

CHAPTER 4. SELECTION OF PRIORITY PROJECT

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The Feasibility Study is implemented for the three projects to improve the situations in the Middle District, which is the city center of Alexandria. These improvements are expected to exert pervasive effects towards the whole city area and also anticipated to be the preferential plan by the Governorate of Alexandria.

1) Collection, haulage and street sweeping improvement project in the Middle District

The plan of the improvement project for collection, haulage and street sweeping systems is drawn up in conformity with the frame proposed in the Master Plan.

The waste collection, haulage and the street sweeping plan, in combination with the new Abis Compost Plant project and the sanitary landfill project at MBSDS, will upgrade the cleansing service of the Middle District to a level close to the target established in the Master Plan and improve the environmental sanitation of the area.

This will show the Governorate of Alexandria the knowhow for implementing the project and the effect of the system proposed in the Master Plan, and this will eventually lead to the development of the cleansing work throughout the city along the guidelines of the Master Plan.

2) Sanitary landfill project at MBSDS

The plan for implementing the sanitary landfilling in the MBSDS where wastes from the Middle, Gomrok and part of the West Districts are being disposed of is drawn up.

The implementation of the sanitary landfilling at the MBSDS shall lead to the transfer of appropriate landfilling technology, which shall be the base of the waste disposal system to be adopted in Alexandria, and

furthermore, it can break the deadlock related to securing future disposal sites, which, as a matter of fact, is partly brought about by the insanitary landfilling (open dumping without a thoroughgoing control) being implemented so far in the city, and in particular it is considered that the sanitary landfill scheme can be a countermeasure indispensable for attaining the consent of the relevant authorities for securing future disposal sites in the Green Belt, as proposed in the Master Plan.

The Master Plan proposes securing two sanitary landfill sites in the East and West of the Green Belt, within 20 km distance from the city center, but in reality the implementation of the Plan 2005, which is the superior plan of this project, is behind schedule. Such being the case, the quarry site in Ameriyah District is regarded as the most prospective site for final disposal site after finishing the landfill in the MBSDS for the time being although efforts are still being made to secure appropriate sites in the Green Belt. The sanitary landfilling in the quarry site shall be taken into consideration if the acquisition of sites in the Green Belt has failed.

3) New Abis Compost Plant Construction Project

The construction of the New Abis compost plant will bring about effective utilization of wastes as well as reduction of waste amount. Also, if the compost could be produced stably with satisfaction of the customers as to its quality and quantity, the composting scheme would consolidate its positive evaluation from the standpoint of the national economy, including the possibility of opening the way for establishing a subsidy system on the national level. Such being the case, this composting plant should be regarded as an important project in view of its multifarious potentialities.

As can be seen, the composting project is expected to develop the resource recovery and effective utilization of waste in the s.w.m. of Alexandria in the long-run.

The new plant capacity is determined on the basis of the following:

- a. Compost demand in the Alexandria Governorate at present exceeds the amount produced in the 460 t/d compost plant, and the demand in 2005 of all agricultural lands within the area is estimated to reach 660 t/d in consideration of the amount of all other organic fertilizers available within the area.
- b. Since the construction of the compost plant should conform to the policy of realizing the establishment of an independent financial base for the cleansing service in Alexandria, the introduction of new plant shall be limited to a unit of plant while the financial base is still immature.
- c. The site area for the new compost plant arranged by the Alexandria Governorate adjoins to the existing plant and the area can allow the construction of the plant of 250 to 350 t/d in capacity.
- d. 300 t/d is the desired capacity of the plant by the authorities of the Alexandria Governorate.
- e. Since the construction site for the new plant is located near the Middle District, the plant will be used primarily to treat waste generated in that district. Accordingly, if the scale of the plant is set at 300 t/d, then when combined with the 160 t/d capacity of the existing plant, the resulting capacity will be 460 t/d. This figure adequate to meet the treatment needs of the Middle District in 1990.

In consideration of the foregoing five items, it is reasonable to construct a compost plant with a capacity of 300 t/d to treat waste primarily generated in the Middle District.

CHAPTER 5. PROJECT PLAN

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5.1 Collection, Haulage and Street sweeping in Middle District

5.1.1 Subject for Planning

As Middle District is a gateway to Alexandria where many vacationers visit in summer, enhancement of the beauty of the town and the improvement of the sanitary condition are earnestly demanded. Despite the fact that the District Cleansing Sect. has been devoting tremendous efforts to daily waste collection and street sweeping, the rewarding results have not been accomplished up to now. Following three points can be enumerated as the main causes.

- a. The collection system to ensure stable collection (establishment of the standard of the service level, regulation on the manner of waste discharge, maintenance of collection vehicles, readjustment of organizations, etc.) has not been adequately prepared.
- b. Deficient collection system causes the increase of littered waste in the streets and consequently results in the higher cost of street sweeping.
- c. Poor understanding of the citizens on cleansing operation and insufficient citizenry cooperation are being obtained.

Accordingly, the fundamental subjects concerning the waste collection, haulage and street sweeping in Middle District are as follows:

- a. Improvement of the collection system to provide the more stable fulfillment of the collection service.
- b. Integration of the street sweeping activities.
- c. Securing the cooperation of the citizens.

And technical systems to respond to these subjects should be formulated as rationally as possible with due regards to the limited financial resources of the city and other conditions. For this purpose, the following matters should be studied in detail.

a. Formulation of an effective collection and haulage system

- Optimization of the collection method, frequency, time and the discharge method.
- Optimum operation of the vehicles such as dispatching
- Repletion of the collection and haulage equipments (including countermeasures for narrow alleys)
- Establishment of a maintenance system
- Optimization of the allotment of the street sweeping and collection
- Improvement of technical competence and the working ethics of personnel

b. Formulation of a rational street sweeping system

- Reorganization of street sweeping activities
- Improvement of sweeping frequency and sweeping method, etc.
- Fuller provision of sweeping equipments and materials
- Improvement of the working ethics of personnel

5.1.2 Preconditions for Planning

1) Target Year of Plan

The target year shall be 2000.

2) Land use status of the project area

As shown in Fig. 5-1-1, Middle District is roughly divided into the following three areas; the built-up urban areas between the coastline and the Mahmoudia Canal, the industrial area between the said canal and the agricultural road, and the agricultural area south of the agricultural road. The industrial area and the agricultural area also include residential areas in small scale.

The gross area of Middle District is about 63.4 Km², broken down into 9.5 Km² of the built-up urban area, 2.2 Km² of the industrial area and 51.7 Km² of the agricultural area (including 2 km² of the Lake Maryut).

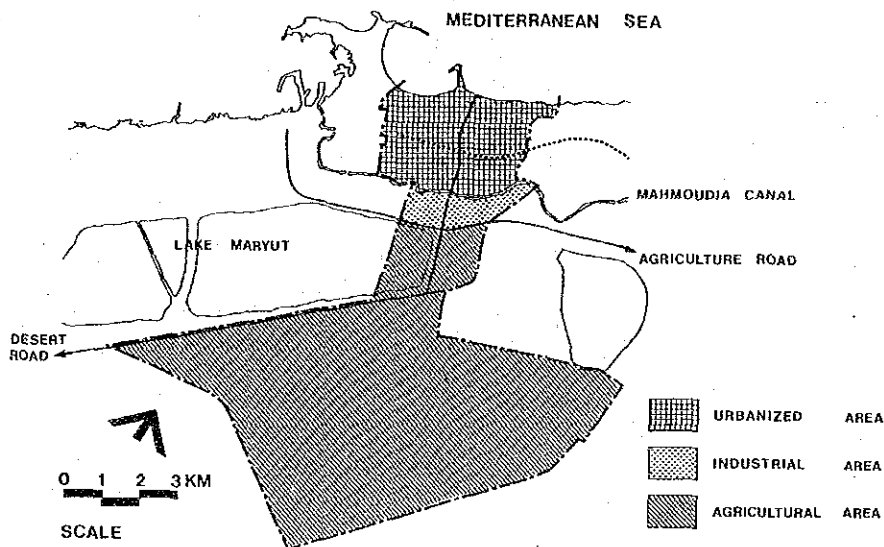


Fig. 5-1-1 AREA DIVIDED WITH LAND USE IN MIDDLE DISTRICT

3) Future land use

The land use pattern in the district is unlikely to change substantially even in 2000, except that a housing development program to accommodate population growth of the district has been planned in a part of the agricultural area, so that the residential area is calculated to increase by that much. The projected land use in 2000 is as shown in Table 5-1-1.

Table 5-1-1 LAND USE IN MIDDLE DISTRICT

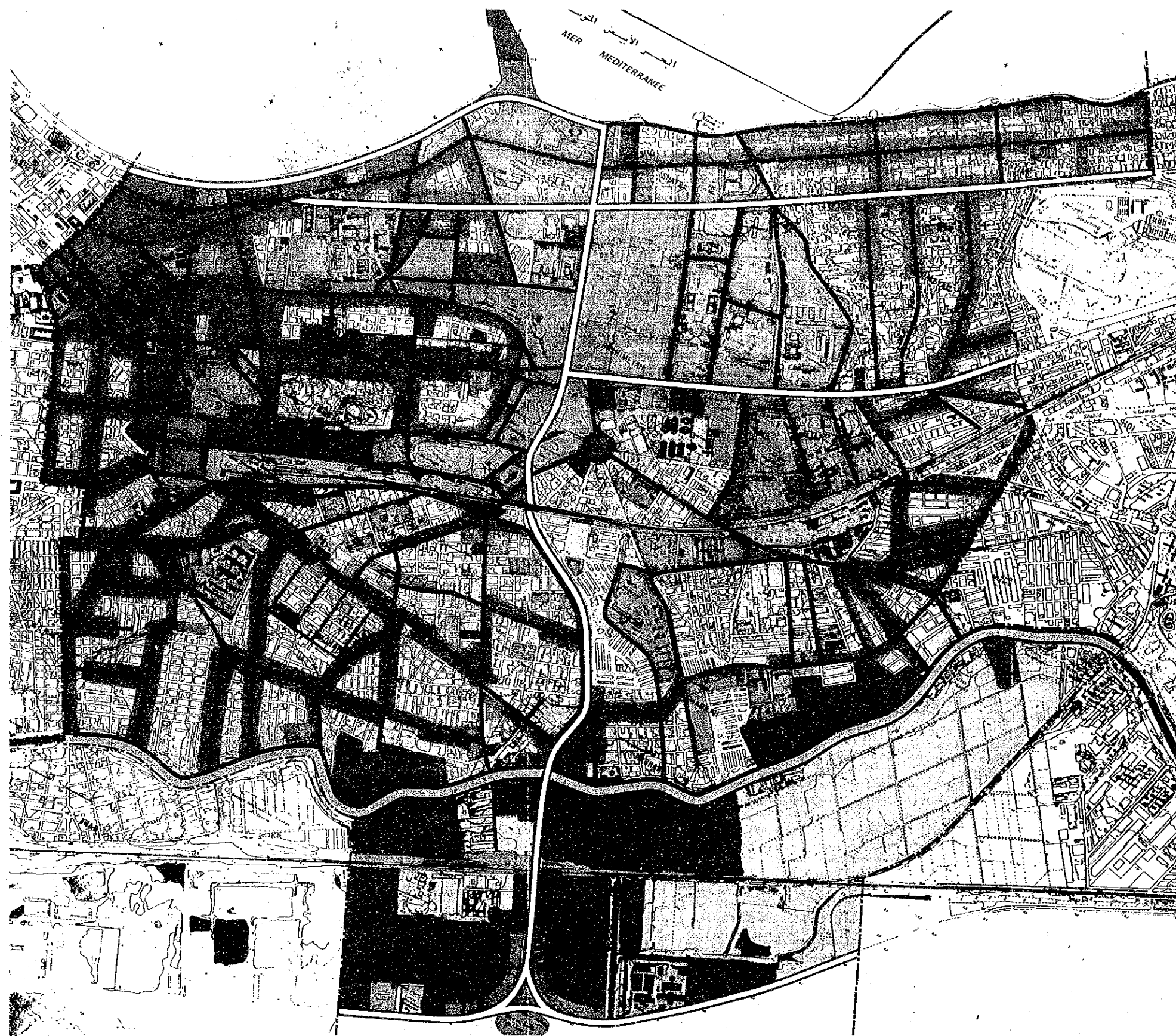
(ha.)

Area	Classification	1985	2000
Built-up Urban Area	1. Commercial & Business	90	96
	2. Residential	419	419
	3. Industrial	40	40
	4. Green Tract	105	105
	5. Others	296	290
	Sub-total	950	950
Industrial Area	1. Factory	81	110
	2. Others	141	112
	Sub-total	222	222
Agricultural Area	1. Commercial & Business	0	1
	2. Residential	7	15
	3. Others	5,159	5,150
	Subtotal	5,166	5,166
Total		6,338	















The future land use pattern in the built-up urban area and the industrial area is as shown in Fig. 5-1-2.

4) Estimated population

The present and the future population is as shown in Table 5-1-2. By 2000, the present population of 760,000 is estimated to increase by 32,000 and reach to 792,000. It was assumed that 22% of the population growth, or about 7,000 persons, will be accommodated in the new urban area planned in the present agricultural area, and that the remaining 25,000 persons or so shall be accommodated in the built-up urban area.



LEGEND

-  CENTRAL COMMERCIAL & BUSINESS
-  LOW DENSITY COMMERCIAL & BUSINESS
-  PUBLIC FACILITY
-  RESIDENTIAL
-  INDUSTRIAL
-  MEDICAL & EDUCATIONAL
-  RECREATION
-  PARK & CEMETERY
-  WATER SUPPLY
-  TRANSPORT
-  FARMLAND
-  TRUNK ROAD
-  MAIN ROAD
-  MAHMOUDIA CANAL & PROPOSED ROAD

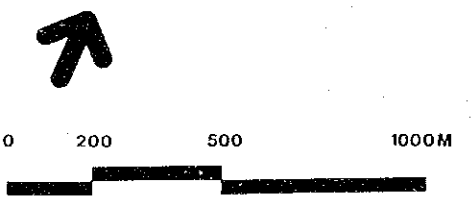
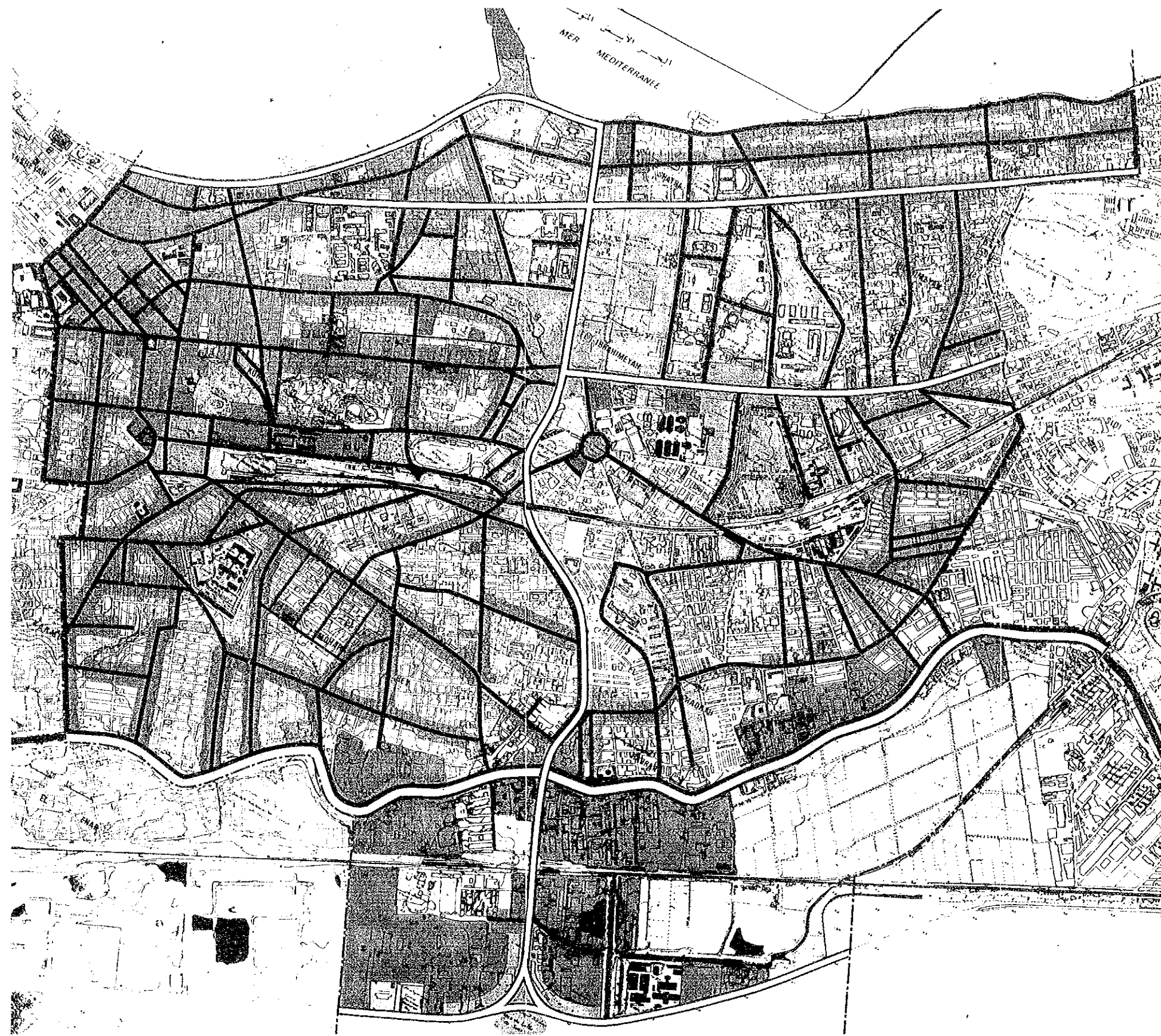
















Fig. 5-1-2

FUTURE LAND USE PLAN OF MIDDLE DISTRICT

THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA



LEGEND

-  CENTRAL COMMERCIAL & BUSINESS
-  LOW DENSITY COMMERCIAL & BUSINESS
-  PUBLIC FACILITY
-  RESIDENTIAL
-  INDUSTRIAL
-  MEDICAL & EDUCATIONAL
-  RECREATION
-  PARK & CEMETERY
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-  MAIN ROAD
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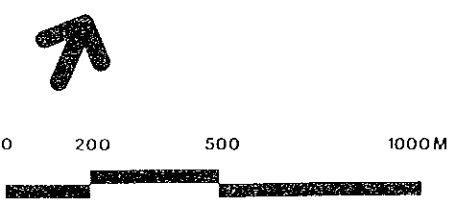


Fig. 5-1-2

FUTURE LAND USE PLAN OF MIDDLE DISTRICT

THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA

Table 5-1-2 ESTIMATED POPULATION GROWTH

(persons)

Zone	1985	1990	1995	2000
Bab Sharky police station				
Ibrahimiya El Bahariya	96,146	97,348	98,565	99,797
Azarita El Shatby	30,298	30,677	31,060	31,448
Bab Sharky Wabor El Maiya	10,596	10,728	10,863	10,998
Ezbet El Gama	6,067	6,143	6,220	6,297
El Hadara El Kibliya	117,676	119,147	120,636	122,144
Moharam Bey police station				
Bab El Gedia (Sharky)	77,581	78,357	79,140	79,932
Bab El Gedia (Gharby and Menasha)	30,804	31,112	31,423	31,737
El Sobhiya	11,393	11,487	18,242	18,393
Imbrouzo and Moharam Bey	134,171	135,613	137,071	138,545
Ragheb Basha	72,177	72,899	73,628	74,364
Bawalino and El Eskandarany	82,047	82,929	83,820	84,722
Attarin police station				
Attarin (Sharky)	93,537	9,616	9,696	9,776
Attarin El Sory	9,328	9,405	9,483	9,561
Attarin (Gharby)	17,256	17,399	17,538	17,684
El Mesalla (Sharky)	18,365	18,595	18,827	19,062
El Merghry	10,764	10,853	10,943	11,034
El Mesalla (Gharby)	8,212	8,315	8,419	8,524
Kom El Deka (Sharky and Gharby)	17,682	17,827	17,973	18,120
Total	760,100	768,450	783,547	792,138

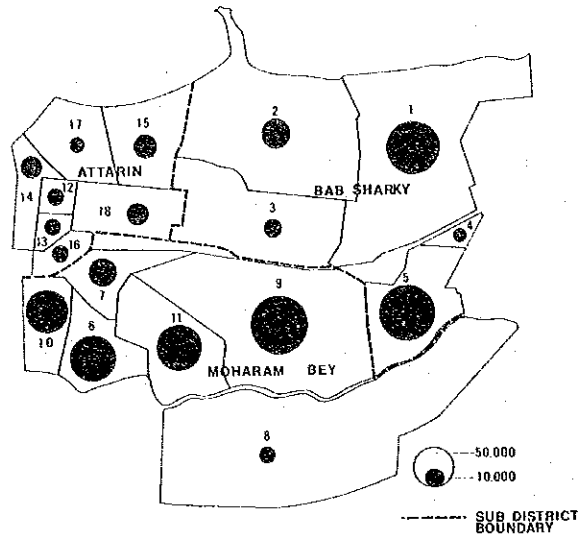


Fig. 5-1-3 POPULATION DISTRIBUTION IN MIDDLE DISTRICT
(Current Status)

5) Present and future Waste amount

It is estimated to be 433 t/d in 1990 and 550 t/d in 2000, or in other words the waste amount in 2000 will be 1.4 times that of 1984 as shown in Table 5-1-3.

Table 5-1-3 PRESENT AND FUTURE WASTE AMOUNT BY SUB-DISTRICT

		(t/d)			
Sub-District	Type of source	1984	1990	1995	2000
Attarin	Domestic Waste	27	30	33	36
	Commercial Waste	53	61	74	84
	Sub-total	80	91	104	120
Bab Sharki 8th	Domestic Waste	44	48	53	58
	Commercial Waste	29	33	39	45
	Sub-total	73	81	92	103
Bab Sharki 7th	Domestic Waste	35	39	43	47
	Commercial Waste	18	20	23	27
	Sub-total	53	59	66	74
Ghorbal 6th	Domestic Waste	21	23	25	27
	Commercial Waste	9	10	11	13
	Sub-total	30	33	36	40
Moharam Bey 7th	Domestic Waste	102	113	124	136
	Commercial Waste	51	56	66	77
	Sub-total	153	169	190	213
Total	Domestic Waste	229	253	278	304
	Commercial Waste	160	180	210	246
	Total	389	433	488	550
Vacationers' Waste		18	18	18	18
Beach Waste		3	3	3	3

In the commercial waste, the amount of market waste is estimated as shown in Table 5-1-4. The share of the market waste in the commercial waste is 46% in 1984 and will be 40% in 2000.

Table 5-1-4 MARKET WASTE AMOUNT BY SUB-DISTRICT

(t/d)

	Number of Market	1984	1990	1995	2000
Attarin	5	22	24	26	29
Bab Sharki 8th	3	14	15	16	18
Bab Sharki 7th	2	14	16	17	19
Ghorbal 6th	2	7	8	8	9
Moharam Bey 7th	5	17	19	21	23
Total	17	74	82	88	98

6) Required considerations in planning

(1) Commerce

There are 28,600 shops in Middle District, of which about 40% or 11,000 shops are concentrated in Attarin, the central commercial and business area.

(2) Conditions of roads

The total extended length of roads at present in the built-up urban area is 203 Km. The breakdown of these roads by road width is as shown in Table 5-1-5. The road condition within the area is not assumed to change considerably even in 2000.

Table 5-1-5 PRESENT CONDITION OF THE ROADS BY WIDTH
(only for the built up urban area)

Classification	Width (m)	Length (km)
Trunk	more than 12	17.2
Main	" 7.5	48.8
Secondary	" 5	110.3
Tertiary	" 3.5	138.0
Others	less than 3.5	57.7
Total		372.0

(3) Buildings

Middle District has about 26,400 buildings, and the majority are multiple dwelling houses having four to six stories. No space for a new building can be found anywhere in the build-up urban area. The population density has reached to as high as 791 persons/ha.

(4) Residential area in suburban region area

The Nadi El Seid located in south of the Agricultural Road, is residential area with low rise buildings of two to three stories. The population of the area is about 20,000, the land area about 7 ha, and the incomes of the residents are relatively low. The streets are 6 - 8m wide, but most of them are unpaved. The waste collection frequency is as low as three times to once a week. Waste is open dumped at the vacant lot located at the southern end of the area.

The only existing housing area is this Nadi El Seid, however, in the future, a site of 6-8 ha is planned to be allocated in the landfill site of MBSDS for a new housing project.

(5) Cleansing office and cleansing zone

Location of the cleansing offices which control the cleansing service within its zone, area of each cleansing zones and sub-zone are shown in Fig. 5-1-5. Middle District is divided into 24 cleansing sub-zones except the EL-sobia and Ezbet Nadi El Seid which are located in the suburban area.

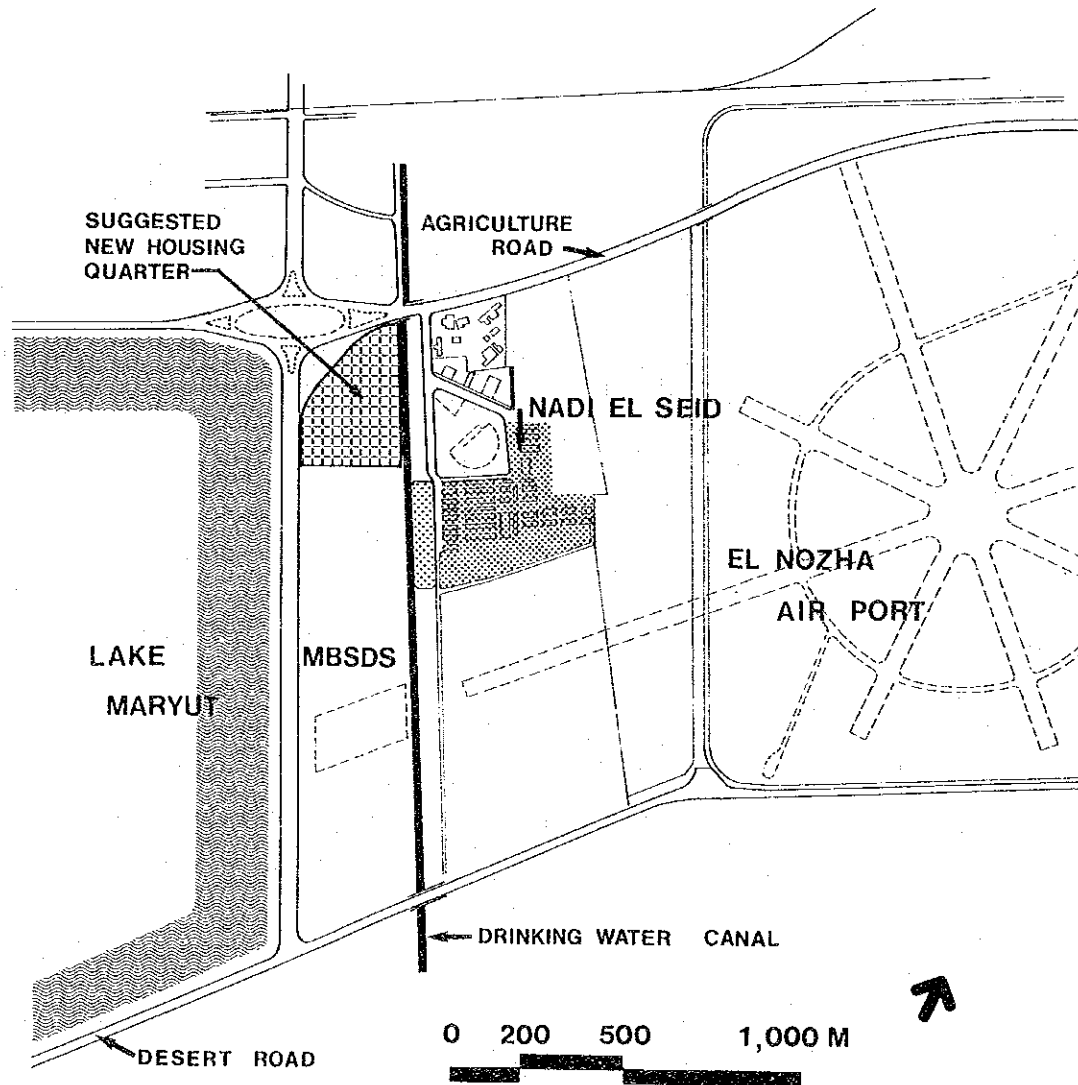


Fig. 5-1-4 LOCATION MAP OF NADI EL SEID AND THE PLANNED AREA

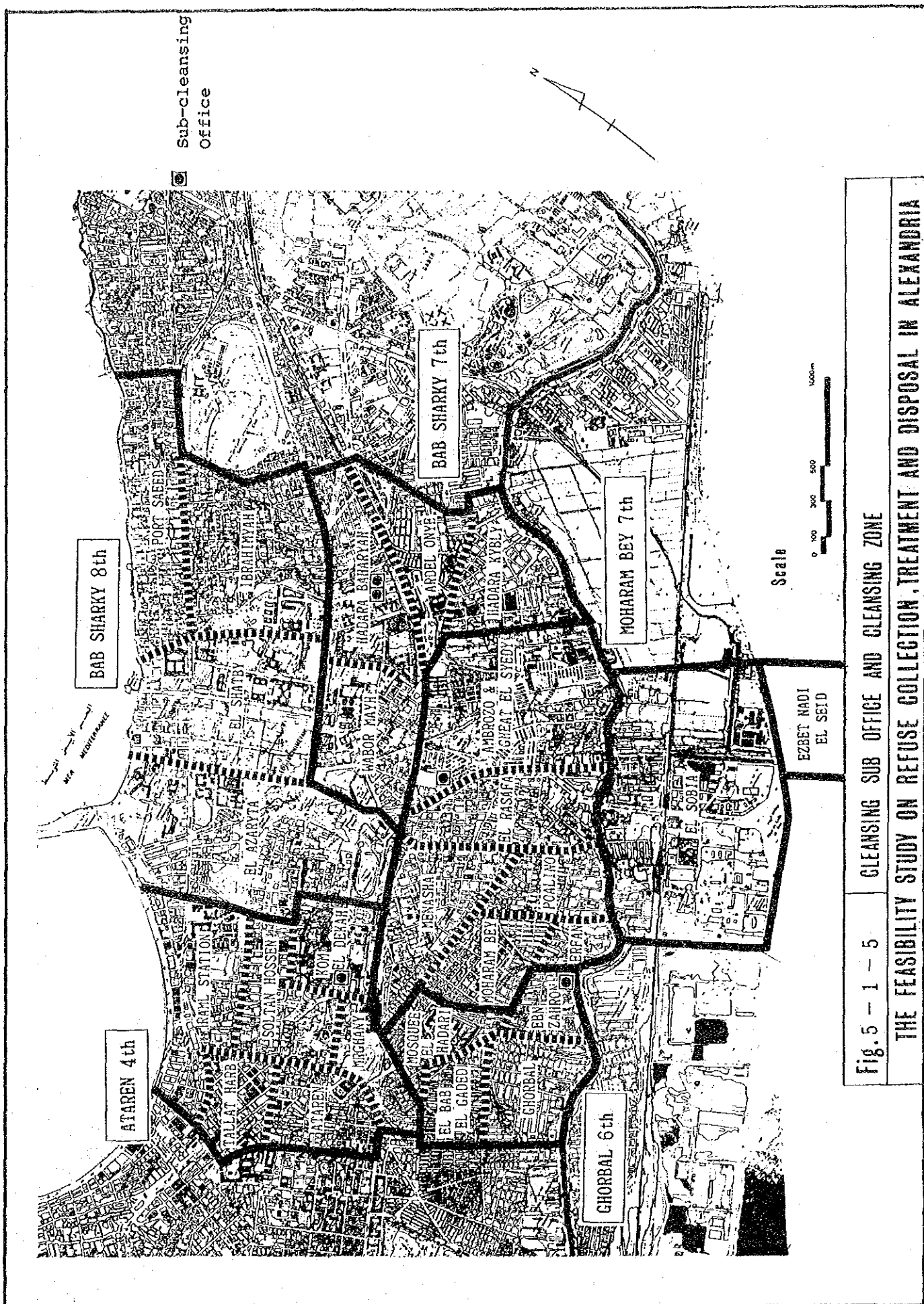


Fig. 5 - 1 - 5 GLEANSING SUB OFFICE AND GLEANSING ZONE

THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA

5.1.3 Improvement Plan for Collection and Haulage

1) Basic policy for the plan formulation of collection and haulage

The basic policy for the improvement of the waste collection and haulage is based on the subjects for planning described in the section 3.5.2.

(1) Service Area

The waste collection service covers all residents of the Middle District in the residential areas, and commercial and business centers as well as the suburban residential areas. Waste is collected from the shops, offices, markets, beaches, small factories and residences.

(2) Classification of the service areas

The collection service area is classified by four areas for the necessity of forming the different collection systems required to cope with the situation of the areas and difference of the waste discharge system.

a. City center

Consists of the central district of Alexandria, where vigorous commercial and business activities occur and the cleaning service is particularly important in this area.

b. Residential area

Consists of high population density area, where most of the waste is generated from the households.

c. Suburban residential area

Consists of the areas located on the outskirts of the city, where relatively low income families live.

d. Beach area

Waste is generated by the vacationers only during the summer season.

(3) Measures for coping with specific waste sources

Large amount of waste generated in the commercial areas and business establishments affect the collection service when the generation amount fluctuates. Such being the case, a special collection system different from the general service is considered.

(4) Waste discharge method

Waste should be discharged to the defined place by using specified container during a certain period of time.

The waste discharge places will be determined in consideration of the characteristics of the service area, but the maximum carrying distance shall not exceed 100m. Locations of the waste stations are selected by taking into consideration the street conditions and after consultations with the residents.

Plastic bag is used as the waste container in view of the availability and its advantages regarding the easiness of waste storage in households and sanitations as well. Special consideration is taken depending on whether the purchase cost of plastic bags will become a burden on the residents and when the use of plastic bags is not suitable (e.g. in the case of wastes from business establishments).

(5) Collection frequency

Daily collection is adopted in principle in consideration of the physical structure of the city, but the collection in such specific areas as suburban area is examined separately.

(6) Crew size

The crew size is determined to enable the most efficient operation of the collection vehicles.

(7) Standard amount of collection work

The collection vehicles perform the standard number of trips, and attention should be paid to prevent conspicuous inconsistencies in the net work time between one collection vehicle and another.

Furthermore, the standard waste loading amount per worker per day should be determined, and once more attention should be paid to prevent conspicuous inconsistencies of the loading work among the workers.

(8) Collection zones

The collection zones shall be demarcated so as to enable one collecting vehicle to collect the wastes generated in various zones within the standard number of trips without undue delay.

(9) Collection vehicles

The collection vehicle shall be suitable for the work efficiency without disrupting the image as the central area in Alexandria. Moreover, the vehicles to be used should be standardized so as to facilitate the maintenance and control of the spare parts.

(10) Shift system

At present, the waste collection service is made in two shifts, morning and afternoon, but in principle, it should be changed to one-shift system.

(11) Transfer station

The transfer station shall be constructed taking into consideration the construction cost saving and the easy maintenance. The scale of the facilities shall be such as to serve the Middle, Gomrok and part of the West District with consideration of the waste amount reduction due to compost plant operation.

(12) Garage

The garage being constructed at present is assumed to be used as the basis of collection vehicles.

(13) Maintenance

Maintenance system shall be established so as to provide an efficient use of the collection vehicles.

2) Examination of the basic policy of the project

(1) Area covered by the collection service

The area to be covered by the waste collection service consists of the existing urban area from the north of the Mahmoudiyah Canal to the main residential areas in the suburban area located in the south of the said Canal as shown in Fig. 5-1-6.

Collection service covers approximately 100% of the population in these areas.

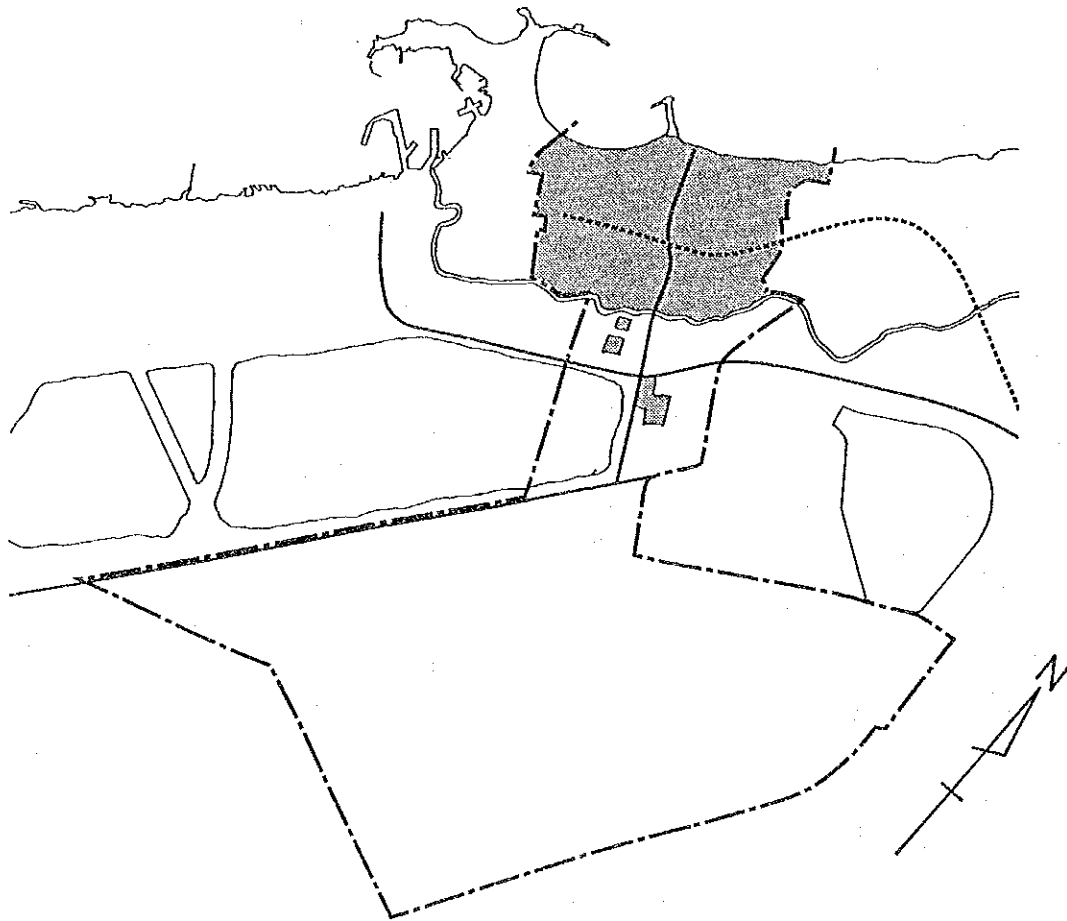
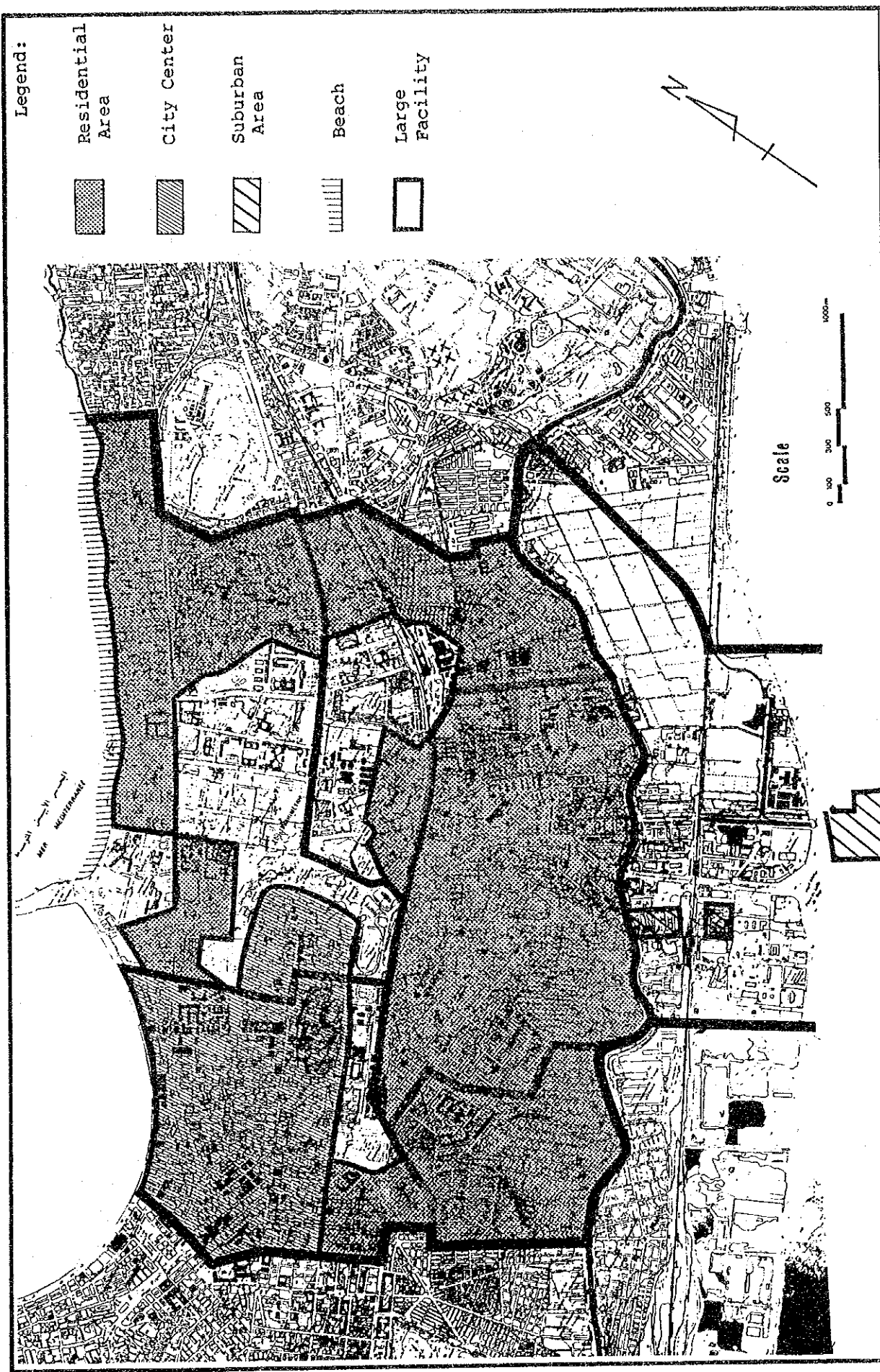


Fig. 5-1-6 COLLECTION SERVICE AREA

(2) Classification of the service area

The service area is divided into 4 categories of zones in accordance with the characteristics of the waste set out in the area as shown in Fig. 5-1-7. The city center area, one of the 4 zones, is defined as the area surrounded by Champeleon, El Gabruty, Lamonbah, Soliman Yosri, Mohafza, Salah El Din, El Bosta El Kadima and 26th July Streets. Currently, the area is under the charge of 2 cleansing sub-offices, but a unified waste collection service is regarded necessary in view of the importance of the unity and autonomy of the area.



CLASSIFICATION OF THE COLLECTION SERVICE AREA

THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA

(3) Measure for special facilities

Sources discharging waste surpassing $1\text{m}^3/\text{d}$ in terms of volume and $20\text{kg}/\text{d}$ in terms of weight are regarded as special facilities in this study. The major facilities classified by the specific sources are shown in Fig. 5-1-8.

The waste collection service involving these special facilities shall be implemented separately from the ordinary waste collection system.

(4) Discharge method and collection frequency

The discharge method and the collection frequency of wastes are defined in accordance with the classification of the service area as presented in Table 5-1-6.

Table 5-1-6 METHOD OF DISCHARGE AND COLLECTION FREQUENCY

Type of Area	Collection Point	Method of Discharge	Collection Frequency	Discharge Time
City Center	Building entrance	Plastic bag	Daily	20:00 - 8:00
Residential Area	Predetermined collection point	Plastic bag	Daily	20:00 - 8:00
Suburban Area	Predetermined collection point	Container provided by the community	3 times in a week	20:00 - 8:00
Beach Area	Open stations to be provided	Collected by beach sweepers	Daily (only in summer)	-

In connection with the waste collection in residential areas, the installation of communal containers is considered within the lower-income areas prior to switching to the aforementioned scheme. Furthermore, the following countermeasures shall be taken for the special facilities.

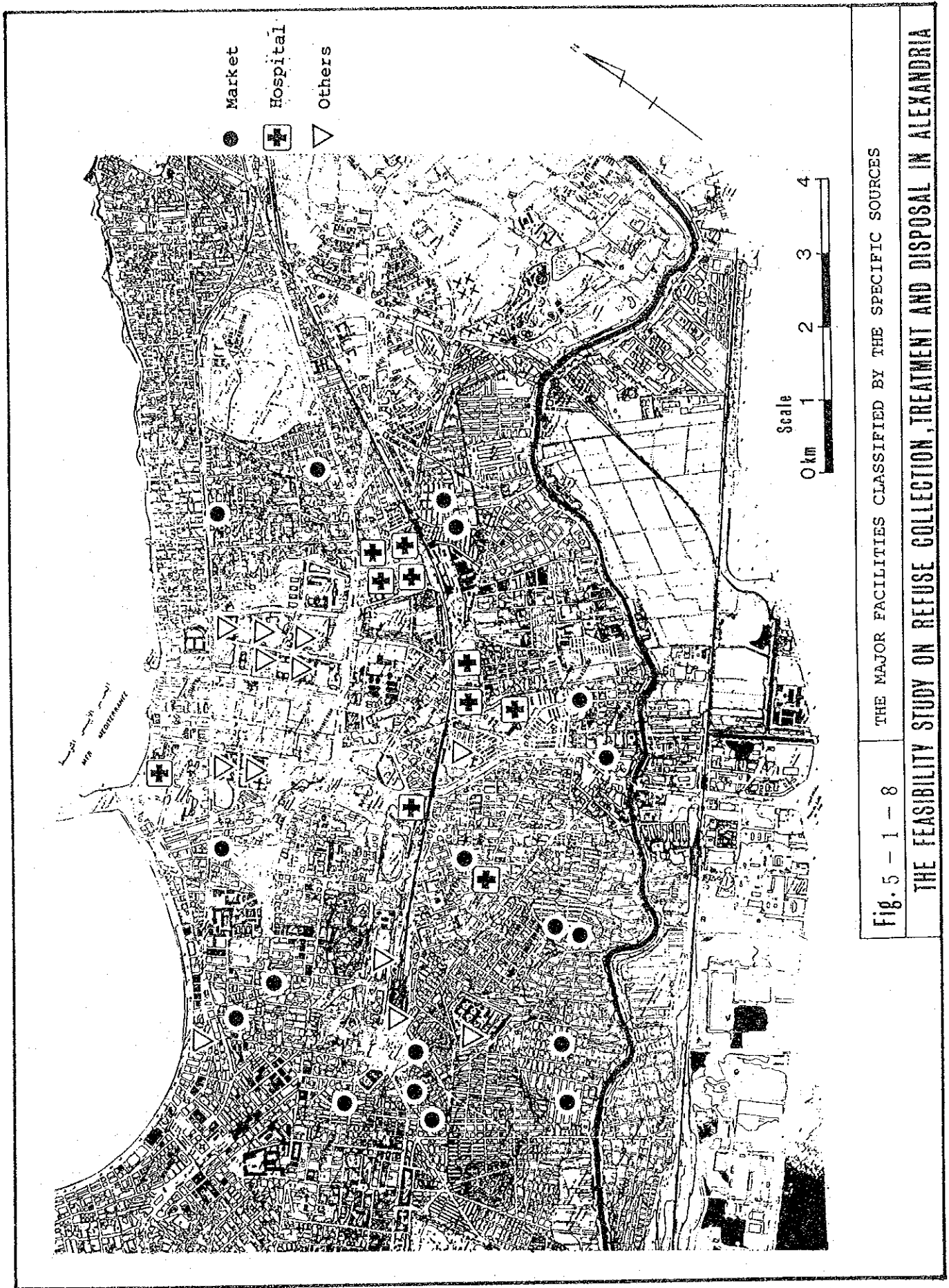


Fig. 5 - 1 - 8

THE MAJOR FACILITIES CLASSIFIED BY THE SPECIFIC SOURCES

THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA

Type of Area	Collection Point & Method of Discharge	Collection Frequency
Market	Containers will be placed. Where the space is not available, waste shall be discharged at the pre-determined collection point by the plastic container.	1 to 3 times in a day depending on the situation of waste discharge.
Other Facilities	Containers will be placed within the property, or storing and discharging with the plastic container may be substituted.	Depending on the situation of waste discharge.

(5) Method of collection

a. City center

In the city center, the necessity to divide the process into primary and secondary collection is unavoidable in view of the peculiarities of this area. It is decided to carry out the primary collection with lightweight vehicles as described hereafter instead of sweepers which are currently in service because of the advantage from the cost standpoint.

i) Crew of the lightweight vehicle

The crew consisting of three persons, one driver and two collection workers, is regarded as appropriate to implement the most efficient collection within the limited time, assuming the precondition that the collection should be finished early in the morning because of the location of the area at the center of the city, and the condition of optimum allotment for one worker and of minimum cost for the collection.

ii) Dispatchment and unloading from the lightweight vehicles

The collection of waste with the lightweight vehicles shall commence 30 minutes before the starting time of the secondary collection vehicles. After unloading the waste from the lightweight vehicles, the collection workers move to the next pick up site for preparation of the collection work of the next trip.

iii) Transfer to the secondary collection vehicle shall be made on the main street. The lightweight vehicle shall be brought back-to-back with the secondary collection vehicle, then, the worker of the secondary collection vehicle shall transfer the waste directly. Transfer work is carried out manually. It is assumed that the transfer work shall be finished within five minutes with three crew members.

iv) Secondary collection vehicles

In principle, the secondary collection vehicles should wait for the lightweight vehicles on the wide main streets, though they will be used for the direct collection of waste from the main street on the route as well.

b. Residential areas

i) In ordinary residential areas, waste placed at the collection points shall be directly loaded in the collection vehicle by the collection workers.

ii) As for the crew size, it is possible to be formed by three workers per collection vehicle, however, in consideration of three trips within the time, four crew members gives satisfactory collection services.

The number of round trips of each collection vehicle could be increased by increasing the number of workers per truck, but this alternative is not taken into consideration in this study, because the larger number of round trips causes the larger uncertainty regarding the time required for the round trips, and this uncertainty could result into an unreasonable scheduling.

c. Suburban residential area

- Communal containers sized approximately $2m^3$ are installed at the collection points, and the haulage should be carried out with the special vehicles for container.
- Three workers are assigned to each vehicle.

d. Beach area

- Sweepers of the beach area collect waste at the predetermined places.
- The assistants put the collected waste into nets.
- The nets are loaded on the haulage vehicles by hoisting them with the crane mounted on the vehicle.
- Each vehicle crew is formed by four workers.

e. Specific facilities

- Waste generated at the specific facilities provided with communal containers shall be dealt the same way as the case of the suburban areas.
- In other cases, the waste shall be discharged by putting it, as much as possible, in appropriate containers and shall be loaded by the workers. In this case, crews are composed of four workers.

The crew number required in the respective case mentioned above are tabulated in Table 5-1-7.

Table 5-1-7 THE NUMBER OF THE COLLECTION CREW

Type	Crew size
Light truck	3
Standard collection vehicle	5
Special vehicle for containers	4
Special waste-truck equipped with crane	5

(6) Standard work amount

- The compulsory trip frequency system is adopted as a criterion for measuring the work of the collection vehicle, in view of the easiness of control.
- The work amount of the collection worker shall range in loading from 2 to 3 t/person per day by manual operation. This point was also taken into consideration when the crew number was determined.

(7) Collection vehicle

- The collection vehicle is examined from the standpoints of their cost, waste collection capacity, work efficiency, appearance, stability, adaptability to the road conditions and easiness of repair.

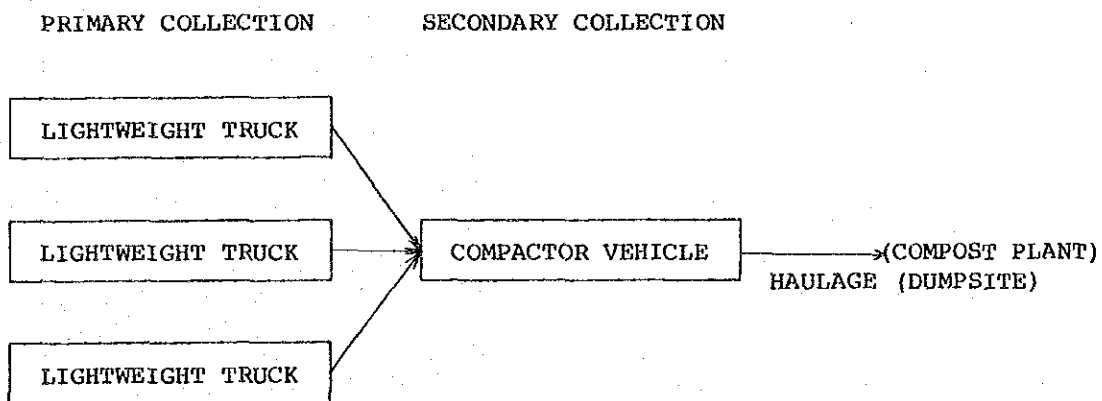
a. Lightweight trucks (for primary collection)

Three types of lightweight waste-trucks are taken into consideration

- Tractor type (with dumping mechanism)
- Ordinary lightweight truck (without dumping mechanism)
- Container loaded on lightweight truck

The ordinary lightweight truck is adopted in this project in view of the advantages regarding mobility and stability, because there is no conspicuous cost difference in the alternative vehicles.

The lightweight trucks in charge of the primary collection will make 8 round trips, and the schedule of the secondary collection vehicles should be adjusted so as to prevent the occurrence of waiting time for the transfer from the primary collection vehicles while the secondary collection vehicles are hauling waste to the disposal sites.



b. Standard collection vehicle

There are five types of waste collection vehicle.

- Small-sized dump truck (4-ton truck)
- Large-sized dump truck (8-ton truck)
- Compactor vehicle (4m^3)
- Compactor vehicle (8m^3)
- Compactor vehicle (10m^3)

The compactor vehicle (10m^3) is excluded in view of the restrictions imposed by the street width and parking space, and the compactor vehicle (4m^3) and small-sized dump truck (4-ton truck) are excluded in view of the cost and waste collection efficiency. Comparing the large-sized dump truck with the compactor vehicle (8m^3), the former one is advantageous from the standpoints of the purchasing cost and easy of maintenance, but on the other hand it is not so advantageous from the standpoint of the collection efficiency. Finally, the compactor vehicle (8m^3) was adopted as the standard collection vehicle for the city center of Alexandria by taking into consideration of its merits regarding the conservation the urban view and environment as well as its appeal to the citizens.

When there are many vehicles parked on the streets along the collection routes, the waste-trucks will be forced to operate in one-way traffic in some cases. In reality however, the waste collection work can be carried out by detouring the traffic of ordinary vehicles, because the streets in the city are arranged in a grid pattern.

The standard compactor vehicle will be able to make four round trips by improving the waste discharge manner. If the discharge method remains unchanged however, it is quite difficult to make three full round trips, and in reality compactor vehicles are forced to suspend the collection halfway of the third trip and go to the disposal site. Therefore, the collection capacity will be increased by 1.2 times by adopting the new system. (Fig. 5-1-9).

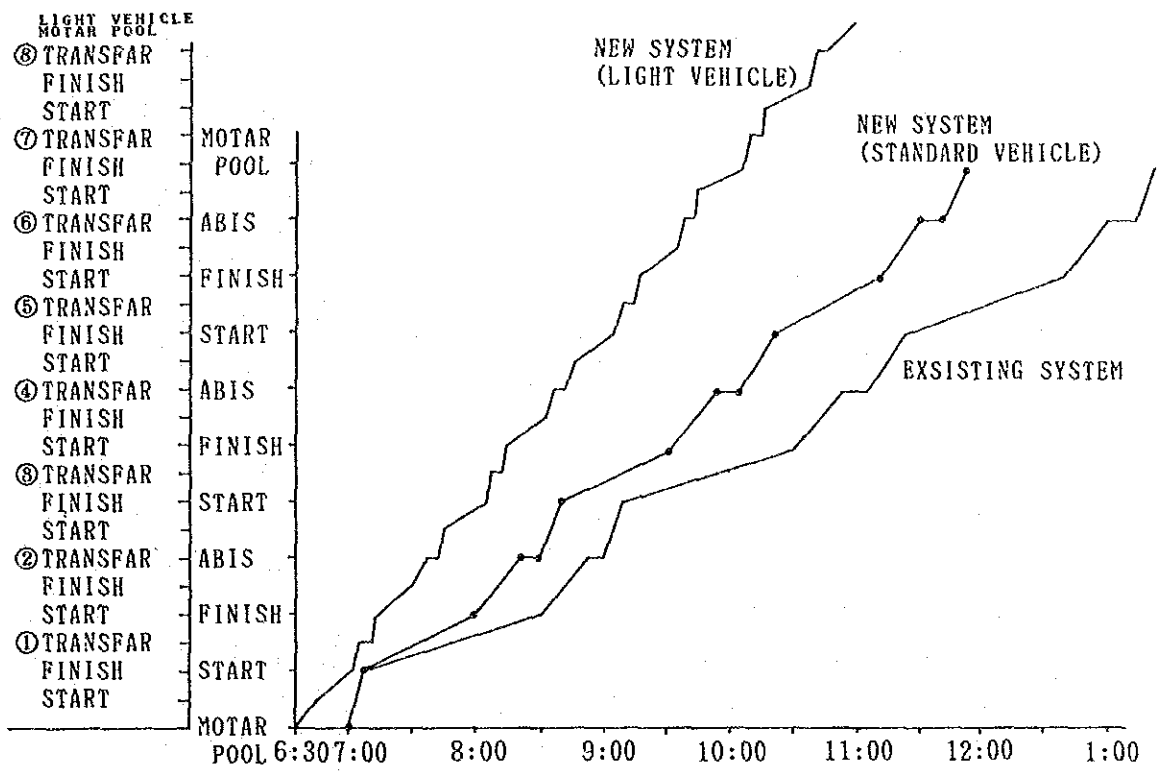


Fig. 5-1-9 STANDARD TIME SCHEDULE PATTERN OF THE WASTE TRUCKS

c. Special vehicles for communal container

There are various kinds of special vehicles for communal container. Truxmore type is adopted since the Truxmore is currently in service in the project area.

d. Special waste-truck

Special waste-truck equipped with small-sized crane shall be used for waste collection in the beach areas.

(8) Waste collection zones

The waste collection zones shall be demarcated so as to cover three round trips by a standard compactor vehicle without unreasonable delay. It is assumed that the standard compactor vehicle will collect nine tons of waste per day under normal circumstances even though 15% of fluctuation occurs in the waste generation amount. From this result, collection zones for 2000 is determined as shown in Fig. 5-1-10. In this case, the service area is divided into 49 zones. The streets to be used as waste collection routes in conjunction with the study are shown in Fig. 5-1-11.

(9) Transfer station

After 1990, waste will be hauled to the quarry dump site located 36km away from the center of the Middle District. In this study, two alternatives are developed as a haulage scheme, one is direct haulage with the collection vehicle and the other is transfer haulage with large-sized trucks. From the result of their comparative examination, the latter is more advantageous from the economic aspects.

On the other hand, in connection with the transfer station, there are various alternatives consisting of the combination of the undermentioned systems and transportation equipments, but it is concluded that the simplest configuration of alternative without compactor and large-capacity trailer, is determined to be the most appropriate alternative for this project in view of the cheapest cost and the reliability.

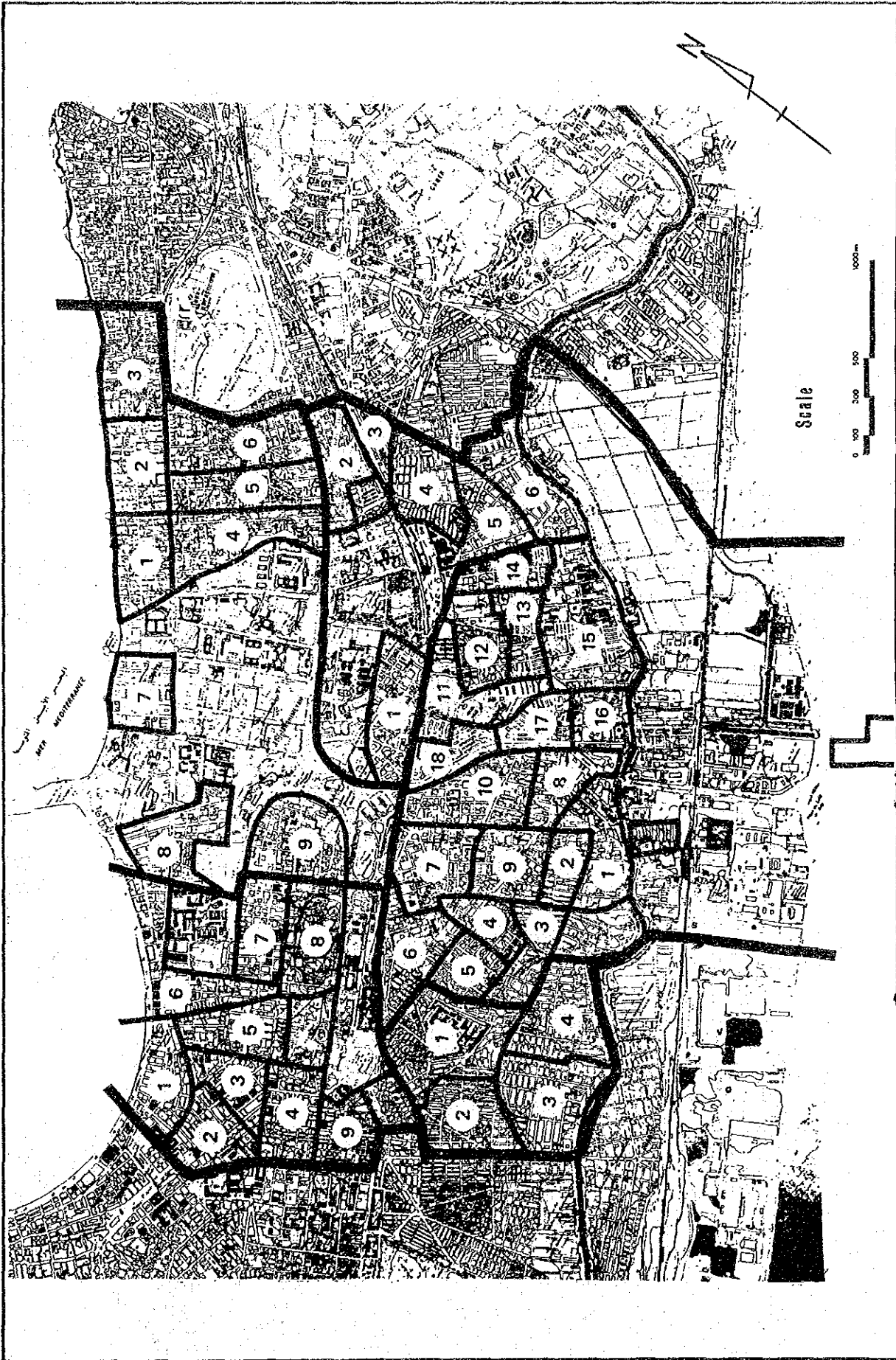


Fig. 5 - 1 - 1 0 EXAMPLE OF WASTE COLLECTION ZONES IN 2000 AD
 THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA

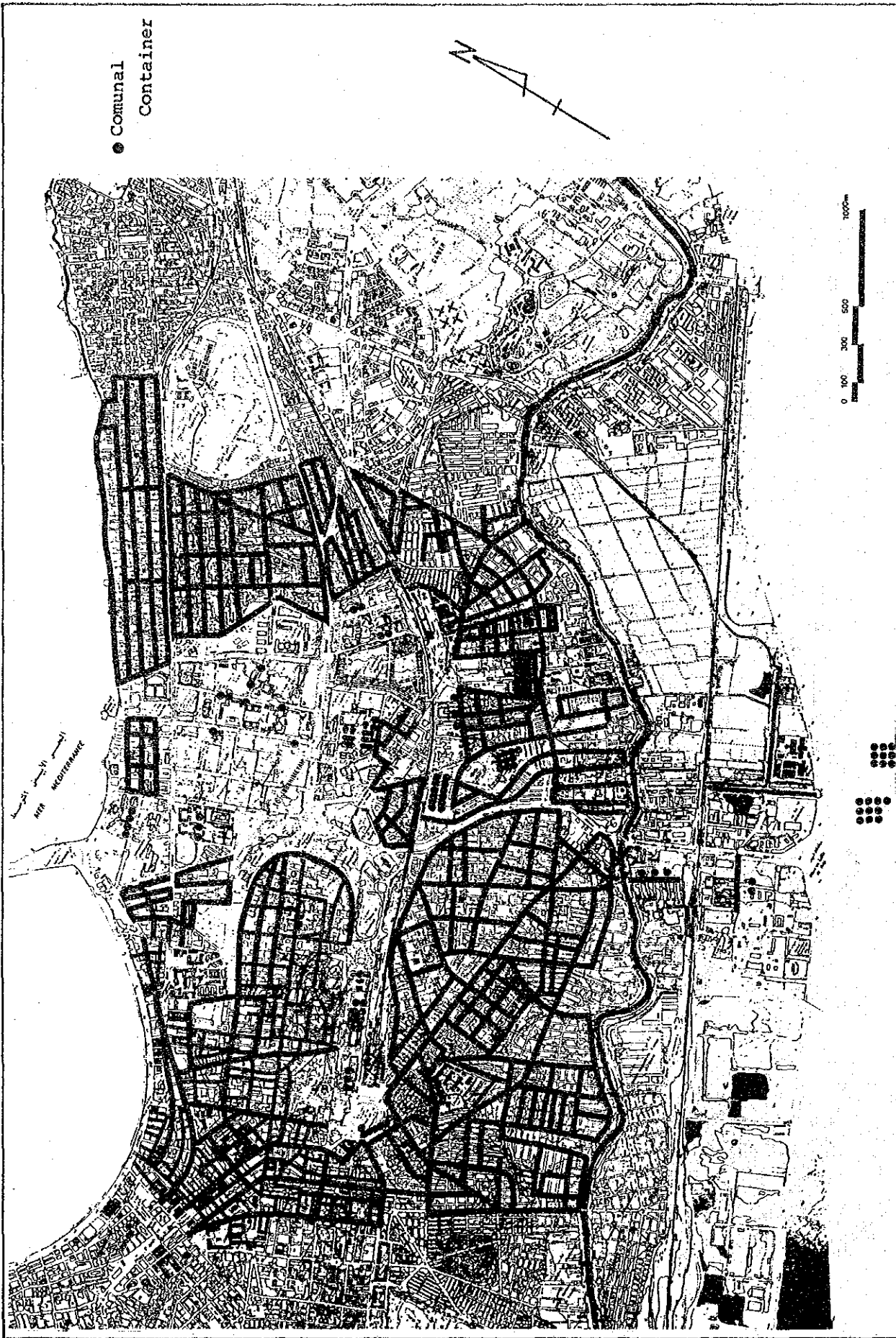
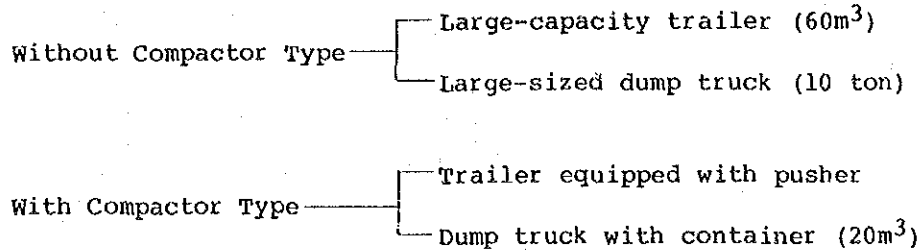


Fig. 5-1-11 MAP OF WASTE COLLECTION ROUTES

THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA

TYPES OF TRANSFER STATION



When transfer and transportation of waste from the West, Gomrok and Middle Districts is considered, one transfer station is constructed in view of the geographic conditions of the area and availability of the site.

The required conditions of the transfer station site are summarized in the following:

- close to the waste collection area
- close to trunk roads
- free from environmental problems
- accessibility of large-sized trailers
- availability of approximately 8000m² area

The site adjacent to the Abis compost plant was selected for the proposed construction site of the transfer station taking into consideration of the conditions aforementioned.

At a peak time in 2000 the reloading frequency from collection vehicle to large-capacity trailer is expected at a rate of every 0.7 minute. However, the waiting time and the congestion for reloading wastes can be eliminated by providing 4 charging chutes in the transfer station.

The loading time to the large-capacity trailer is set as follows, by taking into consideration the time for setting the large-capacity trailer under the loading chute, and the fluctuations in the arriving time of collection vehicles.

Loading time	30 minutes (15 collection vehicles, 2 minutes/vehicle)
Transportation time	90 minutes (round trip)
Unloading	30 minutes (waste should be pushed out from the trailer by loaders)
Total	150 minutes

Assuming that each trailer will make two daily round trips, the transportation capacity of each trailer will be 24 t/d. (The waste density is assumed to be 0.40 t/m³).

The operation time schedule is shown in the Table 5-1-8, and the final processing capacity in five hours is 480 t.

Table 5-1-8 TIME SCHEDULE OF THE TRANSFERRED HAULAGE TRAILER

Trailer No.	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00
Gate A								
1	----- ----- ----- ----- ----- ----- ----- -----							
2	----- ----- ----- ----- ----- ----- ----- -----							
3	----- ----- ----- ----- ----- ----- ----- -----							
4	----- ----- ----- ----- ----- ----- ----- -----							
5	----- ----- ----- ----- ----- ----- ----- -----							
Gate B								
6	----- ----- ----- ----- ----- ----- ----- -----							
7	----- ----- ----- ----- ----- ----- ----- -----							
8	----- ----- ----- ----- ----- ----- ----- -----							
9	----- ----- ----- ----- ----- ----- ----- -----							
10	----- ----- ----- ----- ----- ----- ----- -----							

When the composting plant stops its operation, the waste stored in the storage yard should be loaded onto the dump trucks by loaders, and should be transshipped in succession to the transfer haulage trailers. Two loaders and three large-sized dump trucks are required to finish the transshipment to the transfer haulage trailers within 30 to 40 minutes, because the time required to carry out the aforementioned succession is approximately 10 minutes. It will be possible to handle a maximum of 480 tons of stored waste within five hours of overtime work by adopting the aforementioned transshipment procedure.

(10) Garages

The garages of the district should be provided with vehicle maintenance as well as the vehicle parking, fuel replenishment, etc. In particular, the following functions of maintenances and controls are indispensable in the garages.

- . Custody of the collection vehicles
- . Periodic preventive maintenance
- . Simple disassembly and repair

As for the overhaul of collection vehicles, it is appropriate to give a commission for such work to a specialized workshop outside.

The common garage for Middle and Gomrok Districts is under construction at Moharam Bey. The land area of the site is about 1.1ha with a capacity of accommodating 135 vehicles which is estimated to be required in 2000. (Refer to Fig. 5-1-12.)

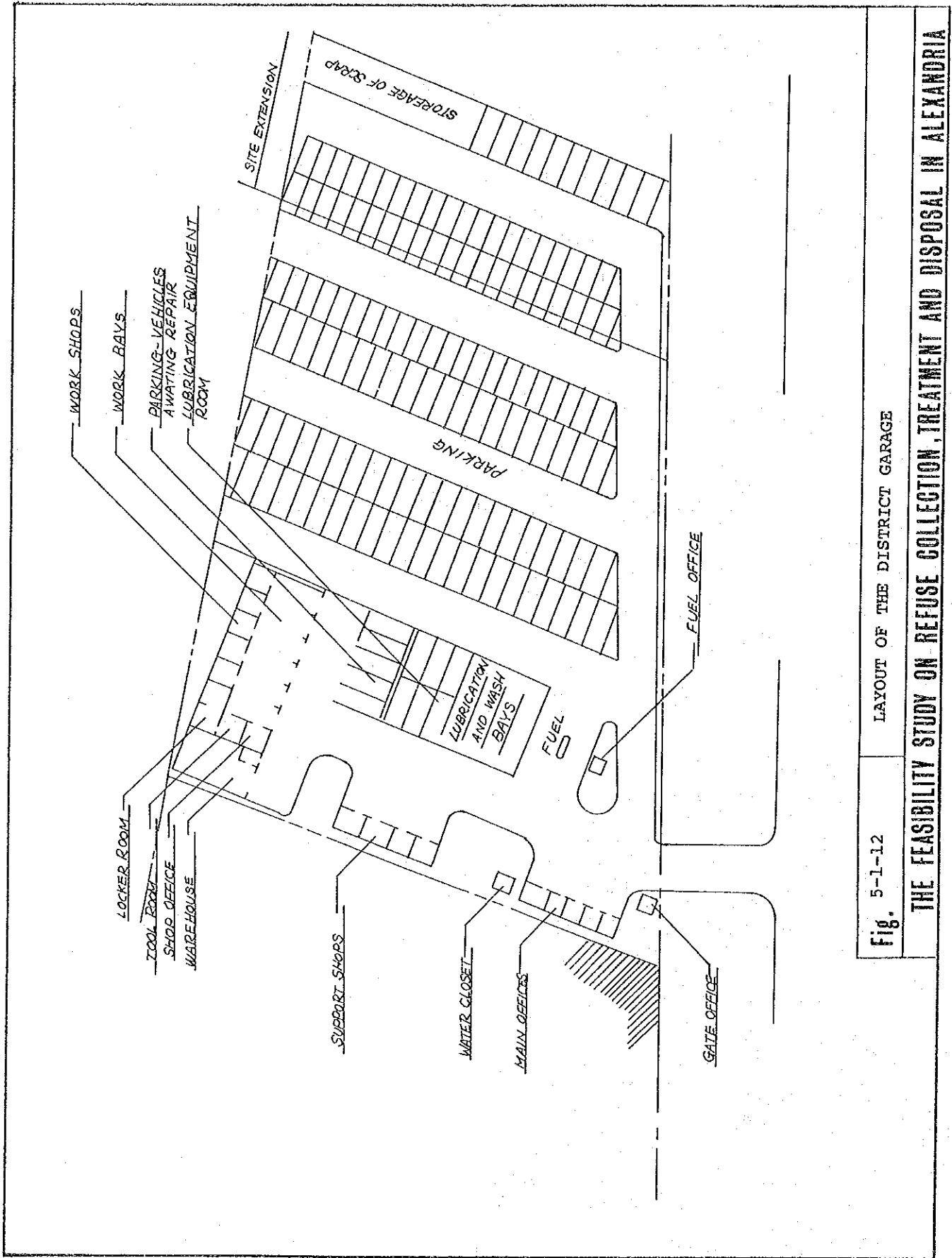


Fig. 5-1-12 LAYOUT OF THE DISTRICT GARAGE

THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA

Following numbers of machinery and tools shall be furnished at the garage.

1. Over head crane (5 ton)	1 (set)
2. Air Compressor (100 liter)	1
3. Hydraulic Press (35 ton)	1
4. Mechanic tool set	4
5. Hydraulic jack (30 ton)	4
6. Transmission jack (1.8 ton)	1
7. Engineers vise	4
8. Air impact wrench (1.2Drive)	2
9. Air blow gun	2
10. Engine cleaning gun	1
11. Parts cleaner	1
12. AC.Arc welder set	1
13. Gas welder set	1
14. Bench drill	1
15. Bench grinder (dia. 250 and 205)	2 + 2
16. Cleaning equipment	2
17. Tyre service tools	1
18. Battery maintenance equipment	1
19. Tool room	1
20. Measuring tools	1

(11) Maintenance

Collection vehicles should always be ready to work so as to secure a stable and reliable waste collection service. A considerable number of stand-by vehicles is required to fill the gap of the broken down vehicles being repaired, if the maintenance is carried out through the current scheme of "meet-the-troubles-as-they occur". The preventive maintenance scheme consisting of the undermentioned points is indispensable in order to improve the collection vehicle working-ratio from the current 50% to 80%.

- . Location and repair of malfunctions by periodic preventive inspection
- . Periodic replacement of parts, adjustments, etc. judging from the collection and analysis of data referring to troubles and repairs that occurred in the past.

Preventive check and maintenance are aimed at preventing malfunctions in the collection vehicles before they occur. The preventive inspection and maintenance scheme comprising some occasional repair of malfunctions as well, mainly consists of the cleaning, inspection, adjustment, lubrication, change of filters, check of abnormal abrasion, heating and friction, loose bolts, oil leaks, etc., and it should be implemented by drivers and mechanics.

Preventive inspection and maintenance measures often tend to be neglected, because their contents are simple and furthermore bad consequences due to negligence of such measures do not immediately appear. Practically however, they are very important, and their neglect will result in frequent malfunctions and long down time of the collection vehicles like the conditions at the present time.

The data obtained from the below mentioned survey should be taken into consideration in the maintenance scheme of collection vehicle.

- a. Working conditions of collection vehicles.
- b. Conditions related to the climate and environment (temperature and dust)
- c. Problems related to the fuel used (fuel used in Egypt contains 0.5% of sulphur)
- d. The travelling distance of collection vehicle in the average distance to approximately 70km/day, that is approximately 2,100km/month).
- e. Frequency malfunctions in odometers of collection vehicles.

In view of the items a. b. c. d. above, it is necessary to shorten the maintenance implementation interval. In addition, in connection with item e. it is recommendable to examine the implementation of a periodic maintenance plan in terms of number of days.

The following plan shown in Table 5-1-9 can be taken into consideration as a reference for the maintenance implementation scheme.

Table 5-1-9 REFERENCE FOR THE MAINTENANCE IMPLEMENTATION SCHEME

Person Responsible	Daily	Level A	Level B	Level C	Level D
Driver/Operator	o				
Oil & Grease man		o	o	o	o
Mechanic			o	o	o

- Daily maintenance

Check of engine oil and cooling water level, oil leak at the various parts, damage in external parts, operational malfunction, etc., by drivers. (The inspection should be carried out in conformity with a check list prepared in advance).

- Level A

Change of engine oil and greasing of various parts (to be carried out in conformity with a check list prepared in advance).

- Level B

Inspection, adjustment, change of oil filter, etc., to be carried out (to be carried out in conformity with a check list prepared in advance)

- Level C

Inspection, adjustment and repair to be carried out (in conformity with a check list prepared in advance)

- Level D

Semi-overhaul of the collection vehicle, consisting of inspection, adjustment, repair and a periodic replacement of parts affected by abrasion or damage should be carried out.

The check lists of the daily maintenance and Levels A, B, C and D should be prepared in accordance with inspection and maintenance data provided by the manufacturer.

Ex-post-facto maintenance is the repair and restoration for malfunctions and accidents. Generally speaking, there are various types of malfunctions, unexpected accidents and troubles, functional impairment due to abrasion and deterioration from prolonged use, temporary misoperation (occurring frequently in electric systems), etc., and in reality the actual types of malfunctions are numerous and it is difficult to find out. Furthermore, it is indispensable to reduce as much as possible the ex-post-facto repairs, because they require considerable cost and time.

Every malfunction has its cause, and it is very important to keep the records mentioned in the followings:

- The travelling time and distance in case of a breakdown or malfunction
- Situation of the malfunction
- Causes of the malfunction
- Countermeasures taken against the malfunction

Summarization and analysis of the said records will make it possible to forecast future malfunction occurrences, contributing therefore to examine countermeasures to cope with the forecasted malfunctions and improving the reliability of the collection vehicle maintenance work.

3) Staged application of the new waste collection system

Citizenry cooperation regarding the waste discharge manner is indispensable for the successful application of the new waste collection system. And it is necessary to acquire the reorganization of regional offices of the s.w.m. system.

The staged application of the new waste collection system should be started from the city center as shown in Table 5-1-10, in view of its convenience to attract citizens, and its gradual expansion should follow to low-income areas. Thus the introduction of plastic bags in low income areas should be after 1996.

Table 5-1-10 THE STAGED APPLICATION

	1990 (1st Stage)	1991-1995 (2nd Stage)	1996-2000 (3rd Stage)
New Collection System	Introduction of the system in the north areas of the railway.	Expansion to the south areas of the railway, excluding low-income areas.	Further expansion to low-income areas.
Shift system	Full-scale switching from 2-shift collection system to 1-shift		
Strengthening of maintenance system	Accomplishment of 80% actual working-rate		

The target areas for the staged application of the new waste collection system are shown in Fig. 5-1-13.

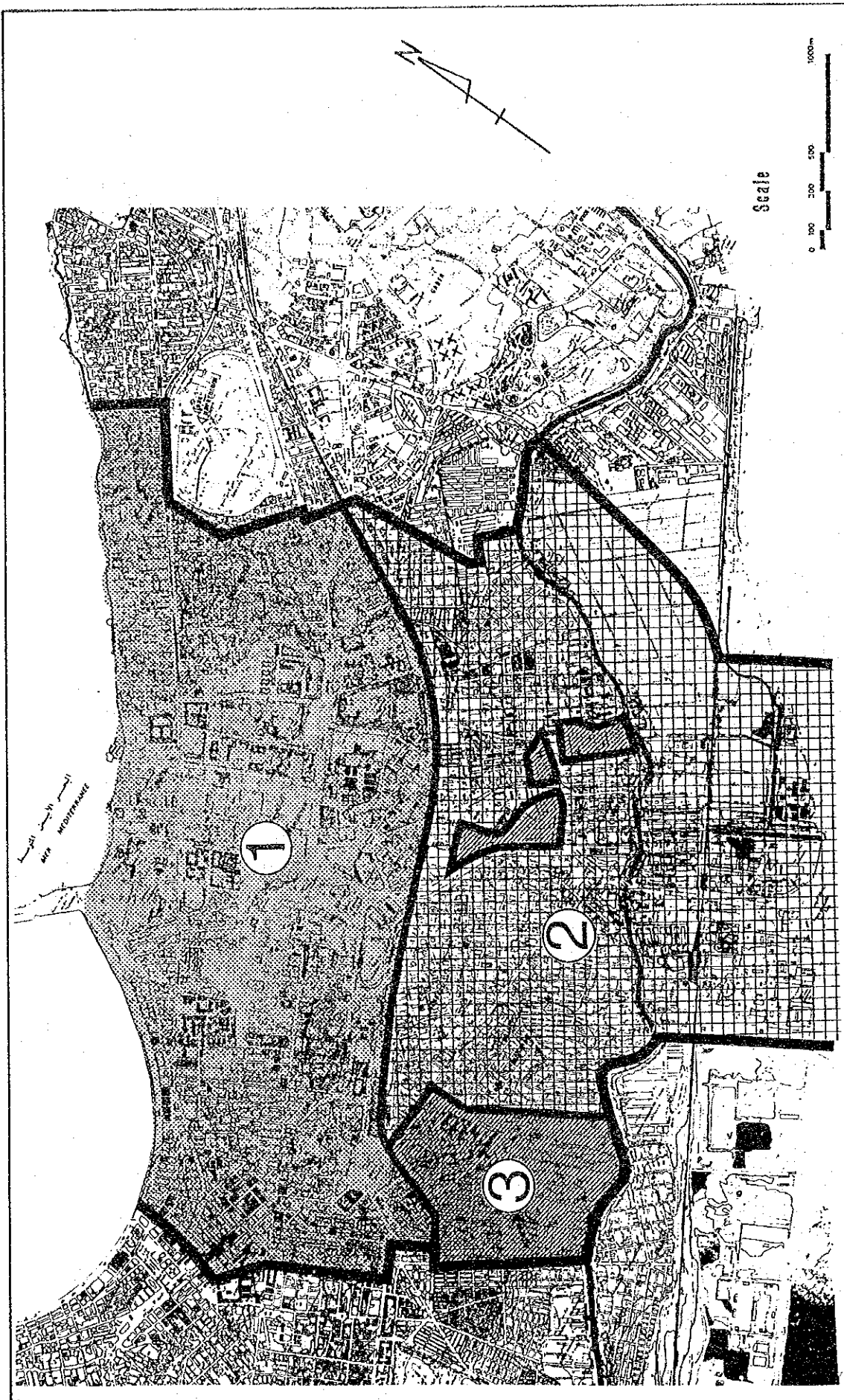


Fig. 5-1-13

AREAS OBJECT OF STEPPED APPLICATION OF THE NEW WASTE COLLECTION SYSTEM

THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA

4) Required equipments and workers for waste collection

(1) Collection vehicle and worker for the operation of waste collection

The waste amount in various collection zones, which are the premises for allotment of collection vehicle and worker, are shown in Table 5-1-11.

Table 5-1-11 WASTE AMOUNT BY TYPE TO BE COLLECTED FROM EACH ZONE

(t/d)

Zone	Type of Waste	1990	1995	2000	Remarks
Attarin	Ordinary waste	53.6 (40)	74.6 (50)	87.6 (60)	Figures in the parenthesis indicate waste amount collected by light trucks
	Facility waste	15.4	16.4	17.4	
	Market waste	12.0	13.0	15.0	
	Total	91.0	104.0	120.0	
Bab Sharky 8th	Ordinary waste	61.8	71.8	80.8	
	Facility waste	4.2	4.2	4.2	
	Market waste	15.0	16.0	18.0	
	Total	81.0	92.0	103.0	
Bab Sharky 7th	A				This part will be applied to the new waste collection system in 1st stage.
	Ordinary waste	4.0	4.5	5.0	
	Facility waste	1.3	1.3	1.3	
	B				
	Ordinary waste	23.3	44.7	50.1	
	Facility waste	15.7	0.0	0.0	
	Market waste	14.7	15.5	17.6	
	Total	59.0	66.0	74.0	
Ghorbal	Ordinary waste	5.5	13.5	30.5	
	Facility waste	19.5	14.5	0.5	
	Market waste	8.0	8.0	9.0	
	Total	33.0	36.0	40.0	
Moharam Bey 7th	Ordinary waste	56.7	109.4	178.5	
	Facility waste	90.0	54.0	5.0	
	Market waste	19.0	21.0	23.0	
	Waste collected in suburban areas	3.3	5.6	6.5	
	Total	169.0	190.0	178.5	

The collection vehicle allocation scheme for each collection zone, calculated on the basis of the planned waste amount, is shown in Table 5-1-12.

Table 5-1-12 COLLECTION VEHICLE ALLOCATION SCHEME
(actual operation basis)

		(Unit)		
Zone	Type of Vehicle	1990	1995	2000
Attarin	Compactor vehicle	8	9	11
	Container vehicle	1	1	1
	Light truck	9	11	13
	Total	18	21	25
Bab Sharky 8th	Compactor vehicle	5	7	8
	Container vehicle	1	0	0
	Total	6	7	8
Bab Sharky 7th	Compactor vehicle	3	8	9
	Container vehicle	1	0	0
	Small sized dump truck	2	0	0
	Large sized dump truck	1	0	0
	Total	7	8	9
Ghorbal	Compactor vehicle	1	3	4
	Container vehicle	1	1	0
	Small sized dump truck	1	0	0
	Large sized dump truck	1	0	0
	Total	4	4	4
Moharam Bey 7th	Compactor vehicle	3	13	22
	Container vehicle	5	4	2
	Small sized dump truck	1	0	0
	Large sized dump truck	9	0	0
	Total	18	17	24

The number of waste collection workers and drivers required in each cleansing zone by each year is shown in Table 5-1-13.

Table 5-1-13 NUMBER OF WASTE COLLECTION WORKERS AND DRIVERS REQUIRED IN EACH ZONE

	(Person)			
	1985	1990	1995	2000
Collection Worker				
Attarin	28	64	73	88
Bab Sharky 8th	25	28	34	38
Bab Sharky 7th	16	28	38	43
Ghorbal	20	16	18	19
Moharam Bey 7th	29	78	77	113
Total	118	214	240	301
Driver				
	33	69	69	85

Note: The manpower required in Moharam Bey 7th will increase substantially in 1990, because the 2-shift system by the district and ADS will change in full scale into the 1-shift system.

The annual plan for purchase of collection vehicles is shown in Table 5-1-14.

Other conditions taken into consideration in the aforementioned calculations are summarized in the followings:

- It is assumed that vacationers' waste can be dealt with by extending the working time.
- It is assumed that in the zones in which the new waste collection system will be applied in the 2nd stage (Ghorbal, Moharam Bey and Bab Sharky 7th) the collection efficiency is less by 20% than that one with the new system in the 1990.

- The number of collection vehicles by type to be purchased after 1990 is planned on the premise of preserving the continuity of the fleet composition in types and number.
- Always, 80% of the collection vehicles can be operated as a result of the improvement of the maintenance system.
- The 2-shift system by district and ADS is assumed to be changed into the 1-shift system from 1990.

Table 5-1-14 NUMBER OF WASTE COLLECTION VEHICLES REQUIRED

	(Unit)														
	86	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
Compactor vehicle	12	12	12	12	24	27	30	38	45	48	49	51	52	54	65
Truxmore	19	19	16	16	11	11	11	8	8	8	8	7	7	7	4
Small-sized dump truck	8	8	8	8	8	8	7	3	0	0	0	0	0	0	0
Large-sized dump truck	12	13	14	15	14	11	10	8	0	0	0	0	0	0	0
Lightweight truck	0	0	0	0	11	11	12	12	12	12	13	13	14	14	15
Special truck	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
Total	51	52	50	51	69	69	71	70	66	69	71	72	74	76	85

(2) Vehicles and manpower for transfer station

The waste amount to be hauled through the transfer station is shown in the Table 5-1-15.

Table 5-1-15 THE WASTE AMOUNT TO BE TRANSFERRED

	(t/d)										
	1990	91	92	93	94	95	96	97	98	99	2000
Weekday	262	280	298	316	335	355	374	395	415	437	458
Holidays*	742	760	778	796	815	835	854	875	895	917	938
The planned q'ty to be treated in the first shift	384	384	432	432	432	480	480	480	480	480	480

*Note: No operation day in the compost plant

The required number of equipments and manpower are shown in the Table 5-1-16 and 5-1-17, respectively.

Table 5-1-16 NUMBER OF EQUIPMENTS REQUIRED

	(Unit)										
	1990	91	92	93	94	95	96	97	98	99	2000
Trailers	11	11	11	11	11	12	12	12	12	12	12
Wheel loaders	4	4	4	4	4	5	5	5	5	5	5
Large sized dump trucks	6	6	6	6	6	7	7	7	7	7	7

Table 5-1-17 MANPOWER REQUIREMENT OF THE TRANSFER STATION

	(person)		
	1990	1995	2000
Director	1	1	1
Manager	1	1	1
Maintenance technician	3	3	3
Driver			
- Trailer	10	12	12
- Wheel loader	5	5	5
- Dump truck (8m ³)	7	7	7
Sub-total	22	24	24
Worker			
- Assistant	6	10	10
- Cleaning	5	5	5
Sub-total	11	15	15
Administrative			
- Record	2	2	2
- Clerk	3	3	3
Sub-total	5	5	5
Total	43	49	49

5.1.4 Street sweeping plan

1) Basic Policy for the Street Sweeping Improvement

The basic policy for the street sweeping improvement, based on the current problems and in conformity with the Master Plan, is as follows:

(1) Service area

Sweeping service will be implemented in all the streets in the urban area. As for the suburban areas, the service will be limited to the residential area.

(2) Classification of the streets

Streets shall be classified in terms of the characteristics of each street, such as main streets, commercial/business area streets, residential area streets, etc.

(3) Street sweeping and waste collection shall be regarded as separated systems

(4) Service frequency

The service frequency shall be determined by taking into consideration the characteristics of the streets and the citizenry cooperation regarding the waste discharge manner.

(5) Cooperation of the citizens regarding not throwing or littering waste on the streets

Most of street waste can be reduced by minimizing the throwing and littering of waste on the streets, and therefore the citizenry cooperation not to do these activity is indispensable for effective street sweeping.

(6) Street sweeping system

No crew system will be adopted in street sweeping systems, and all sweepers should use hand cart. Collected street wastes should be hauled separately from the waste collection system.

(7) Standard length of the street for one sweeper shall be established.

(8) Litter bins should be installed in the commercial area.

(9) Types of equipments

Equipments available in Egypt should be used for street sweeping and the continuous use of mechanical sweepers should be considered as well.

(10) Depots

Depots should be provided at places where sweepers can access on foot.

(11) No-parking days should be considered on streets to be swept.

(12) The penalty system should be strengthened.

2) Examination of the basic composition of the project

(1) Service area

The service area of the street sweeping is the same as that one of waste collection (refer to Fig. 5-1-6).

(2) Classification of streets to be swept

The streets are classified in accordance with the waste scattering situation and the priority of street sweeping as follows:

- A. Shopping streets and main streets in the City Center
- B. Important main streets
- C. The City Center's minor streets and residential areas' main streets
- D. Streets in market areas
- E. Minor streets in residential areas

Above streets of A., B. and C. are shown in Fig. 5-1-14.

(3) Relationship between waste collection and street sweeping

Three alternatives can be introduced as follows:

- a. Non separated system, in which sweeper undertakes the waste collection work too.
- b. Semi-separate system, in which sweeping is separated from the waste collection work, but collected street waste is hauled by the collection vehicles.
- c. Separate system, in which sweeping and collected street waste haulage are performed completely independent from the waste collection service.

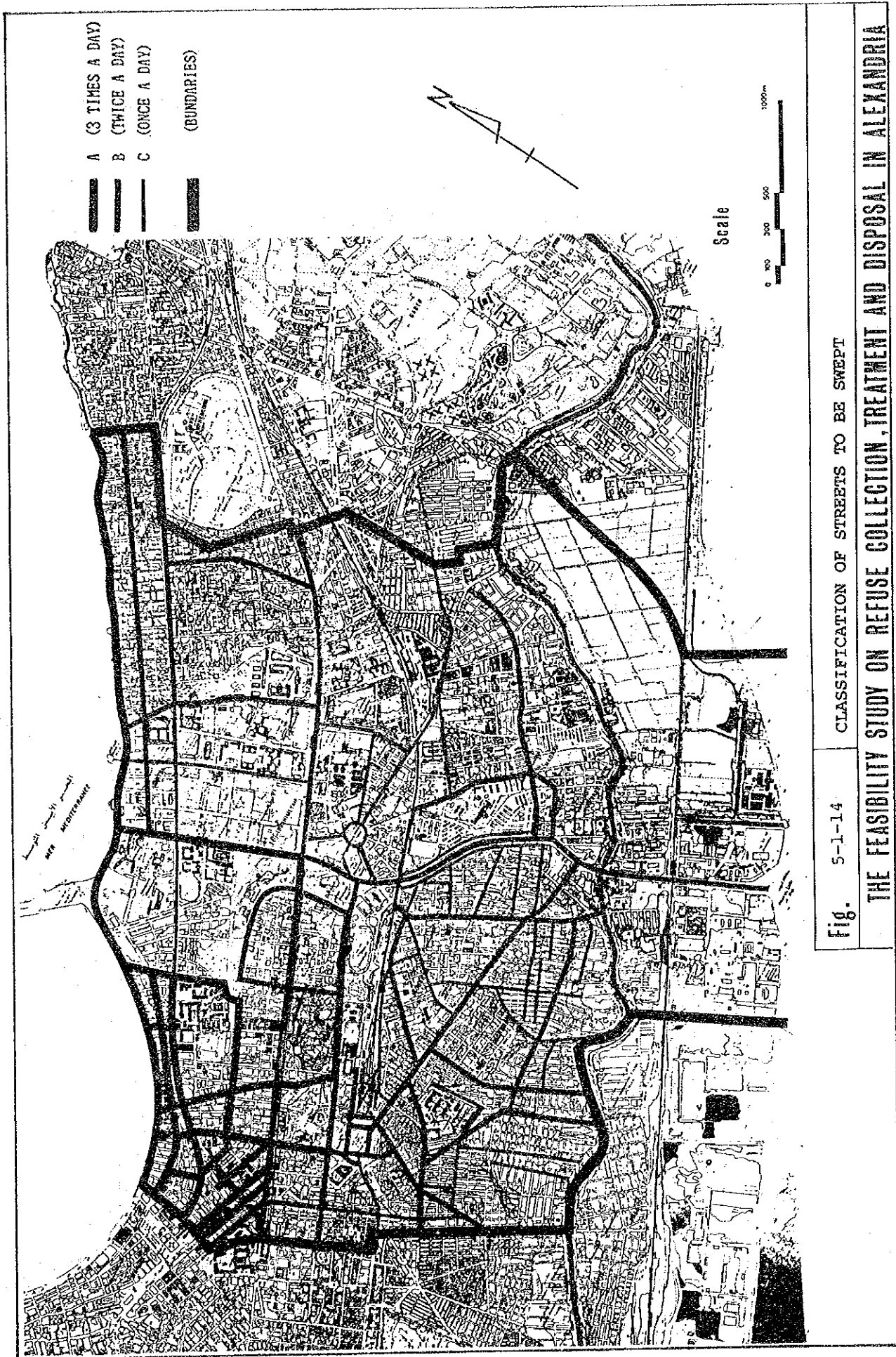


Fig. 5-1-14

CLASSIFICATION OF STREETS TO BE SWEEP

THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA

Of the three alternatives, the separate system is regarded the most appropriate to realize the effective street sweeping.

(4) Street sweeping frequency

Sweeping frequency is as shown in Table 5-1-18 by the classified street. As for the minor streets of the residential areas, the frequency is determined by the waste scattering condition.

Table 5-1-18 FREQUENCY OF SWEEPING

City Center's shopping streets and main streets	3 times a day
Important main streets	Twice a day
City Center's minor streets and main streets in residential areas	Once a day
Market areas	Once a day
Minor street in residential areas	Once or twice or 3 times a day

At present street sweeping is once a day in minor streets of residential areas, but in this study it is regarded as appropriate to reduce the frequency in order to improve sweeping efficiency by introducing the separate system, and reducing waste amount on the streets as a result of strengthening the citizenry cooperation through social education and guidance. The study concerning the frequency carried out during the collection experiment in the summer 1985 indicates that twice a week is sufficient in the area in question. However, the adequate sweeping frequencies are applicated from once to thrice a week in accordance with citizenry cooperation.

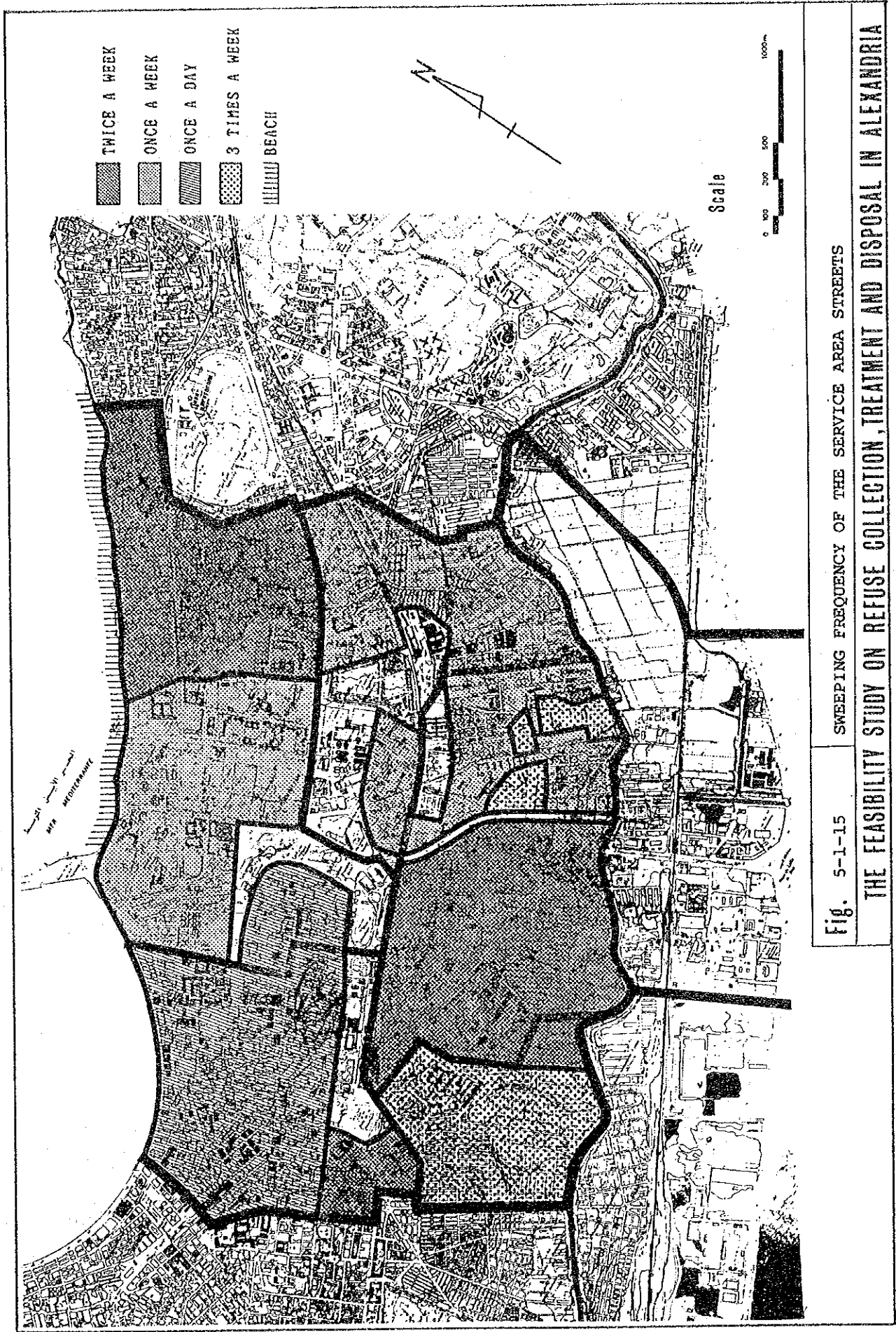


Fig. 5-1-15 SWEEPING FREQUENCY OF THE SERVICE AREA STREETS

THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA

(5) Countermeasures against street waste generation

At present, household waste accounts for a considerable proportion of the street waste, but if an appropriate waste collection service is implemented, and waste discharge regulations are enforced by means of prohibiting household waste discharging on the streets, then the amount of street waste generation is assumed to be reduced substantially.

The correctness of the said assumption was confirmed by the waste collection experiment carried out in the summer 1985, but the implementation of other countermeasures such as strengthening the penalty system and social education from a long-ranging standpoint are indispensable for further reduction of street waste generation.

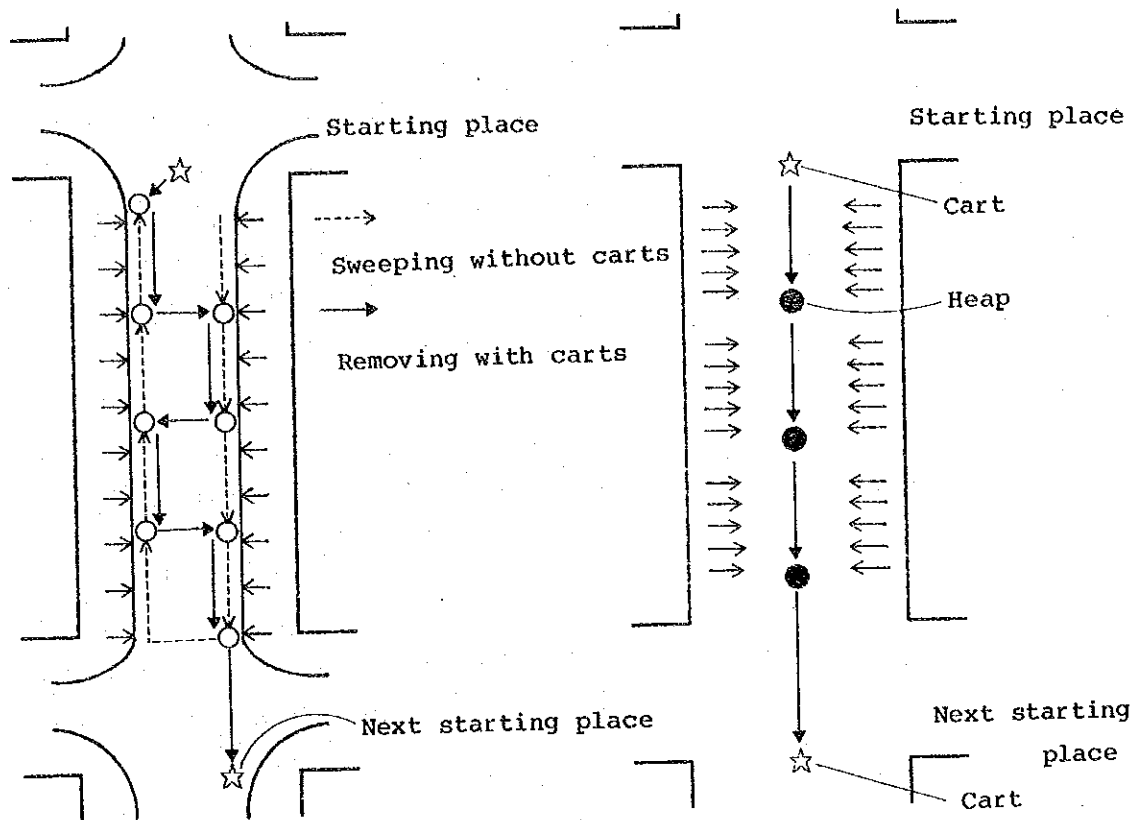
Such being the case, education programs in schools and covering the citizens in general should be attached special importance as key elements composing the plan for improving the street sweeping service, and should be promoted in a regular and systematic way.

(6) Street sweeping process

a. Manual street sweeping

In principle, street sweeping work shall be carried out manually. Every morning the sweeper shall report his attendance at the depot, before going to the area allotted to him on foot. The sweeper shall carry out his sweeping work along the prescribed course, by using a hand cart, a broom and a basket placed in the area allotted to him, piling up the street waste at regular intervals until the end of the course. Then, he shall return to the starting point, and shall travel all over the course, loading the street waste in the hand cart.

In detail, distinct processes are required in streets with sidewalks at both sides, such as in main streets, and minor streets without sidewalk (Refer to Fig. 5-1-16).



1. Setting a cart at starting place
2. Sweeping from one side
3. Making a small heap each distance
4. After arriving next corner, the other side is swept by going back to the starting place in the same manner.
5. After sweeping, the sweeper puts waste into the cart moving from heap to heap.
6. And then, setting the cart at the next starting place
7. Continuing work
8. After the cart is filled, he pushes the cart to the nearest reloading place. Then two workers put waste into a small-size dump truck.

1. Setting a cart at starting place
2. Sweeping from both sides to the center
3. Making a small heap each distance
4. Going back to the starting place after reaching next corner
5. Putting waste into the cart
6. Setting the cart at next starting place
7. Continuing work
8. After the cart is filled, he pushes the cart to the nearest reloading place. Then two workers put wastes into a small-size dump truck.

Fig. 5-1-16 METHOD OF MANUAL STREET SWEEPING