

3.4 Final Disposal System

3.4.1 Designed Disposal Amount

(1) Unit weight of landfilled waste (r)

For setting up the final disposal facility plan, it is very important to estimate the landfill volume of waste which can receive based on the unit weight of the landfilled waste. However, the unit weight of the waste at the landfill site varies from 0.35 to 2.0 ton/m³ depending on waste composition and the extent of compaction, and further, the unit weight at the present disposal sites in Alexandria has not been measured yet. Therefore, the unit weight is determined as follows based on data collected in Japan (See Tab. 3-4-1 and 3-4-2) considering that the waste of Alexandria has lower moisture content.

- Landfilled waste without any treatment : r = 0.8 ton/m³
- Compost reject : r = 0.6 ton/m³

The several coefficients of equivalent volume according to the waste characteristics in Japan are shown in Tab. 3-4-1 and 3-4-2.

Tab. 3-4-1 COEFFICIENT OF EQUIVALENT VOLUME
ACCORDING TO WASTE CHARACTERISTIC IN JAPAN

Coefficient Characteiristic	Coefficient of Equivalent Volume (m ³ /ton)	
	Range	Average
Rather Combustible Waste (more than 60% is combustible)	1.0 - 1.35	1.07
Rather Incombustible Waste. (more than 60% is incombustible)	0.63 - 2.34	1.16
Mixed Waste	0.78 - 2.44	1.41

Source: Japan Waste Management Association

Tab. 3-4-2 COEFFICIENT OF EQUIVALENT VOLUME
TO WASTE CHARACTERISTIC

(m³/ton)

Volume Indication		Coefficient of Equivalent Volume				Percentage of Covering Soil in Total Volume
		Point		Block		
Sample Site						
Combustible Waste	First Layer	1.02	1.05	0.91	1.05	17%
	Second Layer	1.07		1.18		18%
Resource Segre-gated Waste	First Layer	1.80	1.69	1.25	1.37	16
	Second Layer	1.57		1.49		15
Direct Hauled Waste		-	-	2.47	-	15

Source : Tokyo Metropolitan Government

N.B.

i)
$$C = \frac{V}{W}$$

where;

C: coefficient of equivalent volume (m³/ton)

V: waste volume without covering soil (m³)

W: waste weight without covering soil (ton)

ii) Point: coefficient of equivalent volume is calculated according to the result of field unit weight test.

Block: coefficient of equivalent volume is obtained through the division of the landfilled volume of the block by the weight of the total landfilled waste there.

(2) Designed Disposal Amount

According to that discussion and using the unit weight (r) mentioned before, the designed disposal amount per year is calculated.

The following conditions are applied for this calculation:

- The vacationer waste is generated 90 days in summer and directly hauled to the final disposal site.
- The unit weight of the vacationer waste is 0.8 ton/m^3 .
- The unit weight of reject out of compost plant are 0.6 ton/m^3 .
- The percentage in weight of reject out of compost plant is shown in Tab. 3-4-3.

Tab. 3-4-3 PERCENTAGE OF COMPOST

(weight percent)

Item	Year			
	1984	1990	1995	2000
Unit Solid Waste	100	100	100	100
Compost Reject	29.4	31.6	32.4	33.2

Tab. 3-4-4 shows the designed disposal amount by 2000. As can be seen, the untreated waste is divided into municipal and vacationer waste for convenience. The final disposal volume per year by 2000 is shown in Fig. 3-4-1. The acquisition plan of final disposal site will be established according to the accumulated final disposal volume. Results of calculations are shown in Tab. 3-4-5 and Fig. 3-4-2.

Tab. 3-4-4 DESIGNED DISPOSAL AMOUNT

(1,000m³)

	1985	1989	1990	1994	1995	1999	2000
- Municipal Waste	517	590	609	740	772	906	939
- Vacationer Waste	41	41	41	41	41	41	41
- Compost Reject	29	30	31	31	31	32	32
- Total	587	661	681	812	844	979	1,012

N.B. Both the Municipal waste and vacationer waste to be directly hauled to the final disposal site.

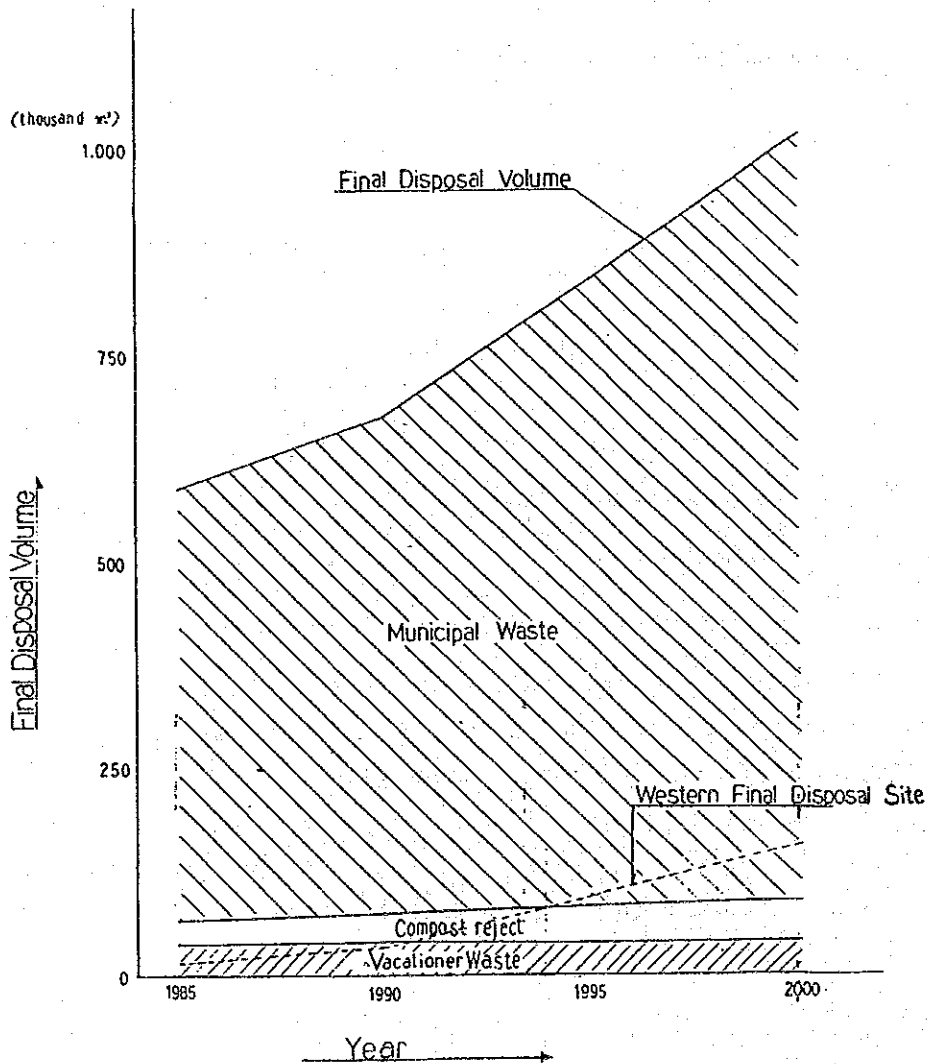


Fig. 3-4-1 FINAL DISPOSAL VOLUME PER YEAR

Tab. 3-4-5 ACCUMULATED FINAL DISPOSAL VOLUME

(Unit: 1,000m³)

Year	EDS	WDS	Total	Accumulation
1985	561	25	586	586
1986	577	28	605	1,191
1987	592	32	624	1,815
1988	607	35	642	2,457
1989	623	38	661	3,118
1990	638	42	680	3,798
1991	659	54	713	4,511
1992	681	65	746	5,257
1993	702	77	779	6,036
1994	723	89	812	6,848
1995	745	100	845	7,693
1996	766	112	878	8,571
1997	788	124	912	9,483
1998	810	136	946	10,429
1999	831	147	978	11,407
2000	853	159	1,012	12,419

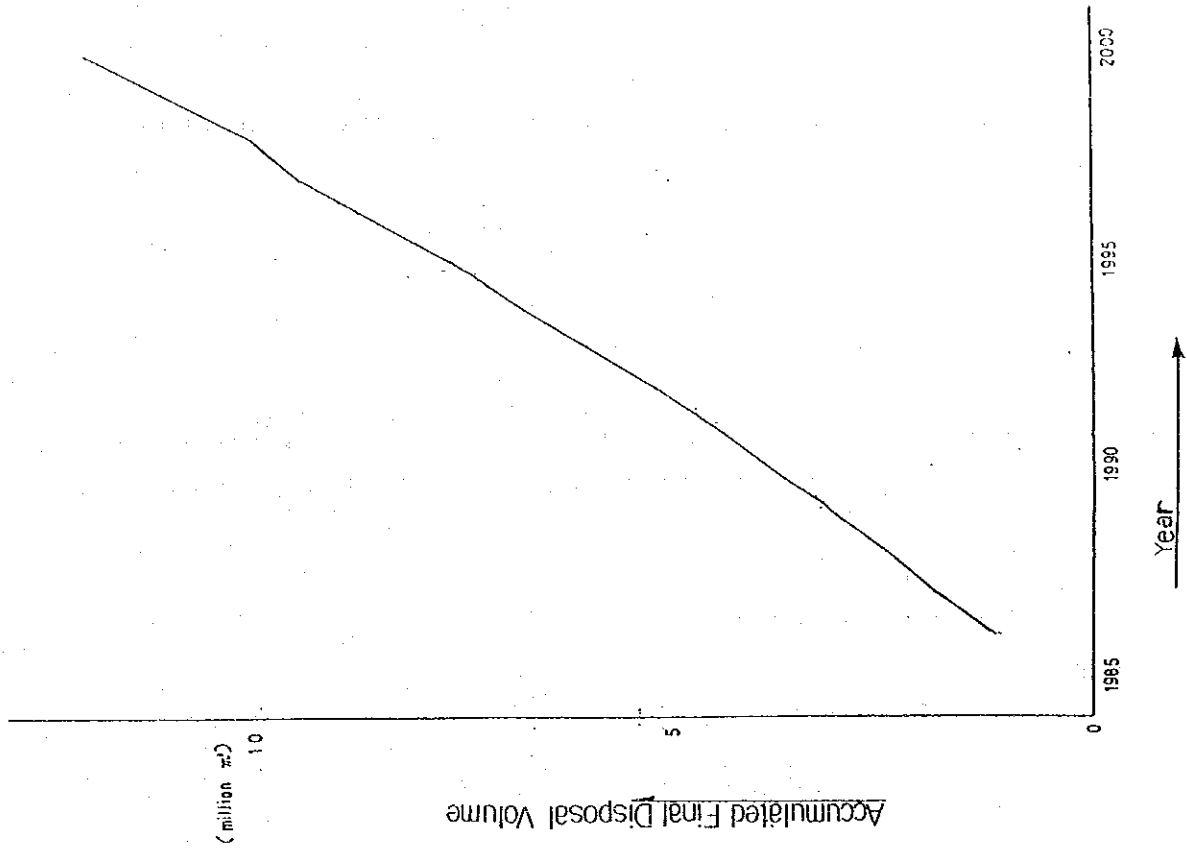


Fig. 3-4-2 ACCUMULATED FINAL DISPOSAL VOLUME

3.4.2 Green Belt Final Disposal Site

The proposed location of the Green Belt Final Disposal Site is shown in Fig. 3-4-3.

Fig. 3-4-4 shows the Green Belt Final Disposal Site Plan. The detailed are summarized below.

(1) Landfill plan

a. Capacity of landfill

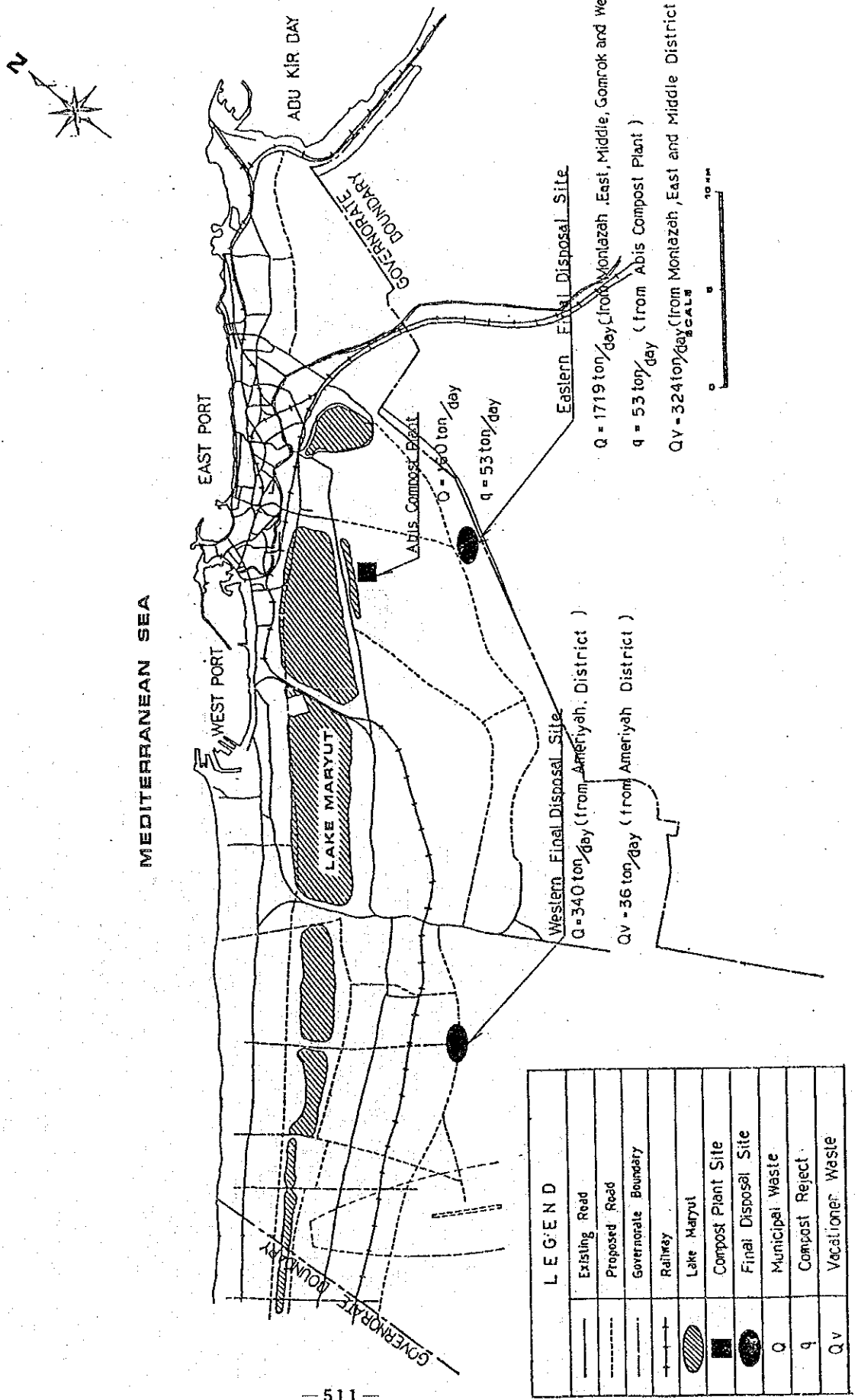
The capacity of landfill per unit landfill lot (Q) for the waste without covering soil is calculated applying the landfill depth of 3.0m as shown below.

$$\begin{aligned} Q &= 877.1\text{m} \times 977.1\text{m} \times 3\text{m} \\ &= 2,571,043\text{m}^3 \\ &\text{Say } 2.57 \text{ million m}^3 \end{aligned}$$

b. Life expectancy for landfill

For convenience of utilization of the reclaimed land in the future, flat landfill (3m depth for solid waste layer) is applied as shown in Fig. 3-4-4. Each unit landfill lot can absorb a volume of 2.57 million m^3 of landfilled waste without covering soil as mentioned above. Using the designed disposal amount in 2000, as discussed in Section 3-4-1, the life expectancy of unit landfill lot is estimated as 2.54 years.

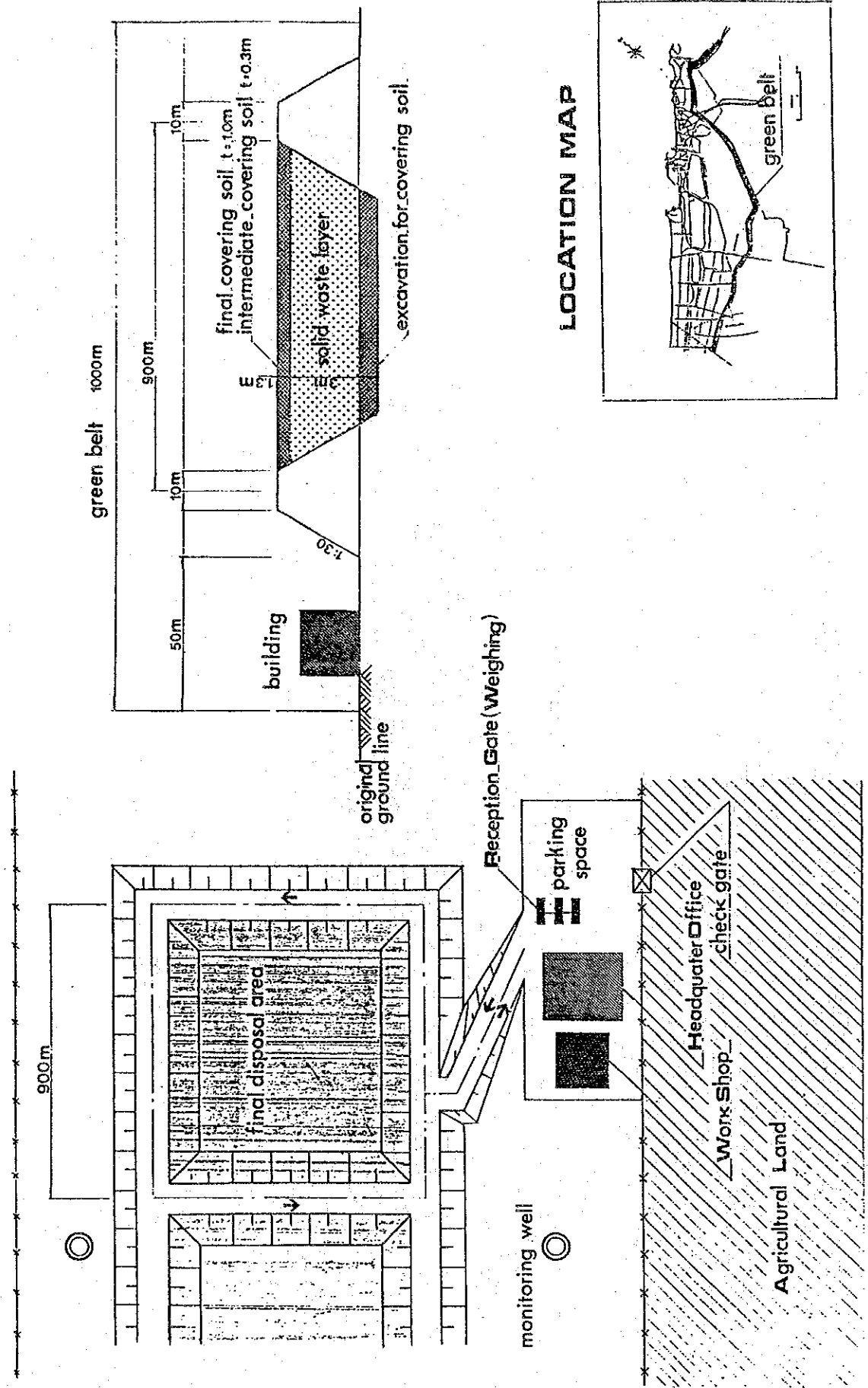
S.R. FIG 3-4-3 LOCATION OF GREEN BELT FINAL DISPOSAL SITE



S. R. FIG. 3-4-4 GREEN BELT FINAL DISPOSAL SITE PLAN

CROSS-SECTION

PLAN



c. Covering soil

Sanitary and well-planned landfill of the waste will result in stable reclamation in shorter periods of time. Fundamental actions to this end are to lay solid waste evenly on the site, to compact with rollers and finally, to overlay the surface with covering material. Thickness of the layer of the waste is generally 3 meters; however this is certainly not a fixed figure. It varies according to nature of the waste, applicability of landfill method, topography of landfill site, expected land use of the completed landfill site, environmental conditions of the surroundings, and so forth. In this study, thickness of the layer of the waste is determined as 3 meters.

Cover material will be applied as follows:

- Daily cover is applied when a landfill work of the day is completed.
- "Intermediate cover" is made, if necessary, before temporary ceasing of landfilling due to any other conditions, such as the prevention from fires, the trafficability of the collection car and soon.
- "Final cover" is made when landfilling is completed.

The thickness of the covering soil layer is determined based on the nature of waste, applicability of landfill method, effect on pollution prevention, nature of cover material, etc. Generally, a thickness between 15 and 50cm for daily cover and between 50 and 100cm for final cover are adopted. In this study, thickness of daily and final cover are to be maximum 30cm and 100cm respectively considering land use plan of the reclaimed land. The soil from landfill site is used for cover. If possible, the compost produced in the compost plants may also be used.

d. Land use plan of reclaimed land

Decomposition of organic materials in landfilled solid waste takes a long time; it continues even after final completion of landfilling. This constrains early utilization of completed landfill sites. Landfill reclaimed land is suitable for use as a park, athletic field, golf course, motorpool, open storage yard, farmland, orchard, and public facilities site; however, a clear picture of the future land use plan will be set up and landfill plan, in conformity with the expected land use, will be selected in advance of its commencement. The land use plan should be beneficial to the neighbouring inhabitants whose cooperation in provision and operation of the landfill facilities is required. The green belt proposed in Plan 2005 may be used for the purpose of final disposing of wastes.

(2) Facility plan

The facility plan is shown in Fig. 3-4-5, and it is summarized in Tab. 3-4-6.

a. Embankment

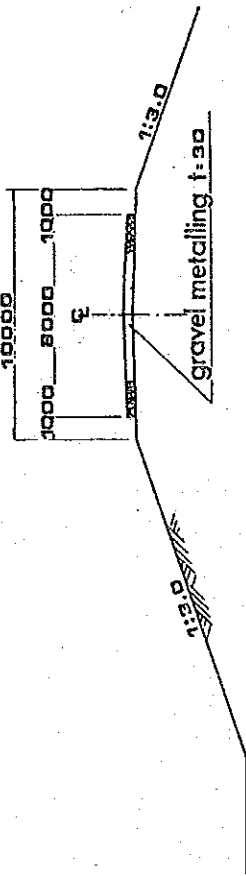
In case of the Green Belt final disposal site, an embankment is required because of flat land. The planned landfill area is enclosed by the previously-constructed embankment and waste is disposed into the embankment.

Some of the main advantages of this method are:

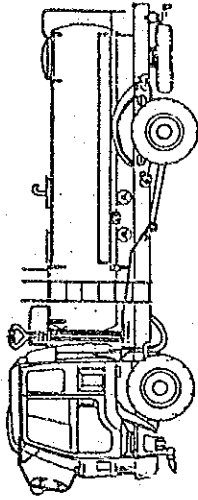
- facilitation of operation control
- protection of scenic environment
- prevention of odour and waste diffusion
- prevention of leakage of leachate out of the site

S. R. FIG. 3-4-5 FACILITY AND LANDFILL EQUIPMENT PLAN

CROSS-SECTION OF SITE CIRCUIT ROAD

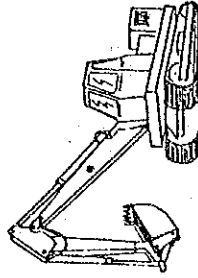
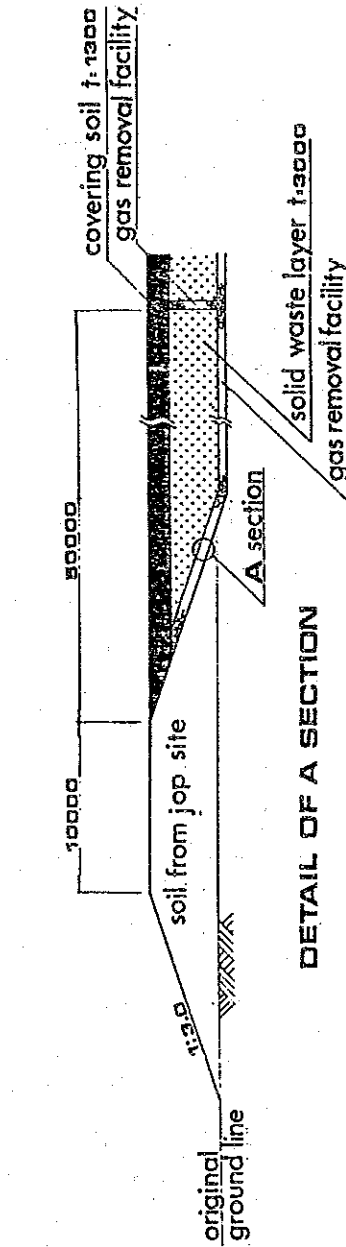


LANDFILL EQUIPMENT



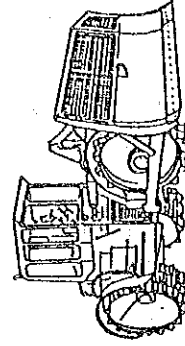
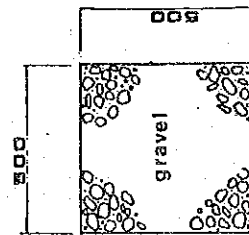
motor sprinkler

GAS REMOVAL FACILITY



back-hoe

DETAIL OF A SECTION



landfill compactor

Tab. 3-4-6 FACILITY OF FINAL DISPOSAL SITE

Facility	E.D.S.	W.D.S.
Final disposal volume (m ³ /year)	853,000	159,000
Embankment Material	Soil from job site	
Slope	1:3.0	1:3.0
Disposal Capacity (m ³ /block)	2,570,000	2,570,000
Capable year for disposal (year)	3.0	16.2
Covering soil		
Material	Soil from job site	
Daily covering soil thickness (cm)	Max. 30	Max. 30
Final covering soil thickness (cm)	100	100
Site Circuit Road		
Total width (m)	10	10
Carriage width (m)	8	8
Pavement material	gravel	gravel
Pavement thickness (cm)	30	30
Monitoring Well		
Number of Monitoring well	2	2
Depth (m)	20	20
Gas Removal Facility km	37.4	37.4
Fence m	3,800	3,800
Office Building m ²	450	190
Work Shop m ²	135	75
Truck Scale (units)	4	1

The embankment will be constructed with the excavated soil of the disposal area. The slope is 1:3.0. In case acquisition of the entire final disposal site is difficult the embankment can be constructed step by step as the mounding landfill method. Plan and cross section of an mounding landfill method is shown in Fig. 3-4-5.

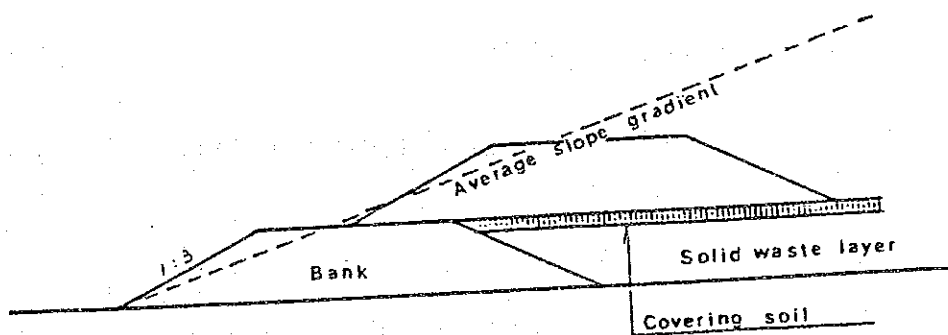


Fig. 3-4-6 MOUNDING LANDFILL METHOD

B. Rainwater drainage facilities

Considering the annual rainfall of 185mm and the annual evaporation of 1,490mm, it is judged that the disposal site itself has enough capacity to regulate the rain water because the excavated soil is used for embankment and cover material. Further, when one site becomes almost full, it is possible to regulate the rain water by constructing a new site neighboring the former one. Therefore, only an earthen side ditch is provided.

c. Road

The road planned in the Plan 2005 will be used for access from the urban area of Alexandria to the disposal site. An site circuit road with a width of 10m, carriage width of 8m and pavement (crushed gravel) thickness of 30cm is planned on the top of the embankment around the landfill site, in consideration of future use of the site after reclamation.

d. Leachate collection and treatment and impervious facilities

Since there are no private houses and the annual rainfall is far less than the annual evaporation, nothing is provided for leachate collection and treatment and impervious facilities except for two sets of monitoring wells for observing leachate in case of emergencies.

e. Disaster prevention facilities

In this study, the following disaster prevention facilities are planned.

- Fence

A fence of 1.8m height is planned around the disposal site in order to prohibit the intrusion of animals and scavengers.

- Gas removal facility

Considering the land use of the reclaimed land, gas removal facility is provided for the growth of plants and promotion of waste decomposition. it is provided every 50m lengthwise and breadthwise, and its material is gravel (refer to Fig. 3-4-5).

- Motor sprinkler

As a countermeasure against fire at the site and breeding of vector and vermin, a motor sprinkler with a tank of 10m³ is supplied, which can also be used as a disinfectant.

f. Control and management facilities

The following facilities will be provided.

- Truck scale

It is necessary to install equipment for weighing and recording of incoming waste amount as it is essential for proper disposal operation.

- Headquarters office

This building is used for administration, management, rest room for the workers and other miscellaneous purposes.

- Work shop

Work shop is for simple repairs and daily maintenance of the landfill equipments.

(3) Landfill equipments and organization plan

a. Landfill equipments

Landfill equipments are classified into two groups:

- i. Machines for waste placing and compacting
- ii. Machines for trenching, cutting and overlaying for covering soil

Types of relevant machines and their suitability are described in Tab. 3-4-7, and illustrations of the main types of machines are displayed in Fig. 3-4-5. The following landfill equipments are planned to be installed.

- Back-hoe
- Dump Truck
- Bulldozer
- Landfill compactor
- Motor sprinkler

Tab. 3-4-7 COMPARISON OF LANDFILL EQUIPMENT PERFORMANCE

Machine Type	Waste Handling			Soil Covering		
	Level- ing	Compact- ing	Trench- ing	Level- ing	Compact- ing	Drag- ging
Crawler-dozer (Bulldozer)	Excel- lent	Good	Fair	Excel- lent	Good	Poor
Crawler-loader (Tractor shovel)	Good	Good	Excel- lent	Good	Good	Poor
Wheel-dozer	Excel- ent	Good	Fair	Good	Good	Poor
Wheel-loader	Good	Good	Fair	Good	Good	Poor
Scrape-dozer (Scraper)	Poor	Poor	Good	Excel- ent	Poor	Poor
Power shovel	Poor	Poor	Excel- lent	Fair	Poor	Poor
Landfill compactor	Excel- lent	Excel- lent	Poor	Good	Excel- lent	Poor

Source: The text by Japan Environmental Sanitation Center

b. Organization plan

A typical final disposal site organization map is shown in Fig. 3-4-7.

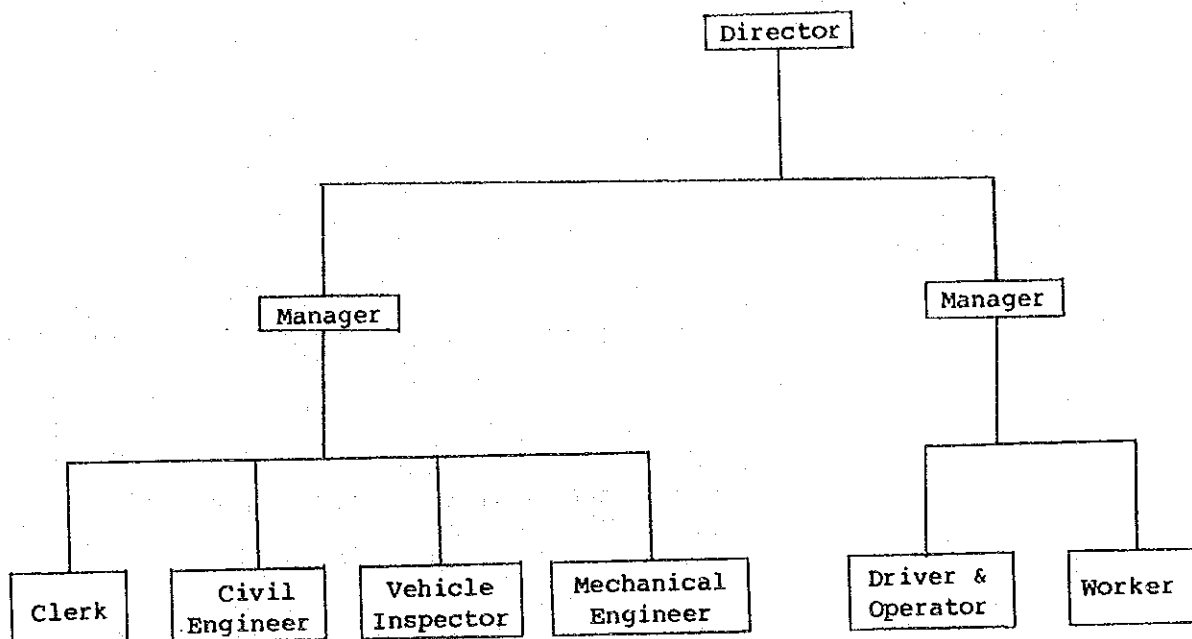


Fig. 3-4-7 FINAL DISPOSAL SITE ORGANIZATION MAP

3.4.3 Construction stage plan

Final disposal sites will be constructed one by one in accordance with the cumulative waste disposal amount. The staged construction plan of final disposal sites is shown in Tab. 3-4-8. The required capacity to be disposed of by 2000 is 12,400,000m³.

The equipment and manpower requirement in each stage of the final disposal are shown in Tab. 3-4-9. Those requirement increases annually.

Tab. 3-4-8 CONSTRUCTION STAGE PLAN OF FINAL DISPOSAL

	-1989	1990-1994	1995-1999	2000-
Alternative 2				
No. of Lots; EDS	2	2	2	-
No. of Lots; WDS	1	-	-	-
Total	3	2	2	-
Building (m ²)	850	-	-	-
Trucks Scale (units)	5	-	-	-
Equipment (units)				
Initial Procurement	13	1	-	-
Replacement	-	13	14	-
Total	13	14	14	-

Tab. 3-4-9 MACHINE AND MANPOWER OF EACH STAGE FOR FINAL DISPOSAL

	'89	'90-'94	'95-'99	2000
Machine (Unit)				
Back-hoe ; 0.7m ³	1	1	1	1
Back-hoe ; 0.4m ³	1	1	1	1
Dump Truck ; 11t	2	2	3	3
Bulldozer ; 11t	2	2	2	2
Landfill Compactor; 20t	1	1	1	1
Sprinkler ; 30t	3	3	3	3
Sprinkler ; 10m ³	3	3	3	3
Total	13	13	14	14
Manpower (persons)				
Administrative	5	5	5	5
Technical	17	17	20	20
Driver	24	24	26	26
Worker	12	12	13	13
Total	58	58	64	64

CHAPTER 4. PLANNING CONDITION AND PLAN FOR PROJECTS

4.1 Collection Haulage and Street Sweeping

1) The estimated waste amount

The waste amount of Middle District is estimated to be 550 ton/day in 2000, and 433 ton/day in 1990. The amount in the year 2000 is 1.4 times that of 1984. A collection project will be planned according to the above mentioned amount. The amount of waste generated from the different sources is as follows (Table 3-1-1):

Table 3-1-1

Type of source	1984	1990	2000
Household	229	253	304
Market	389	433	550
Other commercial			
Total	389	433	550
Beach			
Vacationer	10	18	18

2) Framework of collection & haulage plan

(1) Providing collection service

a. Coverage of collection service

Collection service will be provided in all residential areas. Thus, served urban population ratio to the total urban population will be approximately 100%.

The waste that will be considered in the collection plan is mainly domestic waste, commercial waste, summer vacationers waste, and coastal waste. However, the waste generated from small factories located inside the city is included in the commercial waste. The streets waste will also be considered in the sweeping plan.

(2) Classification of served areas

The plan of the collection system should be suitable for each area's special conditions. The following five zones are defined according to each's specific conditions.

- City center
- Ordinary residential areas
- Suburban areas
- Markets
- Coastal area

These zones will be shown on the map in accordance to discussions held between Egyptian counterparts and JICA study team.

(3) Method for discharge, frequency, collection points and collection method

a. Storage for discharge

Principal storage for discharge will be defined as follows:

Type of zone	Contents
- City center	Plastic Bags
- Ordinary Residential Area	Plastic Bags
- Suburban area	Communal containers
- Markets for other special facilities	Communal container Will be decided according to the situation.
- Beach area	Open stations at sea side.

b. Frequency and working time

Frequency and working time will be defined as follows:

Type of zone	Frequency	Working time
- City center	Daily	Summer 6:00 - 12:00
- Ordinary Residential Area	Daily	Winter 7:00 - 13:00
- Suburban Area	Twice a week	7:00 - 13:00
- Markets or other special facilities	According to the situations	
	- once a day -----	morning shift
	- twice a day -----	morning shift and afternoon shift
	- three times a day -----	morning, afternoon and evening shift
- Coastal Area	April to October	
	Daily	7:00 -
	November to March	12:00
	twice a week	

c. Collection points

Collection points will be defined as follows:

Type of zone	Contents
City center	No waste stations Citizens can put at the entrance of the building.
Ordinary Residential Areas	The waste stations will be arranged along the side walks of the main streets and alleys. (The maximum waste carrying distance is approx. 100 m.)
Suburban Areas	The large communal containers will be arranged at the entrances to these areas.

Type of zone	Contents
Markets or other special facilities	In principle the large communal containers will be arranged in this area. If there is no place for containers, the waste stations will be designated according to the situation.
Coastal area	Making stations according to the situation.

d. Collection method

Type of zone	Contents
City center	Small vehicles will collect waste (First collection). Large vehicles will take waste from small ones (Second collection).
Ordinary Residential Areas	Middle or large size vehicles will collect waste from the designated stations.
Suburban Areas	Special vehicles will lift communal containers and collect its wastes.
Markets or other special facilities	Special vehicles will be used for the large containers. But, if impossible, medium or large size vehicles will collect waste from the designated stations.
Beach area	Special vehicles equipt with a crane.

3) Framework of street sweeping plan

(1) Coverage of sweeping

Collection service will be provided in all residential and city center areas in Middle District.

(2) Classification of streets

Streets will be classified according to their priority for sweeping. The classified streets will be defined as follows:

- A. City center's shopping streets and main streets.
- B. Important main streets.
- C. City center's minor streets and Residential areas' main streets.
- D. Market areas.
- E. Residential areas' minor streets.

(3) Frequency

The frequency of sweeping will be defined according to the classification of streets as follows:

- A. 3 times a day
- B. Twice a day
- C. Once a day
- D. Once every two days
- E. Once or twice a week

(This will be decided according to the situation).

(4) Method of sweeping

Manual sweeping will be the basic method of sweeping. But the mechanical sweeping will be used in the trunk roads. (At present, mechanical method is used in the trunk roads).

(5) Allocation

The length to be swept by each sweeper will be 1.5 Km/day in the A, B and C class streets and 1.0 Km/day in the D class streets. (Total length swept by sweeper will be 3.0 Km in the A, B and C class streets and 1.5 Km in D Class streets, because the A, B and C class streets have side walks on both sides. Also main streets are easier for sweeping than minor streets in the residential area since minor streets condition is worse than main streets. This is why the assigned length in the D-class streets is shorter than the other ones). In the markets areas, the number of sweepers will be allocated according to the situation.

(6) Tools

Each sweeper is given a broom and a green basket, both which are available in Alexandria. And principally each sweeper is assigned a push cart. Basically two container carts will be selected.

(7) Transfer

The vehicles will be required to carry the collected waste to the dump site and to carry the push carts to the sweeping area.

4) Equipment

(1) Collection equipment

Among all the collection equipment the price of the collection vehicle is the highest. Collection vehicles are two types. One is a vehicle made especially for collection and the other is an ordinary vehicles. The cost of the special vehicle is higher than the ordinary one. But the special vehicle will be selected in order to obtain high efficiency of cleansing activities.

Necessary 4 types of vehicles:

- Vehicle to lift the containers (capacity 12 m³).
- Compactor vehicle (Capacity 6 m³).
- Compactor vehicle (Capacity 8 - 10 m³).
- Small vehicle without dump function (Capacity 2 - 3 m³).

(2) Sweeping equipment

- Mechanical sweeping.
- Ordinary dump truck (4 m³)

5) Transfer station

(1) General

After the present disposal site will be finished the garbage must be carried to the new disposal site which is located at a distance of 40 Km in Ameriyah. But, when Abis new compost plant will be constructed in 1990, the capacity of transfer station can be reduced.

(2) Designed capacity

On considering the necessary amount of transfer in 2000, the capacity will be designed as 250 ton/day including rejects from compost plants.

(3) Location of transfer station

In accordance with the conditions of existing land use, the transfer station will be located beside the new Abis compost plant.

(4) Transfer system

A transfer system without compaction shall be selected. This system is very simple and it is the cheapest in construction cost. The detailed reasons concerning selection are mentioned in the Interim Report Chapter 3.

6) Garage workshop

New garage of Middle district and Gomrok district is under construction in Moharam Bey. Here only a guideline for arranging equipment will be given.

7) Organizational structure for collection operation

(1) Manpower

The crew size of collection can be reduced according to progress and improvement of citizens discharge manner. Therefore, the crew size can be as follows:

- very small vehicle one assistant
- compactor vehicle two or three assistants
- container vehicle three assistants

And, administration and inspection manpower will be defined according to the number of sweepers and assistants.

(2) Organizational structure

It is necessary to strengthen the organization for operation. In order to manage cleansing activities, the organizational structure should take the following functions.

District Branch
Cleansing Central
Office

General
affairs

- General affairs
- Planning (Operation of Collection & Sweeping)
- Instruction for employee
- Store
- Collection - Grasping the situation
- Finding the problems
- Sweeping - Finding the solution to problems

Execution

Instruction

- Public education
- Public relation
- Punishment
- Registering
- Accounting
- Collection

Collection
fee

District
Garage

- General affairs
- Work shop

Sub District
Cleansing office

- General affiars
- Inspection

8) Regulation

It will be required to make cleansing activities clear to citizens and cleansing staff so as to establish the cleansing regulation.

This regulation is important in order to achieve the cleanliness of Alexandria.

This regulation should define the following items:

- . Responsibility between district and citizens.
- . Definition of waste which district must collect.
- . Definition of cleansing activities.
- . Classification of service area.
- . Prohibition of scavengers or zabaleen activities.
- . Discharge manner which citizens must obey.
- . Prohibition of cleansing workers special activities.
- . Penal regulation and fine.
- . Definition of cleansing instructions.
- . Definition of collection fee.

9) Cost

The price of items for calculating the operation cost will be defined.

- | | |
|------------------|--|
| (1) Vehicle | Open-type dump truck (10 ton) |
| | Open-type dump truck (6 ton) |
| | Compactor-type truck (8 m ³) |
| | Compactor-type truck (6 m ³) |
| | Small vehicle |
| (2) Cart | (two container type) |
| (3) Broom | |
| (4) Green basket | |

(5) Fuel & Spare parts	Open-type dump truck (10 ton)
	Open-type dump truck (6 ton)
	Compactor type truck (8 m ³)
	Compactor type truck (6 m ³)
	Small vehicle
	Fuel cost LE/1

(6) Communal container

(7) Wage	Driver	LE/year
	Assistant	LE/year
	Sweeper	LE/year