

Fig. L.3-6 Collection Routes and Points of Ban Sisavath Kang

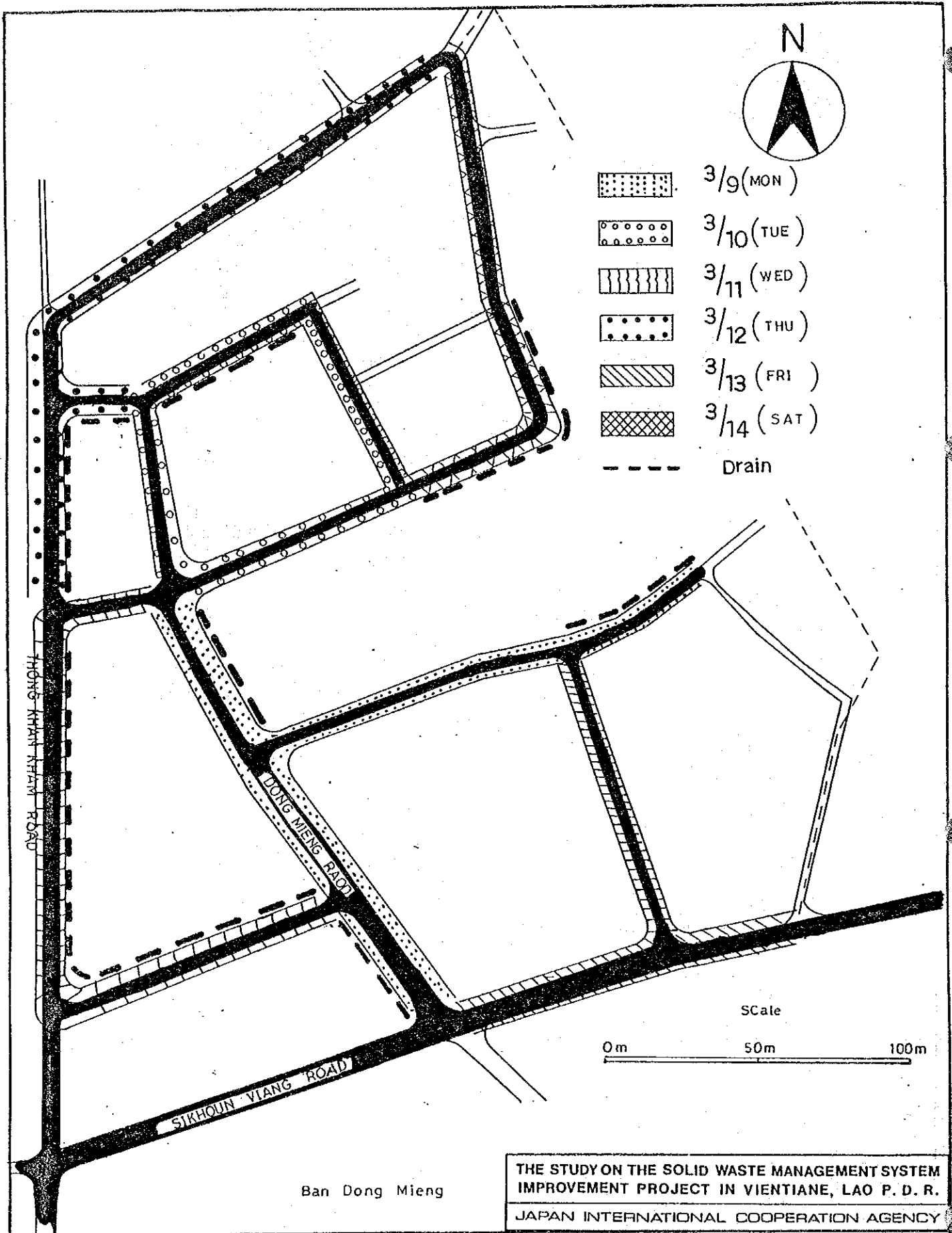


Fig. L. 3-7 Collection Routes for Cleaning-up of Road, Draing and Public Areas in Ban Dong Mieng

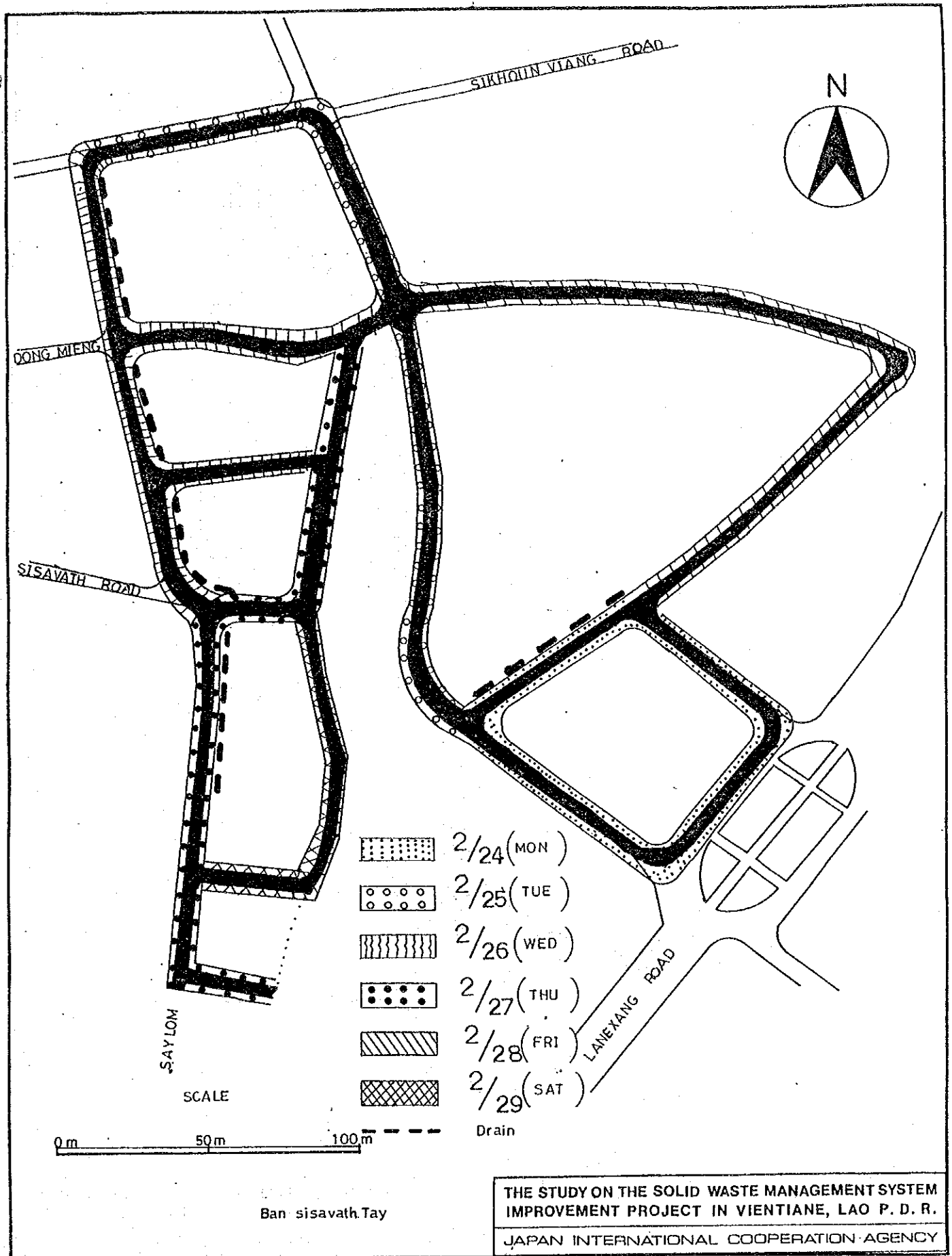


Fig. L.3-8 Collection Routes for Cleaning-up of in Ban Sisavath Tay

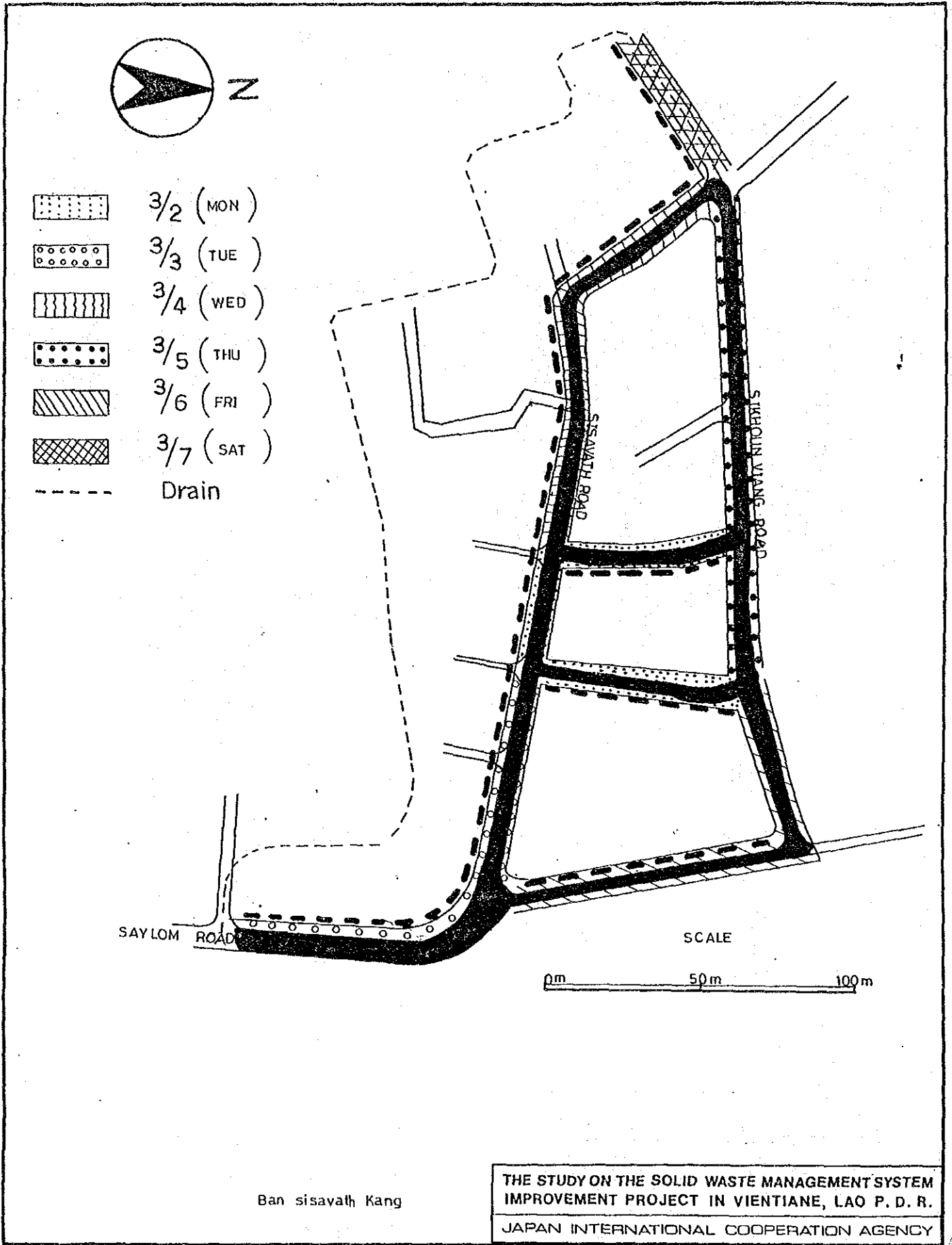


Fig. L.3-9 Collection Routes for Cleaning-up of in Ban Sisavath Kang

L.3.2 Implementation

The collection experiment was implemented in the three experimental areas from February 24 to March 18, 1992. During the experiment in order to examine the workability of proposed plan, the following studies were carried out;

- time and motion study (collection time, the distance for transportation, collection amount of waste, etc.);
- community consciousness survey (comparison of the CCS before and after the experiment);
- examination of operation and management system of collection vehicles;
- examination of the administrative system of workers;
- examination of the accounting system.

Among these, the operation and management of the collection vehicles, administration of workers and the accounting system were executed as immediate improvement measures in the experiment. The contents and results of them are mentioned in Appendix K.

1) Time and Motion Survey for Collection Experiment

a. Objectives of the study

The objectives of the study are;

- To examine the proposed collection system in the Basic Plan;
- To compare the collection efficiency between present collection system and collection experiment.

b. Contents of the study

The details of the study are described in Appendix E.5.

c. Method of the survey

The details of the study are mentioned in Appendix E.5.

d. Results

The results of the time and motion study executed to observe the collection and haulage system in the present collection areas and in the collection experiment are shown in Table L.3-5 and L.3-6, respectively.

In order to observe the present collection and haulage system, the time and motion study was executed for 8 days. Each of the collection vehicles of the DCTC and private contractors were traced for 4 days. On the other hand, the vehicle supplied by JICA was traced for 5 days to observe the collection and haulage system of the collection experiment.

i. time for collection service works

Working time starts from the departure of the collection vehicle from the depot until it arrives in the depot and is shown in Fig.L.3-9. The length and pattern of the time for collection service works is very different from the present collection system and the collection experiment.

The average working time in the collection experiment is approximately 2 hours per trip. Departure and arrival time of the vehicle is almost regular, however, working time in the present collection system varies from a minimum of 2 hours per trip and a maximum of about 7 and half hours per trip due to the irregularities in the departure and arrival time of the vehicles.

Table L.3-5 Collection Time, Distance and Loading Weight of Waste Observed in The Present Collection System

Items	1	2	3	4	5	6	7	8	9	10	11
1. Basic Information											
DCTC or Private Company	DCTC	DCTC	DCTC	DCTC	DCTC	DCTC	P-SWM	P-CRC	P-CRC	P-SWM	P-ISC
Vehicle No.	238	238	238	248	248	160	312	443	443	312	1208
Date of Survey	Nov. 13	Dec. 12	Dec. 12	Dec. 16	Dec. 16	Dec. 17	Nov. 12	Dec. 18	Dec. 18	Dec. 19	Dec. 20
Collection Area	Namphou	Medicine Factory	Namphou	Medicine Factory	Lao Beer Company	Wattay	Phone Xai	Namphou	Namphou	Phon Xai	Sok - Paluang
Crew	4	5	5	4	4	5	5	5	5	5	7
Drivers	1	1	1	1	1	1	1	1	1	1	1
Collectors	3	4	4	3	3	4	4	4	4	4	6
Departure Time from Depot	8:10	9:06	11:15	9:17	12:36	9:06	8:58	8:47	14:42	8:37	8:34
Arrival Time in Depot	10:15	11:15	13:41	12:10	16:26	13:49	15:25	12:38	17:10	16:03	15:14
Number of Trips	1	2(1st.)	2(2st.)	2(1st.)	2(2st.)	1	1	2(1st.)	2(2st.)	1	1
Type of Collection Vehicle	D T	D T	D T	D T	D T	O T	D T	D T	D T	D T	D T
Loading Capacity(m3)	8	8	8	10	10	10	12	10	10	12	10
2. Time (min.)											
Collection Time	45	38	87	45	121	109	215	106	70	248	243
Transportation Time											
Between Stations	18	0	57	0	0	49	46	11	14	54	86
Other Transportation	55	76	72	123	104	65	50	109	59	91	45
Unloading Time	5	5	5	5	5	45	5	5	5	5	5
Others(lunch, rest, repairs etc.)	2	10	45	0	0	15	71	0	0	48	21
Total	125	129	266	173	230	283	387	231	148	446	400
3. Distance (km)											
From Depot to 1st. Station	4	3	4	4	10	3	12	4	4	5	4
From 1st. Station to Last Station	19	0	7	0	0	12	73	1	1	11	24
From Last Station To Dump Site	15	22	21	22	31	21	12	21	20	16	19
From Dump Site to Depot or Next Collection Area	15	16	21	33	21	21	13	20	22	20	20
Total	53	41	53	59	62	57	110	46	47	52	67
4. Loading Waste (kg)											
Total	1,500	920	1,070	2,300	2,540	1,870	1,900	2,170	2,230	2,960	2,570

Note: D T:Dump Truck , O T:Open Truck without a Hoist

Table L.3-6 Collection Time, Distance and Loading Weight of Waste Observed
in the Collection Experiment

Items	1	2	3	4	5
1. Basic Information					
DCTC or Private Company	DCTC	DCTC	DCTC	DCTC	DCTC
Vehicle No.	383	383	383	383	383
Date of Survey	Mar. 9	Mar. 9	Mar. 10	Mar. 10	Mar. 11
Collection Area	Dong Miang	Ban Dong Miang	Sisavath Tay	Sisavath Tay	Sisavath Kang
Crew	5	5	5	5	5
Drivers	1	1	1	1	1
Collectors	4	4	4	4	4
Departure Time from Depot	8:30	14:15	8:20	14:15	8:21
Arrival Time at Depot	10:28	16:20	10:20	16:26	10:45
Number of Trips	2(1st.)	2(2st.)	2(1st.)	2(2st.)	1
Type of Collection Vehicle	D T	D T	D T	D T	D T
Loading Capacity(m3)	10	10	10	10	10
2. Time (min.)					
Collection Time	25	25	21	38	42
Transportation Time					
Between Stations	19	18	24	26	31
Other Transportation	69	77	57	62	66
Unloading Time	5	5	5	5	5
Others(lunch, rest, repaire etc.)	0	0	13	0	0
Total	118	125	120	131	144
3. Distance (Km)					
From Depot to 1st. Station	3.2	3.2	1.0	2.1	3.4
From 1st. Station to Last Station	1.3	1.2	4.1	1.6	1.9
From Last Station To Dump Site	19.8	19.5	18.5	18.4	19.0
From Dump Site to Depot or Next Collection Area	20.0	19.7	19.7	19.7	19.7
Total	44.3	43.6	43.3	41.8	44.0
4. Loading Waste (Kg)					
	1,120	1,130	860	1,180	1,760

Note; D T:Dump Truck

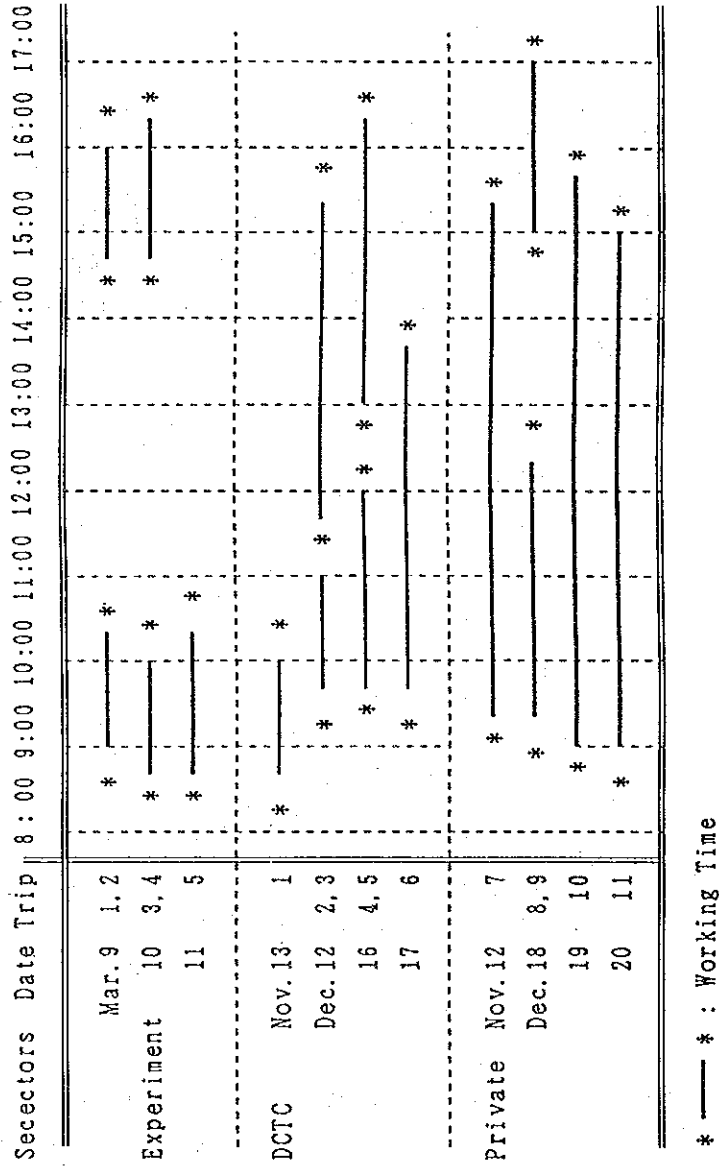


Fig. L.3-10 Time for Collection Service Works

Working time covers the following:

- collection time;
- transportation time between stations;
- transportation time aside from that between stations;
- unloading time;
- others (lunch, rest, repair etc.).

The items of the working time are stated in Fig.L.3-10. The difference in the working time of the collection experiment and the present system can be mainly attributed to the collection time. Collection time of the experiment is about 30 minutes per trip, while collection time of present system is as shown below.

Average	:	120 minutes
Minimum	:	40 minutes
Maximum	:	250 minutes

ii. distance

The distances covered by the collection services are as follows:

- distance from the depot to the collection area;
- distance in the collection area;
- distance from the collection area to disposal site; and
- distance from disposal site to the depot or next collection area.

The distances covered by the collection services are shown in Fig.L.3-11. The transportation distance in the present system is larger compared with that of the experiment. Moreover, the distance in the collection area of private-SWM and private-ISC is exceptionally long.

iii. Amount of Collected Waste

Average amount of collected waste of each sectors is observed as follows:

Experiment : 1.2 ton/trip;
DCTC : 1.7 ton/trip; and
Private Contractors : 2.4 ton/trip.

On the other hand, loading ratio is calculated as shown below. Hereupon, loading ratio means the ratio of loading volume of waste per trip to the loading capacity of the vehicle.

Loading ratio of vehicle for experiment : 70 %
Loading ratio of DCTC vehicles : 110 %
Loading ratio of vehicles belonging to private contractors: 130%

Note;

- [Loading Ratio (%)] = [Loading Volume of Waste per Trip]/
[Loading Capacity of Vehicle] x 100 %
- [Loading Volume of Waste per Trip] = [Loading Amount of Waste
per Trip]/0.173*

* 0.173 = Apparrent Specific Gravity (ASG) observed by the WACS
for waste hauled in KM18-DS

Amount of waste loaded by collection vehicles of DCTC and private contractors exceeds that of the collection experiment. The loading ratio, however, already exceeded 100% of the loading capacity of the vehicle. It is, therefore, concluded that the capacity of the vehicle for collection experiment will enable the expansion of the collection areas and that over loading may result frequent trouble or breakdown of the collection vehicles and irregular collection services.

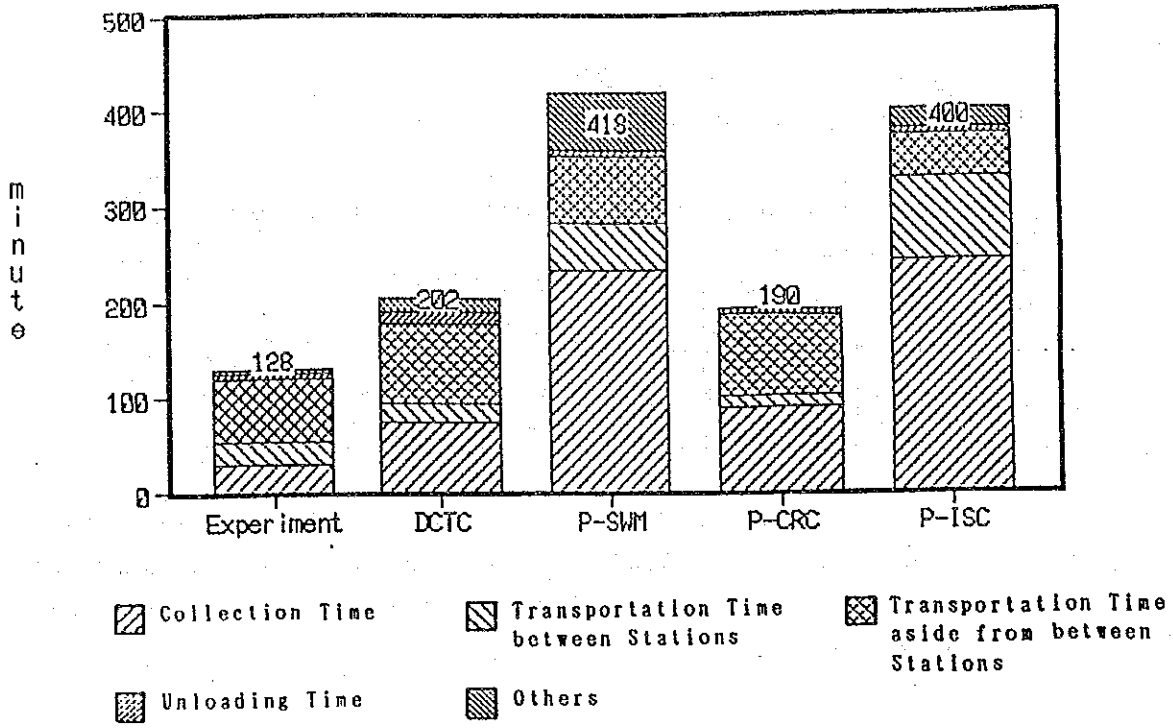


Fig. L.3-11 Comparison of Working Time for One Trip

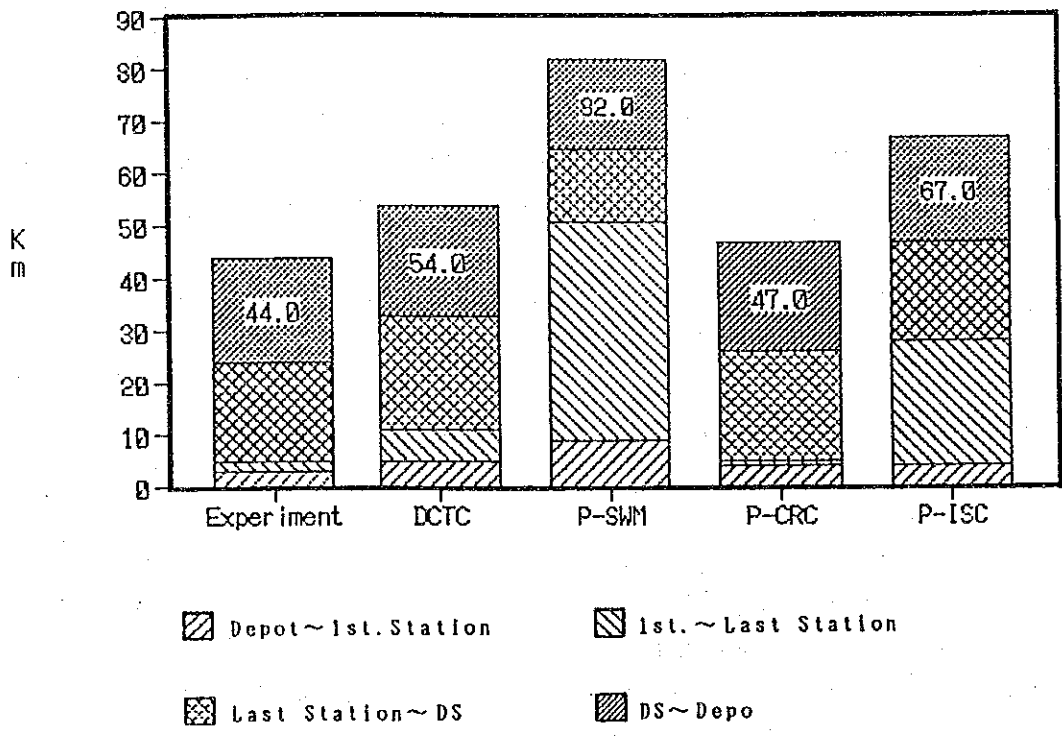


Fig. L.3-12 Comparison of Transportation Distance for One Trip

- iv. Collection efficiency of experiment and present system are shown in Table L.3-7. The Collection amount per working time per worker in the experiment was not so different from that of the other sectors at 113 kg/hr/worker. This is due to the loading ratio; i.e. the collection vehicle in the experiment keeps loading capacity while the present system exceeds it. The collection amount per collection time per worker, however, is considered to be considerably effective compared to other sectors at approximately 480 kg/hr./worker.

The following are concluded from the above mentioned comparison between present collection and collection experiment.

- The collection routes established in the collection experiment are proved to be suitable.
- The curb and bell collection proposed in the Basic Plan is accepted with the cooperation of the residents and its results high efficiency of the collection time.

2) Community Consciousness Survey for Collection Experiment

a. Objectives of the survey

The main objectives of the CCS (Community Consciousness Survey) are described as follows:

- to confirm the change in the awareness of the community before and during the collection experiment.
- to check the adaptability of the proposed collection system in the collection experiment.

Table L. 3-7 Comparison of Collection Efficiency

Items	Experiment	DCTC	P-SWM	P-CRC	P-ISC	Remarks
1. Basic Information						
a. Average Number of Crews	5	5	5	5	7	
b. Total Number of Trips Studied	5	6	2	2	1	
c. Average Capacity for Loading(m ³)	10	9	12	10	10	
2. Average Time for One Trip(min.)						
d. Collection Time	30	74	232	88	243	
e. Transportation Time						
f. Between Station	24	21	50	13	86	
g. Other Transportation	66	83	71	84	45	
h. Unloading Time	5	12	5	5	5	
i. Others(lunch, rest, repair etc.)	3	12	60	0	21	
j. Total	128	202	418	190	400	
3. Average Distance for One Trip (Km)						
k. From Depot to 1st. Station	3.0	5.0	9.0	4.0	4.0	
l. From 1st. Station to Last Station	2.0	6.0	42.0	1.0	24.0	
m. From Last Station To Dump Site	19.0	22.0	14.0	21.0	19.0	
n. From Dump Site to Depot or Next Collection Area	20.0	21.0	17.0	21.0	20.0	
o. Total	44.0	54.0	82.0	47.0	67.0	
4. Average of Loading Waste for One Trip(Kg)						
	1,210	1,700	2,430	2,200	2,570	
5. Collection Efficiency						
Collection Amount per Working Time per Worker(kg/hour/worker)	113	101	70	139	55	$4./\{(j/60)\}$ *a)
Collection Amount per Collection Time(kg/hour)	484	276	126	300	91	$4./\{(d/60)\}$ *a)
6. Loading Ratio(%)						
	70	109	117	127	149	$4./\{(c*0.173)\}*100$

0.173 : Apparent Specific Gravity (ASG) observed by the WACS for waste hauled in KM18-DS

b. Contents of the survey

i. survey period

The survey was conducted to compare the degree of awareness of the community before and during the execution of the collection experiment.

The schedule is shown as follows:

- before execution of collection experiment: February 20, 1992
- during the collection experiment: March 12, 1992

ii. survey areas and number of samples

The households covered by the CCS were selected from the candidate areas of the collection experiment. Although Bans Sisavath Neua and Tong Sang Nang were excluded from the collection experiment, they were included in the CCS in order to know the possible expansion method for their area. The survey areas and number of samples are as follows:

	Survey Areas	Number of Samples
Before the execution of collection experiment		15
	Sisavath Tay	5
	Sisavath Kang	5
	Dong Mieng	5
During the collection experiment		19
	Sisavath Tay	5
	Sisavath Kang	5
	Dong Mieng	5
	Sisavath Neua	2
	Tong Sang Nang	2

Note: The same households were selected from Sisavath Tay, Kang and Dong Mieng both before and during the collection experiment.

iii. method of survey

A questionnaire was prepared based on the CCS questionnaire which was used to grasp the present condition of SWM in the study area and is shown below.

The CCS was conducted by interviewing each resident. The answers obtained were put into the computer and processed and are described in the next section.

QUESTIONNAIRE FOR COMMUNITY CONSCIOUSNESS SURVEY

No. _____

Items for Interviewer

1. Date : _____
2. Interviewer : _____

I General Questions

Answers

3. Type of Interviewee : _____
 - 1 Housewife
 - 2 The Master
 - 3 Children
 - 4 Other family member
 - 5 Housekeeper (servant)
 - 6 Others
4. Address : _____
5. Number of persons staying in the house : _____
6. Number of dwelling years at this place : _____
 - 1 Less than 5 years
 - 2 5 ~ 9 years
 - 3 10 ~ 19 years
 - 4 20 years or more
7. Total expenditure of your family per month : _____
 - 1 Less than 50,000 kips/month
 - 2 50,000 ~ 75,000 kips/month
 - 3 75,000 ~ 100,000 kips/month
 - 4 100,000 ~ 150,000 kips/month
 - 5 More than 150,000 kips/month

II Questions on Discharge of Waste from Your House

8. Where do you discharge waste from your house ? _____
- 1 Into dustbins to be collected by worker
 - 2 Around my premises without dustbins
 - 3 Communal container
 - 4 Discharge Point recognized by your community
 - 5 Garbage compartment fixed in the house
 - 6 Cannal and drain
 - 7 Others (Please specify) :

9. What types of dustbins do you use. _____
- 1 Plastic bag
 - 2 Plastic bucket
 - 3 Metal bucket
 - 4 Bamboo basket
 - 5 Others (Please specify) :

10. Why do you use it ? _____
- 1 It is clean after collection work.
 - 2 It prevents foul odour.
 - 3 It is easy handling.
 - 4 Keep away pest such as flies.
 - 5 Others (Please specify) :

11. How much capacity does such dustbins hold ? _____
- 1 Less than 30 liters
 - 2 30 ~ 49 liters
 - 3 50 ~ 99 liters
 - 4 100 liters or more
12. How much volume of waste discharged from your family in terms of middle size of bamboo basket ? _____ liter/week

13. How many times do you discharge a waste in a month? _____

14. What time do you usually discharge your waste ? _____

- 1 6:00 ~ 8:59
 - 2 9:00 ~ 11:59
 - 3 12:00 ~ 14:59
 - 4 15:00 ~ 17:59
 - 5 Others
-

15. Where do you put your dustbin ? _____

- 1 In front of my premises
 - 2 Behind the premises
 - 3 In the house (kitchen)
 - 4 In the garden
 - 5 Others (Please specify) :
-

6 I don't know.

16. Is the dustbin with or without lid ? _____

- 1 With
- 2 Without
- 3 I don't know.

17. Do you have ever seen human scavengers
and animals on your waste ? _____

- 1 YES
- 2 NO

18. How do you discharge garden wastes (fallen
leaves and cut trees or grasses) ? _____

- 1 Discharge the garden waste with other waste.
- 2 Open combustion/burning.
- 3 Composting (producing fertilizer from wastes)
- 4 Needless to discharge garden wastes

5 Others (Please specify) :

19. Does anyone in your family sweep the road shoulder or adjacent public area in front

- 1 YES, Everyday
- 2 YES, Sometimes
- 3 No

20. Does anyone in your family clean the drain around your house ?

- 1 YES, Everyday
- 2 YES, Sometimes
- 3 No

III. Questions on Services of Waste Collection in Your Area

21. Do you receive a collection service ?

- 1 YES
- 2 NO

If "YES", please answer the followings;
(No. 22 ~ No. 31)

22. Are you satisfied with the collection service ?

- 1 YES
- 2 NO

23. If "NO", what are the reasons ?

- 1 Frequency of collection service is low.
- 2 Collection time is irregular.
- 3 Collection time is very early or late.
- 4 Behaviour of workers is bad.
- 5 Collection work is crude.
- 6 Collection fee is expensive.
- 7 Other (Please specify)

24. Do you know the waste discharged from your house is collected ? _____
- 1 YES
 - 2 NO
25. If "YES", how is the waste collected ? _____
- 1 Curb collection system
 - 2 Door to door collection system
 - 3 Bell collection system
 - 4 Others
26. Is collection service done at fixed day in a week ? _____
- 1 YES
 - 2 NO
27. Is collection service done at fixed time in the day ? _____
- 1 YES
 - 2 NO
28. If "YES", what time is your waste normally collected ? _____
- 1 6:00 ~ 8:59
 - 2 9:00 ~ 11:59
 - 3 12:00 ~ 14:59
 - 4 15:00 ~ 17:59
 - 5 Others (Please specify) :
- _____
29. How much do you pay for the collection service per a month ? _____ kips/month
30. What do you think about the collection fee ? _____
- 1 Expensive
 - 2 Cheap
 - 3 Suitable

4 Others

31. What is your reason to receive collection service ? _____

- 1 Because of low collection fee
- 2 Because of cleaning up the premise
- 3 Because of cleaning up the area
- 4 Because of improvement of sanitary condition in the area
- 5 Because of no place to discharge
- 6 Others

32. Do you know which authority is responsible for disposal of solid waste discharged by residents ? _____

- 1 State
- 2 Municipality
- 3 Yourself
- 4 State Sanitation Company
- 5 Private contractor
- 6 Others

33. Have you ever had any guidance on methods of proper discharge ? _____

- 1 YES
- 2 NO

34. In your area, are there "Clean Day" in which people are requested to participate on the "Public Cleansing" basis ? _____

- 1 YES
- 2 NO

35. If "YES", did you participate in such "Public Cleansing" in your area ? _____

- 1 YES
- 2 NO
- 3 I don't know.

36. Do you think that your area is beautiful ? _____

- 1 YES
- 2 NO

37. If "NO", what are the reasons ?

- 1 A waste is littering in the area.
- 2 Drains are unsanitary.
- 3 Discharge manner is not proper.
- 4 Others

38. If "NO", what shall you do to clean up your area ? _____

- 1 Receiving of collection service
- 2 Cleaning up drains
- 3 Pavement of a roads
- 4 A cure of throwing a waste to public areas
- 5 Others

39. Have ever talked about sanitary disposal of waste in your family ? _____

- 1 YES
- 2 NO

40. Do you think a education for sanitary disposal of waste is need ? _____

- 1 YES
- 2 NO

41. Do you have a trust in cleansing section of Vientiane Municipality regarding the collection service ? _____

- 1 YES
- 2 NO

c. Result of survey

The results of the survey are summarized as follows.

i. general conditions

The Interviewees were:

i) Residents who have been receiving collection services from private contractors before the collection experiment.....2 residents (13%)

ii) Residents who received collection services through the collection experiment. 13 residents (87%)

On the other hand, in the areas not covered by the experiment only one out of 4 residents was found to be receiving collection services from private contractors.

Total expenditure per month per family is more than 50,000 kips. One third of the residents in the experimental areas and three fourths in the non experimental areas exceeds 100,000 kips per month.

ii. discharge and storage

i) discharge points

Waste was discharged in various places before the experiment. However, discharge points were changed to collection points, with the use of bamboo baskets in the experiment. In the non experimental areas, discharge points of waste are mainly places recognized by the community.

ii) dustbins

The majority of the residents have been using bamboo baskets to store and discharge waste before the experiment. Therefore, the use of bamboo baskets as dustbins is acknowledged in the experiment. One of the reasons why residents use bamboo baskets is its handiness. The capacity of dustbins varied from 30 - 100 liters before the experiment, however, in the experiment, the size of the bamboo baskets was uniformed (medium size) and the capacity was decided around 70 liters.

Most of the dustbins used before and during the experiment have no lids.

iii) discharge volume of waste

The discharge volume of waste increased to around 50 liters to 70 liters in the experiment.

iv) discharge time of waste

50% of the residents discharged waste in the morning and the other 50% in the evening before the experiment. In the experiment, discharge time of waste was divided into three: before 9 o'clock, 9 - 12 o'clock and 12 - 15 o'clock.

v) Percentage of the residents who have seen human scavengers and animals decreased from 40% to 20%. It is also believed that the residents discharge their waste in accordance with the collection time.

vi) garden Waste

Discharge method of garden waste has been changed. Before the experiment, 70% of the residents burned them in the open, however, during the experiment, 90% of the residents discharge it along with the other wastes generated from residences.

vii) Most of the residents sometimes sweep the roads and public areas and clean the drains. No change has been observed in before and during the experiment.

iii. collection service

i) All of the residents receiving collection services indicate satisfaction.

ii) All of the residents received collection services at a fixed day and time in the experiment.

iii) 14 residents (93%) pay 1,000 kips per month and 1 resident (7%) pays 2,000 kips per month for collection fees.

iv) The residents' reason for receiving collection services before the experiment was due to the absence of a disposal site. During the experiment, however, community consciousness was heightened according to the following reasons given by the residents when asked of the same question.

- because it cleans the premises. ...6 residents (40%)
- because it cleans the area. ...3 residents (20%)
- because it improves sanitary conditions. ...3 residents (20%)

iv. community consciousness for waste

- i) Percentage of residents who received guidance on the proper discharge of waste during the experiment has increased compared with before the experiment. This can be mainly attributed to the meetings conducted for explaining matters concerning the experiment.
- ii) The percentage of residents who are aware of the "Clean Day" in their area and participate in the activity increased due to the execution of cleaning of roads, drains and public areas through public cooperation in the collection experiment.
- iii) Percentage of residents who consider their area to be beautiful has increased from 33%, before the experiment, to 87%, during the experiment.
- iv) The percentage of residents who think that collection services are necessary to clean up the area increased from 40%, before the experiment, to 100%, during the experiment.

Details of the CCS are shown below.

- 1) Percentage of residences and shop owners who have solid waste collection service. (Q21)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (15 Samples)	During Experiment (15 Samples)	(4 Samples)
2 (13%)	15 (100%)	1 (25%)

- 2) Total expenditure of each family per month. (Q7)

	Collection Experiment Areas		Non-Collection Experiment Areas
	Before Experiment (15 Samples)	During Experiment (15 Samples)	(4 Samples)
1. Less than 50,000 kips/month	1 (7%)	1 (7%)	0 (0%)
2. 50,000 ~ 75,000 kips/month	5 (33%)	5 (33%)	0 (0%)
3. 75,000 ~ 100,000 kips/month	4 (27%)	4 (27%)	1 (25%)
4. 100,000 ~ 150,000 kips/month	5 (33%)	5 (33%)	3 (75%)
5. More than 150,000 kips/month	0 (0%)	0 (0%)	0 (0%)
Total	15 (100%)	15 (100%)	4 (100%)

3) Place of discharge (Q8)

	Collection Experiment Areas		Non-Collection Experiment Areas (4 Samples)
	Before Experiment (15 Samples)	During Experiment (15 Samples)	
1. Into dustbins to be collected by worker	2 (13%)	15 (100%)	
2. Around premises without dustbins	4 (27%)	0 (0%)	
3. Communal container	0 (0%)	0 (0%)	1 (25%)
4. Discharge point recognized by your community	1 (7%)	0 (0%)	3 (75%)
5. Garbage compartment fixed in the house	3 (20%)	0 (0%)	
6. Cannal and drain	0 (0%)	0 (0%)	
7. Others	5 (33%)	0 (0%)	
Total	15 (100%)	15 (100%)	4 (100%)

4) Type of containers for carrying waste to discharge point. (Q9)

	Collection Experiment Areas.		Non-Collection
	Before Experiment (15 Samples)	During Experiment (15 Samples)	Experiment Areas (4 Samples)
1. Plastic bag	0 (0%)	0 (0%)	1 (25%)
2. Plastic bucket by your community	1 (7%)	0 (0%)	0 (0%)
3. Metal bucket fixed in the house	1 (20%)	0 (0%)	1 (25%)
4. Bamboo basket	13 (87%)	15 (100%)	2 (50%)
5. Others	0 (0%)	0 (0%)	0 (0%)
Total	15 (100%)	15 (100%)	4 (100%)

5) Reasons why the container is used. (Q10)

	Collection Experiment Areas		Non-Collection Experiment Areas (4 Samples)
	Before Experiment (15 Samples)	During Experiment (15 Samples)	
1. It is clean after collection work.	1 (0%)	0 (0%)	0 (0%)
2. It prevents foul odour.	0 (0%)	0 (0%)	0 (0%)
3. It is easy handling.	14 (93%)	15 (100%)	4 (100%)
4. Keep away pest such as flies	0 (0%)	0 (0%)	0 (0%)
5. Others	0 (0%)	0 (0%)	0 (0%)
Total	15 (100%)	15 (100%)	4 (100%)

6) Capacity of the container. (Q11)

	Collection Experiment Areas		Non-Collection Experiment Areas
	Before Experiment (15 Samples)	During Experiment (15 Samples)	
1. Less than 30 liters	1 (0%)	0 (0%)	2 (50%)
2. 30 ~ 49 liters	6 (40%)	0 (0%)	0 (0%)
3. 50 ~ 99 liters	9 (60%)	15 (100%)	2 (50%)
4. 100 liters or more	0 (0%)	0 (0%)	0 (0%)
Total	15 (100%)	15 (100%)	4 (100%)

7) Discharge volume of waste a week. (Q12)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (15 Samples)	During Experiment (15 Samples)	
		(4 Samples)
43 liters	70 liters	50 liters

8) Time of discharge of the waste. (Q14)

	Collection Experiment Areas		Non-Collection Experiment Areas (4 Samples)
	Before Experiment (15 Samples)	During Experiment (15 Samples)	
	1. 6:00 ~ 8:59 AM	7 (47%)	
2. 9:00 ~ 11:59 AM	1 (7%)	5 (33%)	1 (25%)
3. 12:00 ~ 14:59 PM	0 (0%)	5 (33%)	0 (0%)
4. 15:00 ~ 17:59 PM	4 (27%)	0 (0%)	1 (25%)
5. Others	3 (20%)	0 (0%)	2 (50%)
Total	15 (100%)	15 (100%)	4 (100%)

9) Place of the dustbin. (Q15)

	Collection Experiment Areas		Non-Collection Experiment Areas (4 Samples)
	Before Experiment (15 Samples)	During Experiment (15 Samples)	
	1. In front of their premises	4 (27%)	
2. Behind the premises	4 (47%)	0 (0%)	1 (25%)
3. In the house (kitchen)	1 (7%)	0 (0%)	2 (50%)
4. In the garden	2 (13%)	0 (0%)	0 (0%)
5. Others	1 (7%)	0 (0%)	0 (0%)
Total	15 (100%)	15 (100%)	4 (100%)

10) Percentage of the dustbin with lid. (Q16)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (15 Samples)	During Experiment (15 Samples)	(4 Samples)
1 (70%)	3 (20%)	1 (25%)

11) Percentage of residents and shop owners who have seen human scavengers and animals on their waste. (Q17)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (15 Samples)	During Experiment (15 Samples)	(4 Samples)
6 (40%)	3 (20%)	0 (0%)

12) Discharge method of garden waste.. (Q18)

	Collection Experiment Areas		Non-Collection Experiment Areas
	Before Experiment (15 Samples)	During Experiment (15 Samples)	(4 Samples)
1. Discharge the garden waste with other waste.	2 (20%)	13 (87%)	1 (25%)
2. Open combustion/burning	11 (73%)	2 (13%)	3 (75%)
3. Composting (producing fertilizer from wastes).	0 (0%)	0 (0%)	0 (0%)
4. Needless to discharge garden wastes	0 (0%)	0 (0%)	0 (0%)
5. Others	1 (7%)	0 (0%)	0 (0%)
Total	15 (100%)	15 (100%)	4 (100%)

- 13) Percentage of residents and shop owners who sweep the road shoulder or adjacent public area in front of their house. (19)

	Collection Experiment Areas		Non-Collection Experiment Areas (4 Samples)
	Before Experiment (15 Samples)	During Experiment (15 Samples)	
	1. Everyday	1 (7%)	
2. Sometimes	13 (86%)	12 (80%)	3 (75%)
3. No	1 (7%)	1 (7%)	0 (0%)
Total	15 (100%)	15 (100%)	4 (100%)

- 14) Percentage of residents and shop owners who clean drain around their houses.

	Collection Experiment Areas		Non-Collection Experiment Areas (4 Samples)
	Before Experiment (15 Samples)	During Experiment (15 Samples)	
	1. Everyday	0 (0%)	
2. Sometimes	15 (100%)	15 (100%)	4 (100%)
3. No	0 (0%)	0 (0%)	0 (0%)
Total	15 (100%)	15 (100%)	4 (100%)

15) Percentage of residents and shop owners who are satisfied with the collection service. (Q22)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (2 Samples)	During Experiment (15 Samples)	(1 Sample)
2 (100%)	15 (100%)	1 (100%)

16) Percentage of residents and shop owners who are aware of the collection system in their area. (Q24)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (2 Samples)	During Experiment (15 Samples)	(1 Sample)
1 (50%)	10 (67%)	0 (0%)

17) Collection system (Q25)

	Collection Experiment Areas		Non-Collection Experiment Areas
	Before Experiment (1 Sample)	During Experiment (10 Samples)	(0 Sample)
1. Curb collection system	0 (0%)	8 (80%)	-
2. Door to door collection	1 (100%)	-	-
3. Bell collection system	1 (100%)	2 (20%)	-
Total	1 (100%)	10 (100%)	-

18) Percentage of residents and shop owners who receive the collection service at fixed day in a week ? (Q26)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (2 Samples)	During Experiment (15 Samples)	(1 Sample)
1 (50%)	15 (100%)	0 (0%)

19) Percentage of residents and shop owners who receive the collection service at fixed time in the day. (Q26)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (2 Samples)	During Experiment (15 Samples)	(1 Sample)
0 (0%)	15 (100%)	0 (0%)

20) Amount of money paid per month for the collection service. (Q29)

	Collection Experiment Areas		Non-Collection Experiment Areas
	Before Experiment (2 Samples)	During Experiment (15 Samples)	(1 Sample)
1. 500 kip/month	2 (100%)	0 (0%)	0 (0%)
2. 600 kip/month	0 (0%)	0 (0%)	1 (100%)
3. 1,000 kip/month	0 (0%)	14 (93%)	0 (0%)
4. 2,000 kip/month	0 (0%)	1 (7%)	0 (0%)
Total	2 (100%)	15 (100%)	1 (100%)

21) The reason to receive collection service. (Q31)

	Collection Experiment Areas		Non-Collection
	Before Experiment (2 Samples)	During Experiment (15 Samples)	Experiment Areas (1 Sample)
1. Because of low collection fee.	0 (0%)	0 (0%)	0(0%)
2. Because of cleaning up the premise.	0 (0%)	6 (40%)	0 (0%)
3. Because of cleaning up the area.	0 (0%)	3 (20%)	1 (100%)
4. Because of improvement of sanitary condition in the area.	0 (0%)	3 (20%)	0 (0%)
5. Because of no place to discharge.	2 (100%)	3 (20%)	0 (0%)
6. Others			
Total	2 (100%)	15 (100%)	1 (100%)

22) Knowledge of residents and shop owners regarding the responsible organization for disposal of solid waste. (Q32)

	Collection Experiment Areas		Non-Collection Experiment Areas
	Before Experiment (15 Samples)	During Experiment (15 Samples)	
1. State	0 (0%)	0 (0%)	
2. Municipality	1 (7%)	3 (20%)	
3. Themselves	0 (0%)	0 (0%)	
4. State Sanitation Company	8 (53%)	11 (73%)	1 (25%)
5. Private contractor	0 (0%)	0 (0%)	1 (25%)
6. Others	0 (0%)	0 (0%)	
7. I don't know.	6 (40%)	1 (7%)	2 (50%)
Total	15 (100%)	15 (100%)	4 (100%)

23) Percentage of residents and shop owners have ever had a guidance on method of proper discharge of wastes. (Q33)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (15 Samples)	During Experiment (15 Samples)	
		(4 Samples)
1 (7%)	15 (100%)	2 (50%)

24) Percentage of residents and shop owners who have a "Clean Day" in their area for "Public Cleansing" service by the residents. (Q34)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (15 Samples)	During Experiment (15 Samples)	(4 Samples)
6 (40%)	11 (73%)	4 (100%)

25) Percentage of residents and shops who participate in the "Public Cleansing" in their area. (Q35)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (15 Samples)	During Experiment (15 Samples)	(4 Samples)
9 (60%)	12 (80%)	4 (100%)

26) Percentage of residents and shop owners who think that their area is beautiful. (Q36)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (15 Samples)	During Experiment (15 Samples)	(4 Samples)
5 (33%)	13 (87%)	1 (25%)

27) The reason that their area is not beautiful. (Q37)

	Collection Experiment Areas		Non-Collection Experiment Areas
	Before Experiment (10 Samples)	During Experiment (2 Samples)	(3 Samples)
1. A waste is littering in the area.	3 (30%)	2 (100%)	1 (33%)
2. Drains are unsanitary	1 (10%)	0 (0%)	2 (67%)
3. Discharge manner is not proper.	5 (50%)	0 (0%)	0 (0%)
4. Others	1 (10%)	0 (0%)	0 (0%)
Total	10 (100%)	2 (100%)	3 (100%)

28) The method to clean up their area. (Q38)

	Collection Experiment Areas		Non-Collection Experiment Areas
	Before Experiment (10 Samples)	During Experiment (2 Samples)	(3 Samples)
1. Receiving of collection service.	4 (40%)	2 (100%)	1 (33%)
2. Cleaning up drains.	2 (20%)	0 (0%)	2 (67%)
3. Pavement of a roads.	0 (0%)	0 (0%)	0 (0%)
4. A cure of throwing a waste to public areas.	4 (40%)	0 (0%)	0 (0%)
5. Others	0 (0%)	0 (0%)	0 (0%)
Total	10 (100%)	2 (100%)	3 (100%)

29) Percentage of residents and shop owners who have talked about sanitary disposal of waste in their family. (Q39)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (15 Samples)	During Experiment (15 Samples)	(4 Samples)
11 (73%)	12 (12%)	3 (75%)

30) Percentage of residents and shop owners who think that a education for sanitary disposal of waste is needs. (Q40)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (15 Samples)	During Experiment (15 Samples)	(4 Samples)
14 (93%)	15 (100%)	3 (75%)

31) Percentage of residents and shop owners who have a trust in cleansing section of Vientiane Municipality regarding the collection service. (Q41)

Collection Experiment Areas		Non-Collection Experiment Areas
Before Experiment (15 Samples)	During Experiment (15 Samples)	(4 Samples)
13 (87%)	15 (100%)	4 (100%)

3) Operation and management system of collection vehicles

The contents of the system and results are mentioned in Appendix K. The following items were examined in the collection experiment;

a. Weekly schedule of collection vehicles.

Management of collection vehicles and regular services to residents etc., contracted by DCTC under weekly terms.

b. Improvement of basic knowledge.

Training to improve the basic knowledge of the DCTC operators and mechanics regarding operation and maintenance.

c. Execution of regular maintenance.

Execution of training course on regular maintenance system for the operators and mechanics.

4) Executing committee for collection experiment

A committee was established in order to carry out the collection successfully. The number of staff totaled to 18 persons. Consequently, the committee was well organized. The clarification of duties and responsibilities resulted in efficient labour.

Collection crews were especially managed according to working day table. The details of the contents and results are mentioned in Appendix K. The items examined in the collection experiment are as follows;

a. Improvement of accounting system.

Introduction of a separate accounting system for SWM using an accounting sheet.

b. Improvement of fee collection by using ledgers.

Contract and fee collection based on ledgers.

c. Collection of data for operational expenditure.

Introduction of monthly analysis sheet using an accounting sheet.

L.4 Findings

- 1) Number of residences and shops contracted in the experiment were 306. The figure is equivalent to 30% of the total number of families in the 3 bans, while the present ratio of residents covered by the collection service is only 4.8% in the residential area.

A total of 33 families applied for a new contract for collection services after the experiment (March 25). This occurrence indicates that the number of participants will increase in future.

- 2) As shown in Table L.4-1, total amount of fee collected during the one-month experiment was 314 thousand kips. This is equivalent to about 50% of the total waste collection fee per month of DCTC in 1990.

Table L.4-1 Revenue and Expenditure of Collection Experiment

Unit; Kips

Item	Revenue Expenditures
1. Revenue	<u>402,110</u>
- Collection Fee	314,000
- Tipping Fee	88,010
- Others	100
2. Expenditure	<u>353,490</u>
- * Personnel Expenditure (18 persons)	216,300
Administration (5 persons)	(38,200)
Cleansing Service (10 persons)	(138,100)
KM 18-DS (3 persons)	(40,000)
- Fuel & Lubricant for Vehicle	100,200
- Maintenance for Vehicle	28,000
- Others (Administrative Expenditure etc.)	8,990
3. Balance	<u>48,620</u>
- Total Revenue	402,110
- Total Expenditure	353,490

* Note; The figure 216,300 includes the personnel expenditure for actual working days in the experiment; i.e. Two and half days per week.

The balance of revenue and expenditure had a surplus of about 49 thousand. Therefore, it proved that the experiment was feasible.

- 3) Bell and curb collection system were applied to the experiment. Due to regular and designated collection services to residences and shops in the area, the residents conceded in bringing their waste to collection points. Consequently, an effective collection work was achieved as proven by the T & M study. It is also proven that the proposed collection system in the Basic Plan should be implemented for the method of the extension of the collection service to the whole Vientiane urban area.

Some of the residents and shops in the area requested for the collection of other waste not stipulated in the contract. By continuous explanation and instructions, however, only contracted wastes were strictly collected. Finally, the residents understood the principle.

In order to respond to the request of extra amount of waste discharge, extra ticket (250 kips/basket) was proposed to residents and shops who temporarily discharged large amount of waste temporarily.

- 4) As for the cleaning-up of roads, drains and public areas through public cooperation, a cleansing day was proposed and implemented in each Ban.

The Study Team informed the chiefs of the 3 Bans the designated day for cleaning, method of cleaning and type of waste to be cleaned, and asked them to explain the details to the residents and to solicit volunteers. In addition, announcements were made on the loudspeaker before the designated days. The result of the cleansing work by the residents, however, was not satisfactory.

DCTC as well as the chiefs of the Bans were requested to take further efforts such as the implementation of public campaigns and education, in order to achieve the public cooperation in its cleansing services.

5) The role of the fee collectors is considered to be quite important. Their two major duties are to conduct contract negotiations and to collect fees and to act as the medium of the DCTC administrators and the residents in order to improve SMW in the area. These duties are important factors in the extension of collection services.

2) Balance of Revenue and Expenditure on Collection Experiment

The balance of revenue and expenditure on collection experiment is shown in Table L.5-2. During experiment, an accounting system was established apart from the other DCTC accounting. The expenditure concerned with the experiment, e.g. personnel expenditure, fuel & lubricant for collection vehicle and operation & maintenance expenditure was released by the fee collected from residents and tipping fee collected from the incoming vehicles to KM 18-DS. The results of the balance for four months are shown as follows.

Revenue : 1,615,910 kips
 Expenditure : 1,111,390 kips
 Balance : + 540,520 kips

Table L.5-2 Balance of Revenue and Expenditure

Unit:Kips

	Revenue	Expenditure	Balance
March	402,110	353,490	+ 48,620
April	455,400	155,630	+ 299,770
May	405,400	291,100	+ 114,300
June	389,000	311,170	+ 77,830
Total	1,651,910	1,111,390	+ 540,520

3) Amount of Waste Hauled to KM 18-DS

Amount of waste hauled to KM 18-DS from commencement of observation by the truckscale (November 11,1991) to the commencement of collection experiment (January 23,1992) is shown as follows;

DCTC	:	6.1 ton/day	(35%)
Private Contractors	:	7.8 ton/day	(45%)
Directly	:	3.5 ton/day	(20%)

Total : 17.4 ton/day (100%)

Amount of waste hauled to KM 18-DS from February to May was changed as follows;

DCTC	:	7.7 ton/day	(37%)
Private Contractors	:	8.4 ton/day	(40%)
Directly	:	4.7 ton/day	(23%)

Total : 20.8 ton/day (100%)

The waste collection capability of DCTC increased to 1.6 ton/day in comparison with before the experiment. 1.6 ton/day is equivalent to 26% of the present waste collection capability of DCTC. It was deduced that the capability of DCTC was improved. The collection capability of DCTC and private contractors became almost equal.

APPENDIX M

EXPERIMENT ON SANITARY LANDFILL OPERATION

APPENDIX M EXPERIMENT ON SANITARY LANDFILL OPERATION

M.1 Objectives

M.1.1 Purpose of Pilot Project

There are many improvement measures in the Basic Plan. In terms of the technical system for the Basic Plan, the following two are main objectives;

- a. Extension of collection service to the whole population of the Vientiane urban area; and
- b. Execution of sanitary landfill for disposal of solid waste collected.

In order to examine the workability of the proposed Basic Plan and to make the Plan more practical, pilot project consisting of collection experiment and experiment on sanitary landfill operation have been carried out for one month from the middle of February.

After the preparation of a draft plan, various meetings with the organization and persons concerned in the project have been held in February in order to concrete and strengthen the draft plan. After the modification of the draft plan, both collection and sanitary landfill operation experiment have been carried out from the end of February.

M.1.2 Objectives of the Experiment

Basically, the objectives of the experiment on sanitary landfill operation were;

- i. to demonstrate the impact of the environmental improvement at the present KM 18-DS by the execution of sanitary landfill operation;
- ii. to examine the workability of the level 2 sanitary landfill development and operation proposed for one of the first priority project of the Basic Plan; and
- iii. to identify the problems and obstacles to be solved for the successful execution of the sanitary landfill development and operation at level 2.

However, in order to obtain the first objective, that is to demonstrate the impact of the environmental improvement, it was necessary to execute some of the immediate improvement measures such as

- i. to clean-up waste disposed at the entrance, scattering waste, etc.;
- ii. to prepare a good access to the inside of the KM 18-DS; and
- iii. to construct a fence in front of the site.

It was, therefore, that the above-mentioned measures have been executed at the time of the experiment on sanitary landfill operation.

M.2 Proposed Plan

M.2.1 Site Development Plan

First of all, the site development for experiment on sanitary landfill operation at the KM 18-DS should be done before the execution of the experiment. The site development plan is illustrated in Fig. M.2-1, and the outline of it is described below.

1) Clean-up Site

Since a crude open dumping has been conducted for more than 20 years at the KM 18-DS, there were considerable amount of wastes disposed without any order. These wastes not only create ugly view but also impede the operation of landfill, especially those disposed at the entrance. It is, therefore, necessary to clean up the wastes disposed at the entrance and proposed experimental area of the KM 18-DS at first.

2) Construction of an Enclosing Bund

After the clean-up, an enclosing bund for experiment, as shown in Fig. M.2-2, is constructed in accordance with the following orders;

- construction of the embankment with the cleaned up wastes;
- excavation of the bottom of experimental area to obtain cover soil; and
- covering the embankment with the soil excavated.

3) Construction of Good Access

Since there was no landfill equipment available for the KM 18-DS and it was very difficult to obtain one, the landfill operation after the experiment was supposed to become the same as before and meet many difficulties especially in term of access to the inside of the site.

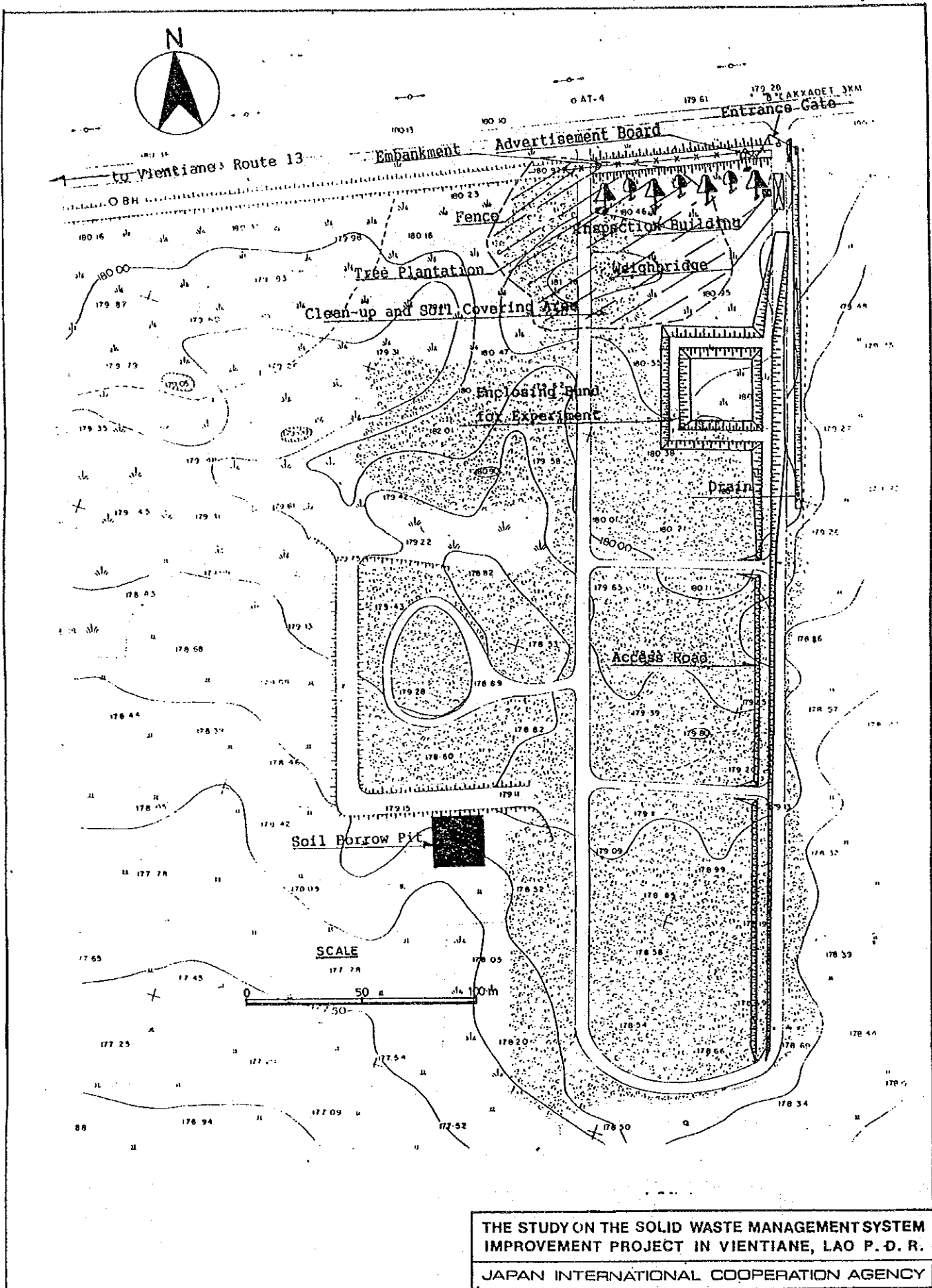


Fig. M.2-1 Site Development Plan for the Experiment on Sanitary Landfill

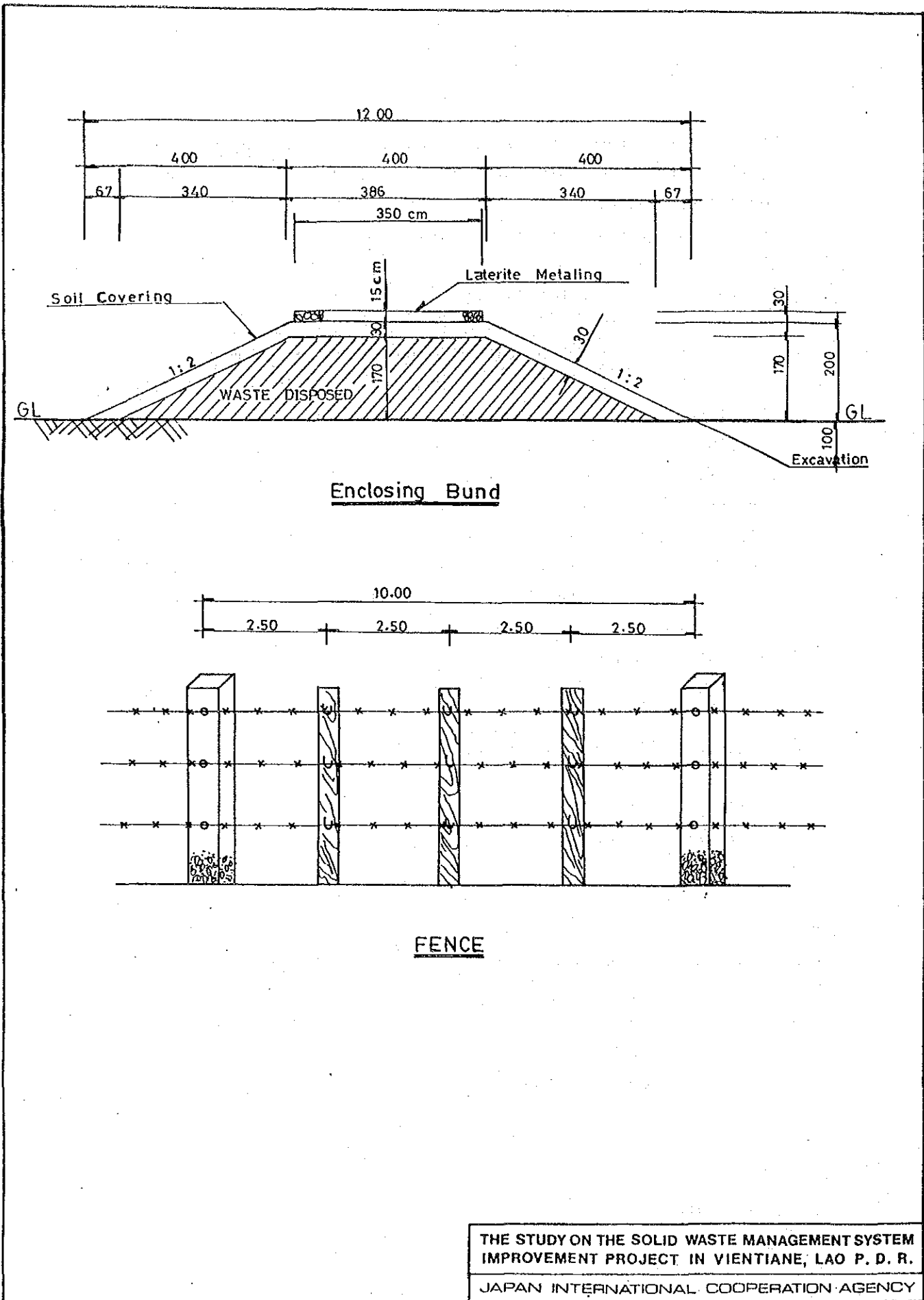
It is, therefore, proposed to construct a good access to the inside of the KM 18-DS in order to avoid dumping waste at the entrance. The access road is constructed with the soil obtained from a soil borrow pit in the site.

4) Improvement of the Entrance

Due to the operation of the crude open dumping for more than 20 years, the image of the KM 18-DS was very bad in the citizens of Vientiane Municipality. They thought the site as a kind of a dirty latrine of the city. There were many flies, leachate, odor, waste littering, and even fire. Since the route 13 is the trunk road of the nation, a lot of the people noticed the KM 18-DS as one of the dirtiest place in Vientiane. It is, therefore, necessary to change the images of the citizens on the KM 18-DS in order to secure the continuous use of the site for the Basic Plan.

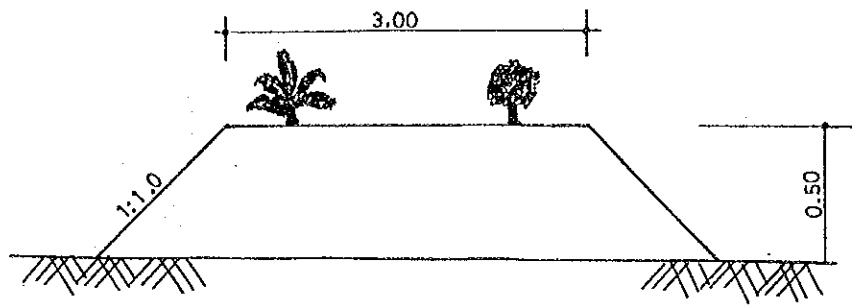
The improvement plan of the entrance of the site is proposed as follows (see Fig. M.2-2 and M.2-3);

- clean-up the waste disposed;
- covering the cleaned up area with soil obtained from the borrow pit;
- construction of a bund along the route 13;
- construction of a fence on the bund;
- plantation of coconut trees and tako trees (specie of local tree) on the bund;
- installation of an advertisement board which explains sanitary landfill operation;
- construction of a drain along the access road into the inside of the site; and
- construction of an entrance gate.

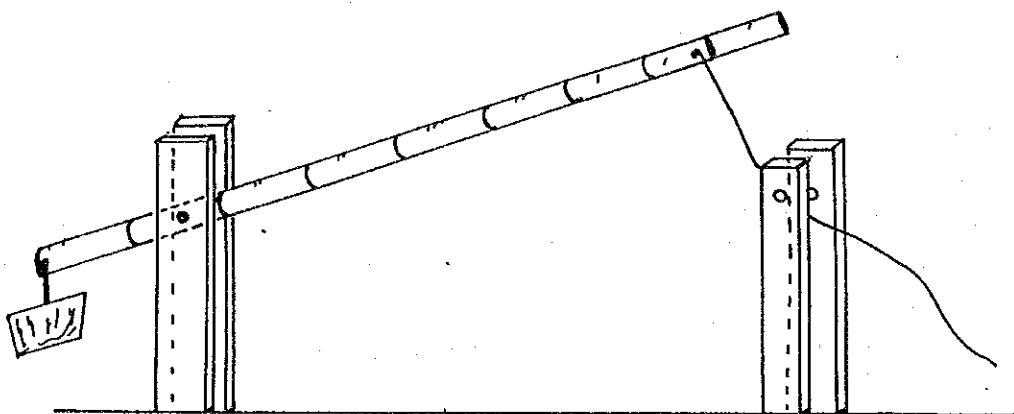


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 IMPROVEMENT PROJECT IN VIENTIANE, LAO P. D. R.
 JAPAN INTERNATIONAL COOPERATION AGENCY

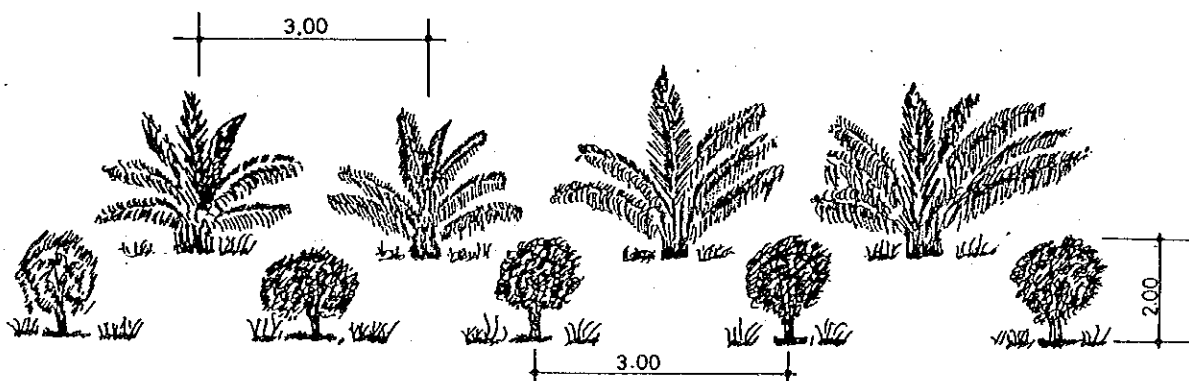
Fig. M.2-2 Plans of Enclosing Bund and Fence



EMBANKMENT



ENTRANCE GATE



PLANTATION

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Fig. M.2-3 Plans of Embankment, Entrance Gate and Plantation

M.2.2 Operational Plan

Due to the expenditure for the site development plan, the budget for the sanitary landfill operation was limited. In order to execute a sanitary landfill operation with the limited budget, the following operational plan is proposed;

- a. The waste is filled in places directed to the driver by the staff.
- b. The dumped waste is spread and crushed by a bulldozer into a flat horizontal layer for sufficient compaction.
- c. After the completion of landfill operations, the covering operation is performed by the sandwich method.
- e. Final cover is laid on top of the layer of landfill.

M.3 Results

M.3.1 Execution

1) Joint Work

In order to pursue technology transfer to the Laotian counterparts, the experiment should be carried out with the joint work of DCTC and the Study Team. The DCTC was requested to assign the following staffs to the experiment by the Study Team;

- two operators for a bulldozer and a hydraulic excavator;
- a driver for a dump truck; and
- an engineer for the supervision of the experiment.

However, the request was not realized except for the assignment of the engineer, because the equipment and vehicles were rent from a private company and the operators of DCTC were not capable on the operation of them.

2) Execution

The site development works commenced on February 13, 1992 and the sanitary landfill operation started on February 23, 1992. The experiment ended on March 2, 1992. For the execution of sanitary landfill development and operation, the following equipment and vehicles were deployed according to the demand of the works;

- a bulldozer;
- a hydraulic excavator;
- three dump trucks;
- a wheel loader; and
- a motor grader.

M.3.2 Findings

Results and findings following the execution of the experiment on sanitary landfill operation are described below.

- i. After the completion of the basic site development, the experiment on sanitary landfill operation commenced on February 23 in the presence of the governor and a vice governor of Vientiane Municipality. It was a great opportunity for the highest municipal administrators to understand the necessity of sanitary landfill operation, because they knew the previous KM 18-DS before the development and they were surprised on a big change from the ugliest view to environmentally acceptable landfill view. Subsequently, the authorization of KM 18-DS and securing land for it was smoothly done. In addition, a special budget for the improvement of the site and securing land was allocated by the Municipality.
- ii. Since the site development included a landscaping work, i.e. clean-up and covering the entrance with soil, plantation of trees, and construction of fence and entrance gate, the dirty entrance of the site became a playground in which the surrounding residents could enjoy sports. This improved the image of the KM 18-DS very much.
- iii. As an access road was constructed by the soil obtained at the borrow pit, a smooth access into the inside of the site was achieved even in a rainy season. Consequently, the dumping waste at the entrance did not occur and unloading time of the collection vehicles at the site was reduced.
- iv. It was proved that the sanitary landfill operation of level 2 could be done by DCTC if the necessary equipment were available. The necessity of the sanitary landfill operation was clearly understood by the relevant authorities.

APPENDIX N

*FEASIBILITY STUDY OF THE
FIRST PRIORITY PROJECT*

APPENDIX N FEASIBILITY STUDY OF THE FIRST PRIORITY PROJECT

N.1 Preliminary Design of Technical System

N.1.1 Design Conditions

1) Contents of the First Priority Project

Stepwise approach is necessary to achieve the targets of Basic Plan considering the financial limitation and difficulty of obtaining public cooperation.

Phase improvement plan is proposed as follows.

- a. Phase I 1995 - 1997
- b. Phase II 1998 - 2000

Before commencement of Phase I project, immediate improvement projects are proposed in order to contribute to successful implementation of the Phase I project.

The Basic Plan consists of various projects. Among the various projects in the Basic Plan the first priority project regarding the technical system in 1995 (Phase I) is proposed and the outline of that is described below.

- Extension of collection service area;
- Establishment of appropriate transfer system for the institutional wastes;
- Establishment of public cooperation for cleaning-up road and drain;
- Establishment of proper operation and maintenance system; and
- Construction and execution of a sanitary landfill level 2 at the KM 18-DS.

2) Design Conditions

The following are the design conditions of the first priority project;

- target year ; 1995
- target area ; Vientiane urban area
- population ; 163,100 persons
- service population ; 81,500 persons
- collection amount ; 68.3 ton/day
 - by Vientiane Municipality (58.3)
 - by private contractor (10.0)
- road sweeping service by Vientiane Municipality ; 15 km
- cleansing activity through public cooperation ; 48 Bans (villages)
- length of road for sprinkling water ; 150 km
- final disposal amount ; 72.3 ton/day
- final disposal level ; level 2
- waste stream; as shown in Fig. N.1-1

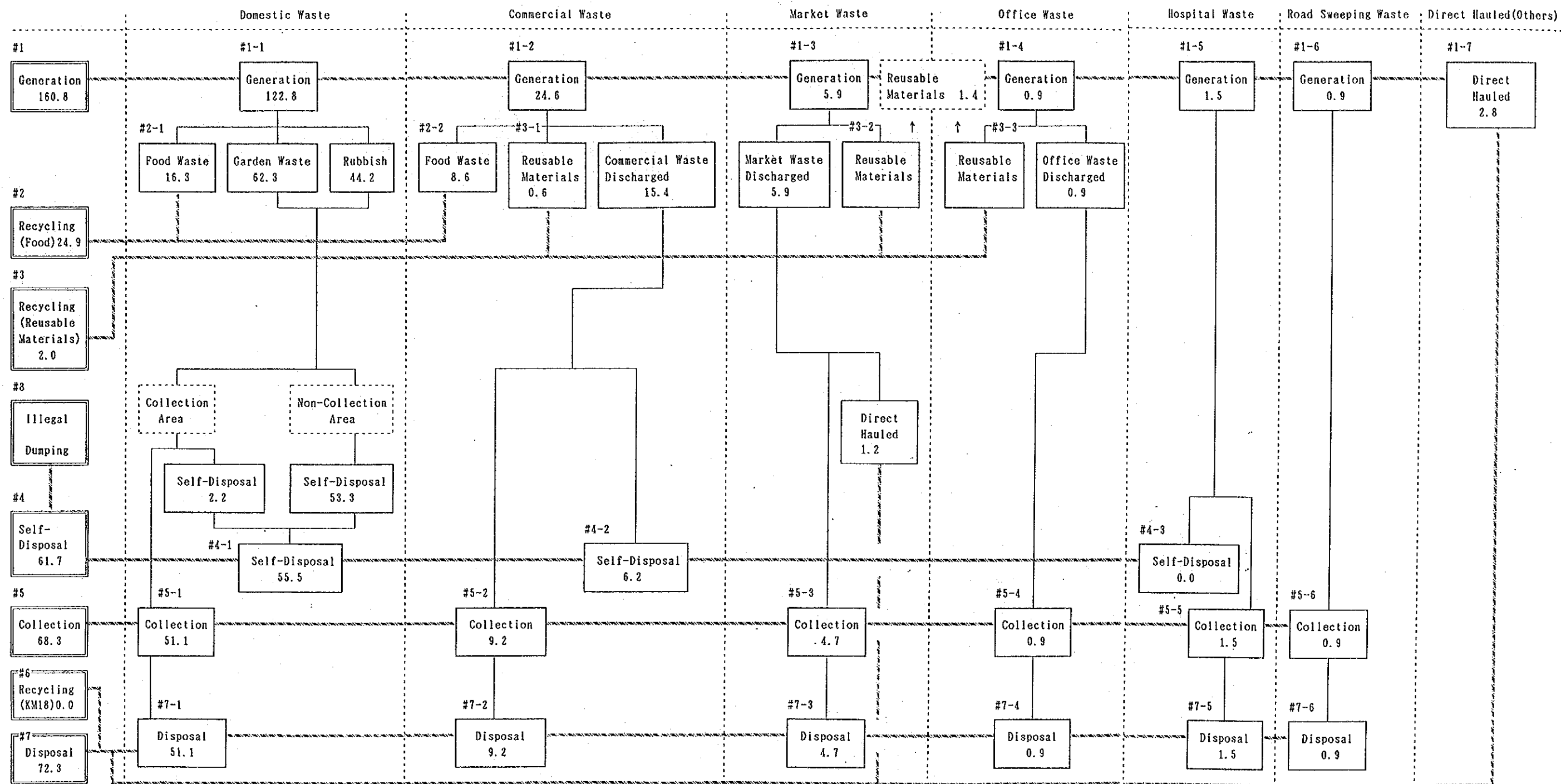


Fig. N.1-1 Future Waste Stream in The Study Area(1995) (Unit: Ton/Day)

N.1.2 Collection and Haulage

1) Strategy for Expansion of Collection Area

As described in the previous section N.1.1, the present ratio (4.8%) of residents covered by the collection services shall be increased to 50% in 1995 in the condition of the Beneficiary-Pay-Principle due to the financial limitation of the Municipality. This is, however, very hard tasks. The collection experiment, therefore, was carried out in order to derive a strategy for the expansion of collection area.

a. Collection experiment

The collection experiment was carried out to mainly examine.

- extension method of collection services;
- establishment of the Beneficiary-Pay-Principle;
- establishment of an efficient and reliable collection system;
and
- establishment of public cooperation.

In order to examine the above, the Study Team set up the following criteria on final selection of the experimental area;

- i. Upon consideration of the nature of the experiment, the experiment should be succeeded by DCTC after the experiment by the Study Team. As such the experiment should achieve favorable results to some extent.
- ii. In terms of the favorable results to some extent, the experiment should prove that at least the operation and maintenance cost (personnel expenditure, fuel and lubricant cost, etc.) of the experimental areas. In addition, the experiment should be successfully done in order to extend the collection services in these areas.

iii. Consequently, the ratio of participation in the experiment should be more than 25% and an efficient collection work should be done in the areas.

iv. Afterwards, new strategies and tactics should be formulated to proceed with the expansion of the collection services in other areas.

As a result, the three Bans were selected from 5 candidate Bans. The Table N.1-1 shows the relation of population density and ratio of participation in the candidate Bans.

Table N.1-1 Population Density and Ratio of Participation in the Candidate Bans

Name of Ban	Population Density (person/ha)	Ratio (%) of Participation	Final Selection
Dong Mieng	73	35	Yes
Thong Sang Nang	42	17.7	No
Sisavath Kang	102*	27	Yes
Sisavath Tay	102*	27	Yes
Sisavath Neua	102*	10.9	No

Note: *Sisavath Kang and Neua was established recently, divided from Sisavath Tay. Only total area of 3 Bans is available at this moment.

After the one month of the experiment, the following findings are derived from it.

- 30% of the total number of families in the 3 Bans participated in the experiment, it proved that at least the operation and maintenance cost of the experiment was covered.
- Proposed bell and curb collection system is feasible and results the effective collection works.

b. Strategy for expansion of collection area

Based on the collection experiment, the strategy for expansion of collection area is proposed as follows,

- i. The expansion of collection area shall be achieved by a stepwise manner and the experience obtained in the experiment shall be fully utilized. According to the requests and needs which may come, proposed collection system shall be revised based on the experiences.
- ii. The expansion shall be commenced in densely populated area (hereinafter referred as priority area), because necessity of collection services are considered to be higher and more effective collection can be expected. Consequently, a self-sustainable SWM and reliable collection system can be established easily.
- iii. Afterwards, the expansion will be done to the other area (hereinafter referred as less priority area) based on the well-established SWM system, especially in terms of financial capability.
- iv. In case there are some difficulties for applying curb and bell collection system in a area due to the limited passable roads in the area, the introduction of handcarts for primary collection may be considered in the condition of the extra expenses occurred from the introduction shall be shouldered by the beneficiary.
- v. In order to make the above more practical, the priority area is defined as the area of which population density is more than 70 persons per hectare. The priority area in 1995 is illustrated in Fig. N.1-2. As shown in the figure, the priority area is the same of the core of the city.

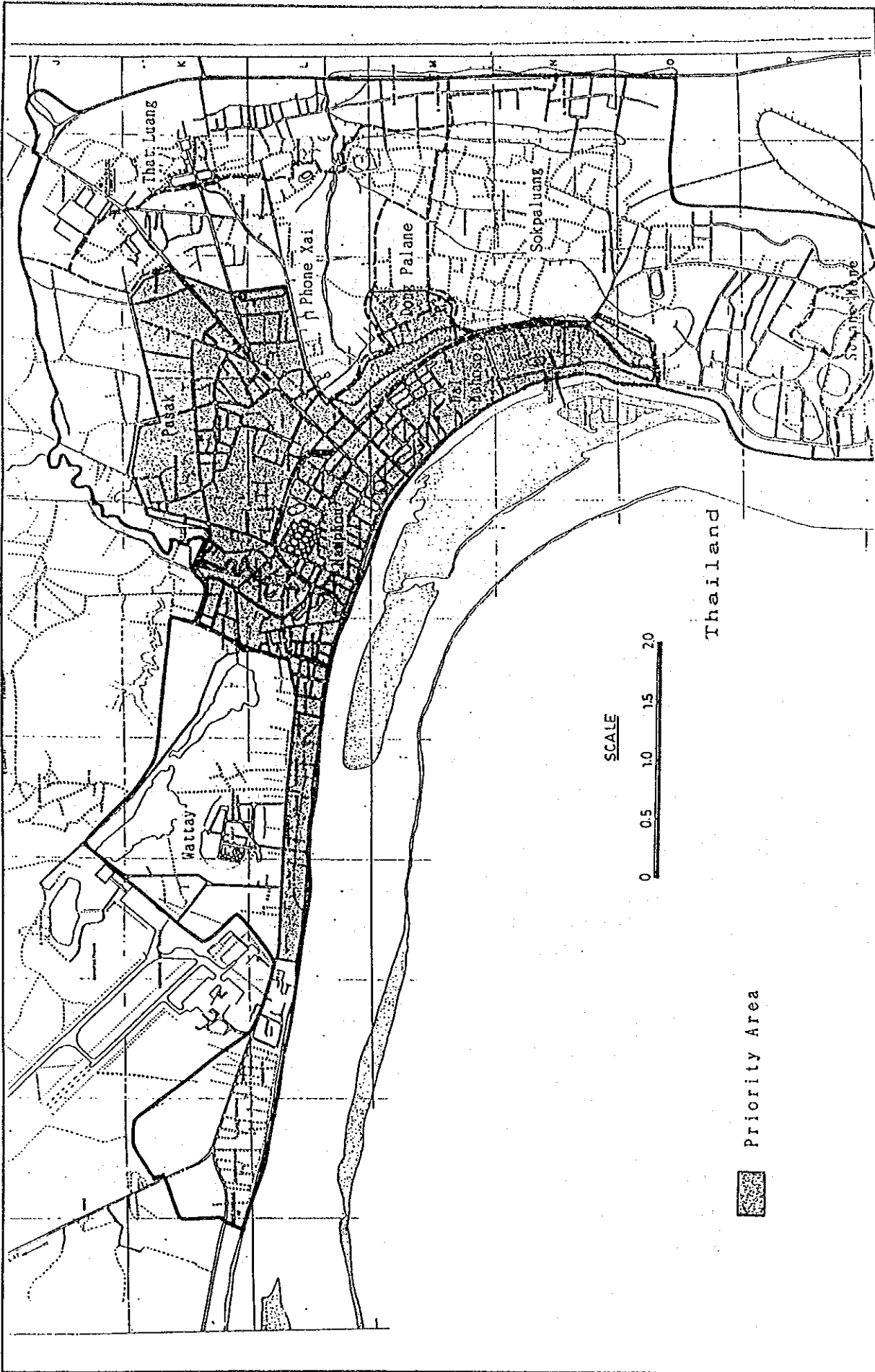


Fig. N.1-2 The area with a population density of more than 70 persons/ha in 1995

THE STUDY ON THE SOLID WASTE MANAGEMENT SYSTEM
 IMPROVEMENT PROJECT IN VIENTIANE, LAO P.D.R.
 JAPAN INTERNATIONAL COOPERATION AGENCY

2) Basic Policy for Design

The basic policy for the preliminary design of the collection and haulage system regarding the phase I project are as follows.

- a. To be acceptable to the residents.
- b. To be able to improve the environmental and sanitary conditions in the project area.
- c. To be secure and effective.
- d. To be harmonious with both the discharge and storage method and collection and haulage method.
- e. To select the proper equipment according to system.
- f. To be able to extend a collection service with self-sustainable solid waste management.

3) Outline of the Discharge and Storage and Collection and Haulage System in 1995

Outline of amount of waste is shown as follows;

- Amount of Generated Wastes	: 160.8 ton/day
- Amount of Recycled Wastes	: 26.9 ton/day
- Amount of Self-disposed Wastes	: 61.7 ton/day
- Amount of Collected Wastes	: 68.3 ton/day
Domestic Wastes	: 49.5 ton/day(50% of all waste discharged from residences except self-disposed waste)
Commercial Wastes	: 9.2 ton/day(60% of all waste discharged from shops except self-disposed waste)
Institutional Wastes	: 7.1 ton/day(100%)
Road Sweeping Wastes	: 0.9 ton/day(100%)
- Amount of Disposed Wastes	: 72.3 ton/day

The discharge and storage system and collection and haulage system to be achieved by 1995 is shown in Table N.1-2 and N.1-3, respectively.

Table M.1-2 Outline of Proposed Discharge and Storage System in 1995

Generation Source	Source Separation	Type of Refuse Bins	Storage & Discharge Points	Discharge Frequency
Residential Area	<ul style="list-style-type: none"> Continuance of present system - Partly separate discharge (Food waste is separated as food for domestic animals.) 	<ul style="list-style-type: none"> Continuance of present system - Bamboo basket 	<ul style="list-style-type: none"> - Designated road sides or designated 	<ul style="list-style-type: none"> - Once a week
Commercial Area	<ul style="list-style-type: none"> Continuance of present system - Partly separate discharge (Food waste is separated as food for domestic animals.) 	<ul style="list-style-type: none"> Continuance of present system - Bamboo basket 	<ul style="list-style-type: none"> - Designated road sides or designated 	<ul style="list-style-type: none"> - Once a week (more than twice a week)
Market	<ul style="list-style-type: none"> Continuance of present system - Mixed discharge 	<ul style="list-style-type: none"> - Communal container 	<ul style="list-style-type: none"> - Placing a container in the premises 	<ul style="list-style-type: none"> - Everyday
Office	<ul style="list-style-type: none"> Continuance of present system - Mixed discharge 	<ul style="list-style-type: none"> - Communal container 	<ul style="list-style-type: none"> - Placing a container in the premises 	<ul style="list-style-type: none"> - Everyday
Hospital	<ul style="list-style-type: none"> - Separate discharge (Infectious waste should be segregated from other wastes.) 	<ul style="list-style-type: none"> - Communal container 	<ul style="list-style-type: none"> - Placing a container in the premises 	<ul style="list-style-type: none"> - Everyday

Table N.1-3 Outline of Proposed Collection and Haulage System in 1995

Generation Source	Service Coverage (%)	Collection Frequency	Mixed or Separate Collection	Collection System	Collection Time	Collection Tools	Haulage Method	Transfer System
Residential Area	100 %	- Once a week	- Mixed collection	- Curb collection and bell collection	- Day time	-Not necessary	- Dump truck (10m ³)	- Without transfer
Commercial Area	100 %	- Once a week (more than twice a week.)	- Mixed collection	- Curb collection and bell collection	- Day time	-Not necessary	- Dump truck (10m ³)	- Without transfer
Market	100 %	- According to the rotation	- Mixed collection	- Station collection	- Day time	-Not necessary	- Detachable container truck(5m ³)	- Transfer from the station
Office	100 %	- According to the rotation	- Mixed collection	- Station collection	- Day time	-Not necessary	- Detachable container truck(5m ³)	- Transfer from the station
Hospital	100 %	- According to the rotation	- Separate collection	- Station collection	- Day time	-Not necessary	- Detachable container truck(5m ³)	- Transfer from the station

4) Required Number of Close Dump Truck (CDT)

Required units of CDT in the target year for the feasibility study in 1995 are calculated according to the following items:

- strategy for expansion of collection area as described;
- population covered by collection service;
- Amount of collected waste; and
- specification and working condition of CDT.

a. Population and shops to be covered by the collection services in 1995

Population density of each Ban is shown in Table N.1-4 and the areas where the population density shall be more than 70 persons/ha in 1995 is shown in Fig. N.1-2.

There are presently 44 Bans in the study area with a population density of more than 70 persons/ha. The population in these Bans totals 67,188, and is equivalent to 47% in Vientiane urban area. These figure is estimated to increase to 48 Bans, 89,033 persons and 55% in 1995. Moreover, it is supposed that the service coverage would be extended as follows.

Table N.1-5 Extension of Service Coverage

	1991	1995	2000
Domestic Waste			
Priority Area (more than 70persons/ha)	4.8%	80%	100%
Less Priority Area (not more than 70persons/ha)	4.8%	10%	100%
Commercial Waste			
Shop	22.3%	60%	100%

N.1-4 Population and Population Density (1)

Zone	Village	Area (ha)	Population				Population Density(person/ha)			
			1985	1991	1995	2000	1985	1991	1995	2000
Zone A	Total	2,935	130,262	142,723	163,146	192,832	44.38	48.63	55.59	65.70
	Sub Total	1,906	60,750	70,249	80,301	94,913	31.87	36.86	42.13	49.80
Phone Xai		409	12,200	13,175	15,060	17,801	29.83	32.21	36.82	43.52
1	Fai	23	1,664	1,703	1,947	2,301	72.35	74.04	84.64	100.04
2	Phone Xai	50	2,249	2,290	2,618	3,094	44.98	45.80	52.35	61.88
3	Naxay	22	2,035	2,189	2,502	2,958	92.50	99.50	113.74	134.43
4	Nong Bone Tay	220	2,626	1,336	1,527	1,805	11.94	11.43	13.07	15.45
①	Nong Bone Neua			1,179	1,348	1,593				
5	Phonsa At	27	1,311	1,599	1,828	2,160	48.56	59.22	67.70	80.01
6	Nongsangtho	24	1,115	1,294	1,479	1,748	46.46	53.92	61.63	72.85
7	Saphang Mo	43	1,200	1,585	1,812	2,141	27.91	36.86	42.13	49.80
Hal Mahosot		110	9,324	10,206	11,666	13,789	84.76	92.78	106.06	125.36
8	Phia Wat	12	924	1,060	1,212	1,432	77.00	88.33	100.97	119.35
9	Khao Gnot	18	1,392	1,236	1,413	1,670	77.33	68.67	78.49	92.77
10	Simuang	11	1,659	1,622	1,854	2,191	150.82	147.45	168.55	199.22
11	That Khao	13	1,264	1,245	1,423	1,682	97.23	95.77	109.47	129.39
12	Pha Pho	14	982	1,155	1,320	1,561	70.14	82.50	94.31	111.47
13	Pha Xay	7	1,007	1,023	1,169	1,382	143.86	146.14	167.06	197.45
14	Bung Khangong Tay	24	1,139	1,229	1,405	1,660	47.46	51.21	58.54	69.19
15	Bung Khangong Neua	11	957	1,636	1,870	2,210	87.00	148.73	170.01	200.94
Sokpaluang		632	16,093	20,208	23,100	27,303	25.46	31.97	36.55	43.20
16	Phonsavanh Neua	46	2,185	1,764	2,016	2,383	47.50	57.41	65.63	77.57
②	Phonsavanh Tay			877	1,002	1,185				
17	Saphane Thong Neua	94	3,356	1,677	1,917	2,266	35.70	17.84	20.39	24.10
18	Saphane Thong Tay	57	1,255	1,673	1,912	2,260	22.02	84.30	96.36	113.89
③	Saphane Thong Kang			1,076	1,230	1,454				
④	Thong Saphane Thong			2,056	2,350	2,778				
19	Sokpaluang	48	785	829	948	1,120	16.35	17.27	19.74	23.33
20	Phone Papao Tha	99	2,113	1,571	1,796	2,123	21.34	35.19	40.23	47.55
⑤	Phone Papao Thong			1,913	2,187	2,585				
21	Wat Nak	91	2,213	2,203	2,518	2,976	24.32	24.21	27.67	32.71
22	Thaphane Xay	79	1,761	2,013	2,301	2,720	22.29	25.48	29.13	34.43
23	Thong Kang	86	1,672	1,761	2,013	2,379	19.44	20.48	23.41	27.67
24	Phanh Manh	32	753	795	909	1,074	23.53	24.84	28.40	33.57
That Luang		265	13,677	14,427	16,491	19,492	51.61	54.44	62.23	73.56
25	Phone Kheng Tay	54	2,638	1,453	1,661	1,963	48.85	44.41	50.76	60.00
⑥	Phone Kheng Neua			945	1,080	1,277				
26	That Luang Neua	19	1,833	1,884	2,154	2,545	96.47	99.16	113.35	133.97
27	That Luang Kang	19	1,804	1,955	2,235	2,641	94.95	102.89	117.62	139.02
28	That Luang Tay	23	2,466	1,565	1,789	2,114	107.22	68.04	77.78	91.93
29	Hong Ke	59	1,802	2,306	2,636	3,116	30.54	39.08	44.68	52.81
30	Sisangvone	30	1,418	1,577	1,803	2,131	47.27	52.57	60.09	71.02
31	Phone Thanh Neua	61	1,716	1,623	1,855	2,193	28.13	44.95	51.38	60.73
⑦	Phone Thanh Tay			1,119	1,279	1,512				
Souane Mone		490	9,456	12,233	13,983	16,528	19.30	24.97	28.54	33.73
32	Wat Sob	13	577	600	686	811	44.38	46.15	52.76	62.36
33	Pho Xay	16	674	647	740	874	42.13	40.44	46.22	54.63
34	Souane Mone	16	957	1,040	1,189	1,405	59.81	65.00	74.30	87.82
35	Haysok	29	805	914	1,045	1,235	27.76	31.52	36.03	42.58
36	Chomcheng	16	775	806	921	1,089	48.44	50.38	57.58	68.06
37	Khok Ninh	19	676	594	679	803	35.58	31.26	35.74	42.24
38	Saysathane	14	820	853	975	1,152	58.57	60.93	69.65	82.32
39	Phone Savang	161	856	785	897	1,061	5.32	4.88	5.57	6.59
40	Done Pamay	40	312	2,196	2,510	2,967	7.80	54.90	62.76	74.17
41	Sang Veuy	87	459	670	766	905	5.28	7.70	8.80	10.40
42	Chomphet Neua	16	1,197	1,415	1,617	1,912	74.81	88.44	101.09	119.49
43	Chomphet Tay	63	1,348	1,713	1,958	2,314	21.40	27.19	31.08	36.74

N.1-4 Population and Population Density (2)

Zone	Village	Area (ha)	Population				Population Density (person/ha)			
			1985	1991	1995	2000	1985	1991	1995	2000
Zone B	Sub Total	939	60,152	61,998	70,870	83,765	64.06	66.03	75.47	89.21
Dong Palane		127	7,088	6,675	7,630	9,019	55.81	52.56	60.08	71.01
44	Nong Chanh	28	2,588	2,053	2,347	2,774	92.43	73.32	83.81	99.06
45	Dong Palane Tha	43	1,356	1,393	1,592	1,882	31.53	32.40	37.03	43.77
46	Dong Palane Thong	12	1,270	1,303	1,489	1,760	105.83	108.58	124.12	146.71
47	Phonsinpuane	44	1,874	1,926	2,202	2,602	42.59	43.77	50.04	59.14
Pasak		391	26,838	28,607	32,701	38,651	68.64	73.16	83.63	98.85
48	Hatsady Neua	33	2,394	1,057	1,208	1,428	72.55	71.06	81.23	96.01
⑧	Hatsady Tay			1,288	1,472	1,740				
49	Saylom	8	1,014	1,197	1,368	1,617	125.75	149.63	171.04	202.16
50	Thon Khan kham Neua	29	2,964	1,445	1,652	1,952	102.21	98.76	112.89	133.43
⑨	Thon Khan kham Tay			1,419	1,622	1,917				
51	Sisavath Tay	42	4,210	1,922	2,197	2,597	100.24	102.74	117.44	138.81
⑩	Sisavath Neua			1,006	1,150	1,359				
⑪	Sisavath Kang			1,387	1,585	1,874				
52	Sidamdouane	22	1,433	1,786	2,042	2,413	65.14	81.18	92.80	109.68
53	Sibounheuan	38	1,513	1,950	2,229	2,635	39.82	51.32	58.66	69.33
54	Dong Mieng	30	1,862	2,191	2,505	2,960	62.07	73.03	83.48	98.67
55	Thong Sangnang	48	1,602	2,028	2,318	2,740	33.38	42.25	48.30	57.08
56	Hong khay Keo	42	441	678	775	916	10.50	16.14	18.45	21.81
57	Savang	42	1,524	1,734	1,982	2,343	36.29	41.29	47.19	55.78
58	Thong Toum	24	1,704	1,769	2,022	2,390	71.00	73.71	84.26	99.59
59	Khoua Luang Neua	8	2,200	2,034	2,325	2,748	275.00	254.25	290.63	343.52
60	Khoua Luang Tay	15	2,102	2,179	2,491	2,944	140.13	145.27	166.05	196.27
61	Sihon	10	1,875	1,537	1,757	2,077	187.50	153.70	175.69	207.66
Wattay		421	26,226	26,716	30,539	36,096	62.29	63.46	72.54	85.74
62	Sithan Neua	29	2,473	1,387	1,585	1,874	85.28	47.83	54.67	64.62
63	Khounta Tha	34	1,826	1,168	1,335	1,578	53.71	56.29	64.35	76.06
⑫	Khounta Thong			746	853	1,008				
64	Na Kham	38	1,797	1,898	2,170	2,564	47.29	49.95	57.09	67.48
65	Nong Douang Neua	24	1,207	1,399	1,599	1,890	50.29	58.29	66.63	78.76
66	Nong Douang Tay	76	2,493	1,373	1,569	1,855	32.80	33.01	37.74	44.60
⑬	Nong Douang Thong			1,136	1,299	1,535				
67	Oup Moung	12	905	1,089	1,245	1,471	75.42	90.75	103.74	122.61
68	Nong Panay	8	1,050	1,147	1,311	1,550	131.25	143.38	163.89	193.71
69	Wattay Noy	20	2,566	1,281	1,464	1,731	128.30	64.05	73.22	86.54
70	Wattay Yai	26	1,722	2,690	3,075	3,634	66.23	103.46	118.27	139.79
71	Akad	17	1,388	1,623	1,855	2,193	81.65	95.47	109.13	128.99
72	Muong Va Tha	8	805	912	1,043	1,232	100.63	114.00	130.31	154.02
73	Muong Va Thong	6	1,607	1,662	1,900	2,246	267.83	277.00	316.64	374.25
74	Sikhay Tha	10	1,463	1,543	1,764	2,085	146.30	154.30	176.38	208.47
75	Sikhay Thong	7	1,838	2,137	2,443	2,887	262.57	305.29	348.97	412.47
76	Gnapha	70	1,127	1,301	1,487	1,758	16.10	18.59	21.25	25.11
77	Sibounheuang	36	1,959	2,224	2,542	3,005	54.42	61.78	70.62	83.47
Zone C	Sub Total	90	9,360	10,476	11,975	14,154	104.00	116.40	133.06	157.27
Namphou		90	9,360	10,476	11,975	14,154	104.00	116.40	133.06	157.27
78	Xieng Nhune Thong	13	3,428	1,950	2,229	2,635	263.69	291.08	332.73	393.27
⑭	Xieng Nhune Tha			1,834	2,096	2,478				
79	Mixay	47	1,488	1,465	1,675	1,979	31.66	70.19	80.24	94.84
⑮	Hay Sok			1,834	2,096	2,478				
80	Wat Chanh Tha	20	2,814	1,946	2,224	2,629	140.70	97.30	111.22	131.46
81	Wat Chanh Thong	10	1,630	1,447	1,654	1,955	163.00	144.70	165.41	195.50

Note: ① The villages numbered from ①~⑮ were not included in the UNDP Master Plan for Urban Development in Vientiane.
 ② Name and area of the zone corresponds with the UNDP Master Plan.

Consequently, it is estimated that the population covered by the collection services will arrive to 81,500 persons and will be equivalent to 50% in 1995 according to the following calculation;

- Priority Area :
163,143 persons x 55% x 70% = 62,810 persons Say 63,000
- Less Priority Area :
163,143 persons x (100-55)% x 25% = 18,353 persons Say 18,500
- Total = 81,500 persons
- 81,500 persons/163,143 persons x 100 = 50%

Note;

- 163,143 : population in 1995
- 55% : percentage of population in the priority area in 1995.
- (100-55)% : percentage of population in the less priority area in 1995.
- 70% : collection service coverage in priority area in 1995
- 25% : collection service coverage in less priority area in 1995

On the other hand, it is estimated that the number of shops to receive collection services will reach 1,720 according to the basic plan which stated that 60% of the shops in the study area will receive collection services in 1995.

$$2,860 \text{ shops} \times 60\% = 1,720 \text{ shops}$$

Note ;

- 2,860 shops : number of shops in 1995
(2,500 shops x 1,034⁴)
- 60% : percentage of shops to receive collection services in 1995

b. Amount of collected waste

Total amount of domestic and commercial waste collected is estimated at 60.3 ton/day in 1995. The amount is calculated as follows:

- Amount of domestic waste collected

Priority Area : 63,000 persons x 626 g = 398.5 tons/day

Less Priority : 7,340 persons x 626 g = 11.5 tons/day

- Amount of commercial waste collected

shops : 1,720 shops x 5,384 g = 9.3 tons/day

- Total : 39.5 + 11.5 + 9.3 = 58.8 tons/day

Amount of domestic and commercial waste collected by private contractors is projected to be 10 tons/day in the future.

Average amount of waste collected daily is 13.9 ton in 1991. Of these wastes, those collected by private contractors and by the Municipality are 7.8 ton and 6.1 ton, respectively. Since a further increase in the amount of waste collected by private contractors is not considered, the amount will be set to 10 tons/day in 1995 in the Study.

Amount of domestic and commercial waste collected by each sector is tabulated in Table N.1-6.

Table N.1-6 Amount of domestic and commercial waste collected by each sector.

(Unit:ton/day)

Items	Domestic Waste (Priority Area)	Commercial Waste	Domestic Waste (Less Priority Area)	Total
a. Total amount of domestic and commercial waste collected	39.5	9.3	11.5	60.3
b. Amount of domestic and commercial waste collected by Vientiane Municipality		38.8	11.5	50.3
c. Amount of domestic and commercial waste collected by private contractors		10.0	0.0	10.0

d. Outline of dump truck specification and working condition

By the law in Vientiane Municipality, wastes loaded in the collection vehicles should be covered in order to avoid scattering. Although open dump trucks are popular in the Study area, a close dump truck is planned. The specification for the close dump truck is summarized as follows:

- i. loading capacity : 10m^3
- ii. type of vehicle : closed type dump truck

Working condition of the vehicle are as follows:

i. loading ratio

It is necessary to establish the loading ratio to be able to accommodate allowances for extra waste discharge and new customers. The loading ratio is, therefore, estimated at 85% in order to avoid over loading.

ii. number of trips

Number of trips per day of the collection vehicles in priority and less priority area are estimated to be 3 and 2 trips, respectively. Bases of calculation are tabulated in Table N.1-7. Working hours is set up to be 7 hours from 8 to 12 o'clock in the morning and from 2 to 5 o'clock in the afternoon, according to the present system.

The collection time in the 2 areas greatly differ according to collection time. Collection time in less priority area is longer than priority area. A combination of curb and bell collection system would be suitable in priority area. It was proven in the collection experiment that waste collection per trip takes about one hour in this collection system. Therefore, one hour is set up for collection time in priority area. On the other hand, collection time in less priority area would be two hours due to the condition of the road and the long distance between stations.

Table N.1-7 Operation Plan for Collection Vehicle (CDT)

	Domestic Waste (Priority Area) Commercial Waste	Domestic waste (Less Priority Area)
Working Time (hr.)	7	7
Round Trip Distance (km)	36	36
Speed (km/hr.)	40	40
Collection Time (hr.)	1	2
Unloading Time (hr.)	0.25	0.25
Opening Check Time for Vehicle(hr.)	0.5	0.5
Closing Check and Washing Time for Vehicle (hr.)	0.5	0.5

Calculation of number of trips

$$\begin{array}{l}
 \text{Priority Area} \quad \frac{7 - 0.5 - 0.5}{36 / 40 + 1 + 0.25} = 3.0 \\
 \\
 \text{Less Priority Area} \quad \frac{7 - 0.5 - 0.5}{36 / 40 + 2 + 0.25} = 2.0
 \end{array}$$

e. Calculation of required number of CDT

Close dump trucks (CDT) will be used for the collection of domestic and commercial wastes. The number of vehicles required in 1995 is estimated to be 14 units.

Bases of calculation are shown in Table N.1-8.

Table N.1-8 Number of Collection Vehicles (DCT) Required for Domestic and Commercial Wastes

Item	Unit	Domestic Waste (Priority)	Commercial Waste	Domestic Waste (Less Priority Area)	Total Remark
a. Total amount of domestic and commercial waste collected	ton/day	39.5	9.3	11.5	60.3
b. Amount of domestic and commercial waste collected by Vientiane Municipality (V.M.)	ton/day	38.8		11.5	50.3
c. Amount of domestic and commercial waste collected by private contractors	ton/day	(10.0)		0	(10.0)
d. Volume of domestic and commercial waste collected by V.M	m ³ /day	224.3		66.5	290.8* ¹
e. Number of collection vehicles required	Unit	8.8		3.7	12.5* ²
f. Number of collection vehicles required (including spare vehicles)	Unit				14* ³

Note ;

* 1 Apparent specific gravity of the waste in the collection was observed at 0.173(ton/m³) in the Time & Motion Study, and is shown below.

	Private-SWM	DCTC	Average
Loading Capacity	12m ³	8m ³	-
Loading Condition	Full	Full	-
Weight of Loading Waste	1.9 ton	1.5 ton	-
Apparent Specific Gravity	0.158	0.188	0.173

* 2 The required number of collection vehicle was determined based on the following calculation.

[Volume of Collected Waste]

[Loading Capacity(10m³)]x[Loading Ratio(0.85)]x[Number of trip per Day(2 or 3)]

* 3 Spare vehicles required is 10% of the actual number of collection vehicles required.

5) Required Number of Detachable Container Truck (DCT)

DCT will be used as a collection vehicle for institutional, road sweeping and grass cutting wastes due to its improved loading efficiency.

In principle, institutional wastes will be collected by container system. It is, however, difficult to use the container system for all institutional wastes because of the following reasons:

- a. Collection fee payability;
- b. Space for containers; and
- c. Amount of waste discharged from each institution.

Therefore, 70% of all institutional wastes, will be collected by container system, and the remaining 30% will be collected by the close dump truck.

Required units of DCT and Container in the target year for the feasibility study in 1995 are calculated according to the following items:

- survey on large waste producers ;
- amount of waste discharged by each producer; and
- specification and working condition of DCT and container.

a. Survey on large waste producers

Large waste producers who should set up containers are selected according to the following conditions:

- large waste producers who can pay the collection fee;
- large waste producers whose waste discharge manners should be improved rapidly; and
- large waste producers with enough spaces for containers.

The survey was executed by the Study Team and DCTC to observe the above conditions according to the list shown by DCTC. Consequently, a total of 20 institutions were selected. The list of the candidate large waste producers who should have containers is in Table N.1-9, and their location is shown in Fig. N.1-3.

All of the general hospitals in the project area are selected as large waste producers whose method of discharging infectious waste and loading efficiency should be improved. In principal, two containers will be put in the hospital premises, one for infectious waste and another for non-infectious waste.

Six markets and nine offices were considered as large waste producers which should mainly improve their loading efficiency.

b. Amount of waste discharged from each producer

Amount and volume of waste discharged from each institution and collected from road sweeping activities are calculated according to the following:

- amount of discharged waste per unit

Shop in Market	: 1,301 g/shop
Hospital	: 957 g/bed
Road Sweeping	: 58,000 g/km

- ASG (Apparent Specific Gravity) observed at WACS:

Market	: 0.227 kg/l
Hospital	: 0.139 kg/l
Office	: 0.077 kg/l
Road Sweeping	: 0.056 kg/l

c. Specification and working conditions of DCT and Container

The specification and working conditions of DCT and containers are shown as follows:

Table N.1-9 Survey on Large Waste Producers

Name of Large Waste Producers	Present Conditions		
	Collection Fee (per Month)	Collection Frequency (per Week)	Place of Waste Storage
1. Mahosot Hospital	100,000 kips	4	Cart hauled by DCTC vehicle
2. Police Hospital	9,000 kips	4	Open heap
3. Sethathirat Hospital	25,000 kips	1	Container placed outside
4. Lao Soviet Hospital	10,000 kips	4	Container
5. 103 Hospital	10,000 kips	4	Open heap
6. Sikhai Market	32,000 kips	4	Cart hauled by DCTC vehicle
7. Kok Pho Market	20,000 kips	4	Storage by each shops
8. Nong Duang Market	48,000 kips	4	Cart hauled by DCTC vehicle
9. Phong Thong Market	-	-	Open heap
10. Nong Chang Market	20,000 kips	6	Open heap
11. That Luang Market	150,000 kips	6	Open heap in concrete yard
12. Public Health College	10,000 kips	1	Stock yard with roof
13. Municipality Police	-	-	Open heap at the public road
14. French Embassy	US 90 \$	4	Open heap
15. Indonesian Embassy	US 56 \$	1	Open heap in concrete yard
16. Japanese Embassy	US 75 \$	4	Open heap
17. Lao Beer	10,000 kips	4	Open heap in concrete yard
18. American Embassy	US 300 \$	4	Stock yard with roof
19. Soviet Embassy	US 121 \$	4	Open heap in concrete yard
20. DCTC	-	-	Open heap



Fig. N.1-3 Proposed Containers' Location Map for Large Waste Producers and Roads

THE STUDY ON THE SOLID WASTE MANAGEMENT SYSTEM
IMPROVEMENT PROJECT IN VIENTIANE, LAO P. D. R.
JAPAN INTERNATIONAL COOPERATION AGENCY

- capacity of container : 5m^3
- average collection frequency

Amount of waste discharged from markets, hospitals and those collected from road sweeping activities differ from each other as shown in Table N.1-10. Although it takes a number of days to fill the container with waste, the frequency of transportation is assumed twice a week on the average. Consequently, the number of container hauled per day is 14.

$$40 \text{ units} \times 2/6 = 13.3 \text{ units/day} \quad \text{Say } 14 \text{ units}$$

- number of trips

Number of trips per day of the detachable container truck is calculated based on Table N.1-11. Consequently, the number of trips is 5.

Table N.1-10 Amount and Volume of Waste Discharged from Each Institutional Facility,
Collected from Road Sweeping and Grass Cutting Activities

	No. of Unit	g/unit	Amount of Waste(ton)			Volume of Waste(m3)		
			1991	1995	2000	1991	1995	2000
Market (shops)								
Sikhai	230	1,301	0.3	0.3	0.4	1.3	1.5	1.8
Nongdouang	400	1,301	0.5	0.6	0.7	2.3	2.6	3.1
Kok Pho	120	1,301	0.2	0.2	0.2	0.7	0.8	0.9
Phone Thong	124	1,301	0.2	0.2	0.2	0.7	0.8	1.0
Nong Chanh	786	1,301	1.0	1.2	1.4	4.5	5.1	6.1
That Luang	1045	1,301	1.4	1.6	1.8	6.0	6.8	8.1
Hospital (beds)								
Mahosot	450	957	0.4	0.5	0.6	3.1	3.5	4.2
Police	60	957	0.1	0.1	0.1	0.4	0.5	0.6
103 Hospital	450	957	0.4	0.5	0.6	3.1	3.5	4.2
Setthathirat	200	957	0.2	0.2	0.3	1.4	1.6	1.9
Lao Soviet	150	957	0.1	0.2	0.2	1.0	1.2	1.4
Office (employee)								
Public Health College								
Municipality Police								
French Embassy								
Indonesia Embassy								
Japanees Embassy	*		Fof further study			Fof further study		
Lao Beer								
USA Embassy								
Soviet Embassy								
DCTC								
Road Sweeping (KM)								
	15	58,000	0.9	0.9	0.9	15.5	15.5	15.5
Total			5.6	6.3	7.3	40.1	43.6	48.7

Note ; * Although a discharge ratio of the office is 31g per employee,
it may differ from its activity. It is, therefore, the frequency
of container transporation should be studied in the future.

Table N.1-11 Operation Plan for Collection Vehicle (DCT)

Working Time (hr.)	7
Round-Trip Distance (km)	36
Speed(km/hr.)	40
Loading Time(hr.)	0.25
Unloading Time(hr.)	0.25
Opening Check Time for Vehicle(hr.)	0.5
Closing Check Time and Washing Time for Vehicle (hr.)	0.5

$$\text{Number of trips} = \frac{7 - 0.3 - 0.3}{36/40 + 0.15 + 0.15} = 5.3 \text{ Say } 5$$

d. Required number of containers and DCT

i. required number of containers

The volume of waste discharged from each institution shall be less than 5m^3 per day in 1995. Since That Luang market exceeds 5m^3 , i.e. 6.8m^3 , 2 containers shall be set there. Because of the segregation of infectious and non-infectious wastes for hospitals, two containers shall be set there. Therefore, a total of 40 containers, including spares, are required. The number of containers required and the collection frequency are shown in Table N.1-12.

ii. required number of DCT

Number of detachable container trucks(DCT) required is 3 units, including a spare vehicle.

Table N.1-12 Number of Containers Required

Classification	Number of Containers	Remarks
1. Market		
Sikhai	1	
Wongdouang	1	
Kok Pho	1	
Phone Thong	1	
Nong Chanh	1	
That Luang	2	
Sub-Total	7	
2. Hospital		
Mahost	2	One for infectious waste and another for non-infectious waste
Police	2	
103 Hospital	2	
Setthathirat	2	
Lao-Soviet	2	
Sub-Total	10	
3. Office	9	
4. Road Sweeping, Grass Cutting	11	
5. Spare Containers	3	One for each vehicle
Total	40	

$14/5 \times 1.1 = 3.1$ Say 3

14 : Number of containers hauled per day

5 : Number of trips per vehicle

0.1 : Spare vehicle estimated to be 10% of the number of vehicles actually required.

5) Motorcycle

A motorcycle is required for fee collection. One collector will be able to cover around 3 bans, and 18 collectors will cover the areas covered by the collection services in 1995. Therefore, a total of 18 motorcycles are required.

N.1.3 Road Sweeping, Drain cleaning and Grass Cutting

1) Basic Policy

Road sweeping, drain cleaning and grass cutting systems are presently not well established in the project area because of poor equipment and weak organization of cleaning activities. Accordingly, the basic policy for the preliminary design of these system regarding the phase I project has been considered as follows:

- a. To be able to improve the environmental and sanitary conditions in the project area;
- b. To select the proper equipment according to system;
- c. To be secure and effective;
- d. To establish an organization to manage the system; and
- e. To establish cleansing activity through public cooperation.

2) Outline of Road Sweeping, Drain Cleansing and Grass Cutting System in 1995

The outline of road sweeping, drain cleansing and grass cutting system to be achieved by 1995 is shown in Table N.1-13.

3) Required Number of Detachable Container Trucks (DCT)

DCT will be used as the collection vehicle for road sweeping and grass cutting wastes as well as institutional wastes. The number of DCTs and containers for road sweeping and grass cutting wastes were calculated and mentioned in N.1.2.

4) Required Number of Small Dump Trucks (SDT)

SDT will be used as the collection vehicle for wastes cleaned up at the drains of roads covered by the sweeping services and cleaned through public cooperation. Required units of SDT in the target year for the feasibility study in 1995 are calculated as follows.

Table N.1-13 Outline of Proposed Road Sweeping, Drain Cleansing and Grass Cutting System in 1995

Type of Cleansing Service	Cleansing System	Cleansing Area and Length	Cleansing Equipment	Cleansing Frequency
Road Sweeping	<ul style="list-style-type: none"> • Manual sweeping by labourers • Station collection system using containers(5m3) • Haulage method by detachable container trucks 	Present road covered by the sweeping services (15km*)	Detachable container truck and container	Everyday except on sundays and holidays
Sprinkling Road	<ul style="list-style-type: none"> • Mechanical sprinkling roads with water 	150 km (65% of roads in VM)	Water trucks	Once a week
Drain Cleansing	<ul style="list-style-type: none"> • Manual cleaning by labourers * • Loading method by wheel loader • Haulage method by small dump trucks 	Drains of roads covered by the sweeping services (15km*)	Small dump trucks & a wheel loader	Once every six
Grass Cutting	<ul style="list-style-type: none"> • Grass cutting by cutting machines • Station collection system using container(5m3) • Haulage method by detachable container trucks 	Side of road covered by the sweeping services (15km*)	Grass cutters	Every two months
Cleansing Activity through Public Cooperation	<ul style="list-style-type: none"> • Cleaning by residents and collection and haulage by the Municipality 	50% of Vientiane urban area	Small dump truck & wheel loader	Once every two months

Note; * The road length which receives sweeping services.

a. Cleaning of the drains of roads covered by the sweeping services

i. length of the drains

Cleaning of the drains of roads covered by the sweeping services is done by DCTC. The length of the drains is approximately 30km.

ii. frequency of drain cleansing

Frequency of drain cleansing is established once every six months.

iii. amount of drain cleansing waste

Amount of drain cleansing waste is calculated as follows.

$$0.3 \text{ m} \times 0.1 \text{ m} \times 30,000 \text{ m} = 900 \text{ m}^3/150 \text{ days}$$

Note;

0.3 m : Average width of drain

0.1 m : Depth of waste accumulated in the drain

30,000 m : Length of the drain

150 days : Total working day except Sunday in every six months

iv. Specification and working condition of SDT

The specification and working condition of SDT are shown as follows:

- loading capacity of SDT : 1.5 m^3
- number of trips : 3 trips

v. number of vehicles

Two vehicles are required according to the following:

$$900 \text{ m}^3/150 \text{ days}/1.5\text{m}^3/3 \text{ trips} = 1.3 \text{ Say } 2 \text{ units}$$

b. Cleansing activity through public cooperation

Cleansing activity through public cooperation means the cleansing of roads, drains and public areas by residents themselves and collection and haulage of the waste generated from those places by V.M. One SDT for cleansing activity is required according to the following:

- Number of Bans where cleansing activity will be established:
48 Bans in 1995 as well as collection service.
- Frequency of cleansing activity shall be once every two months.
- The SDT shall collect waste cleaned up in a Ban per day.

c. Required number of SDT

3 SDT is required.

- 2 for the drains of the road covered by the sweeping services
- 1 for cleansing activity through public cooperation

5) Grass Cutter

A grass cutter instead of manual grass cutting will be used to improve cleansing efficiency. DCTC is responsible for collection of the wastes cleaned up by the sweeping services (15 km). The length of the roads to be cleaned is around 1.5 km/worker, therefore, 10 grass cutters are required.

$$15 \text{ km} / 1.5 \text{ km/worker} = 10 \text{ units}$$

6) Water Truck

A water truck will be used to the road and prevent the generation of clouds of dusts. 2 water trucks are required according to the following conditions:

- Total length of road in the study area : 230 km
- The length of road to sprinkle in 1995 : 150 km (65%)
- The length of road covered by one truck : 12 km/day
- Frequency of sprinkling activity : once a week

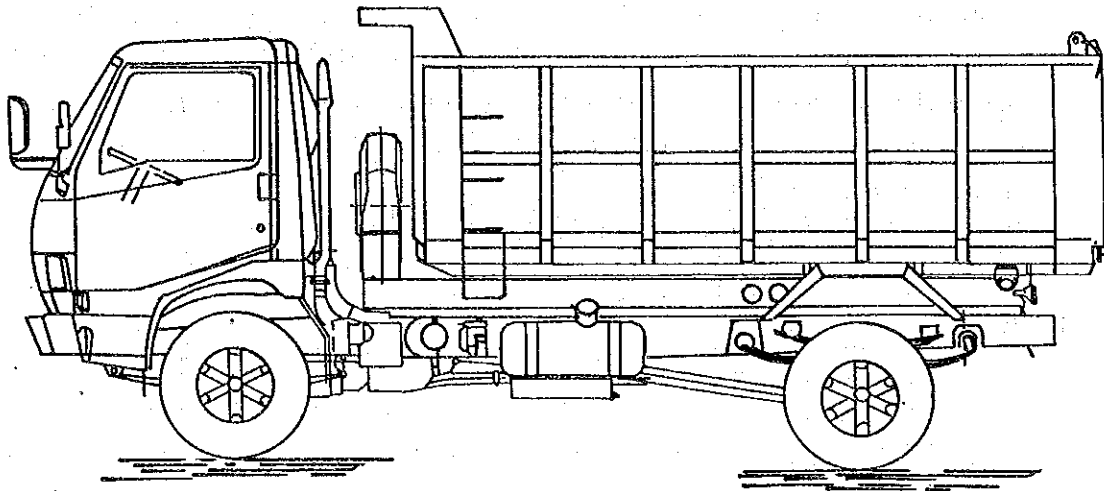
$$150 \text{ km} / (12 \text{ km} \times 6 \text{ days per week}) = 2 \text{ trucks}$$

The water trucks will also be used at the KM 18-DS according to the request.

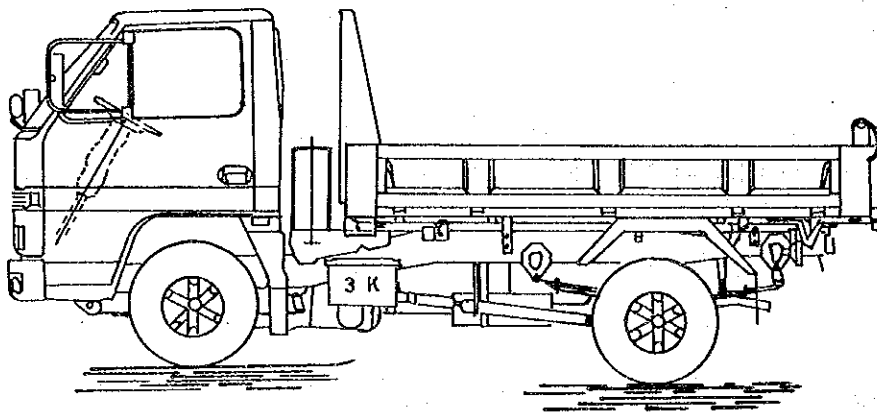
7) Others

A wheel Loader will be required to clean up waste after cleansing of drain and cleansing activity through public cooperation. In principle, a wheel loader will be worked with small dump trucks.

A pick up will be required for the supervision of the workers and for emergencies.



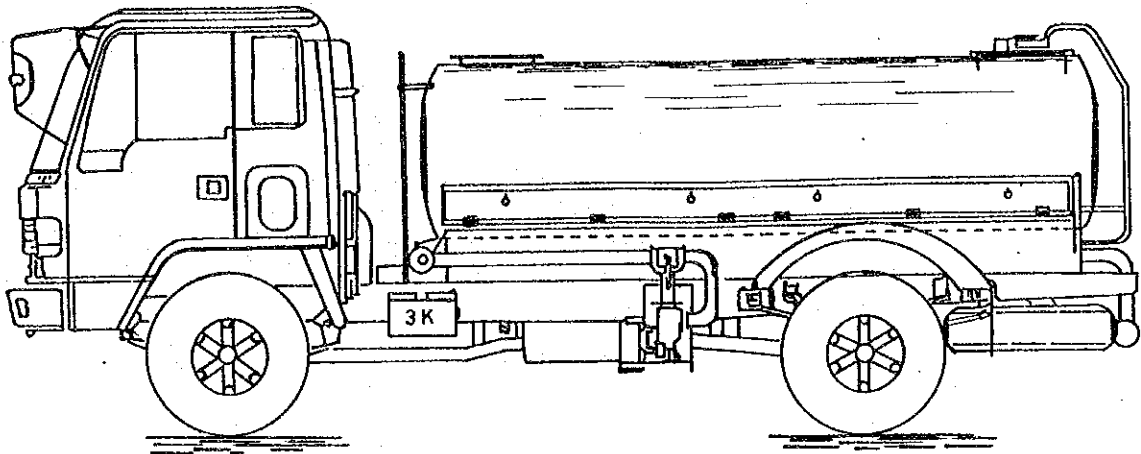
Close Dump Truck



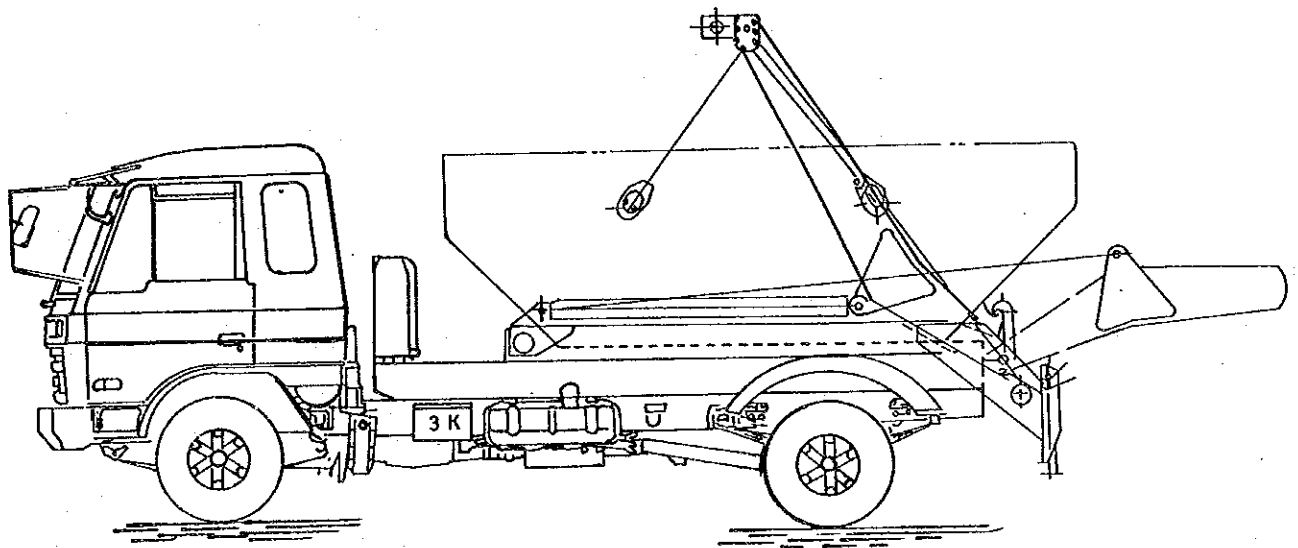
Small Dump Truck

THE STUDY ON THE SOLID WASTE MANAGEMENT SYSTEM
IMPROVEMENT PROJECT IN VIENTIANE, LAO P. D. R.
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. N.1-4 Conception Drawing for Close Dump Truck and Small Dump Truck



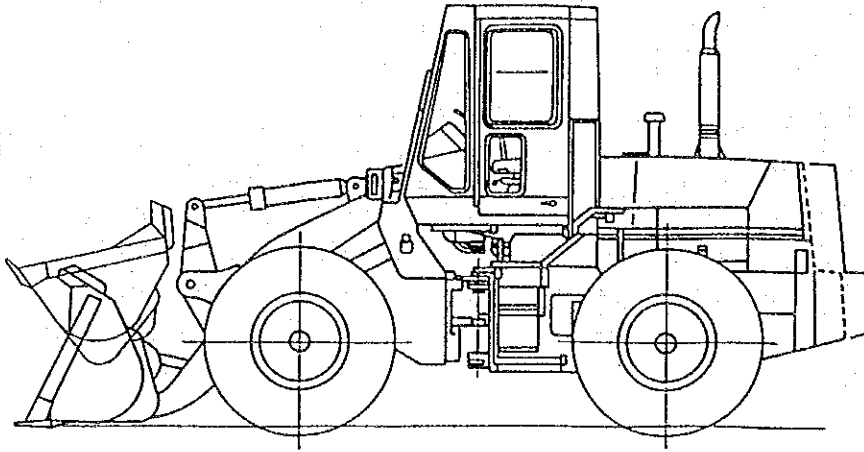
Water Truck



Detachable Container Truck

THE STUDY ON THE SOLID WASTE MANAGEMENT SYSTEM
IMPROVEMENT PROJECT IN VIENTIANE, LAO P. D. R.
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. N.1-5 Conception Drawing for Water Truck and Detachable Container Truck



Wheel Loader

THE STUDY ON THE SOLID WASTE MANAGEMENT SYSTEM
IMPROVEMENT PROJECT IN VIENTIANE, LAO P. D. R.
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. N.1-6 Conception Drawing for Wheel Loader

N.1.4 Final Disposal

1) Planning Conditions

(1) Basic Principals

The final disposal site composes the ultimate termination place of accumulated waste, resulting in a land reclamation site by means of landfill. Accordingly, upon consideration of the necessary functions of a final disposal site, the basic principals for the execution of the preliminary designs regarding Phase I of the project have been conceived of and are arranged in the following.

- a. An adequate landfill volume exists within the area selected as the final disposal site. The guarantee of landfill volume in Phase II (2000) and the smooth derivation from the landfill design of Phase I are considered.
- b. The design appropriately pertains to the topography, geology and surrounding environment.
- c. The wastes disposed of at the site are to be harmless and stabilized quickly.
- d. During and after completion of the filling, the area does not become a pollution outbreak source.
- e. During and after completion of the filling, safety from disaster is guaranteed.
- f. The completed site will be of a configuration harmonious with the surrounding environment.
- g. Throughout and after completion of the filling, the operation and maintenance expenses will be kept low.

2) Designed Landfill Volume

a. Condition for estimation

- i. landfill periods : 1995-1997 (Phase I)
1998-2000 (Phase II)
- ii. unit weight of wastes disposed : 0.7 ton/m³
(after compaction)
- iii. Covering materials : 35% of the waste volume

b. Designed landfill volume

The designed landfill volume for the KM 18 disposal site within Phase I and II is tabulated in Table N.1.14.

Table N.1-14 Designed Landfill Volume

Item	Unit	Phase I	Phase II	Remarks
Disposal Amount	t/day	101.7	152.9	Phase I in 1997 Phase II in 2000
Cumulative Disposal Amount Total	1000 t	95.1	148.0	
Cumulative Disposal Volume	1000 m ³	135.9	211.4	0.7 ton/m ³
Cumulative Cover Soil Volume	1000 m ³	47.6	74.0	35% of the above volume
Designed Landfill Volume	1000 m ³	183.5	285.4	

(3) Topography and Geology

a. Topography

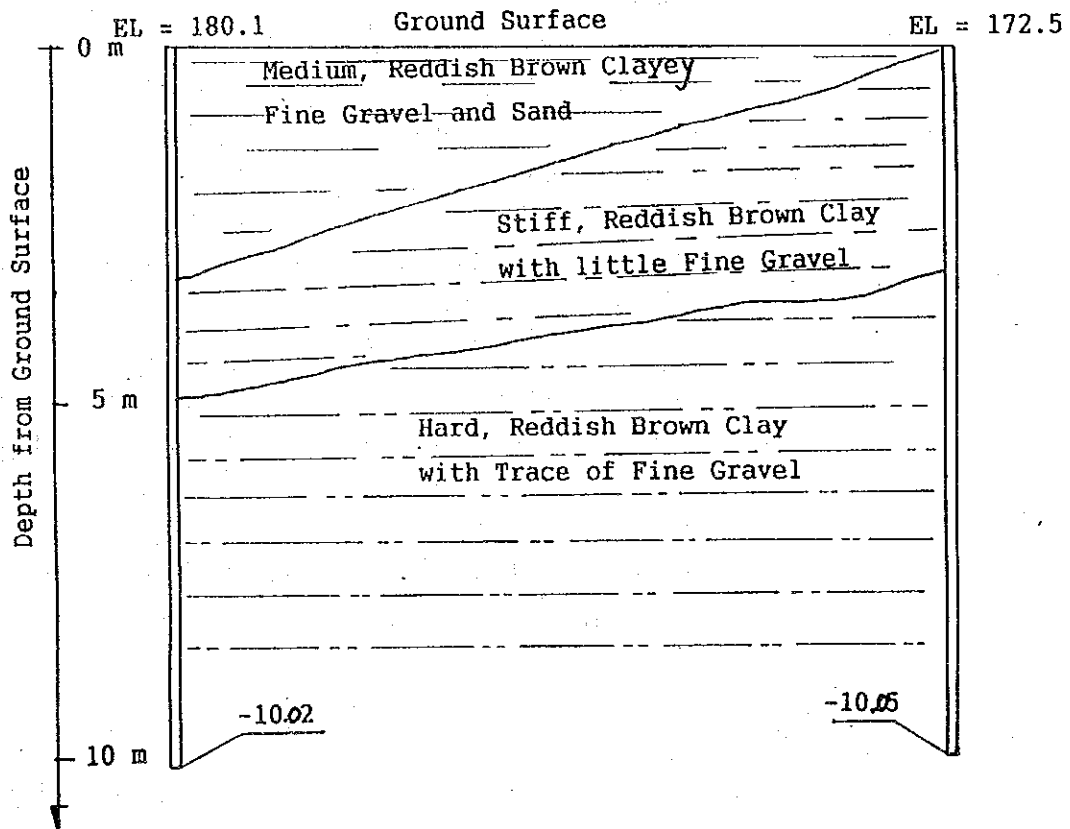
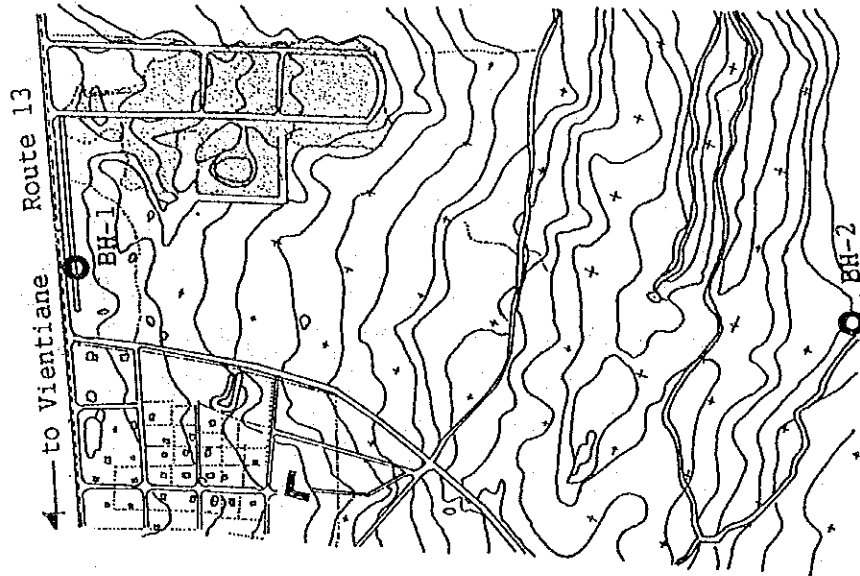
The final disposal site at KM 18 is located along the south of the Route 13 which connects Vientiane and Savannakhet. It has been used as the dump site for Vientiane for more than 20 years. The elevation of the area is between 172 m to 180 m. Generally, the site is flat and covered with bush and trees. Partly, there is cultivated land.

b. Geology

The geology is principally stiff to hard clayey soil accumulated layers where little fine gravel and sand are observed. The sub-soil investigation was done by boring and the following is the derived profile. A geological profile of the KM 18-DS is illustrated in Fig. N.1-7.

Table N.1-15 Characteristics of Clayey Soil

Items	Unit	PADS
Natural Moisture Content	%	20 - 28
Bulk Density	ton/m ³	1.65 - 1.70
Specific gravity	g/cm ³	2.69 - 2.74
Attergerg limit		
- Plastic limit	%	51 - 70
- Liquid limit	%	20 - 29
Permeability coefficient	cm/sec	2.52x10 ⁻⁵ - 5.86x10 ⁻⁶



THE STUDY ON THE SOLID WASTE MANAGEMENT SYSTEM
 IMPROVEMENT PROJECT IN VIENTIANE, LAO P. D. R.
 JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. N.1-7 Geological Profile of KM 18-DS

2) Facility Design

(1) Facility Lay-out

a. Design principals

The design principals for the facility lay-out are as follows.

- i. Since the site shall be used as the only disposal site for Vientiane urban area by 1995 when the Phase I operation will start, the design is to consider the disposal and clean-up of the waste disposed of by the end of 1994.
- ii. The design is to smoothen the execution and transitions in the work from Phase I through to Phase II.
- iii. Regarding the surrounding land use conditions, the consideration is that each facility cast no adverse impacts on the local area.
- iv. The on-site roads and/or landfill operation flow are to be uncomplicated and harmonious.
- v. The administration facilities are to be erected near the entrance to the disposal site for full inspection of the waste collection vehicles.
- vi. Each type of facility is to not be decentralized but placed near administration facilities, making maintenance operation easy.
- vii. The leachate cycling facilities are to be placed as far away as possible from residential areas. (for Phase II)

b. Types of facilities

i. main facilities

- enclosing structureEnclosing soil bund and divider
- drainage systemSurrounding drain/on-site drain (surfaces)/drain for reclaimed area.
- accessApproach road/on-site road.

ii. environmental protection facilities

- buffer zone
- gas removal facilities
- monitoring facilities (use of existing wells)

iii. building and accessories

- site office (use of the existing building)
- weighbridge (use of the existing one)
- safety facilities...gates/fences (use of the existings)
- fire prevention facilities...water truck
- other...parking lot/greenery/car wash, (improvement of the existings)

c. Lay-out design

The lay-out of the main facilities is done and shown in Fig. N.1-8.

i. approach road

The existing approach road is planned to use the access to the site. The sight distance of the intersection of the existing Route 13 is to be adequate.