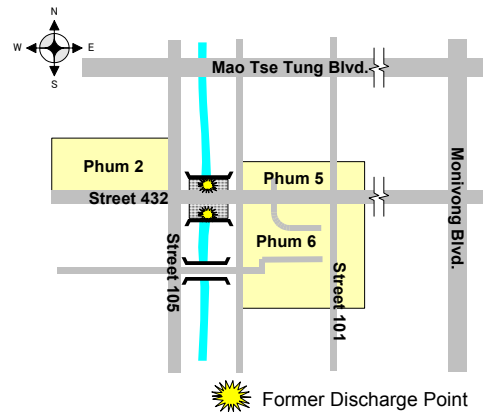


Figure 4-11: Project Site in Sangkat Boeung Trabek

### c. Consensus Building (Establishment of Working Group)

Ordinary Cambodian people are not familiar with basic social rules in general. Therefore, in order to introduce discharge rule smoothly it is necessary to build a broad consensus about discharge rules with local residents and business establishments and to spend enough time to make them understand the discharge rules clearly.

For the establishment of a broad consensus and close cooperation among all stakeholders, the team proposed to establish a working group including representatives of local residents and business as well as local authorities and CINTRI, so that all the stakeholders can meet regularly to exchange opinions and reflect their opinions in the discharge rules. The team asked environmental NGOs to participate in the process as observers.

Participants of the working group:

- JICA study team
- DOE (MPP)
- Collection service company (CINTRI)
- Local authorities of project sites
- Representatives of local residents and business establishments in the project sites
- Environmental NGOs

All the important issues such as the content of discharge rules were finalized at the working group meetings.

## 4.4.2 Findings

Many of the residents in the center of Phnom Penh, where waste is scattered and large waste heaps are often observed, want to clean their areas. Even though many of the local residents do not respect basic social rules such as traffic rules, it is possible to introduce discharge rules and to promote public participation in solid waste management if the benefit as well as the content of discharge rules can be shown clearly to local residents.

Key elements for successful results are examined in this section. Problems to be solved for the expansion of discharge rules to the whole city are also summarized.

**a. Key elements**

**a.1 Common awareness of problems**

It is important for all the stakeholders to have common awareness of the problems caused by bad waste management in order to introduce waste discharge rules smoothly. In the pilot project, through working group meetings and community meetings, DOE and the team could build a common awareness of solid waste management with local authorities and residents as well as CINTRI. Common awareness contributed to active participation and cooperation of local authorities and residents.

Visual presentation materials made based on video files shot during the observation survey had a significant effect on making local authorities and resident have common awareness.

**a.2 Strong leadership of local authorities**

In Monorom, the strong leadership of the Sangkat chief played an important role in the successful result. Under his leadership, Phum officials were actively involved in disseminating information on the newly established discharge rules to local residents and persuading them to participate in solid waste management. As a result, local residents were confident that other people would follow the rules and were therefore willing to follow the rules themselves.

It is imperative for DOE to establish close cooperation with Khans and Sangkats for expanding discharge rules to the whole city.

**a.3 Clear benefit**

For smooth implementation, it is very important for DOE to show the benefits of discharge rules clearly, as well as the concrete instructions on how to store and discharge waste.

The successful result of the pilot project could be utilized as an example to show the benefit of discharge rules when DOE expands the application of discharge rules to other parts of the city.

**b. Issues to be solved for the expansion of discharge rules**

**b.1 Disseminate information to the whole city**

In the pilot project, one of the criteria for selecting project sites was the willingness of local authorities to clean their districts. For the expansion of discharge rules, it is necessary for DOE to disseminate information about the pilot project at the Khan and Sangkat level, so that more Sangkats are willing to work with DOE to clean their areas.

DOE also has to make newly established waste discharge rules widely known in the whole city by active public relations activities through such media as TV, radio and newspaper.

**b.2 Ban on bringing waste out from the block of residence to other areas**

The results of the observation survey revealed that a lot of people regularly dumped waste at waste heaps, some distant from their houses, on their way to the office or shops. Even though the conditions of the pilot project sites were significantly improved, those who used to dump their waste probably continued to dump waste in the neighboring areas.

Therefore, it is necessary for DOE to prevent them from bringing waste to other areas outside of their block of residences. DOE should impose a ban on bringing waste from the location of their residence to other areas and make the ban known widely in the whole city.

### b.3 Dealing with street vendors

The observation survey also revealed that street vendors such as coconut and sugar cane sellers which move around the city discharged large amounts of waste at the waste heaps. At present, they discharge waste anywhere they want. Moreover, they dump waste directly on the ground. It is critical for DOE to control these street vendors for the expansion of waste discharge rules to the whole city.

## 4.5 Development and Promotion of Urban Waste Compost Market

### 4.5.1 Outline of the Study

The study team conducted the following activities.

Study Item	Description
1. Compositional analysis of compost	The composition (C/N ratio, pH, N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O <sub>5</sub> , impurities, glass, metals) of the compost produced by COMPED and CSARO was analyzed.
2. Market study	A market survey targeting 50 farmers from within a 20 mile radius of Phnom Penh (10 villages x 5 farmers) was conducted.
3. Field trials	Field trials (2 types) conducted by 3 farmers from Svay Rieng and 2 sites of IVY pilot farm under the instruction of IVY*, comparing the rice yields with and without compost
4. Field visits to observe field trials	Field visits were arranged for farmers from Svay Rieng and Phnom Penh to demonstrate the effects of compost, and lectures were held on basic knowledge of compost.
5. Production of promotional video	Promotional videos, leaflets and panels were made on compost production and the field trials

\* IVY : International Volunteers of Yamagata, an NGO based in Svay Rieng

### 4.5.2 Findings

Regarding the results of the compositional analysis of the urban waste compost produced by COMPED and CSARO in Phnom Penh, the pH and impurities exceeded the compost quality standards in Thailand. However, this can be dealt with by improving the compost production process. Therefore, the compost can be marketed.

The results of the field trials conducted in Svay Rieng demonstrated that the use of urban compost can increase rice yields. The study team made a promotional video showing the production process of compost and the field trials that were conducted. At the second seminar, the video will be shown to the participants along with a presentation of compost using panels in order to demonstrate the effectiveness of urban waste compost. The videos will be also lent out to NGOs producing urban waste compost to further promote its use.

The interview surveys conducted in the villages revealed that the farmers are well aware of the importance of organic fertilizer. However, the supply of compost is not steady so they have to rely on chemical fertilizers. This shows that if a system for providing a steady supply of compost at a reasonable price is established, there will be an increase in demand.



In the field trial, in order to produce 2,000 kg of rice, 50kg of chemical fertilizer and 10,000 kg of urban waste compost were required. The chemical fertilizer costs 900~1,200 riel/kg while the compost costs 200~500 riel/kg. Therefore, the investment to produce the same yield is 45 to 80 times greater for compost. Even taking into account the effect of soil improvement, if cost is not reduced to one tenth of the current amount, the farmers will have no choice but to rely on chemical fertilizers.

COMPED sells compost at 200 riel/kg to fruit farms and farmers who grow vegetables in the suburbs of Phnom Penh, while CSARO sells compost at 350 riel/kg for home gardens and horticulture. Although both are small scale markets, for limited purposes there is a demand. Therefore, although urban waste compost cannot compete with chemical fertilizers in terms of cost, a demand for high value crops can be expected.

## 4.6 Development of a Data Management System for SWM

### 4.6.1 Outline of development

The study team developed the data management system for SWM shown in the table below and conducted training for PPWM on operation of the system.

System development	Description
1. Management system for waste brought to disposal site	Development of a database of weighbridge data and a system that sums up and analyzes the data.
2. Fee Collection Management System	The Utility Billing System (UBS) used in the NIP area is improved so that it can be applied to other areas. The system includes a customer database and a function for printing out bills and receipts.
3. Management System for Waste Picker Registration	This system manages the personal information of waste pickers working at the SMC disposal site as well as prints out ID cards.
4. Web Site Development	A web page is developed on the MPP's web site as a source of information on SWM in Phnom Penh.

### 4.6.2 Findings

#### a. Incoming waste management system

The weights compiled from the weighbridge installed in Phase 1 of the study revealed that the SMC disposal site receives waste from approximately 160 vehicles per day, disposing of about 700 tons of waste. Furthermore, through this system, a data input system necessary for SWM was established by enabling data to be summed up by incoming vehicle, location and waste type.

#### b. Fee Collection Management System

PPWM is using the Utility Billing System (USB) developed by NORAD as its system for collecting fees. The USB is a database management system created in Clarion and its application is limited to the NIP area. Therefore, the Study Team modified the system so that it can be applied to Kongkea Pos, Village 14 and the 4 Sangkats received from CINTRI. At present, PPWM has a list of the customers in the trial area and two operators in charge of

printing out bills and receipts so that it can determine the amount to be collected and the actual amount collected.

However, in the event that PPWM develops a customer management system covering the entire population in the PPWM service area in the future, the UBS created in Clarion will have the following limitations:

1. As modifications to the system can only be carried out by system engineers familiar with Clarion software, it will not be possible to cope with such modifications nation-wide.
2. The UBS cannot be used on a network. Therefore, it will not be possible to update data and to print out the large quantity of bills and receipts in time to cope with the increasing number of customers in the future.
3. Because the data cannot be exported, it will not be possible to produce reports other than the ones printed by UBS. Furthermore, it will not be possible to exchange data with Sankgats in the future.

If PPWM is to expand its collection service to the unserved area in the rural area, it is advisable to compile the existing system on DB software which is versatile and widely used.

**c. Waste Picker Registration Management System**

In the trials to improve the SMC disposal site, the study team introduced a waste picker registration system and registered a total of 2,907 waste pickers. In developing the waste picker database, information such as the no. of waste picker households, the age distribution, the number of waste pickers residing in each area, and so on was obtained. In strengthening PPWM's collection system, this information can be used, with proper care, to organize the waste pickers for cleaning work or SHGs

**d. Web Site Development**

A SWM page was created on MPP's web site. Visitors can post their comments and opinions on the site. By making information on SWM open to the public and hearing comments from a wide variety of people, this page is expected to be useful in establishing a SWM system based on public participation.

## 5 Institutional Capacity Building (ICB)

### 5.1 Objective and Method

#### 5.1.1 Objective

In order to smoothly implement the M/P, the institutional capacity building (ICB) of the implementing agencies, i.e. PPWM, DPWT and DOE, for the management and operation of SWM services in Phnom Penh is essential.

Accordingly, the JICA study team implemented the above-mentioned ICB as described below.

#### 5.1.2 Method

The SWM system in the MPP is basically divided into a collection system (including public area cleaning) and a final disposal system. The management and operation of SWM activities in MPP are carried out by DPWT, DOE, and PPWM. However, the majority of collection and street cleaning services and the collection of fees for such services are conducted by a single private contractor.

Given such conditions, in order to strengthen the management and operational capabilities of DPWT, DOE, and PPWM, the Study implemented the following ICB program:

1. ICB through the implementation of pilot projects (PPs) :  
In order to provide OJT (on-the-job training) through the actual improvement of SWM services, PPs for the improvement of the collection and final disposal systems and public education campaign were made in collaboration with the C/P as PPs.
2. ICB through seminars, workshops, etc :  
ICB was implemented through explanatory meetings of various reports, weekly meetings, seminars and workshops and C/P training.

### 5.2 ICB through the Implementation of PP

#### 5.2.1 Improvement of the SMC Disposal Site

##### a. Contents of ICB

Planning for the improvement of SMC disposal site commenced in April 2003, and the improvement work was completed in September 2004. Through this improvement PP, ICB was conducted for the planning, operation and management of a final disposal system, as shown in the table below.

Table 5-1: ICB through PP for the Improvement of SMC Disposal Site

Category	Item	Description
Planning	Formulation of an improvement plan	<ul style="list-style-type: none"> <li>• Training in planning methodology was given through weekly meetings.</li> </ul>
	Preparations for implementation of the improvement plan	<ul style="list-style-type: none"> <li>• Negotiations were conducted to secure land for expansion of the disposal site.</li> <li>• Rule of the SMCDS was prepared and executed.</li> <li>• Contract of the operation of SMCDS was modified.</li> <li>• Construction work was supervised.</li> <li>• WP registration system was introduced.</li> </ul>
Operation	Formulation of an operational plan	<ul style="list-style-type: none"> <li>• Training in planning methodology was given through weekly meetings.</li> </ul>
	Implementation of the operational plan	<ul style="list-style-type: none"> <li>• A Daily Landfill Operation Plan was prepared.</li> <li>• Monitoring and control system of leachate was developed.</li> <li>• Instructions were given to collection vehicle drivers, heavy equipment operators and WP regarding the working face, and enforced.</li> </ul>
Management	Control of waste brought to the site	<ul style="list-style-type: none"> <li>• The incoming vehicles and waste were checked and controlled.</li> <li>• Incoming vehicles were weighed by weighbridge and the data was compiled.</li> <li>• On-site roads were maintained.</li> </ul>
	Operational control	<ul style="list-style-type: none"> <li>• Control of WPs.</li> <li>• Operation and maintenance of the working face.</li> </ul>

## b. Outcome and problems

### b.1 Outcome

The main outcome was that PPWM established a management system (preparation and execution of the rule of SMCDS, operation and maintenance of the working face, development of monitoring and control system of leachate, setting of site boundaries, registration and control of WP, etc.) to a certain degree for the SMC disposal site, which before the PP was simply an open dump with no rules or order. Furthermore, PPWM is making thorough implementation of the rule of SMCDS by canceling the contract with the former operation contractor due to the neglect of the rule.

In addition, a system for monitoring the incoming vehicles and waste using the weighbridge installed at the entrance was established. The type and amount of waste that is disposed of at the site as well as where it comes from and who brings it is recorded.

The management system was also strengthened in physical terms. The number of PPWM staff members operating the SMC disposal site was increased from one person before the PP to four people. Moreover, one of the two Deputy Governors of PPWM also took responsibility of the site operation. PPWM also assigned a staff member to its head office to manage the weighbridge data that it receives daily.

### b.2 Problems

Although a management system was established by PPWM to some degree, further ICB in respect to the following is needed to establish a final disposal system.

1. The further building up of human resources to establish a system for proper disposal, control of WP and environmental monitoring.
2. The strengthening of the operation and maintenance system of equipment and

vehicles in order to realize proper disposal.

3. The strengthening of an environmental monitoring system such as leachate control, etc.

## 5.2.2 Improvement of the Waste Collection System

### a. Contents of ICB

Improvement of the waste collection system was conducted with the primary aim of verifying the effectiveness of container collection and establishing the operational system to eliminate the areas in MPP where waste is not collected and/or the collection service is inadequate in the Phase 2 study. In the Phase 3 study, the study team and PPWM conducted the pilot project providing the collection service to the four Sangkats using the equipment PPWM owned presently to establish an integrated waste collection system including finding customers, the collection service, and fee collection. PPWM is still continuing these activities at present.

Table 5-2: ICB through PP for the Improvement of Waste Collection System

Category	Item	Description
Planning	Formulation of an improvement plan	<ul style="list-style-type: none"> <li>• Training in planning methodology through weekly meetings.</li> <li>• Public meetings were held, and the improvement plan was formulated reflecting the requests and comments of the residents.</li> <li>• A waste collection fee system was planned.</li> </ul>
	Preparation for implementation of the improvement plan	<ul style="list-style-type: none"> <li>• Primary collection workers were organized and contracts were negotiated.</li> <li>• Negotiations were held with Sangkat.</li> <li>• Beneficiaries of the collection service were registered and controlled.</li> <li>• A service agreement was signed with the beneficiaries of the collection service.</li> <li>• Public cleansing campaign was planned and held</li> </ul>
Operation	Formulation of operational plan	<ul style="list-style-type: none"> <li>• Training in planning methodology through weekly meetings.</li> <li>• Preparation and explanation of the action manual in an emergency</li> </ul>
	Implementation of operational plan	<ul style="list-style-type: none"> <li>• Preparation of collection route plan for collection vehicles and workers</li> <li>• Instructions were given to collection vehicle drivers and collection workers and strictly enforced.</li> <li>• An explanatory meeting on the collection routes and practical training were given to the drivers.</li> <li>• Collection and management of waste fee</li> </ul>
Management	Customer management (beneficiaries of collection service)	<ul style="list-style-type: none"> <li>• Establishment of the customer relation section and education and training of the staffs.</li> <li>• Signing and management of collection service agreements</li> <li>• Deal with public complaints</li> <li>• Preparation and update of customer lists</li> </ul>
	Operation and management	<ul style="list-style-type: none"> <li>• Operation and maintenance of collection vehicles and containers</li> <li>• Operation and maintenance of container site</li> <li>• Control of primary collection workers</li> </ul>

**b. Outcome and problems**

**b.1 Outcome**

The main outcome was that a system for collecting fees from the beneficiaries, a prerequisite to the provision of the collection service, was developed to a certain degree. In the fee collection system, PPWM makes a contract with the residents and prepares bills, and the Sangkat collects fees based on that.

In addition, the collection service by PPWM, which prior to the implementation of the PP was simply collecting waste and dumping it at the disposal site, extends to service quality; PPWN now deals with customer complaints, operates and maintains the container sites, manages the primary collection work, etc.

PPWM drivers and collection workers also maintain the vehicles and equipment (i.e. they inspect the equipment before starting work, wash the vehicles and containers, etc.), which was rarely done prior to the implementation of the PP.

**b.2 Problems**

Although PPWM has established a management system to some degree, in order to develop a collection system that will eliminate unserved and inadequately serviced areas, further ICB is required in respect to the following:

1. Further capacity building of PPWM staff in order to realize the expansion of the collection service proposed in the M/P
2. Strengthening of coordination with concerned persons (Sangkats, primary collection workers) required for the expansion of the collection service; that is, to expand and strengthen coordination among PPWM, DOE, Sangkats, and residents in order to carry out fee collection, update customer lists, and monitor the collection service.
3. Establishment of cooperation with the residents, the customers, in order to prevent the scattering of waste, operate and maintain the container sites, and eliminate free riders.
4. Urgent preparation of the maintenance facility for the equipment

**5.2.3 Public Education Campaign**

**a. Content of ICB**

As mentioned in the chapter of pilot project, DOE is the organization responsible for increasing public awareness and promoting public participation in MPP, but so far DOE has had no experience but a public campaign. In carrying out the campaign, DOE urged people to clean the city but did not provide specific instructions on how to discharge waste, consider how to promote public participation, or examine modifying the collection system. As a result, the campaign ended without a significant achievement.

Through the pilot project, DOE was expected to gain the knowledge and skills to solve such problems as scattered waste on the street and odor caused by waste by introducing the simple waste discharge rules. The outline of the pilot project from the ICB point of view is shown below.

Table 5-3: ICB through PP for Public Education Campaign

Category	Item	Description
Planning	Formulation of a basic strategy and a plan	<ul style="list-style-type: none"> <li>• To conduct baseline surveys and analyze causes of problems</li> <li>• To organize meetings with other stakeholders and make a broad consensus with them</li> <li>• To decide basic strategies and approaches in cooperation with other stakeholders (making clear roles and responsibilities of each stakeholder)</li> <li>• To formulate the waste discharge rules while examining the appropriateness of current collection systems</li> </ul>
	Preparations for implementation of the plan	<ul style="list-style-type: none"> <li>• To prepare educational materials in cooperation with local authorities and collection service providers</li> <li>• To disseminate information</li> <li>• To give an instruction on how to store and discharge waste both to local authorities and residents</li> <li>• to give an instruction to collection service providers if necessary</li> </ul>
Implementation in the project sites	Implementation of discharge rules	<ul style="list-style-type: none"> <li>• To monitor the behaviors of residents and passersby</li> <li>• to monitor the activities of waste collection service providers</li> <li>• to give an instruction if necessary</li> <li>• to modified discharge rules if necessary</li> </ul>

**b. Outcome and issues to be solved**

**b.1 Outcome**

Through the pilot project, DOE realized the importance of the waste discharge rules, though the discharge rules applied in the pilot project were minimum rules for the proper solid waste management. DOE obtained the know-how to formulate simple discharge rules in cooperation with other stakeholders, disseminate information, and educate local residents and business establishments.

DOE initiated the similar project in other areas in Phnom Penh, referring to this pilot project, with funding from ADB and UNDP. In addition, DOE sought the budget from the SEILA program to expand the waste discharge rules.

**b.2 Issues to be solved**

**(1) Further cooperation with local authorities and collection service providers**

It is urgent for DOE to expand the discharge rules to the whole city. However, the budget and staff of DOE is limited, and it is very difficult to realize it by itself. The close cooperation with local authorities is one of key elements for the successful implementation of the waste discharge rules. DOE staffs, who are assigned to each Khan office, are expected to take a leading role in expanding the discharge rules to the whole city.

In addition, the result of PP showed that the waste discharge rules improved the collection efficiency to a considerable degree. Before the pilot project, there had been little cooperation between DOE and CINTRI. Even though they started discussion about the discharge rules during the pilot project, it is preferable that CINTRI be involved in the waste education activities further. It is necessary for MPP to clarify the roles and responsibilities of collection service providers in the waste education program.

**(2) Disseminate information to the whole city**

The result of pilot project showed that it was not difficult to ask local residents for their cooperation to implement discharge rules. It is, however, very difficult to control the activities of passersby and street vendors that are moving around the city. It is necessary for DOE to make newly established waste discharge rules widely known in the whole city by active public relations activities through such media as TV, radio and newspaper.

**(3) Necessity to increase public awareness further**

As mentioned above, the waste discharge rules applied in the pilot project were the minimum rules necessary to keep their houses and surrounding area clean. At present, many of residents care the cleanness of their houses and adjacent areas, but are not willing to clean the public space. As a result, it seems difficult to keep a communal collection system properly because there is no guarantee to keep the communal discharge points clean, and local residents near the communal discharge points are strongly against this collection system. Even though the cost of communal collection system is low, it is difficult to obtain the consensus of local residents to introduce the communal collection system. In addition, the separate collection system and more sophisticated rules will be necessary in the future. DOE has to take an effort to increase the public awareness further.

**5.2.4 Establishment of Regular Monitoring System (under PP for the improvement of SMC disposal site)**

Before the pilot project for the improvement of SMCDS, MOE/DOE had never conducted the environmental monitoring at the SMC disposal site. The regular environment monitoring by the regulatory organizations is indispensable for the proper pollution control.

On the other hand, in the development plan of the DK disposal site, the team proposed to organize the monitoring committee to control the operation of PPWM. In order to guarantee the regular monitoring by the monitoring committee at the DK disposal site, MOE/DOE should start to prepare for the regular monitoring system now. Therefore, under the pilot project for the improvement of SMCDS, the team decided to support MOE/DOE to initiate the regular monitoring system at the SMC disposal site.

Due to the lack of the budget, it is almost impossible for MOE/DOE to start the same regular monitoring system as the development plan proposed. The team decided to exclude some monitoring items which are not affordable for MOE and DOE. Even though the newly established regular monitoring system is primitive, MOE and DOE could accumulate knowledge and experience through the regular monitoring which includes such tasks as sampling, analysis, data compiling, and data analysis.

**5.3 ICB through seminars, workshops, etc.**

The ICB through seminars and workshops is summarized in the table below.



Table 5-4: ICB through seminars, workshops, etc.

Item	Sub-item	Period	Contents	Participants
Group training	C/P Training in Laos (Vientiane)	29/09/03 - 03/10/03	Understanding of the valuable recommendations made in the M/P (public container collection system, fee collection and customer management system, system for operation of final disposal site and management of incoming waste, etc.)	A total of 9 participants from MOE, MPP, DPWT, DOE, and PPWM
	Group Training Workshop in Cambodia	29/12/03 - 02/01/04	A workshop was held to disseminate the results of the study throughout the country. The aim was to help the concerned persons from local government to obtain the knowledge and information required to formulate a SWM M/P	29 participants from provincial cities, 16 from MPP, and 6 from central government agencies
		13/09/04 - 17/09/04	A workshop was held to disseminate the results of the study throughout the country. The aim was to help the concerned persons from local government to obtain the knowledge and information for the proper operation of SWM services	31 participants from provincial cities, 14 from MPP, and 4 from central government agencies
Technology transfer seminars/workshops	Technology transfer seminar	06/10/03	Explanation of the contents of the SWM Master Plan (Draft). Confirmation of the priority projects. Confirmation of the contents of the pilot projects.	A total of 55 participants, 38 related to MPP, 2 from central government agencies, 1 from an NGO, 4 from international organizations, 2 from the private sector, and 8 from the media.
		26/05/04	Explanation of the contents of the SWM Master Plan and the results of the F/S.	A total of 66 participants, 38 related to MPP, 9 from central government agencies, 12 from NGOs, 1 from the private sector, and 6 from the media.
		18/01/05	Dissemination of the results of the Study and formulation of a consensus among the stakeholders regarding smooth implementation of the M/P	A total of 97 participants, 31 related to MPP, 9 from central government agencies, 23 from NGO, 14 from the private sector, and 20 from the media.
	Workshop to promote the 3Rs	08/01/04 - 09/01/04	As a first step in raising public awareness of the 3Rs, knowledge and information on SWM and the 3Rs are provided to NGOs and government organizations which will play a leading role.	A total of 41 participants, 14 from NGOs, 8 from central government agencies, and 19 from MPP.
Explanation/discussions	IC/R	25/02/03 - 10/03/03	Explanation and discussions of the objectives, methodology, etc. of the study	A total of 33 participants.
	P/R (1)	03/07/02	Explanation and discussions of the concept of the M/P, F/S, and PP.	A total of 41 participants.
	IT/R	23/09/03	Explanation and discussions of the M/P (Draft) and PP (Draft).	A total of 33 participants.

Item	Sub-item	Period	Contents	Participants
	P/R (2)	13/01/04	Explanation and discussions of the method for continuing the F/S (Draft) and PP.	A total of 30 participants
	DF/R (1)	25/05/04	Explanation and discussions of the contents of the SWM M/P and the results of the F/S.	A total of 40 participants
	P/R (3)	27/07/04	Explanation and discussions of the contents of modified SWM M/P and F/S.	A total of 35 participants
	Overall weekly meetings	28/02/03 - 27/06/03 - 03/10/03 - 16/01/04 - 21/05/04 - 23/07/04 - 06/09/04 - 08/10/04 -	Explanation and discussions of the schedule, work, objectives and contents of the study.	5-10 C/P staff (DPWT, PPWM, DOE)
	SMCDS weekly meetings	12/10/03 - 12/01/04 - 24/05/04 - 26/07/04 - 06/09/04 - 04/10/04 -	Explanation and discussions of the schedule, work, objectives and contents of the study.	2-8 C/P staff
Surveys of existing conditions	Waste amount and composition survey	23/03/03 - 30/03/03 - 21/10/03 - 28/10/03 -	Explanation and discussions of the schedule, work, objectives and contents of the survey; implementation of field survey (sampling method, analysis method); data management/analysis.	2-3 C/P staff
	T&M survey	24/03/03 - 06/04/03 - 12/11/03 - 16/11/03 - 01/12/03 - 08/12/03 -	Preparations for survey (arrangement of collection vehicles data, classification of collection systems), implementation of survey, arrangement/analysis of survey results	2 C/P staff
	Water quality survey	23/04/03 28/11/03	Explanation and discussions of the schedule, work, objectives and contents of the survey, field survey (training in sampling method)	1-2 C/P staff
Explanatory meetings for residents	1 <sup>st</sup> public hearing	20/10/03	Explanation of the Dang Kor Disposal Site Development Project (Draft 1) and the EIA survey followed by a Q&A session,	Approx. 96 participants including C/P, MPP, PPWM, Khans, Sangkats, and local residents
	2 <sup>nd</sup> public hearing	25/12/03	Explanation of the Dang Kor Disposal Site Development Project (Draft 2) and the results of the EIA survey followed by a Q&A session.	Approx. 379 participants including C/P, MPP, PPWM, MOE, Khans, Sangkats, and local residents
	3 <sup>rd</sup> public hearing	15/07/04	Explanation of the Dang Kor Disposal Site Development Project (Draft 3) and the results of the EIA survey followed by a Q&A session.	Approx. 352 participants including C/P, MPP, PPWM, MOE, Khans, Sangkats, and local residents

## **6 Feasibility Study**

### **6.1 Selection of Priority Project**

The following three projects were selected as priority projects to be implemented urgently in the first phase of the Master Plan, considering their urgency, financial circumstances and project effects, and feasibility studies were conducted.

- Dank Kor Disposal Site Development Plan
- Waste Collection Service Expansion Project
- SMCDS Closure Project

### **6.2 Dang Kor Disposal Site Development Project**

#### **6.2.1 Design Concept**

The development plan aims to construct a disposal site with a capacity of more than six years in an area of 31.4 ha, which was secured by MPP for Phase 1 of the development plan of the new disposal site. The Dang Kor disposal site will be the first sanitary landfill site with leachate treatment systems and other pollution control facilities in Cambodia.

The team decided to include the following facilities in the development plan in consultation with the C/P.

- Administration Section (PPWM office, the weighbridge facility, and so on)
- Landfill Section and Leachate Treatment Facilities
- Compost Plant (target of organic waste is market waste)
- Maintenance Workshop and Vehicle Depot (for collection vehicles and landfill equipment)

#### **6.2.2 Natural Environment of the Project Site in Dang Kor**

The climate in Dang Kor, where the new disposal site is proposed, is influenced by the south-west and north-east monsoons. The hottest month is April and the coldest is January, and 70% of annual rainfall occurs from May to October. Most of the project site is paddies and fields with some trees and several ponds. There is no road in the project site but national route 303 is located nearby. The ponds, except for the irrigation pond located at the western edge, are pools formed in the borrow pits. The main irrigation canal runs west to east and the branch is on the north side of the main canal in the project site.

The Prel Thnaot river, which is a tributary of the Bassac river, runs west to east in the south of the project site. The people living along this river use the river water for drinking. Most of the people living in the villages scattered in Khan Dang Kor use groundwater for drinking. The project site is located on the deluvial uplands extending to the western side of the Mekong river and covered with a layer of silty clay 10 to 15m thick. There seems to be few flora and fauna to be conserved because there is no forest.

### 6.2.3 Outline of Design

#### a. Design Conditions

##### a.1 Schedule

Phase 1 Landfill Area: operation starts in January 2007

Phase 2 Landfill Area: operation starts in January 2013

##### a.2 Expected disposal amount

The target waste of the landfill is all the municipal waste, except hazardous waste, collected from the entire city of Phnom Penh. The expected waste amount based on the Study Team's population projection to be disposed of at the DKDS after the start of its operation is shown in Table 6-1 below.

The disposal amount calculated based on the population projected by the National Institute of Statistics (NIS) turned out to be approximately 110,000 tons (4.5%) more in the Phase 1 operation than that calculated by the Study Team. That is equivalent to the disposal amount for 3.3 months (about a 1.0m increase in landfill height with a landfill density of 0.8 tons/m<sup>3</sup>), which would have little impact on the landfill plan as a whole.

Table 6-1: Expected Disposal Amount

Year	Waste Amount Disposed of at DKDS	
	Yearly Amount (tons/year)	Accumulated Amount (ton)
2007	337,151	337,151
2008	361,350	698,501
2009	388,616	1,087,117
2010	416,319	1,503,436
2011	439,825	1,943,261
2012	474,938	2,418,199
2013	498,955	2,917,154
2014	524,688	3,441,842
2015	561,991	4,003,833

#### b. Facilities Installment Plan

The layout of the facilities and their allotted areas is shown below.

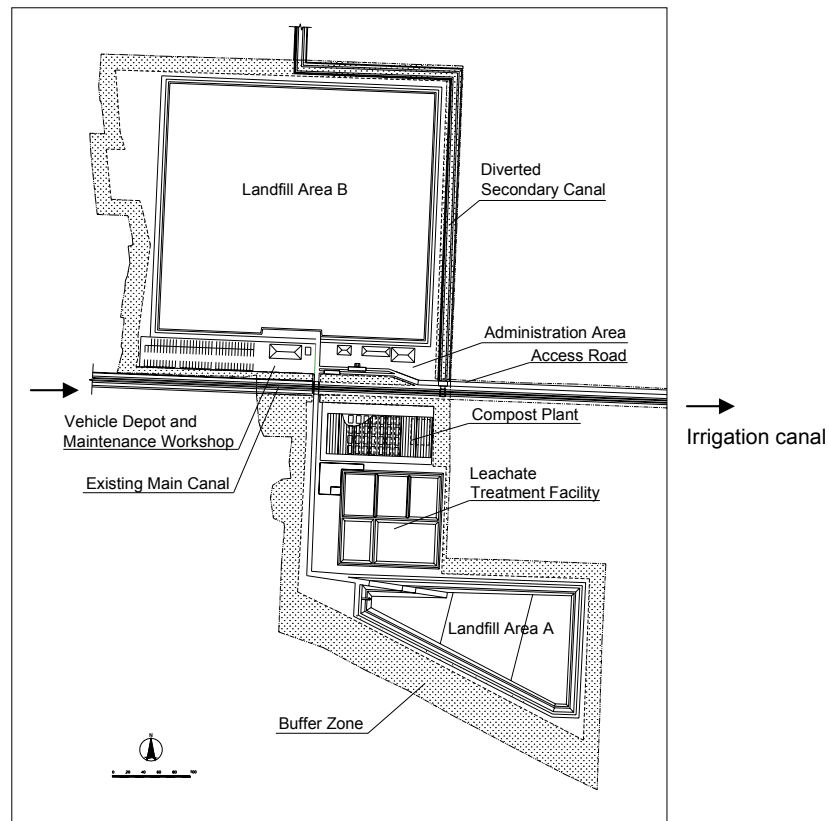


Figure 6-1: Layout Plan of Dang Kor Disposal Site (Phase1)

In order to maximize the area of the landfill section, the areas of other facilities are minimized. The area allotted for the landfill section is around 23.5ha, and the landfill capacity is designed to be 2.3 million m<sup>3</sup> by applying the enclosing bank and divider together.

As mentioned in section 1.2, these facilities are designed based on the results of the geological survey conducted in Phase 2 of the study. Therefore, an additional geological survey should be done for designing the landfill area, administration buildings, vehicle depot and maintenance workshop, which are located on the northern side of the irrigation canal.

Table 6-2: Area of Facilities

Facilities	Area (ha)
Administration Area	0.7
Landfill and leachate treatment facilities	17.0
Compost plant	1.1
Maintenance workshop and Vehicle depot	1.2
Others (Buffer zone etc.)	11.4
Total	31.4

**c. Equipment Plan**

The following equipment for landfill operation is arranged according to the plan.

Table 6-3: List of Landfill Equipment

	Equipment	Specification	Number	Use
1	Bulldozer	21ton	4	To level and compact waste
2	Wheel loader	1.2m3	1	To level waste and maintain on-site road
3	Water Tank truck	6,000 liter	1	To maintain on-site road and extinguish fire
4	Dump truck	11 ton	2	To transport soil
5	Pickup truck	4WD	2	To make a tour of on-site inspection
6	Excavator	0.7m3	2	To excavate soil and maintain drains

Daily inspection and minor repairs are done at the on-site maintenance workshop. Major repairs and overhauls are contracted out. The details of the maintenance workshop are shown in the maintenance plan of collection vehicles.

**d. Organization Structure and Management System**

The Landfill Operation Section under PPWM is in charge of disposal site management. The personnel of the disposal site is shown in the table below.

Table 6-4: Organization Structure of Landfill Operation section

Section	At present	2007	2012	2015
1. Section Chief	1	1	1	1
2. Engineer	-	1	1	1
3. Clerk	-	2	2	2
4. Truck scale operator	2	3	3	3
5. Supervisor	-	4	4	4
6. Operator	-	22	25	29
7. Worker	1	12	12	12
total	4	45	48	52

The proposed personnel for operation of the compost plant in 2007 are shown in the following table.

Table 6-5: Organizational Structure of Compost Plant

Section	Number
1. Section Chief	1
2. Clerk	1
3. Supervisor	2
4. Operator	2
5. Worker	25
Total	31

**e. Monitoring and Information Management System**

Monitoring of underground water, surface water, landfill gas, noise, subsidence, fire, odor and spillage of leachate is conducted at the locations shown in Figure 6.2. Measurements of heavy metals and hazardous substances are important in the monitoring, but these are costly. Considering the financial situation of MPP/PPWM, the team recommends only a few monitoring items such as pH, EC, Cl. Although measurement of these items is simple and cheap, PPWM will be able to detect the seepage of leachate because the concentrations of

these items change remarkably when leachate seeps into the water monitored. If a change is observed, PPWM should measure the water quality including heavy metals and take measures to deal with the situation quickly.

The frequency of the regular monitoring by DOE/PPWM is to be every month and that of the joint monitoring with the monitoring committee mentioned later is to be twice a year.

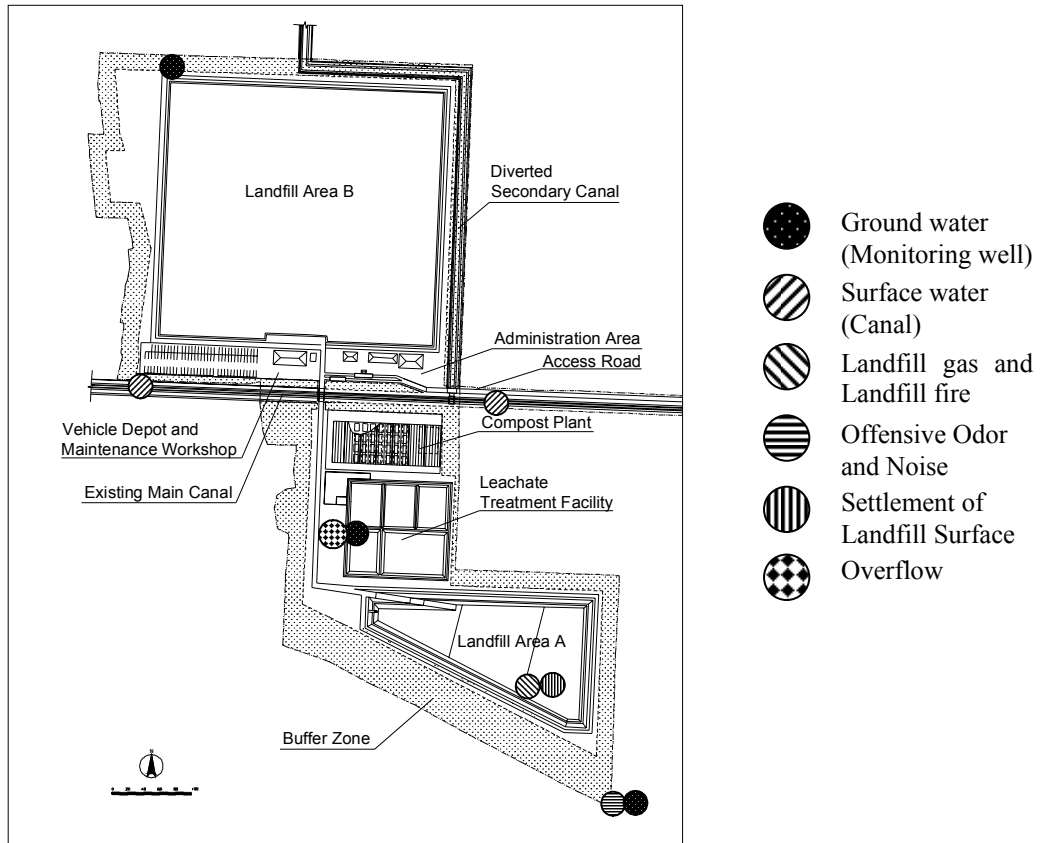


Figure 6-2: Monitoring Points

The monitoring items and stage are shown in the table below.

Table 6-6: Monitoring Plan of Dang Kor Disposal Site

Items	Facility and equipment	Measuring Items	Stage		
			Construction	Operation	Closure
Underground Water	Monitoring well	Electric conductivity, Cl <sup>-</sup> , pH		√	√
Surface Water	Water sampling	Electric conductivity, Cl <sup>-</sup> , pH		√	√
Landfill gas	Gas removal pipe	CH <sub>4</sub> , CO <sub>2</sub> , H <sub>2</sub> O, Temperature		√	√
Noise	Noise level meter	Odor, Noise	√	√	
Settlement	Settlement board	Settlement level		√	√
Landfill fire	Personal check,	Landfill fire		√	√
Offensive odor	Personal check,	Offensive odor		√	√
Overflow	Personal check,	Overflow of the leachate treatment facility		√	√

### e.1 Monitoring Committee

In order to strengthen the monitoring system, a monitoring committee for SMC consisting of MPP, MOE, DOE, village development committee and NGOs is proposed. The monitoring committee will have the following functions.

- The committee members shall join in the monitoring and observe the environmental condition of the site and its surroundings.
- If the operation is suspected of having an effect on environmental conditions, the committee members shall be able to request a survey for it and be able to join on-site inspection.
- For proper operation of the disposal site, the committee shall hold discussions whenever necessary.

The details of monitoring and monitoring committee should be reviewed in the detailed design stage.

### f. Project Cost

The project cost including O&M, except the construction of the maintenance workshop, is expected to be as follows.

Table 6-7: Project Cost of Dang Kor Disposal Site Plan (1,000US\$)

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Administration Section	Investment	95	1,653	0	0	0	0	4	75	0	0	0	1,827
	O&M	0	0	132	132	132	132	137	134	192	139	139	1,269
Landfill Section	Investment	316	6,826	0	0	0	175	193	3,349	1,724	0	0	12,583
	O&M	0	0	486	468	468	468	508	498	506	521	632	4,555
Compost Plant	Investment	59	1,135	0	0	0	0	0	0	110	0	0	1,304
	O&M	0	0	56	56	56	56	62	58	61	63	63	531
Maintenance Workshop	Investment	76	1,498	0	0	0	0	0	0	0	0	0	1,574
	O&M	0	0	121	121	121	121	137	130	138	148	148	1,185
Total	Investment	546	11,112	0	0	0	175	197	3,424	1,834	0	0	17,288
	O&M	0	0	795	777	777	777	844	820	897	871	982	7,540

## 6.2.4 Project Evaluation

### a. Technical Evaluation

The result of soil tests revealed that the proposed disposal site is covered with a clay layer about 10m in depth, and that there is a sand layer with a permeability of  $1 \times 10^{-3}$  cm/s in the eastern part of the site, between 3-4 m in depth from the ground surface. The clay layer has a permeability of  $10^{-6}$  cm/s, which is low enough to stop leachate from penetrating into the underground water. (In Japan, clay liners must have a permeability of  $1 \times 10^{-6}$  cm/s and a thickness of 50cm or more as standard.) The landfill section is to be excavated to a depth of 9m to maximize the landfill capacity and to minimize the landfill operation cost by selling soil. However, there is a possible danger that the permeable layer under the bottom of the landfill area excavated may be expanded with a reduction of pressure and the leachate will consequently seep into the groundwater. Also, the sand layer mentioned above may be widely spread. Therefore, the study team recommends an additional geological survey be conducted



for the detailed design. There is concern that leachate will penetrate through the exposed section of the sand layer so it is to be completely covered with the clay mentioned above. This is adequate to stop the leachate from penetrating. The development plan makes the best use of the natural conditions of the site and succeeds in minimizing the project cost. However, in order to prevent cracking during construction, it is necessary to monitor the moisture content and check the thickness of the clay liner, etc.

Some of the residents living around the proposed disposal site filter and boil the river water and use it for drinking water. Therefore, the treated leachate cannot be discharged into the river. In order to deal with this, the leachate will be treated by evapotranspiration in the dry season, and recirculated to the landfilled waste in the rainy season to promote decomposition. This is judged as a system that does not discharge leachate outside the disposal site. In addition to this mitigation measure for leachate spillage, the landfill area is planned to be enclosed by a dike filled up to a height of 10.2 m above sea level, which is 30cm higher than the flood level recorded in the project site. Although we cannot conclude that it is a perfect plan against natural disasters, mitigation measures to dilute the leachate to a level satisfying the standard for effluent should be prepared to minimize the impact on the surrounding area.

The waste generation amount from 2007 to 2015, estimated based on the future population predicted by the Census Bureau, was 5% more on average than the amounts adopted in the Study. The landfill area developed in the first phase is to have a capacity of six years, from 2007 to 2012. If the population increases according to the estimates by the Census Bureau, the landfill capacity period will be shortened by 3.3 months. Hence, it will not affect the first phase implementation plan. However, in the second phase of development, it is necessary to continuously control the incoming waste amount and analyze the population survey data, while periodically checking for disparities with the plan. The development schedule should be modified accordingly.

## **b. Social Evaluation**

The social impacts that the new disposal site could have are summarized below.

### Negative Impact

- A rise in collection fee
- Loss of the source of income for some farmers in the proposed project site
- Loss of the source of income for waste pickers at the existing disposal site

In order to minimize the rise in the collection fee, the team proposed to sell excavated soil. In addition, the team suggests that the system of determining the collection fee be changed, by charging more to business establishments. This could ease the burden of households.

As a countermeasure to the loss of the source of income for farmers in the area of the new disposal site, the new disposal site could provide them with jobs such as work at the landfill section and the compost plant.

The basic approaches to deal with loss of the source of income for waste pickers are summarized in the evaluation of the project “Closure of the SMC Disposal Site” in chapter 6.4.3.

## **c. Environmental Evaluation**

### **c.1 Conclusion**

Based on the result of careful examination of the project, the environmental resources, the environmental impact analysis, the results of public participation, the environmental

mitigation measures, analysis of alternatives, the environmental management plan and the institutional capacity, it is expected that the negative impact of this development project on the environment can be controlled to be negligible. The breakdown of the conclusion for each aspect is as follows.

### **c.2 Project**

The Project is for the development of a new disposal site in Phnom Penh and the project owner is MPP. The Project is essential for proper SWM in Phnom Penh and to continue to provide SWM services to the citizens, as the existing disposal site, SMCDS, will be closed by the end of 2007. The implementation of the project will provide public benefit to Phnom Penh citizens and contribute to SWM and environmental conservation in Phnom Penh.

The Project covers all stages of development, i.e. the construction stage, operational stage and closure stage, with environmental consideration. The site location, size, and disposal methods were also determined giving adequate consideration to the environment. The environmental management plan is also well considered. In addition to countermeasures, the setting up of a monitoring committee for the Project and training for the staff are also planned.

### **c.3 EIA Procedure**

The Project is subject to an EIA in accordance with the Sub-decree on Environmental Impact Assessment Process in Cambodia. As required in this Sub-decree, first an IEE was conducted and submitted to MOE.

The EIA of the Project was carried out based on the result of the IEE, which covered the environmental items that had been authorized by MOE on July 16, 2003. To obtain the EIA approval, MPP, which is the project owner, filed the IEE and EIA by themselves and held three public hearings mentioned later. The MPP/PPWM carried out their responsibility to explain the project to the stakeholders particularly in the third public hearing. The study team supported MPP to get EIA approval through execution of the environmental survey and preparation of the draft development plan, which were difficult for MPP to do on its own.

### **c.4 Public participation (Public hearings)**

As a part of the EIA survey, public hearings were organized three times. The outline of these public hearings is summarized as follows.

#### **c.4.1. Outline of public hearings**

##### **(1) Objective**

The main purpose of the public hearings was to build a consensus with all the stakeholders.

The first hearing was arranged before the start of the EIA survey. To reflect the opinions and comments from participants in the EIA survey plan and the final development plan was also an important objective.

##### **(2) Main target areas and participants of public hearings**

The following three areas were selected as possibly most affected areas: the area within a radius of 1km from the center of the planned disposal site, along National Road 303, and along the middle part of the Prek Thnot river basin. (In the lowest reaches of the river, river water is not utilized for drinking or domestic water.) In the area within a radius of 1km from the planned disposal site, all the households were regarded as stakeholders, while only local authorities were invited from the two other areas.

From the first public hearing, all the households located inside the circle were supposed to be invited to the public hearings. However, C/P insisted on the importance of informing all the Sangkats and Phums in Khan Dang Kor first and that they should be invited to the first public hearing. In the end, all the Sangkats and Phums were invited, while only representatives (leaders of housing group) of local residents, not all the households, were invited due to the limited space of the place of meeting.

Waste pickers working at the SMC disposal site were not invited to the public hearings because it was almost impossible to organize them due to the lack of representative organizations. Instead, the social environmental survey in the first phase tried to obtain their opinion and future plan after the closure of the disposal site. In addition, PPWM and the team organized a meeting inviting NGOs and community leaders that were actively involved in waste picker issues, to exchange opinions on how to support waste pickers in finding alternative jobs. It is necessary for MPP/PPWM to arrange this kind of meeting regularly from now on and to establish a mechanism through which waste pickers can contact PPWM easily.

#### **c.4.2. Follow-up survey**

Although the question and answer sessions at each public hearing were active, it was expected that many of the local authorities and residents had difficulties in understanding the content of the presentations due to their limited knowledge on solid waste management, and that some participants hesitated to express opinions in front of authorities. Therefore, the team conducted a follow-up survey after each public hearing in order to check their level of understanding of the presentations and to obtain their opinions and comments on the development plan.

The details of three public hearing and the result of three follow-up surveys are shown in Annex 15 (1<sup>st</sup> and 2<sup>nd</sup> hearing) and Annex 18 (3<sup>rd</sup> hearing) of the Supporting Report.

#### **c.4.3. Issues to be solved**

Three public hearings were arranged in order to build consensus with the stakeholders and reflect their comments and questions in the project plan. Public hearings provided opportunities for both the project owners and local authorities and residents to exchange opinions, but due to the limited knowledge of local authorities, residents and NGOs on solid waste management, some participants could not fully understand the presentations at the public hearings, as shown in the result of the follow-up surveys after each of the three public hearings. It is necessary for MPP/PPWM to continue to make an effort to deepen their knowledge on solid waste management and understanding of the development plan.

The development of visual educational materials about waste management for beginners is one possible measure. (A sample of educational material to explain what kind of place final disposal sites are has already been developed.) The presentation method and style should be also improved. One possible idea is for PPWM and MPP staff to visit each village and organize a small meeting to provide necessary information with developed educational materials before the development plan is finalized.

#### **c.5 Capacity of the project owner**

The project owner is MPP. The organizations under MPP responsible for the operation and monitoring of each project are PPWM and DOE. In order to strengthen the capacity of PPWM and DOE staff for implementing projects, they are receiving training through the pilot project for the improvement of SMCDS conducted by the JICA Study Team.

## **c.6 Items that require special consideration**

As a result, the impact of the Project on the surrounding environment is expected to be negligible or diminished through mitigation measures. However, special consideration will be needed for the following items.

### **c.6.1. Proper implementation**

Even if the proposed landfill is planned, designed, and constructed as a sanitary landfill, monitoring of the landfill operation and closure is essential to securing an environmentally sound landfill operation. Therefore, during the construction, operation and closure stage, monitoring should be carried out regularly for surface water/ground water contamination, offensive odor, and landfill fires.

In order to establish a monitoring system, a monitoring committee for the Project is proposed. The committee members shall join in the monitoring and observe the environmental condition of the site and its surroundings.

The committee may include:

- MPP
- MoE
- DoE
- NGOs
- Representatives from local authorities and residents

As for the interval of monitoring, internal monitoring by PPWM shall be done every month, and monitoring by the monitoring committee shall be carried out twice a year.

### **c.6.2. Road improvement**

Based on the waste collection and transportation system in the M/P, the collection vehicles will make a total of 322 trips per day in 2007, which is not such a large number. However, the current road conditions are bad because it is unpaved. The following environmental items would be seriously affected.

- Noise
- Traffic jams
- Air pollution

As for countermeasures, the most effective countermeasure is to pave the road. The ADB will implement the “Mekong Tourism Development Project”. In this project, National Road 303 will be paved in order to create better access from the center of Phnom Penh to the Killing Field Memorial. The section of the road from there to the entrance of the proposed disposal site is also to be paved in the Project. Therefore, noise, traffic jams and air pollution will be negligible.

### **c.6.3. Measures for the landowners lost their land for the project**

The landowners will lose their land being used as a paddy field for the project. They are allowed to cultivate it until the construction is commenced but not after development. Therefore, MPP is requested to prepare jobs such as construction workers during the construction stage and landfill workers in the operation stage.

## **d. Financial and Economic Appraisal**

### **d.1 Outline of the Project**

The Stung Mean Chey disposal site, which is currently used for the final disposal of MSW collected in Phnom Penh, is going to end its life shortly. A new final disposal landfill needs to be developed within the coming few years.

Responding to this, the M/P formulated a project on the development and operation of a new final disposal site with 100ha of land in Khan Dang Kor for 20 years from 2007. The Study here analyzes the financial and economic viability of the 31.4 ha of the development project as the first phase of this new final disposal site.

## d.2 Financial Appraisal

### d.2.1. Preconditions of financial appraisal

The financial appraisal here is made based on the following preconditions.

Table 6-8: Preconditions of the Project for Financial Appraisal

Project Implementation Body	Phnom Penh Waste Management Authority (PPWM)
Project Period	11 years from 2005 to 2015 (The period of landfill operation itself is set at 20 years.)
Project Income	<ul style="list-style-type: none"> <li>The collection of tipping fees on a weight-based rate system from the service users from 2007 to 2015 (Fee collection efficiency is set at 100%).</li> <li>Income from selling the excavated soil (An average annual income of 279,000 US dollars is assumed to be earned during its operation period from 2007 to 2015.).</li> <li>Income from selling compost materials produced in the compost plant at the rate of 200 riels per kilogram (An average annual income of 61,250 US dollars is assumed during its operation period from 2007 to 2015.).</li> </ul>
Investment Cost	The following initial investment will be made from 2005 to 2006. 2004: Land purchase (31.4ha) 2005 and 2006: Design and construction of the landfill and compost plant Phase II development of the landfill will start in 2012 for its operation from 2013.
O/M cost	The O/M cost is estimated for each year from 2007 to 2015 based on the determined unit cost and amount. The disposal site and compost plant are included.
Depreciation	The site development and building for common use including the road, administration building, leachate treatment facility, compost plant and so forth in the final disposal landfill are completely depreciated in 20 years while the landfill area developed in Phase I is completely depreciated in 6 years; 3 years' depreciation will also be counted for the landfill developed in Phase II. The compost plant in the landfill area is completely depreciated in 15 years while the vehicles and equipment used in landfill are depreciated in 7 years with a scrap value of 10%.
Price	All the cost is estimated based on the current price of 2004. No price escalation is included.
Discount rate	10% (same as the MSW collection and haulage project above)

Remark:

1. Durable period of landfill area is equivalent with the number of years it can be used for waste disposal.
2. The remaining value of common facilities after 15 years is included as the scrap value of project assets.

### d.2.2. Financial Appraisal

The financial appraisal is made for two (2) cases, namely the case with no grant assistance and the case with grant assistance.

#### i) Case with no grant assistance

Assuming that the FIRR of the project to be financially feasible is set at 10%, the Study estimated the required tipping fee per ton of waste disposed. The result of the estimation is shown in the table below.

Table 6-9: Financial Viability and Tipping Fee Rates

Tipping Fee Rate (US\$/ton)	Net Present Value (NPV) (US\$)	Financial Internal Rate of Return (FIRR) (%)
1	-10,002,234	-13.15
2	-7,967,689	-7.81
3	-5,933,143	-2.83
4	-3,898,598	1.82
5	-1,864,053	6.20
6	170,493	10.34

Remark: Discount rate is set at 10%.

As shown in the table above, the tipping fee rate needs to be set at 5.92 dollars per ton of waste disposed to achieve the minimum required FIRR of 10%. Considering that the current operation cost of SMC disposal landfill is less than 1 dollar per ton and PPWM currently only charges to CINTRI for tipping fee at the rate of 0.56 dollar per ton of waste received, the required fee rate reaches about eleven-fold of the current fee rates. This means that the proposed new final disposal landfill will not be financially viable as a general public investment with no grant assistance.

**ii) Case with grant assistance**

The Study here analyzes the required tipping fee rate to make the project financially feasible in the case of providing grant assistance to cover the initial investment made in 2005 and 2006.

The financial viability of the project in this case is secured if it earns enough income to cover the whole project cost including depreciation, additional equipment investment and operational expenses arising during the project period without any shortage of the fund.

The figure below illustrates the trend of project cost on a depreciation basis<sup>1</sup> as well as an actual expenditure basis in the case with grant assistance.

As indicated above, the required cost of the project increases between 2011 and 2013, when the second phase development of the landfill site will be carried out. Although the increase of project cost is comparatively moderate on a depreciation cost basis due to equal allocation of the cost among durable years of investment assets based on the fixed installment method, the project needs to accumulate enough fund from its income to cover the investment and operation cost arising in 2012 and 2013 on an actual expenditure basis.

Thus, the income from the project is required to comply with the following conditions so that it can be financially viable:

- Single year income always exceeds the project cost estimated on a depreciation basis; and
- Reserved fund (accumulated income) of the project always exceeds the project cost estimated on an actual expenditure basis.

The result of analysis shows that the required tipping fee to comply with the conditions above is approximately 4.40 US dollars per ton of waste disposal.

The required tipping fee of 4.40 US dollars per ton of waste disposal is still about eight-fold

<sup>1</sup> The project cost in each year on depreciation basis consist of depreciation expense, O/M cost, and additional equipment investment cost, while the project cost on expenditure basis indicates an actual expenditure in each year.

of the disposal cost in 2002. Both PPWM and CINTRI are required to cover this cost based on the amount of waste they dispose at the new landfill. An increase of the tipping fee affects the collection fee for the service provided by PPWM and CINTRI.

### d.3 Economic Appraisal

The Study here made the following economic appraisals of Dang Kor Final Disposal Landfill Project.

- Quantitative cost-benefit analysis of the compost plant operation in Dang Kor Final Disposal Site
- Qualitative assessment of the economic cost and benefit of Dang Kor Final Disposal Site Project

Although it is preferable to assess the economic cost and benefit of the project on a quantitative basis, the major benefits of Dang Kor Final Disposal Site (i.e. improvement of human health and sanitation in the nearby area and avoidance of air and surface/ground water pollution) are difficult to quantify accurately in terms of their economic value with reliable data and methodologies. Taking this into account, the Study only makes a qualitative assessment of the economic benefits obtained from the project.

#### d.3.1. Quantitative cost-benefit analysis of the compost plant operation in Dang Kor Final Disposal Landfill

##### i) Preconditions for cost-benefit analysis of the compost plant operation

In making a cost-benefit analysis of the compost plant operation in Dang Kor Final Disposal Site, the Study established the following preconditions:

Table 6-10: Preconditions of Compost Plant Project

Project Implementation Body	Phnom Penh Waste Management Authority (PPWM)
Project Period	11 years from 2005 to 2015.
Project Income	<ul style="list-style-type: none"> <li>• Income from selling compost materials produced in the compost plant. 1,225 tons of compost is annually produced while the its sales price is established by cases in the range from 100 to 500 riels per kg.</li> <li>• Reduction of final disposal cost by compost production Reduction of final disposal cost is estimated as the result of multiplying the annual compost production of 1,225 tons by the final disposal cost per ton of waste required to reach FIRR of 10% in the case with no grant assistance, which is 5.26 US dollars per ton of waste disposal. Accordingly, the annual reduction of the final disposal cost is estimated as 6,643.5 US dollars.</li> </ul>
Investment Cost	The following initial investment will be made from 2005 to 2006. Plant design: 70,000 US dollars Plant construction: 698,000 US dollars Machinery and Equipment: 110,000 US dollars
O/M cost	The O/M cost is estimated for each year from 2007 to 2015 based on the determined unit cost and amount.
Depreciation	The plant is completely depreciated in 15 years while the machinery and equipment is depreciated in 7 years with a scrap value of 10%. Machinery and equipment will be replaced in the 7 <sup>th</sup> year of plant operation.
Price	All the cost is estimated based on the current price of 2004. No price escalation is included.

##### ii) Result of Economic Cost-Benefit Analysis

Based on the preconditions established above, the Study estimates the economic internal rate of return of the project for each of the cases with the sales price of compost ranging from 100 to 500 riels per kg. The table below shows the result of analysis.

Table 6-11: EIRR of Compost Plant Project by Cases

Sales Price of Compost (riel/kg)	Annual Income (US dollar/year)	EIRR (%)
100	37,628	-10.51
200	67,893	-5.85
300	98,518	-1.36
400	129,143	2.98
500	159,768	7.18

As shown in the table above, the required sales price of compost is more than 300 riels per kg to obtain a positive EIRR. The EIRR of the project will reach 3 % with the sales price of compost at 400 riels (0.1 US dollar) per kg.

#### d.3.2. Qualitative assessment of economic cost and benefit of Dang Kor Final Disposal Landfill Project

In addition to the benefit obtained from operation of the compost plant above, the development and operation of Dang Kor Final Disposal Site is expected to provide the following benefits, although it is difficult to accurately quantify their economic values.

- **Avoidance of negative impacts upon the surrounding environment due to the delay of the closure of SMC disposal site**

If the new disposal site is not developed as scheduled in the M/P, the amount of waste disposal by landfill will exceed the landfill capacity of SMC disposal site. Considering the current insufficient operation of SMC disposal site, such an excessive disposal of waste will cause a collapse of the waste landfill, the spill over of waste to the surroundings, and further leakage of leachate into surface and groundwater. As a result, not only the safety and sanitation of the landfill area, but also the health of residents and economic activities such as agriculture in the nearby areas will be seriously disturbed. The development and operation of Dang Kor Final Disposal Site will prevent such risks from arising in the near future.

- **Avoidance of illegal dumping**

The delay of a new disposal landfill may also encourage the illegal dumping of waste having no proper destination for its final disposal. Such improper dumping of waste, as already found in some areas in Phnom Penh, causes various negative impacts upon the living environment e.g. flooding due to blockage of water flow by dumped waste, river pollution, aggravation of urban sanitation, damage to urban landscape (disfigurement), and so forth. Development and operation of a new disposal site will prevent an increase of such illegal dumping of waste.

- **Improvement of the impression of Phnom Penh City through realization of clean urban environment**

The proper disposal of MSW at the new final disposal site in Dang Kor will improve the urban environment and aesthetic value of the City of Phnom Penh, as the capital city of Cambodia. A well-managed urban environment and infrastructure is the key to vitalizing



economic activities such as foreign capital investment, tourism, and so forth in the City of Phnom Penh. The proper disposal of MSW is an important part of the well-managed urban environment and infrastructure.

- **Inducement of growth in the relevant economic activities**

The Dang Kor Disposal Site Development Project offers not only the proper disposal of MSW by sanitary landfill, but also other environmentally friendly waste management activities such as the production of compost materials from MSW. Although such new activities require additional investment, they also provide opportunities for developing technologies (e.g. methane capture from landfill), know-how, and human skills in the relevant sectors. Such opportunities are expected to vitalize economic activities in the City of Phnom Penh.

Although the benefits mentioned above are difficult to quantify in terms of their economic value, they are estimated to be large enough to meet the cost required.

## **6.3 Waste Collection Service Expansion Project**

### **6.3.1 Design Concept**

According to the collection system proposed in the M/P, MPP/PPWM will eliminate the unserved area and insufficiently serviced area in the city in collaboration with the private sector. What MPP has to do is to provide the waste collection service to the areas in the three rural Khans that are not covered by CINTRI because it is economically unfeasible. This project is to establish a required waste collection system for PPWM, which is the implementing agency of waste management in MPP, to expand its collection service to such unserved areas.

### **6.3.2 Preliminary Design**

#### **a. Design Conditions**

##### **a.1 Target Year**

The collection service by PPWM is to begin in 2007.

##### **a.2 Target Areas of the Collection Service**

PPWM will provide the waste collection service to areas that the private sector cannot cover in the three rural Khans. The service area will be settled based on negotiations between MPP and the private sector, but they have not reached an agreement as of the end of February, 2005. Therefore, the Study team will prepare the waste collection service expansion project based on the planned collection amount estimated below, without identifying the area.

##### **a.3 Planned Collection Amount**

The Study team estimated the planned collection amount for PPWM based on the results of site reconnaissance and analysis of the weighbridge data of SMC disposal site and the following assumptions:

- The daily collection amount in 2004 of the private sector is the mean of the daily waste amount brought in the SMC disposal site during October and November, 2005.

- The waste amount collected by the private sector in the three rural Khans will increase 10% annually after 2004.
- The planned waste amount to be collected by PPWM is the difference between the waste collection amount proposed in the M/P and that of the private sector.

Table 6-12: Planned Collection Amount (unit: ton/day)

Collection amount	2007	2008	2009	2010	2011	2012	2013	2014	2015
Households	82.6	100.2	116.7	132	145.9	158.5	188.2	216.2	242.1
Commercial-Restaurants	8.1	8.5	9.3	9.9	9.9	13.3	13.5	13.6	17.5
Commercial-Others	20.6	22.1	24.5	26.5	26.7	36.3	37.2	38.1	49.1
Markets	14.1	15	16.5	17.8	17.9	24.2	24.7	25.2	32.4
Hotels	0.4	0.5	0.5	0.6	0.6	0.8	0.8	0.8	1
Offices	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4
Schools	1.4	1.4	1.6	1.7	1.7	2.3	2.3	2.3	3
Factories	15.9	16.5	17.9	19	18.8	25.1	25.4	25.6	32.8
Hospitals	2.7	2.8	3	3.2	3.1	4.2	4.3	4.3	5.5
Slaughter House	1.9	2	2.1	2.2	2.2	2.9	2.9	2.9	3.7
Unidentified source	8.4	9.2	10	10.9	11.8	12.7	13.7	15	16.2
Street Sweeping	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.7
TOTAL	156.5	178.7	202.7	224.4	239.2	281.1	313.8	344.8	404.4

#### a.4 Maintenance of Equipment

The daily maintenance work of collection equipment is done at the maintenance workshop at the new disposal site. Major maintenance such as overhauls is contracted out.

#### b. Equipment Plan

The equipment necessary for the collection service shall be utilized in combination based on the optimal technical system proposed in the M/P. The combination of equipment is shown in the following table.

Table 6-13: Combination of Equipment

Generation Source		Collection Method	Equipment	Fr. of collection
Household	Areas with difficult road access	Primary collection + Container collection	SL, Container (5 m3), Recycling Center, Push Cart	3 times per week
		Container collection	SL, Container, (5m3)	3 times per week
	Areas with road access	Curbside/Bell collection	Compactor Truck (4, 8, 15m3)	3 times per week
Business Establishments	Small scale	Curbside/Bell collection	Compactor Truck (4, 8, 15m3)	Every day
	Large Scale	Container collection (Lease)	SL, Container (5 m3)	Anytime available
	Others	Container collection	SL, Container (5 m3)	Anytime available
Road Sweeping		Curbside Collection	Dump Truck	Twice a week
Public Park		Container Collection	SL, Container (5 m3)	Twice a week

The number of necessary collection equipment during the project period is shown below.

Table 6-14: Necessary Collection Equipment

Equipment	2007	2008	2009	2010	2011	2012	2013	2014	2015
Compactor truck 15m3	8	9	10	12	12	14	16	17	19
Compactor truck 8m3	3	3	3	3	4	4	5	5	6
Compactor truck 4m3	3	4	4	5	5	5	6	7	8
Skip loader truck	5	6	7	7	7	8	9	10	11
Container (5m3)	37	45	51	51	52	61	67	74	86
Dump truck	1	1	1	1	1	1	1	1	1
Wheel loader	1	1	1	1	1	1	1	1	1
Pick-up truck	2	2	2	2	2	2	2	2	2

**c. Organization and Management System**

The personnel required for the collection service is shown in the table below.

Table 6-15 : Personnel required for collection service

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Section Chief	1	1	1	1	1	1	1	1	1
Collection Engineer	1	1	1	1	1	1	1	1	1
Supervisor	2	2	2	2	2	3	3	3	3
Clerk	3	3	3	3	3	4	4	4	5
Driver	22	25	27	30	31	34	39	42	47
Operator	1	1	1	1	1	1	1	1	1
Worker	43	49	53	59	61	69	78	84	95
Worker in Center	5	5	5	5	5	5	5	5	5
Sweeper	25	32	32	38	38	44	44	50	50
TOTAL	103	119	125	140	143	162	176	191	208

**d. Facility Plan**

Regular inspection and repair works for the collection vehicles will be done in the maintenance workshop constructed in the new disposal site. In case of heavy duties such as overhaul, PPWM will commission a private workshop to do it.

**d.1 Facilities**

The maintenance workshop will include the following facilities in order to conduct regular inspection and repair work.

- Repair facilities
- Vehicle washing facilities

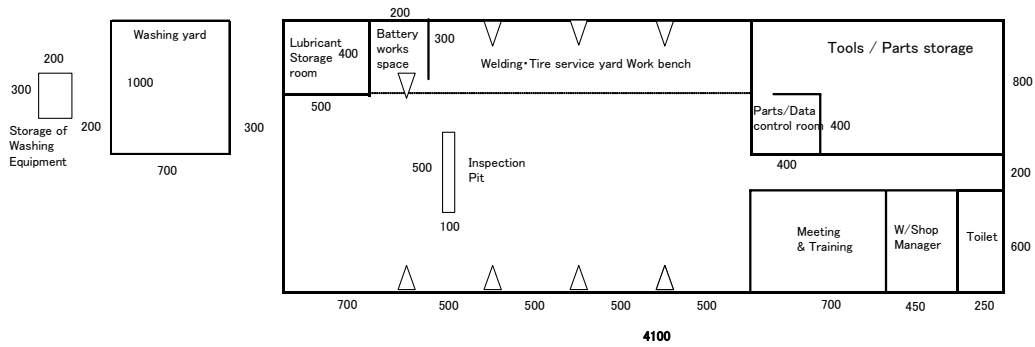


Figure 6-3: Layout Plan of Maintenance Workshop

## d.2 Workshop Tools

Workshop tools necessary for regular inspections and repair work are prepared in order to maintain the equipment in good condition.

- Regular inspection and general repair work
- Inspection and repair of tires
- Battery and welding work
- Spare parts storage
- Office
- Vehicle washing place

The personnel required for the operation and maintenance of equipment is shown in the table below.

Table 6-16 : Personnel Required for O&M of Equipment

Staff	2007	2012	2015
Director	1	1	1
Chief mechanic	2	2	2
Mechanic	6	8	9
Clerk	5	5	5
Total	12	14	15

## e. Fee Collection, Customer Data Management and Monitoring System

As shown in the table below, in the fee collection system, PPWM prepares monthly bills through its customer management system, which was developed based on collection service agreements made with customers. The Sangkat delivers the bills to the customers, collects payments, and sends the payments to PPWM. The Sangkat receives a commission for its service.

As for customer data management, the Sangkat notes any resident shifts at the time it collects the monthly payments and reports any changes to PPWM. Based on that information, PPWM exchanges service agreements and updates the customer database.

As with customer data management, the Sangkat monitors the collection service provided by PPWM when it collects the monthly fees by listening to complaints and suggestions for

improvement from customers, and reports them to PPWM and DOE. PPWM formulates a suitable improvement plan to deal with the complaints and implements it based on DOE approval. If PPWM has not submitted an improvement plan after two weeks, DOE will push PPWM to submit one and inform MPP.

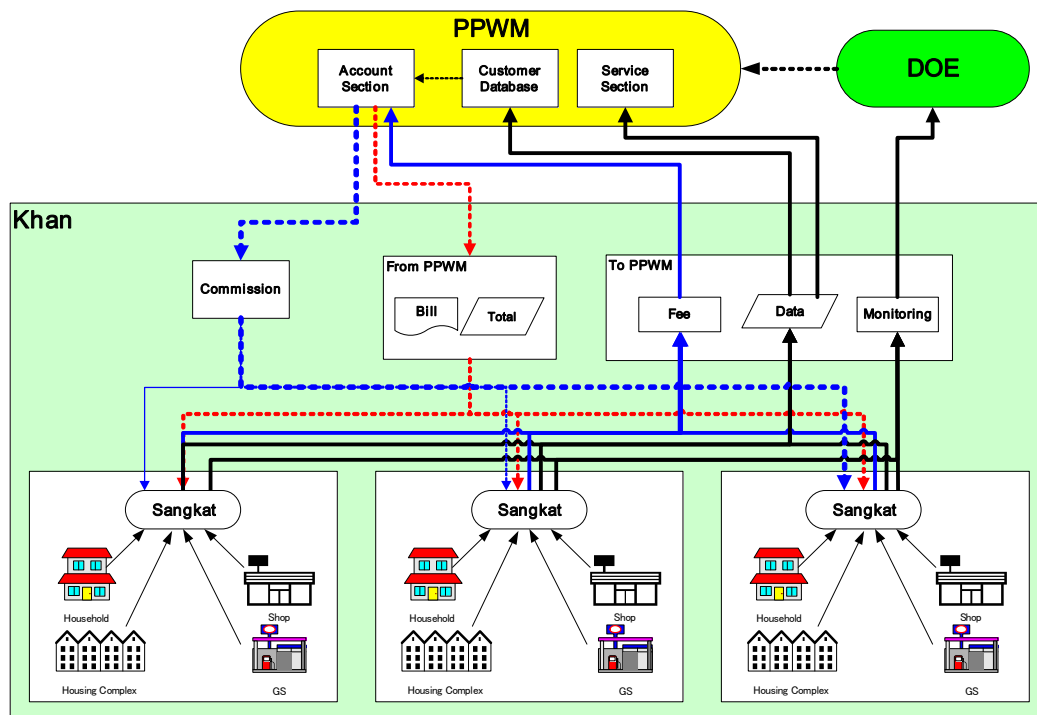


Figure 6-4: Fee Collection System

**f. Project Cost**

**f.1 Required Investment Cost**

The investment cost necessary to procure collection equipment from 2005 to 2015 is shown in Table 6-17.

Table 6-17: Required Investment to Expand Collection Service (US\$1,000)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Collection Equipment	1,746	193	140	195	59	219	320	1,601	521	144
Construction of facilities	58	2	1	2	1	1	2	3	2	-
<b>Total</b>	<b>1,804</b>	<b>195</b>	<b>141</b>	<b>197</b>	<b>60</b>	<b>220</b>	<b>322</b>	<b>1,604</b>	<b>523</b>	<b>144</b>

Note: Facilities include container bases, waste recycling centre.

**f.2 O&M Cost**

The O&M (operation and maintenance) cost consists of the expense for fuel, personnel, spare parts, uniforms and so on. Regarding the O&M cost of the maintenance workshop, the personnel and facility maintenance cost are summed up.

Table 6-18: Operation and Maintenance Cost (US\$1,000)

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fuel	169	191	207	220	225	248	275	298	332
Personnel	83	94	99	110	112	127	138	149	163
Other (uniform etc.)	3	3	4	4	4	5	5	5	6
Maintenance	61	71	77	83	86	97	108	118	133
TOTAL (\$US)	316	359	386	417	428	475	527	569	634

### f.3 Waste Collection Cost

Table 6-19: Waste Collection Cost (US\$1,000)

	2007	2008	2009	2010	2011	2012	2013	2014*	2015	Total
O&M Cost	286	325	352	379	390	434	485	524	588	3,763
Depreciation	178	203	221	245	253	281	322	210	369	2,281
Total Cost	464	528	573	624	643	715	807	734	957	6,044

The waste collection cost per 1 ton of waste from 2007 to 2015 is expected as follows. The average unit cost is 7.74 (US\$/ton).

Table 6-20: Unit Cost

	2007	2008	2009	2010	2011	2012	2013	2014 *	2015	Total
Daily Collection Amount (ton/day)	156.2	178.4	202.3	224	238.8	280.6	313.3	344.3	403.7	
Yearly Collection Amount (ton/ year)	57,017	65,120	73,850	81,760	87,169	102,430	114,358	125,673	147,358	854,735
Unit Collection Cost (\$US/ton)	8.14	8.10	7.76	7.64	7.37	6.98	7.05	5.84	6.50	7.07

\* Depreciation costs in 2014 were off set by sale of scrap vehicles, resulting in a significant reduction of unit costs for that year

### 6.3.3 Project Evaluation

#### a. Technical Evaluation

##### a.1 Collection/Transportation System

Few of the roads in the rural area are well maintained, and many areas are not accessible by collection vehicles. Therefore, the equipment plan adopts curbside collection by compactor truck for areas with well-maintained roads, and container collection by skip loader trucks for areas that are difficult to access.

PPWM has experience with curbside collection by compactor truck so technical problems are not expected. From an operational aspect, however, coordination between discharge and collection is key so PPWM, the implementing body, should obtain public cooperation with the help of DOE to establish an adequate collection system.

As for container collection, although this method will be applied in Phnom Penh for the first time, the technical problems were overcome in the PP. However, in securing the sites for the containers, there was opposition from residents in the surrounding area so it is necessary

to decide on the container locations early on with the cooperation of Sangkats, etc. to prepare for implementation.

In addition, establishing the container collection system will necessitate the hiring of many drivers and collection workers. In implementing container collection, it is vital that a well thought-out employment plan and training program are formulated and that a system is developed by 2006.

#### **a.2 Operation and Maintenance of Equipment**

The equipment maintenance workshop to be constructed is adequate for maintaining the collection vehicles. In implementing the maintenance system, it is important to employ well-trained mechanics and develop a sound management plan for parts. Reasonable budget measures are also necessary in order to provide an adequate supply of spare parts.

#### **b. Social Evaluation**

Expansion of the collection service may put pressure on informal recycling activities. Therefore, it is necessary to share information with recyclers, etc. and make sure the collection days do not overlap with the days when recyclers collect recyclables, so as not to obstruct the recycling activities.

In the plan to expand the collection service, it is necessary to employ many collection workers. The aim is to hire a great number of waste pickers collecting discarded materials at the existing disposal site. However, the registration database of the waste pickers at the existing site, developed in the study, should be effectively utilized to ensure transparent and fair employment.

#### **c. Environment Evaluation**

It is estimated that the collection vehicles will make a total of 322 trips per day in 2007. As a result, the trucks will generate noise and vibration along the road to the disposal site. The degree of noise and vibration depends greatly on the manner of driving so it is essential to train the collection vehicle drivers to drive safely in order to minimize the impact.

The dump trucks for road cleaning may scatter waste when they travel. Therefore, the dump trucks should be required to have tarp covering systems to prevent waste from scattering. As for other equipment such as compactor trucks and closed-type containers, it is necessary to take strict measures to stop waste pickers from picking through them when passing by.

#### **d. Financial and Economic Appraisal**

##### **d.1 Outline of the Project**

The master plan formulated in this Study recommends that CINTRI, the private MSW collection and haulage company, should provide the service in the four urban Khans, where it seems to be financially feasible in terms of private business, and PPWM, the public sector, and CINTRI share the area in the three semi-urban Khans, where the service may not be financially feasible. Consequently, the basic public services will be provided equally to all the people in Phnom Penh.

The financial and economic appraisal made here targets the MSW collection and haulage services in the area where PPWM will provide the collection service.

## d.2 Financial Appraisal

The financial appraisal here is made for 2 (two) cases, namely the case with no grant assistance and the case with grant assistance.

### d.2.1. Preconditions of financial appraisal

The preconditions shown in the table below are common to the two scenarios.

Table 6-21 Preconditions of the Project for Financial Appraisal

Project Implementation Body	Phnom Penh Waste Management Authority (PPWM)
Project Period	10 years from 2006 to 2015
Project Income	Collection of user fees from the service users (households and business establishments) from 2007 to 2015. The fee collection efficiency is set at 80% for household users and for business establishments while the double fee rate of households is applied to businesses on a tonnage basis.
Investment Cost	Initial investment is made in 2006 for the following purposes. (Vehicles) <ul style="list-style-type: none"> <li>• Compactor Truck (loading capacity of 4m<sup>3</sup>, 8m<sup>3</sup> and 15m<sup>3</sup>)</li> <li>• Skip Loader Truck</li> <li>• Communal Containers (5m<sup>3</sup>)</li> <li>• Wheel Loader</li> <li>• Pushcarts</li> <li>• Pick-up Trucks</li> <li>• Dump truck</li> </ul> (Facilities) <ul style="list-style-type: none"> <li>• Container Stations</li> <li>• Recycling Center</li> <li>• Vehicles Maintenance Workshop</li> </ul> Collection and haulage vehicles will be purchased in accordance with the increase in the number of service users and expansion of the service areas while the end-of-life vehicles and equipment will also be replaced.
O/M cost	The O/M cost is estimated for each year from 2007 to 2015 based on the determined unit cost and amount.
Depreciation	Depreciation periods of 20, 15 and 7 years are set for buildings, equipment and vehicles respectively. The scrap value is set at 10% for all vehicles and equipment while the buildings are assumed completely depreciated.
Price	All costs are estimated based on the current price of 2004. No price escalation is included.
Discount rate	10% (same as the case of Dang Kor Final Disposal Landfill Project)

### d.2.2. Financial Appraisal

#### i) Case with no grant assistance

Assuming that FIRR of the project to be financially feasible is set at 10%, the Study estimated the required MSW collection fee per ton of waste. The result of the estimation is shown in the table below.



Table 6-22 Financial Viability and Fee rates

Fee Rate	Net Present Value	FIRR
10	- 1,370,578	- 5.08
11	- 1,022,691	- 1.06
12	- 674,807	2.83
13	- 326,920	6.59
14	20,968	10.22
15	368,854	13.72

Remark: Discount rate is set at 10%.

As shown in the table above, the fee rate needs to be set at above 13.94 US dollars per ton of waste collected to reach an IRR of 10%, the minimum required level of financial profitability of the project. In the case of applying this fee rate, the average monthly fee of MSW collection for household will be as shown in the table below.

Table 6-23: Estimated Fee Rate of MSW Collection for Household

	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015
Amount of MSW collected	Kg/month/household	102	107	113	118	124	113	119	125	113
Fee rate	US\$/month/household	1.42	1.49	1.58	1.64	1.73	1.58	1.66	1.74	1.58

Remark: The decrease of the MSW collection amount in 2012 and 2015 comes from the increase in the reduction of MSW generation at the source by recycling, etc., which is assumed in the M/P.

As shown in the table above, the fee rate of MSW collection for household ranges from 1.42 to 1.74 US dollars per month per household during the project period. This estimated fee rate is between 1.7 to 2.0 fold of the current fee rate of 0.8 to 1.0 US dollar. Taking into account the current willingness and affordability to pay of the households in the three semi-urban Khans, this increase in fee rate is difficult to accept.

#### ii) Case with grant assistance

The Study here analyzes the fee rate of MSW collection in the case of providing grant assistance to fully cover the initial investment cost arising in 2005 and 2006. The financial feasibility of the project in this case is secured if it earns enough income to cover the whole project cost including depreciation, additional equipment investment and operational expenses arising during the project period.

Thus, the income from the project is required to comply with the following conditions so that it can be financially viable:

- Single year income always exceeds the project cost estimated on depreciation basis; and
- Reserved fund (accumulated income) of the project always exceeds the project cost estimated on actual investment basis.

The result of analysis shows that the required fee rate for MSW collection to comply with the conditions above is 11.61 US dollars per ton of waste collected.

The fee rate of 11.61 US dollars per ton of waste is 1.6 to 1.7 fold of the current collection fee rate of 7 US dollars in 2002 and 2003. However, the fee rate is reduced by 17 % by obtaining grant assistance.

Table 6-24: Estimated Fee Rate of MSW Collection for Household

	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015
Amount of MSW collected	Kg/month/household	102	107	113	118	124	113	119	125	113
Fee rate	US\$/month/household	1.18	1.24	1.31	1.37	1.44	1.31	1.38	1.45	1.31

As shown in the table above, the monthly household fee rate of MSW collection ranges from 1.18 to 1.45, which is about 1.2 to 1.5 fold of the current fee rate of 0.8 to 1.0 US dollars per household per month. Although the unit cost is reduced by introducing grant assistance, measures for further reduction of the household fee rate should be developed.

### d.3 Economic Appraisal

The MSW collection service provided by PPWM, which is currently proposed in the M/P, aims at providing the fundamental public service to un-serviced areas in Phnom Penh. Although it requires additional investment, it is the basic obligation of Phnom Penh City to provide equal MSW collection service to all the people living in Phnom Penh.

The current plan of MSW collection service in the three rural Khans is the result of examining the most cost efficient MSW collection and haulage methods by the Study; therefore, the incremental cost arising from the project is minimized as much as possible.

On the other hand, provision of MSW services to the three rural Khans is expected to create the following benefits although it is difficult to quantify in terms of their economic values.

- **Improvement of health, sanitation and environment for the citizen**

The waste is being dumped in the river and streets as well as openly burned in the unserviced area. The serious threats caused by these waste affect human health, sanitation and the living environment not only in the unserviced area but also the whole city. Implementation of the project will prevent such pollution and improve the living environment of the city.

- **Promotion of socio-economic development**

Improvement of health, sanitation and the living environment will increase the value of the area as a base of living and economic activities and vitalize socio-economic activities. Although there is currently a large economic gap between the four urban Khans and three rural Khans, the improvement of public services such as MSW collection will increase the potential of the three rural Khans as an alternative area of urban and economic development in the City of Phnom Penh.

- **Raising public awareness of the environment**

Although provision of MSW collection service at a fee may cause an adverse reaction of the people living in the three rural Khans, it may also raise their awareness on the environment if they properly understand the risk of the uncontrolled dumping of waste and the importance of environmental management in terms of protecting their health and living environment. An increase of public environmental awareness is also expected to encourage the efforts of waste reduction at sources, such as segregation, reuse, and recycling.

All of the expected effects of the project mentioned above will provide enough benefits to cover the cost required for its implementation.

## 6.4 SMCDS Closure Project

### 6.4.1 Design Concept

The closure plan considers the following matters.

1. Smooth transition from the old disposal site to the new disposal site
2. Necessary works to close the SMCDS
3. Monitoring plan after closure
4. Future land use plan

### 6.4.2 Outline of Design

#### a. Design Condition

##### a.1 Schedule of Closure

The existing disposal site will be closed at the end of 2006.

##### a.2 Target Area of Closure Plan

The target area of the closure plan is the municipality owned plot of 7.5ha (including roads) and the privately owned plot of 3.6ha that was expanded under the pilot project (A-1:1.6ha, B-2:2.0ha).

According to the lease contract, the expansion area shall be returned to landowners after the height of the landfill block reaches 4m above the surrounding road. It is, however, preferable that the land is under PPWM management from an environmental point of view, because leachate and landfill gas will continue to be generated and the subsidence will continue. Therefore, the closure plan was formulated on the premise that MPP will extend the lease after closure.

#### b. Transition Plan to the New Disposal Site

In order to ensure smooth transition from the SMC disposal site to the new site without interruption of the waste disposal service, the following is necessary.

- Establishment of PPWM management system  
It is necessary for PPWM to prepare necessary personnel and equipment and to provide training to its staff before the start of the new disposal site.
- Improvement of the Access Road  
MPP should make sure that the construction work of National Road 303, which is financed by ADB, will be completed before the start of the new disposal site operation.
- Formulation of the transition plan  
PPWM shall devise a detailed plan for shifting operations from the SMC disposal site to the new disposal site by the middle of 2006, based on the transition plan prepared by the Study Team.

#### c. Equipment Plan

After completion of the landfill operation, the following construction works will be conducted at the SMCDS.

- Construction of landfill block

- Construction of the drainage system which separates leachate from rainwater mixed with domestic wastewater and installation of pumps and other equipment
- Installation of gas removal pipes
- Covering of the disposal site with soil

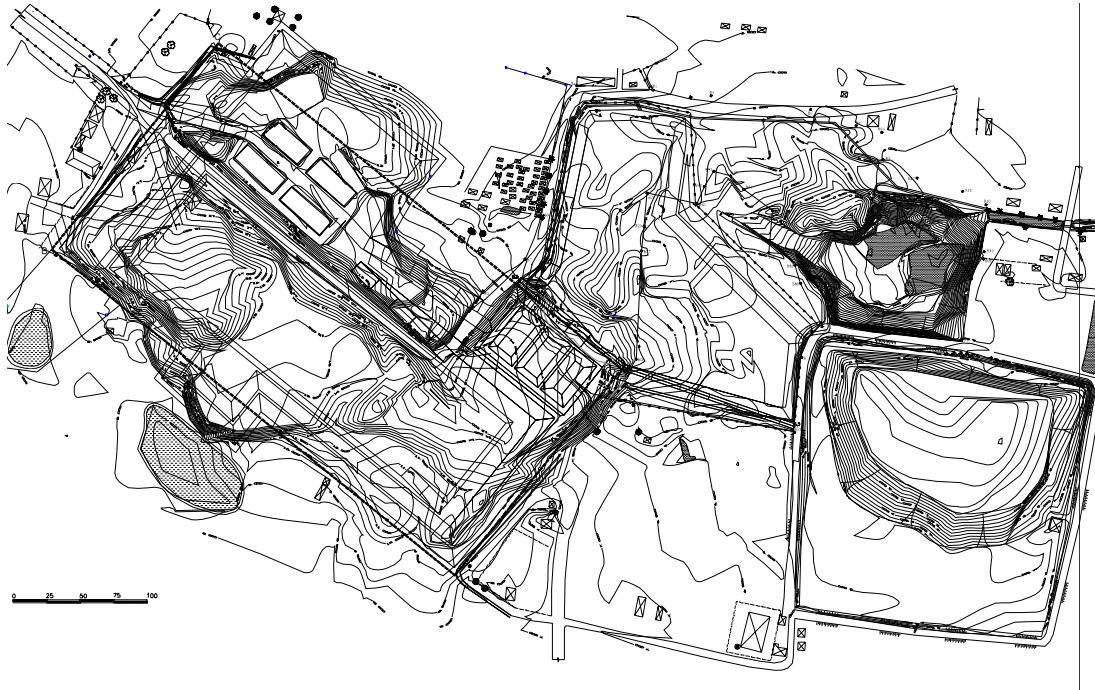


Figure 6-5: Final Shape of the SMCDS

The team proposed that PPWM rent out the disposal site to a business establishment or NGO, which is interested in the use of landfill gas, in order to promote the use of landfill gas.

#### d. Monitoring Plan

PPWM should keep the monitoring system until the landfill area becomes stable (for around 15 years). The items to be monitored are shown below. Measurement of heavy metals and hazardous substances are important in the monitoring but it is costly. Considering the financial situation of MPP/PPWM, the team proposed only pH, EC, Cl as the monitoring items. Although measurement of the proposed items is simple and cheap, we will be able to detect the seepage of leachate because the measurement results will change remarkably if the sample includes leachate. PPWM should conduct a water quality survey including heavy metals in this case and take measures immediately. The frequency of monitoring by DOE/PPWM should be once a month and twice a year for monitoring by the committee, which is mentioned later. The items of monitoring are shown in the table below. Details of the monitoring items are described in chapter 12.3 of the main report.

MOE and DOE started the regular monitoring of the SMC disposal site from July 2004. When this monitoring gets on track, the monitoring system will be strengthened by the monitoring committee to be organized. These monitoring activities are not only for environmental conservation of the SMCDS but also for establishment of the monitoring committee of the Dang Kor disposal site.

Items	Details
1. External appearance of the disposal site	Fixed point observation ① Conditions of soil (final covering) ② Conditions of landfill block (subsidence, change of shape, and so on) ③ Maintenance of drainage systems and leachate treatment systems) ④ Others
2. Groundwater	Regular observation of water quality of monitoring wells
3. Leachate	Regular monitoring inflow and outflow of treatment facilities
4. Landfill gas	Regular analysis of the composition of landfill gas
5. Fire	Regular observation of the fire occurred in the disposal site
6. Noise	Regular monitoring of noise
7. Offensive odor	Regular observation of odor given from the disposal site.
8. Subsidence of the landfill block	Regular measurement of a subsidence using the settlement gauge to be installed
9. Breeding of vermin and rat etc.	Regular check of vermin such as rats, etc. that breed in the disposal site
10. Landfill operation	Observation of the landfill operation
11. Waste scattering	Observation of the waste scattering outside of the disposal site

**e. Future Land Use Plan**

**e.1 Municipality Owned Land**

- Public Park with an observation platform  
To construct an observation platform to take advantage of the height of the landfill block
- Facilities to utilize landfill gas  
To produce charcoal briquettes using landfill gas.

**e.2 Private Land (Expansion Area)**

- Return of land to landowners after final soil covering  
According to the lease, the land should be returned to landowners after the height of the landfill block reaches 4m. It will take a long time, however, before the landfill area becomes stable and there are risks of subsidence and explosions caused by landfill gas. Therefore, it is preferable that the land is managed under PPWM and the team suggests that MPP/PPWM extend the lease or purchases the expanded area. If landowners require MPP to return the land, it is necessary that MPP regulate the use of land and that landowners cannot use it without the permission of MPP
- Facilities without heavy building  
The team recommended that the land be used as a public park or golf training field, which have no risks of damage by subsidence and landfill gas.

**f. Project Cost**

The project cost includes the construction cost and the monitoring cost necessary after closure.

Table 6-25: Project Cost of the SMCDS Closure Plan (US\$1,000)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Initial Investment	75	745								
O&M Cost		24	14	14	24	14	14	24	14	14
Total	75	769	14	14	24	14	14	24	14	14

### 6.4.3 Project Evaluation

#### a. Technical Evaluation

The SMC disposal site has had no pollution control measures since it was opened in the 1960s. Consequently, the waste at the bottom of the landfill is in direct contact with the ground. It is impossible to stop the effects on groundwater, etc. At the present stage, the best countermeasures that can be taken are to minimize the volume of leachate by soil covering; collect, treat, and discharge as much of the leachate that seeps through as possible; and safely collect the landfill gas and use it effectively.

#### b. Social Evaluation

Possible social impacts of the closure of the disposal site are summarized below.

##### 1) Negative impact

- Loss of income source for waste pickers
- Damage to recycling industries in SMC

##### 2) Positive impact

- Improvement of environmental and hygienic conditions around the SMCDS.
- Creation of new business to make good use of landfill gas

#### b.1 Basic approaches to minimize negative impacts

The basic approaches the team proposed PPWM should take to minimize negative impacts on waste pickers and recycling industries are summarized below.

##### b.1.1. Approach to deal with loss of income source for waste pickers

Waste pickers belong to one of the groups most affected by the closure plan. Considering their size in number, it is very important for MPP/PPWM to take necessary measures to minimize the negative impact on them. It is preferable to consider necessary measures as soon as possible in cooperation with other stakeholders.

The team conducted the Social Environmental Survey (SES) during the first phase. However, the situation surrounding waste pickers has changed in the past year, so it is necessary to summarize the changes which have occurred in the past year.

#### (1) Current situations of waste pickers

The result of the SES revealed that there were a lot of incomings and outgoings, while some waste pickers frequently changed their place of work between the disposal site and the city. After the trial of the working area separation finished in the beginning of 2004, many waste pickers chose to work on the streets in the downtown area of Phnom Penh because of the deteriorated conditions of the landfill area caused by improper operation and management of PPWM. In addition, a recycling center operated by a private company in cooperation with

CINTRI hired around 100 waste pickers last August. As a result, the number of waste pickers considerably decreased in the past several months as shown in the table below.

Table 6-26: Number of Waste Pickers at SMCDS (the observation survey)

Date	Number of children	Number of adults	total
2003			
May 30 (Morning)	112	290	402
June 2 (Afternoon)	161	360	521
June 5 (Morning)	144	369	513
2004			
October 18	45	149	204
November 22	18	179	197
December 1	78	196	274

Since the operation and management of the disposal site was improved, it is expected that more waste pickers will return to the disposal site from now on.

The previous survey also showed that there were a lot of incomings and outgoings. Since September 2004, PPWM resumed the registration work for the newcomers. According to the recent registration data, there are 20-30 newcomers every month.

There are still no reliable leaders or self organizations among waste pickers, even though NGOs continue their efforts. It is expected that MPP/PPWM will face enormous difficulties in negotiating with waste pickers in order to consider necessary measures.

## (2) Basic approach

Since the budget and personnel MPP can manage is limited, it is important for MPP/PPWM to make its roles and responsibilities clear and formulate the plan in cooperation with related organizations. The basic approaches the team proposed MPP should take are summarized in this section.

### 1) Identify the target people

According to the result of the Social Environmental Survey, waste pickers at the SMC disposal site varied in terms of age, income, living status and working status. There are many waste pickers who work at the disposal site tentatively, only during the agricultural off season, while some waste pickers who live near the disposal site work only on weekends for additional income.

When PPWM started to register waste pickers at the end of 2003, a lot of people who did not actually work at the disposal site applied for an ID card. After checking waste pickers at the disposal site for a short period, PPWM issued ID cards only to those who had been checked by PPWM staff more than three times. As of October 2004, the total number of ID card holders was 1,558 (out of applicants of 2,967). However, there are still a large number of ID card holders who have already stopped working at the disposal site. It is very important for MPP/PPWM to carefully select real targets for its supporting program.

The team proposed the following criteria to select the targets.

- Must have been working at the disposal site for a long time (Priority is given to those who got the first series of ID cards in the beginning of 2004.)  
New comers are not the targets of the supporting program. This may decrease the incentive for people in rural areas to come to the SMC disposal site.

- Must work full-time at the disposal site (Part-time waste pickers are not to be targets.)
- Must work permanently at the disposal site (Tentative waste pickers coming from rural areas are not to be targets.)
- Select targets based on the household (In order to widen the targets, it is better to select only one person from each household if the number of created jobs is limited.)

Since the actual number of waste pickers who are working at the disposal site now is much smaller than that of the ID card holders, it is necessary for MPP/PPWM to identify who is actually working at the disposal site regularly. The team proposed that PPWM check the ID numbers of waste pickers at the disposal site once a month.

## **2) Establish close cooperation with other stakeholders**

In SMC, NGOs have been actively involved in supporting waste pickers in the past decade. They have their own programs to support waste pickers to change their jobs. When MPP/PPWM consider its supporting program, it is very important to avoid conflict with the NGOs' activities.

It is necessary for MPP/PPWM to make a mechanism in which MPP can discuss necessary measures with other stakeholders regularly. For this purpose, the team and PPWM organized a meeting at the end of September 2004, inviting NGOs and Christian organizations which are supporting waste pickers. At the meeting, the team and PPWM explained the closure plan and its tentative schedule and NGOs introduced their current activities and future plans. The team requested MPP/PPWM to continue to organize this kind of meeting regularly in order to exchange opinions and information. It is preferable to invite local authorities to the next meeting.

## **3) Ask NGOs for their support to communicate with waste pickers**

As a part of the Social and Environmental Survey, the team conducted an interview survey with waste pickers and organized a focus group meeting. At the time of the survey, the development plan of the new disposal site was still uncertain and many of the interviewees could not be serious about the closure of the SMC disposal site. Therefore, it is urgent for MPP/PPWM to discuss the closure plan with waste pickers.

It was, however, impossible for MPP/PPWM to invite waste pickers to the public hearings due to the lack of leaders or self-organized groups among waste pickers. Since many of the waste pickers get some kind of support from NGOs, it is better to ask NGOs for their support to communicate with waste pickers.

As soon as MPP makes a decision to implement the development plan of DKDS, MPP/PPWM should start discussions with waste pickers about alternative jobs and inform its criteria for selecting the target person.

## **4) Disseminate information on the closure plan widely (throughout Cambodia)**

It is critical for MPP/PPWM to control the number of newcomers. In order to decrease the number of incomings, it is necessary to make the disclosure plan of the SMC disposal site known widely and show the criteria for selecting the targets of the supporting program clearly through such media as TV, radio and newspaper.



### (3) Possible supporting programs by MPP

#### 1) Under MPP related projects

MPP/PPWM could create the following jobs under future projects related to solid waste management. The targeted waste pickers would be given priority to get these newly created jobs along with the landowners who sold or will sell their land for the construction of DKDS. However, the number of new jobs shown below is limited so MPP/PPWM have to consider other measures in cooperation with other organizations.

Workers at the DK disposal site (priority will be given to former landowners)

Year	Job	Number
2007	Workers at the landfill operation area	12
2007	Workers at the compost plant	25

Workers for waste collection and street cleansing activities by PPWM

Year	Job	Number
2007	Collection workers	48
2007	Street sweeper	25

Since there is a plan to construct a depot of collection vehicles at the SMC disposal site after its closure, waste pickers who will get jobs as collection workers will not have to change their residence.

#### 2) Supporting NGOs

Providing support to NGOs to implement their activities smoothly is also an important task of MPP/PPWM.

At present, each NGO engages in its own projects, and there are some overlaps of activities. MPP/PPWM could also arrange a place where NGOs can exchange information and coordinate their activities. The above mentioned meeting could have this function.

#### b.1.2. Approach to deal with damage to recycling industries in SMC

Recycling related businesses such as waste buyers and brokers accumulate in SMC, in particular around the disposal site. Many of them buy waste from waste pickers at the disposal site. These businesses are very active and they contribute to the high recycling rate of MPP.

Since the new disposal site will exclude waste pickers from the disposal site, it is expected that the recycling rate will decrease for a while after the closure of the SMCDS. Waste buyers and brokers play an important role in making a recycling system work effectively.

It is important for PPWM to prevent them from losing or discontinuing their business in order to keep or increase the current recycling rate in the future. It is necessary for MPP to confer with recycling businesses in order to examine possible measures.

### c. Environment Evaluation

#### c.1 General

The SMCDS has had no pollution control measures since it started its operation in the 1960s. Final soil covering cannot prevent all possible environment degradation. Therefore, it is very

important for PPWM to keep a close watch on groundwater monitoring to prevent further environmental problems. In addition, it is necessary for MPP to impose a ban on the use of groundwater as drinking water.

Regarding land use, landfill gas could involve some risk. It is necessary for MPP to give proper instructions on the future use of the disposal site in order to secure safety.

The team assumes the necessary monitoring period is at least 15 years. Therefore, it is necessary for MPP/PPWM to establish a monitoring system to conduct the operation for 15 years.

### **c.2 Monitoring systems**

The monitoring systems that were established under the pilot project will continue to be used until the landfill area becomes stable (for around 15 years after its closure). It is necessary to make sure that PPWM will be able to conduct the monitoring operation in the long term. Therefore, the monitoring work of SMCDS should be a part of the management system of the DKDS. This makes it possible for PPWM to utilize necessary personnel and equipment of the DKDS for the SMCDS monitoring. Management of the SMCDS after its closure includes a wide range of tasks, from observation of the external appearance of the disposal site to the operation and management of leachate treatment systems. A staff member of the DKDS will conduct a regular patrol for the above-mentioned routine works. If necessary, engineers or workers will be dispatched for such works as measuring and repair work.

The targets of the routine monitoring by observation are shown below.

- Conditions of soil and grass (final covering)
- Conditions of landfill block (subsidence, change of shape, and so on)
- Maintenance of drainage systems and leachate treatment systems

### **c.3 Water pollution**

Leachate will continue to be produced after the site is closed although production rates and strengths will diminish with time. Therefore, it should be considered.

The basic idea of the plan is to separate leachate from rainwater. Leachate and rainwater are controlled in the following ways.

- Leachate is collected through berms that were installed on each terrace and the top step of the landfill block, and the main pipe that is installed around the block. Collected leachate is pumped to the treatment facilities that were constructed under the pilot project.
- The team designed an open canal surrounding the disposal site as drains of rainwater mixed with domestic waste water. Rainwater and domestic waste water flow by gravity. The drain was constructed in the expansion area of the SMCDS under the pilot project, but its covers only a limited area. It is necessary to install drains in other areas.

### **c.4 Landfill gas**

Landfill gases will continue to be produced after the site is closed although production rates and strengths will diminish with time. Therefore, the following should be considered.

Generated gas is controlled by installing parallel and vertical gas removal pipes.

- It is preferable to install vertical gas removal pipes in accordance with the progress of the landfill operation. It is necessary for PPWM to set up a vertical pipe at a planned spot before the landfill operation starts.
- Parallel pipes are installed before the final soil covering. In the model block that was constructed in the existing area, vertical pipes were already installed; therefore, vertical pipes that are installed from this time on are connected to the existing pipes.
- It is preferable to install gas removal pipes in the expansion area, since removing gas could hasten the process to stabilize the landfill area. However, it depends on the future use of land, and landowners will decide whether pipes are installed in the area or not. It is necessary for PPWM to confer with landowners before finalizing the plan.

#### **d. Financial and Economic Evaluation**

There are two options for raising the funds for environmentally sound and safe closure of the existing Stung Mean Chey Disposal Site (SMCDS). One is the allocation of budget from MPP, and the other is the allocation of income obtained from the operation of new final disposal landfill in Dang Kor. The Study here estimates the cost of environmentally sound and safe closure of SMCDS and its impact upon the tipping fee at the new Dang Kor disposal site if its income is allocated for the closure of SMCDS.

##### **d.1 Cost of environmentally sound and safe closure of SMCDS**

The cost of initial investment for closure and monitoring after closure of the SMCDS is estimated in Table 6-25. Eight hundred and twenty thousand US dollars is required for the initial investment including final soil cover, establishment of a leachate treatment facility, landfill gas pipes, leachate monitoring wells, and so forth. Monitoring of the closed landfill, on the other hand, is estimated to require 14 thousand US dollars annually while 10 thousand US dollars are also required to replace the leachate pumps every three years during the monitoring period.

##### **d.2 The use of income from operation of the New Disposal Site in Dang Kor and its impact upon the tipping fee**

The Study analyzes the impact upon the tipping fee to be set for the operation of the new disposal site in Dang Kor if its income is allocated for closure of SMCDS. As mentioned in 1.1.2 above, it requires a tipping fee of 5 US dollars per ton of waste received to reach the financially viable operation of the Dang Kor disposal site with an IRR of more than 10%. In the case with the allocation of the funds for closure of SMCDS from the income from the Dang Kor disposal site, the required tipping fee is estimated to increase to 5.07 US dollars per ton of waste received. The increase of tipping fee by 0.07 US dollar per ton of waste is only a small change that can be easily addressed by the Dang Kor disposal site as far as it is operated in a financially viable manner.

## **7 Conclusion and Recommendations**

### **7.1 Conclusion**

#### **7.1.1 Problems concerning the Current Municipal Solid Waste Management**

##### **a. Unserviced and insufficiently serviced areas**

CINTRI, who is a private waste collection company, has the right to collect waste and fees in the whole city of Phnom Penh except for a part, according to the contract agreed on on March 21, 2002. This contract stipulates that CINTRI has no obligation to provide collection services to economically unfeasible areas and that MPP shall not permit any third party, nor be permitted itself, to provide any of the services in the city.

According to the results of the study, it was found that the waste collection coverage rate in the four urban Khans is 95% and 40% in the three peri-urban Khans but that there are many unserviced and insufficiently serviced areas in the city. The waste in these areas is thrown away in open spaces and/or waterways. This waste deteriorates the urban environment severely and the waste thrown into waterways blocks the drainage facilities and causes flooding.

##### **b. Open dumping**

The Stung Mean Chey (SMC) disposal site, which has been used from the 1960s, is the only disposal site in the municipality of Phnom Penh. Urbanization has reached the site and many houses are in the surrounding area. Due to inappropriate operation, SMC disposal site has become an open dump and is having a negative impact on the environment such as the daily occurrence of fires, widely diffused smoke and offensive odor, and the breeding of flies and vermin. In spite of the many improvements made in the pilot project conducted in this study, there are still many problems because soil covering cannot be carried out due to the insufficient budget (less than 0.5US\$/ton). In addition to the environmental problems mentioned above, the remaining capacity of the SMC disposal site was estimated at about two years as of the end of 2004. Therefore, urgent development of the new disposal site is indispensable.

##### **c. Garbage heap and waste littering in the city**

In Phnom Penh, even in the central part where the collection service is adequately provided, garbage heaps and waste littering are ubiquitous due to the lack of discharge rules. This not only causes a decline in the urban sanitary conditions but also has a negative impact on the tourist industry due to the spoiled scenery. Although the beauty along the main road is maintained by the street sweeping services, which are carried out somewhat to excess, garbage heaps and waste littering should also be urgently improved through the establishment of discharge rules with public cooperation.

##### **d. Weakness of the public executing system**

Because the cleansing activities have been carried out by the private sector for so long, the public cleansing capability has become as weak as it is today. As a result, the MPP cannot respond to the request to receive equal public services made by the citizens living in areas where the private company does not provide services.

## 7.1.2 Master Plan

The master plan (M/P) was formulated based on the current conditions of SWM mentioned above, aiming to “establish a sustainable SWM system in Phnom Penh by the target year 2015”.

If the M/P is realized, the waste flow in the year 2015 will be as follows:

Year	Generation amount	Amount improperly disposed of at generation source	Collection amount	Amount treated at compost plants	Final disposal amount	Recycling amount
2004	978 (100)	68 (6.9)	717 (73.3)	5.3 (0.5)	693 (70.8)	93 (9.5)
2015	1,739 (100)	0 (0)	1,598 (91.8)	33.3 (1.9)	1,461 (84)	242 (13.9)

Unit : tons/day (the value in parentheses is the ratio of waste generated)

In the M/P, improvement measures to cope with the various problems mentioned above from both technical and institutional aspects were planned.

### a. Technical aspects

#### a.1 Waste collection expansion to eliminate unserved area

- The private company (CINTRI) provides the waste collection service to the entire area of the four urban Khans and the area in the three peri-urban Khans where it is economically feasible. MPP/PPWM provides the collection service to the remaining area in the three peri-urban Khans where is not economically feasible for the private company by receiving foreign grant assistance.
- MPP/DOE should monitor and control the waste collection service provided by PPWM and the private company so that the citizens can receive fair and proper services.
- MPP and the private company should review the territories based on the results of monitoring prepared by the DOE periodically. The contract agreement should also be amended if necessary to reflect the results of the monitoring.

#### a.2 Improvement of final disposal

- MPP should develop the new disposal site as soon as possible by obtaining foreign grant assistance.
- PPWM should continue the pilot project for improvement of the SMC disposal site commenced in this study and build up landfill techniques and operational know-how until the new disposal site is opened.
- PPWM should raise the level of sanitary landfill operation in the SMC disposal site step by step and reduce the environmental impact on the surrounding area gradually.
- PPWM should make repeated efforts to ensure that the users, such as the collection service providers, understand the necessity of raising the disposal fee and accept to pay it by explaining the benefits that the users will receive, such as the shortening of time required for unloading, a reduction in cost of repairing vehicles that break down at the disposal site and increased work efficiency. Through those repeated efforts, PPWM should gradually raise the disposal fee up to 4.4 US\$/ton by the commencement of operation of the new disposal site.

- PPWM should establish a system so that the citizens understand SWM properly and accept to bear the waste fee for proper treatment and disposal by showing the sanitary landfill operation.

**a.3 Prevention of garbage heaps and littering**

- In order to eliminate garbage heaps and littered waste, the collection service providers (PPWM and CINTRI) should establish waste discharge rules specifying the containers to be used and the discharge times, days, and place.
- The service providers should publicize the waste discharge rules to obtain residents' cooperation.
- The service providers should provide a reliable service according to the discharge rules.
- The administrative side (MPP/DOE) should raise public awareness by educating the residents (the beneficiaries of the service) about the need for public sanitation and environmental conservation so that they strictly adhere to the rules. The public education should include the required programs to eliminate the scattering of waste and littering.

**a.4 Promotion of the 3Rs**

In this study, it was found that the amount of waste generated per person is small (487g/person/day), and the traditional private material recovery system is very active and well established (recycling rate is 9.3 %). However, the majority of the valuables recovered are recycled in Thailand and Vietnam. Based on that, in order to promote the 3Rs (Reduce, Reuse, Recycle), the following measures are recommended.

- In order to maintain and preserve the existing recycling system, the MPP should establish a support mechanism (the provision of education and information to dischargers and collectors of valuable materials, small loan system, etc.) for Et Chhay (recycler) and WPs.
- In order to increase the recycling rate, degradable organic waste (kitchen wastes, grass and wood), which currently accounts for 70% of the waste composition by weight, has to be adequately recycled. Therefore, the composting of waste should be promoted. In doing so, judging from the profitability of compost activities and product marketability, it is important to ① target waste that can be produced into good-quality compost at a low cost, such as market waste, yard waste, etc; ② target customers who will buy high cost products, such as fruit and vegetable farmers; and ③ promote community level composting activities in order to progressively increase production according to the increase in demand.

**b. Institutional aspects**

**b.1 Administration and organization**

The roles and responsibility of the organizations concerned with SWM in Phnom Penh should be clarified.

**Cabinet:** To establish and enforce comprehensive SWM policy

**DPWT:** To supervise the disposal site construction works conducted by PPWM

**DOE:** To monitor and control the waste disposal services provided by PPWM and the private contractor for educating and informing the public

**PPWM:** To operate and manage the waste disposal works under its jurisdiction (collection, intermediate treatment, final disposal, etc.)

### b.2 Public-private partnership

- MMP should establish a collaborative relationship among the stakeholders such as Khans, Sangkats, etc. to eliminate unserved areas and insufficiently serviced areas together with the private sector.
- MPP should publicize, educate and enforce the citizens as an administration regardless of whether it is public or private territory.
- The private sector should recognize MPP's obligation to ensure that all citizens enjoy this public service and should take the appropriate measures in response to any requests by MPP regarding this point. At the same time, the private sector should request to receive the support from MPP to obtain public cooperation (payment of fees, proper discharge, etc.) for implementing their activities.

### b.3 Establishment of financial base

- MPP guides PPWM and CINTRI to manage their services by their own income obtained from the user fees.
- MPP should decide on an appropriate waste fee based on the unit costs of works such as collection and transport, street sweeping, park cleansing, final disposal and management. MPP should request the customers to pay the waste fee by explaining that the service provider uses the fees efficiently.
- MPP should lighten the burden on PPWM by obtaining foreign grant assistance because PPWM has to provide the collection service to the areas that are not economically unfeasible for the private sector.

## 7.1.3 Priority Projects

### a. Priority projects

The following priority projects were selected to solve the problems urgently.

Table 7-1: Priority Projects and Investments

(unit: US\$ 1,000)			
Project Name	Contents	investment (2005 - 2006)	Investment (2007)
Dang Kor Disposal Site Development Project	Construction of new disposal site	8,890	0
	Construction of compost plant	1,194	0
	Construction of maintenance workshop	1,574	0
	Sub total	<b>11,658</b>	<b>0</b>
Waste Collection Service Expansion Project		1,804	195
SMC Disposal Site Closure Project		75	745
Total		<b>13,537</b>	<b>940</b>

**b. Project appraisal**

The priority projects were evaluated from technical, social, environmental and economic aspects, and the appropriateness of the projects was verified.

Dang Kor Disposal Site Development Project

The cost required to sustain the sanitary landfill operation in the case that foreign grant assistance is obtained is 4.4US\$/ton. Therefore, for PPWM to secure the required funds, it needs to make repeated efforts to obtain the understanding of the users during operation of the existing disposal site and gradually raise the disposal fee.

Waste Collection Service Expansion Project

On May 12, 2004, CINTRI agreed to the master plan where PPWM provides the collection service to the unserved area, which is a precondition for implementation of this project. In addition, this project requires a fee collection rate of 80% or more, and a fee collection rate of 80% has already been achieved in the pilot project. As the plan for the expansion of collection services by PPWM targets areas that are not economically feasible for the private company, foreign grant assistance must be obtained for its implementation.

SMC Disposal Site Closure Project

As a result of the financial analysis, it was found that assuming the funds for this project are raised through the disposal fee of the new disposal site in Dang Kor, a mere 0.28 dollars/ton will be required. Therefore, implementation of this project is feasible, provided that the new Dang Kor disposal site is carried out as an economically viable project.

**c. Matters to be considered for the project implementation**

The following matters should be considered to implement the priority projects.

Technical aspect

- In the Dang Kor Disposal Site Development Project, a geological survey should be conducted in the detailed design stage, and measures against groundwater contamination by leachate should be taken.
- Leachate runoff should be estimated, and the necessary measures should be taken.
- The improvement pilot project carried out by the study team at the SMC disposal site was an emergency measure. As a long term measure, the closure plan must be strictly adhered to. Also, in closing the site, a monitoring system should be established and continued. The conditions for suspending monitoring should be established by the time of closure.

Social aspect

- As a result of the construction of the new disposal site and closure of the existing one, waste pickers will lose their livelihood and recycling businesses in the surrounding area will be hard hit. For the waste pickers, it is necessary to establish a basis of livelihood for them over time, with the cooperation of NGOs. As for the recycling businesses, PPWM should exchange views with them and examine countermeasures to cope with the situation.
- A foundation to ensure the stakeholders fulfil their responsibilities will be established based on a common understanding by the stakeholders,



administration, citizens, private companies, and NGOs on solid waste management. Therefore, rules for waste management must be established.

#### Environmental aspects

- In the results of the environmental survey, EIA survey and water quality survey, some data was questionable and some minimum quantitative limits were higher than the standard of Cambodia. These include SS, lead, cadmium, total mercury, organic mercury, BOD, COD, nitrogen as ammonium and TSP. However, this data should be reviewed because of the analytical level of the MOE laboratory and lack of advanced equipment for analysis. In order to monitor the environment of the project site effectively, a re-survey of the data mentioned above is indispensable as baseline data.
- It is important to establish measurement systems to meet the Cambodian standard before the start of operation; that is, measurement systems that can detect levels lower than the standard. Therefore, raising of the analytical level of analysts, strengthening of data management and installation of advanced equipment are urgently needed
- At the planned site of the new disposal site, an observation well should be constructed in the shallow part of the permeable layer to monitor water quality and check for groundwater contamination by harmful substances.
- In the dry season, the concentrations of mercury in samples from the Prek Thot River and the irrigation canal at Choeung Eak commune located in and around DKDS exceeded the standard for public water areas in Cambodia. The team tried to find out the pollution source but it could not be determined. The team suggests the 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.

#### **d. Progress of the Dang Kor disposal site development project**

##### **d.1 Environmental Impact Assessment (EIA)**

Based on the IEE implemented in advance, the EIA for the Disposal Site Development Project, which includes the construction of a final disposal site, compost plant, and maintenance workshops, was carried out to determine the impacts of the project on the following:

economic activity, traffic and public facilities, ruins and cultural property, public health, the socially vulnerable, hydrological conditions, fauna and flora, landscape/aesthetics, air pollution, water pollution, soil contamination, noise and vibration, and offensive odour.

It has been concluded that the allowable limit can be maintained by preparing suitable countermeasures based on the results of the EIA.

The EIA was approved by the Ministry of Environment of Cambodia on July 15, 2004.

##### **d.2 Land acquisition and public hearing**

MPP has already acquired 31.4 ha and 5,500m<sup>2</sup> of land for the new disposal site and access road for implementing the Dang Kor disposal site development project.

MPP also held three public hearings targeting the residents living in the project site and surrounding area (96 persons on Oct. 10, 2003; 279 persons on Dec. 25, 2003; and 352 persons on July 15, 2004) and obtained public consensus.

#### **7.1.4 Other SWM Problems and Recommended Countermeasures**

##### **a. Medical Waste Management**

The generation amount of infectious and hazardous medical wastes, estimated on the basis of the medical waste survey results, is 0.96 tons/day, or 350 tons/year. A technical system (separation of infectious and hazardous medical wastes at the source for separate collection, transport and treatment/disposal) for such wastes needs to be established as quickly as possible. Because the amount of hazardous medical waste generated is very limited compared to municipal solid waste, the disposal of such waste will not be such a big burden, on the condition that it is strictly separated from non-hazardous medical waste (general medical waste : 9.7 tons/day, 3,540 tons/year). Therefore, the Ministry of Health (MOH), which is responsible for supervising waste disposal at medical institutions, must ensure the strict separation of hazardous medical waste at the source, at every stage including collection, intermediate treatment, storage, and discharge.

As for non-hazardous medical waste, after strict separation from hazardous waste, it can be collected and disposed of as general waste, as is done at present.

Regarding non-hazardous medical waste, there are problems with disposal at individual medical institutions by small-scale incinerators in respect to air pollution and operation and maintenance. On the other hand, with the construction of large-scale incinerators, it is necessary to overcome problems in terms of size and investment cost recovery.

Hence, as a provisional method, the study team recommends disposal at individual medical institutions by small scale incinerators along with disposal by sanitary landfilling at disposal sites approved by the Ministry of Environment as being suitable for hazardous industrial waste. In the future, hazardous medical waste should be treated en masse at appropriate incineration plants along with other hazardous wastes. When the hazardous waste incineration plants are in operation, strict air pollution controls should be applied to existing small scale incinerators.

This kind of improvement work is accompanied by a rise in expenses. By law, medical institutions must bear all costs for handling hazardous medical waste, from collection to final disposal. Therefore, the Ministry of Environment, with the cooperation of the MOH, should examine ways in which medical institutions should cover the rise in costs.

##### **b. Industrial waste management**

According to the factory survey, the generation amount of hazardous industrial waste (1.9 tons/day, 694 tons/year) is very limited compared to that of non-hazardous industrial waste (56.3 tons/day, 20,550 tons/year). Furthermore, an industrial waste disposal site that has been approved of by the Ministry of Environment as being suitable for hazardous industrial waste is located in the neighboring of Kandal province. Therefore, the DOE and PPWM should establish a strict monitoring system for incoming vehicles to prevent hazardous industrial waste from being disposed of with general waste at the municipal disposal site. Industries categorized as highly potential hazardous industrial waste generators will not be

permitted to dispose waste at the municipal disposal site until they have proven their waste is not hazardous.

Meanwhile, standards and guidelines for implementing control and regulations at the national level should be immediately established, driving home the guiding principle that the polluter is responsible for the waste he generates.

As for non-hazardous industrial waste, after strict separation from hazardous industrial waste, it should be collected and disposed of as general waste, as is done at present.

### c. **Septic tank sludge management**

According to the septic tank sludge survey, the amount of sludge disposed of in the treatment ponds installed at SMC disposal site is a mere 5.8m<sup>3</sup> a day on average (based on 2003 data). Supposing that **30%** of Phnom Penh' population of 1,200,000 are using sludge treatment tanks, the generation amount, estimated based on Japanese data, would be 306m<sup>3</sup> per day, which is **53 times** more sludge than is generated at present.

Judging from this result, ① septic tanks are not working because the majority of them are full with sludge, or ② if the sludge is being collected, it is being improperly disposed of somewhere other than the treatment ponds at SMC disposal site.

In order to improve this situation, MPP should take the following measures:

- Investigate the condition of the installation of tanks and the collection of sludge, and based on the findings, formulate a management for plan septic tanks and septage sludge.
- Examine standards for septic tank management, establish laws for septic tanks, and clamp down on the improper disposal of septage sludge.
- Based on the management plan for septic tanks and septage sludge, establish a collection system and install new sludge treatment facilities.
- While the new sludge treatment facilities are being installed, maintain and use the existing treatment ponds at the SMC disposal site.

## 7.2 Recommendation

### 7.2.1 Recommendation for improvement of the Master Plan

#### a. **Unserviced and insufficiently serviced areas**

- MPP and the private company (CINTRI) should identify the unserviced and insufficiently serviced areas remaining in the city and amend the agreement to allow PPWM to provide the collection service to those areas.
- MPP/DOE should establish a system to monitor and control the service provided by PPWM and the private company.

#### b. **Establishment of a proper final disposal**

- PPWM should continue the pilot project for improvement of the SMC disposal site and develop its capability of landfill management.

- PPWM should raise the level of sanitary landfill operation in the SMC disposal site step by step.
  - PPWM should explain the increased benefit resulting from improvement of the landfill operation to the users and ask them to understand the necessity of raising the disposal fee and agree to pay it.
  - PPWM should negotiate with the user for raising the disposal fee step by step to cover the cost of landfill operation.
  - PPWM should explain the activities conducted for improvement of the SMC disposal site and persuade not only the residents living in the surrounding area but all citizens to share the cost for proper landfill operation.
- c. Implementation of the priority projects**
- Considering the internal difficulty in raising funds, the team recommends that MPP make every effort to secure the funds with foreign assistance to implement the Dang Kor Disposal Site Development Project and Waste Collection Service Expansion Project.
  - To make the project financially sustainable by only the income from the waste fee, MPP should secure a stable fee income system based on the establishment of a reasonable and transparent fee rate system that can be well accepted by all MSW users.
  - MPP should repeatedly explain the Dang Kor Disposal Site Development Project to the citizens living in the project site and the surrounding area until the implementation stage of the project to ensure their adequate understanding and to build public consensus.
  - PPWM should have a meeting with the waste pickers earning their daily bread in the SMC disposal site to discuss the future plan and treatment.
  - In order to supervise the operation of the new disposal site in Dang Kor, the DOE should set up a monitoring committee with the cooperation of the MOE, Khan and Sangkat offices, local residents, NGOs, etc.
- d. Acquisition of land for the facilities needed to implement the M/P**
- MPP should acquire the land for waste treatment and disposal facilities according to the strategies set in Section 3 of this report. However, site acquisition becomes increasingly difficult as more and more residents have the NIMBY syndrome. The MPP should secure the sites in advance.