

Table II-2.1-7 Solid Waste Chemical Content* (1990, 1991)

(Wet Base %)

Item	Class	High	Middle	Low	Slum	Commercial	Market
Water content %		66.5	69.1	59.4	52.5	47.5	65.3
Combustible matter %		27.3	25.9	34.8	33.9	46.0	27.3
Ash %		6.2	5.1	5.9	13.4	6.6	7.5
T-N as N %		1.32	1.46	1.40	1.32	1.59	1.28
T-C as C %		10.84	10.67	13.44	10.97	19.29	11.51
C/N ratio		8.62	7.46	10.18	8.25	12.58	9.06
Lower heating value (kcal/kg)		830	753	1,209	1,364	1,933	835

H = 45V-6w

H: Lower heating value (wet base)

V: Combustible content (%)

W: Water content (%)

* Above samples do not contain noncombustible matter
(glass, metal, stone, ceramic, etc.)

2.2 Service Coverage

Prior to refer to service coverage, a rough area specification is required to evaluate an actual situation of the service coverage.

An exact area specification is extremely difficult, for collection served and non-served areas are mingled confusingly with each other, resulting in the impossibility of clearly defining their zoning. Nevertheless, an area specification has been worked out as shown in Table II-2.2-1.

Service coverage in 1990 was only partial. Conclusions on the service coverage are as follows:

- (1) The percentage of the population whose solid waste is collected is 53.0% of the total population, a low collection rate.
- (2) Collection percentages for the easy collection area, possible collection area, and isolated area are 76.4%, 17.8%, and 0%, respectively.
- (3) As the population whose solid waste is not collected, but to be collected, numbers 223,000, 311,000, and 0 in ECA, PCA and IA, respectively, collection services to these areas need to be strengthened.
- (4) Collection services are not extended to low-income colonies and slums in the marginal areas within easy collection areas. This needs to be quickly improved.
- (5) 12% of the total population practices self-disposal. These people reside in farming and mountainous regions and thus the delivery of collection service is deemed difficult.
- (6) In possible collection areas, the solid waste of 17.6% of the population is actually collected, while that of 61.0% is not, clearly a high figure. Thus, plans for the expansion of collection service must necessarily be concentrated in this area.
- (7) Solid waste collection and disposal systems in isolated areas such as farms should be considered.

Table II-2.2-1 Area Specification in General

Division	Sub-division	Descriptions	Rough ideas of division
<p>1. Easy Collection Areas</p> <p>Population = 944,000 in 1990</p>	<p>1. Collection covered areas</p> <p>Estimated pop. = 721,000 in 1990</p>	<p>Collection served areas by private collectors</p>	<ul style="list-style-type: none"> - Areas within a radius of 5 km. of the Trebol site (in principle) - Easily accessible - Service fees collectable - Economically favorable - Exclusive service coverage by the private collectors
	<p>2. Collection non covered areas</p> <p>Estimated pop. = 223,000 in 1990</p>	<p>Non-served areas neither by the municipality nor by the private collectors</p>	<ul style="list-style-type: none"> - Areas within a radius of 6 km. of the Trebol site (in principle) - Non-accessible - Service fees uncollected or uncollectable - Economically non-compatible - Absence of service coverage
<p>2. Possible Collection Areas</p> <p>Population = 509,000 in 1990</p>	<p>1. Areas to be covered with collection service.</p> <p>Estimated pop. = 401,000 in 1990</p> <p>Service covered population in 1990 90,000</p> <p>Non served population in 1990 311,000</p>	<p>- Partially collection served areas by the Municipality or by private collectors</p>	<ul style="list-style-type: none"> - Areas outside a radius of 6 km. of the landfill site (in principle) - Accessible with considerable difficulties due to <ul style="list-style-type: none"> - far distance - geographical conditions - bad road conditions - Service fees collectable but supposed to be partial because of existing low-income and squatter colonies - Economically less favorable - Actually service covered by <ul style="list-style-type: none"> - Bell collection and - Limited private service
	<p>2. Self disposal areas</p> <p>Estimated pop. = 108,000 in 1990</p>	<p>- Rural and fringe area in the periphery of the study area</p>	<ul style="list-style-type: none"> - Areas outside a radius of 6 km. of the Trebol site (in principle) - Accessible with a great difficulty as a result of: <ul style="list-style-type: none"> - far distance - long and/or steep slopes - bad and/or narrow road conditions - Collection service unbearable because of: <ul style="list-style-type: none"> - inefficiency of service - higher operation cost - Self disposal recommendable
<p>3. Isolated Areas</p> <p>Population: 78,000</p>	<p>On-site collection and disposal areas, either of:</p> <ul style="list-style-type: none"> - communal - individual 	<p>Areas without a regular and routine service, where an appropriate on-site disposal method should be introduced</p>	<ul style="list-style-type: none"> - Passable, but inaccessible by means of conventional collection vehicles due to: <ul style="list-style-type: none"> - geographical features - extremely bad road conditions - Distance to and from the landfill site does not count for much.

The term "Marginal" being ambiguous, its meaning and extension has to be clearly determined in accordance with the area specification described in Table III-3.2-1.

In this report, "Marginal areas" mean not only "collection non-covered" but also "self-disposal" ones in the easy collection areas and the possible areas, respectively. Distance to and from the disposal site is no criterion of a marginal area; that is, some marginal areas can be well found even in the center district of Guatemala City, for example Colonia La Trinidad, Colonia La Ruedita, etc.

2.3 Collection

The situation of collection service in 1990 was as follows:

2.3.1 Share of Work

Share of work of each responsible collector is as follows:

(1) Municipal cleansing department (DLPM)

1) Collection and transport of market wastes:

There are a total of 61 markets, i.e., 28 public markets and 33 satellite marketplaces.

2) Waste collection and transport of public facilities:

Besides public facilities and schools, there are 19 public hospitals and clinics.

3) Transport of sweeping wastes.

4) Recovery and transport of heaped wastes in clandestine open dump sites.

5) The Bell Collection Service in surrounding low-income colonies.

(2) Private collectors

Authorized private collectors collect and transport domestic as well as commercial wastes. In addition to them, there are also individual operators who directly transport wastes to landfill site from generation sources, such as constructors, commercial enterprises, factories, supermarkets and hotels, which produce large quantities of solid wastes.

2.3.2 Results of Collected and Hauled Waste Quantities in 1990

Waste amount collected and hauled by each collector is given in the following table II-2.3-1.

Table II-2.3-1 Results of Waste Amount Collected and Hauled

	(Unit: t/workday)	
Domestic waste subtotal	(513)	(41.4%)
Private	468	37.7%
(Recovered amount included)		
Municipal (Bell Collection)	45	3.7%
Non-domestic waste subtotal	(301)	(24.3%)
Markets and sweeping solid waste (municipal)	195	15.7%
Commercial waste (directly hauled)	106	8.6%
Construction and demolition wastes (directly hauled)	426	34.3%
Total	1,240	100.0%

From the above table, the following conclusions can be drawn;

- (1) Domestic waste comprises approximately 41%, non-domestic waste 24%, and construction and demolish wastes 35%.
- (2) Private collectors collect and transport approximately 38% of the total solid waste and 19% by the municipality with direct transport accounting of 43% of all transport.
- (3) Private collectors collect 75.6% of domestic waste (including commercial waste) and the municipality 7.3%, with direct transport at 17.1% and private and direct transport totaling 92.7%.
- (4) 91.2% of domestic waste (not including commercial waste) is collected privately and only 8.8% by the municipality.

2.3.3 DLPM's Service Levels and Collection and Transport Efficiency

(1) Equipment and Facilities

Of 45 vehicles for collection in the Cleansing Department, there are 4 unrepairable broken vehicles without possibility to repair, 5 or 6 vehicles average are in maintenance or in the repairing workshop, therefore only from 35 to 38 vehicles are working daily. 82 percent of the vehicles have been in operation for more than 12 years, and 58 percent of them has been in operation for more than 15 years. This reality makes necessary an urgent replacement and increase in the quantity of collection vehicles of the municipality, if a satisfactory service (constant operation rate of 90%) is to be rendered.

On the other hand, there are few repairing facilities, nor enough tools to perform minor repairs or services

such as lubrication, change of tires; this makes the vehicles to remain at the workshop longer than necessary.

Maintenance workshops are located in the same building complex including administrative offices, warehouses and facilities for the Cleansing Department personnel.

Entrance to the Mechanical Workshop is not high enough, not allowing entrance of some specifically large collection vehicles, therefore often the attachments are taken off from the vehicle to enter in the workshop. It is not rare to see overhaul of the engine being demounted on the floor of the workshop.

(2) Personnel

In 1990, a total of 177 people are employed by the DLPM for collection operation, 12 convoy employees and 165 collectors.

(3) Solid waste collection results

From August of 1990 to February of 1991, the quantity of solid waste actually collected averaged 240 t/workday. With 177 personnel, this equals a daily working productivity of 1.36 t/person.

(4) Loading efficiency

The loading capacity of a dump truck is 4 ton and 8 t for a collection vehicle. Average actual loading, however, is 2.1 t and 3.76 t, respectively, resulting in a loading efficiency of 52.5% for dump trucks and 47.0% for collection vehicles. This is clearly too low.

(5) Number of trips

According to an analysis of field data, there were 5-7 trips/day by convoy service and 1.21 trips/day by collection vehicle.

(6) Bell Collection Service

Collection routes and areas for the Bell Collection Service are appointed as a rule, but seen in terms of weighed results of 45 t/workday, the effectiveness of this service is not satisfactory.

(7) Collection frequency

Collection frequencies are 6 times/wk for markets, 2 to 6 times/wk for hospital collections, and 1 to 5 times/wk for Bell Collection Service, quite a wide range. Though it may be thought that a collection frequency of 1 to 5 times/wk for the Bell Collection Service is enough, it is really insufficient due to its unreliability and unexpected interruption.

(8) Unloading efficiency at the landfill site

Since the municipal collection vehicles are equipped with dumping devices, unloading is completed and trucks are out of the disposal site within 5 to 15 minutes.

(9) Convoy service

Because loading and unloading efficiency of convoy service is high, its number of trips are 5.7. The average loading efficiency, however, is only 2.1 t/vehicle, or, 50% of the capacity. Improvement of truck bodies, for example by changing lower sideboards for higher ones, is recommendable.

2.3.4 Service Level of Private Collectors and Collection and Transport Efficiency

(1) Number of vehicles

The number of vehicles owned by private collectors is given below in Table II-2.3-2.

The rate of vehicle operation is 95%, higher than that for municipal vehicles. There are 51 drawn carts among the 249 vehicles, a good 20%; the modernization in vehicle type is required. Most trucks are non-dump, box-bodies and rear-loading types. These should be modernized to improve their loading and unloading efficiency.

(2) Number of collectors

A total of 924 employees, of which 786 are collection workers with trucks.

(3) Amount of solid waste collected

From August of 1990 to February of 1991, the quantity of solid waste actually collected averaged 468 t/workday. With 786 personnel, this means the daily productivity of 0.6 t/person, an extremely inefficient rate (one-half of the municipal productivity).

(4) Loading efficiency

Loading efficiencies for Association, Cooperative, and Independent are 2.31, 2.32 and 2.01 t/truck, respectively, pretty low at less than 60% to the loading capacity of 3.7t/truck ($0.248 \text{ (ton/m}^3) \times 15 \text{ (m}^3\text{/truck)} = 3.72 \text{ ton}$).

Table II-2.3-2 Number of Vehicles, Personnel and Average Loading Efficiency

Class	Type	No. of vehicles (Trucks)** ¹	Operation rate (%)** ²	Personnel (Person)** ³	Loading efficiency (t/truck)** ⁴
Association	Truck	198	95	582	2.31
	Horse-drawn cart	36	80	108	0.66
	Manual cart	15	80	30	0.36
	(Total)	(249)	-	(720)	-
Cooperative	Truck	38	95	156	2.32
Independent	Truck	12	95	48	2.01
Total		299	-	924	-

- Notes
- *1 Based on original register
 - *2 Verbal survey results
 - *3 Verbal survey and on-site survey results (with original register as reference)
 - *4 Average results weighed by truck scale

No data is available on unregistered collectors (pirates).

(5) Number of trips

Since there is no data specifying the collection districts and routes of private collectors, one can only estimate. According to the original register, associations make 1 trip/day, cooperatives 1.33 trips/day. According to the field data, Association makes 0.7 trips/day and Cooperative 0.9 trips/day.

(6) Collection frequency

Private collectors make at least 2 to 3 collections/wk and at most 6 collections/wk. This is clearly sufficient. Frequent collections are limited to those houses which are able to pay the collection fees, however, while collection services to those who are unable to pay fees are not carried out. Consequently, a large amount of solid waste remains uncollected in areas abounding in low-income households. In this sense, the service level of private collectors is woefully insufficient undoubtedly creating numerous problems.

(7) Unloading efficiency in landfill disposal sites

Unloading is extremely inefficient. This is due to the fact that trucks crowd into the landfill site at the specified time 12:00 to 15:00 and to the lack of dumping devices. The most important cause, however, is the fact that trucks are unloading at the same time that scavengers are recovering. 30 minutes to several hours are needed for unloading.

2.4 Sweeping Services

Sweeping operations are the direct responsibility of the municipality. The allocation of personnel plays a

prominent role in the Cleansing Department. There is, however, very little relevant data.

2.4.1 Road Sweeping Service

(1) The paved roads have an extension of 1,200 km. According to 1990 municipal data, 377 people are required to sweep these paved roads.

(2) Road sweeping is carried out by both road sweeping vehicles and manual labors.

1) Mechanical road sweeping service

3 road sweepers (B2, B3, and B4)

Number of routes: 12

Frequency: 1 to 7 times/wk

According to data of 1989 and the first half of 1990, the productivity of road sweepers is low.

The average stretch of road swept in the first half of 1990 was 30.97 km/day, or, 5.63 km/h, with vehicle operational factor of 25.3 days/mo. for B2, 22.3 days/mo. for B3, and 8.8 days/mo. for B4.

2) Manual road sweeping

a) Central urban area

Per capita sweeping efficiency is estimated at 3,500 (linear m/day) for 5 routes, with a sweeping frequency of 7 times/wk and an average 16 sweepers, though this efficiency is to be verified. Looking at the sweeping frequency and the number of sweepers, however, service levels seem to be high.

- b) Areas surrounding the central urban area
(including Trebol district)

Per capita sweeping efficiency is estimated at 2,874 m/worker/day for 14 routes, with a sweeping frequency of 1 to 5 times/wk and the number of sweepers at 1 to 33 depending on the route. 1989 data, however, shows that the average number of sweepers was 152 persons/day, sweeping efficiency was 2,287 m/worker/day (79.6%), and that the hourly efficiency was 357 m/worker/hr. Though this indicates high levels of manual sweeping, questions still remain concerning the data.

- c) Terminal market and others

Sweeping efficiency is 163 m/worker/hr with sweeping frequency at 7 times/wk and the average number of sweepers at 38. Looking at generated solid waste and areas to be swept, an efficiency of 163 m/worker/hr seems satisfactory.

2.4.2 Pica Pollo Service

- (1) Service routes and frequency

- 1) Periodical service

There are 12 routes with 5 times/wk service and 4 routes with 2 times/wk service.

- 2) There are 9 irregular routes with once/wk service.

- (2) Work efficiency

Data for 1989 and half of 1990 is as follows. The average number of workers was 51 persons/day. Picked

up solid waste was 19.5 kg/worker/day. Pico Pollo Service seems to supply employment opportunities.

2.4.3 Refuse Bins

98 refuse bins are located in the central urban area, boulevards, and on public gardens which are recovered and transported by municipal collection vehicles. The number of refuse bins placed seems to be extremely few for a municipality with a population of 1,500,000. DLPM justifies this low number of refuse bins, indicating that these are used illegally by merchants and residents to throw commercial and domestic waste, not paying service fee.

2.5 Recovery of Resources

2.5.1 Scavengers

Scavengers are persons engaged in separating and selecting saleable components from the garbage, prior to collection, during transportation, and at the final disposal site, known as "El Trebol."

The following sorters participate in scavenging depending on the location or place of occupation within the economic process:

- (1) "El Trebol" scavengers ("Guajeros")
- (2) Collection personnel from private collection companies
- (3) Formal scavengers, which visit offices and homes prior to the collection to obtain or acquire recoverable material from the solid waste
- (4) Personnel who participate in the marketing process of recoverable and recyclable material together with all intermediaries

(5) To a lesser degree, DLPM collection personnel.

The estimation of the number of scavengers is summarized in Table II-2.5-1.

Table II-2.5-1

Estimate of the Number of Persons Engaged in the Sorting Process - Guatemala

Area of Occupation	No. of Persons
"El Trebol" disposal site	500
Private collectors	700
Formal scavengers	100
Commercial scavengers	20
Others	100
Total	1,420

2.5.2 Recovered material

It is estimated that 29.5 tons of materials and 1,200 bottles are recovered each working day, which signifies approximately 5% of the solid waste collected per working day, which is somewhat higher than what is recovered in other Latin American cities.

(1) Economic aspects:

- 1) The scavengers are paid almost Q. 15,000 for all that is sorted, that is, Q.4.2 million per year. This means a remuneration of Q.10/sorter/day and Q.3,000/scavengers/year.
- 2) The recovery of 5% of what is collected daily does not signify an appreciable relief for the operating costs of DLPM and private collectors, since almost all scavenging is carried out during transport and the final disposal site, after the costs have

already been incurred.

(2) Health aspects:

- 1) The reuse of materials without any sanitary control is potentially dangerous, for the scavengers who handle them, as well as for the public who acquires and uses these materials. Regrettably, there is little that can be done to improve this situation, since survival objectives are more important than the health of the scavengers.
- 2) The scavengers who separate materials prior to collection and during transport are less exposed to sanitary hazards than guajeros.
- 3) The major health risks lie in the handling and separation of waste originating from hospitals, and in exposures to accidents resulting from the imprudence and competition between scavengers, during peak hours when six bulldozers are in operation and up to 22 trucks are unloading simultaneously.

(3) Social aspects:

- 1) Each group engaged in scavenging ("El Trebol" scavengers, private collector personnel, formal scavengers, commercial scavengers) is a homogenous social group, but each group is clearly differentiated from others. Some of the scavengers are even salaried. In other words, each group has a different "status."
- 2) It can be said that the only serious social problem is related to "El Trebol" scavengers. The remaining groups have no social problems and should even be encouraged to continue scavenging.

3) None of the groups engaged in scavenging are organized. This is particularly a problem among "El Trebol" scavengers, since the authorities cannot discuss much less reach an agreement with them, since there is no one to represent them. Unlike in other Latin American cities, the "guajeros" do not have acknowledged leaders.

(4) Technical aspects:

- 1) The recovery process at "El Trebol" is inefficient and ineffective. The process, apart from being dangerous, unhealthy and depressing, is technically inappropriate, and far too much energy is expended to obtain small gains.
- 2) On the other hand, the recovery during the private collection and that carried out by formal scavengers is much more efficient and productive.
- 3) The presence of scavengers, that are actually already present in "El Trebol", together with the operation of DLPM tractors also limits the efficiency of the landfilling process.

2.6 Final Disposal

With respect to the final disposal in the metropolitan area of Guatemala City, present situation of the final disposal and the other related things are as follows.

- (1) Through the field surveys performed by JST it has been estimated that the total amount of solid waste generated from the study area is about 967 tons/day and 1593 tons/day calculated for the year of 2000.

At present about 57% of the total amount generated is open dumped at Trebol disposal site, therefore the rest amount is mostly observed illegally open dumped at many gullies.

- (2) Present traffic condition at the surrounding areas of Trebol dumping site is in a heavy traffic jam condition. It is obvious that the solid waste collection vehicles have additionally worsen the traffic condition because the Trebol is only one official solid waste landfill site to cope with the waste in the metropolitan area of Guatemala City.
- (3) Environmental situation at Trebol landfill site is insanitary generating pollution problems. In "El Trebol", uncontrolled and insanitary picking work by about 500 scavengers, confused operation by collection vehicles and scavengers for waste unloading and recovering, air pollution caused by spontaneous burning of the dumped waste, and water pollution in the gully due to the untreated leachate generated from the waste, are observed.
- (4) Ground condition and access roads at the landfill site are very bad and tend to be maddy in rainy days making the landfill operation very troublesome.
- (5) Sewage and other liquid wastes from the surrounding houses are flowing into the gully making the volume and quality of the leachate larger and worse.
- (6) Trebol landfill site seems to have become a food feeding place for pigs, dogs, sopilotes and so on.
- (7) Meanwhile, besides the household waste, dumping of industrial and hospital wastes are occasionally observed.

- (8) Environmental influence with bad smell, dusts and noise to the dwellers around the site cannot be disregarded.
- (9) Largest reason leading to such environmentally bad situation stated above is the insanitary landfilling method without covering with soil. Construction and demolition wastes are, also dumped at the site, but it is not effectively used for covering.

2.7 Institutional Organization

2.7.1 Public Cleansing Department of the Municipality of Guatemala, DLPM

The Public Cleansing Department of the municipality (DLPM), is an administrative unit of the municipality of Guatemala City which is in charge of planning, operation, supervision and control of public cleansing, including the sweeping of streets, parks, green areas and markets, and the collection, transportation, intermediate treatment and final disposal of solid waste generated in the city. The sweeping services for streets, parks and green areas, as well as the cleansing of markets and the final disposal are provided by DLPM, directly. Collection services are mixed (private and municipal). "Compost" processing at the Alameda Norte installation is the responsibility of the municipality and the communal organization of this colony and the sorting of materials from the garbage and marketing is a private function, with no municipal participation.

Although cleanliness in the central urban areas is acceptable, the outlying areas suffer from clandestine garbage dumping resulting from the lack of a regular collection of solid waste.

In addition, a clear difference of service level is observed between the Public Cleansing Service of Guatemala City and similar services in the Municipalities of Mixco,

Villa Nueva, Chinautla, Villa Canales and Santa Catarina Pinula, whose budgetary resources are very limited.

2.7.2 Organizational Structure

DLPM is dependent on the Public Service Bureau.

Fig. II-2.7-1 shows the organization chart corresponding to the present DLPM organizational structure. The following limitations have been identified concerning this institutional organization:

- (1) A structure with a large number of sections which are requested to report to a single headquarters or manager's office.
- (2) Absence of a planning subsystem.
- (3) Limited supervision of private collection.
- (4) The lack of a community education and participation subsystem.
- (5) Weak supervision of the fulfillment of legal requirements and regulations regarding public cleansing.

2.7.3 Personnel Administration

The distribution of DLPM personnel relative to its organizational structure is shown in Table II-2.7-2. The other personnel characteristics are as follows:

Organization chart of the present DLPM

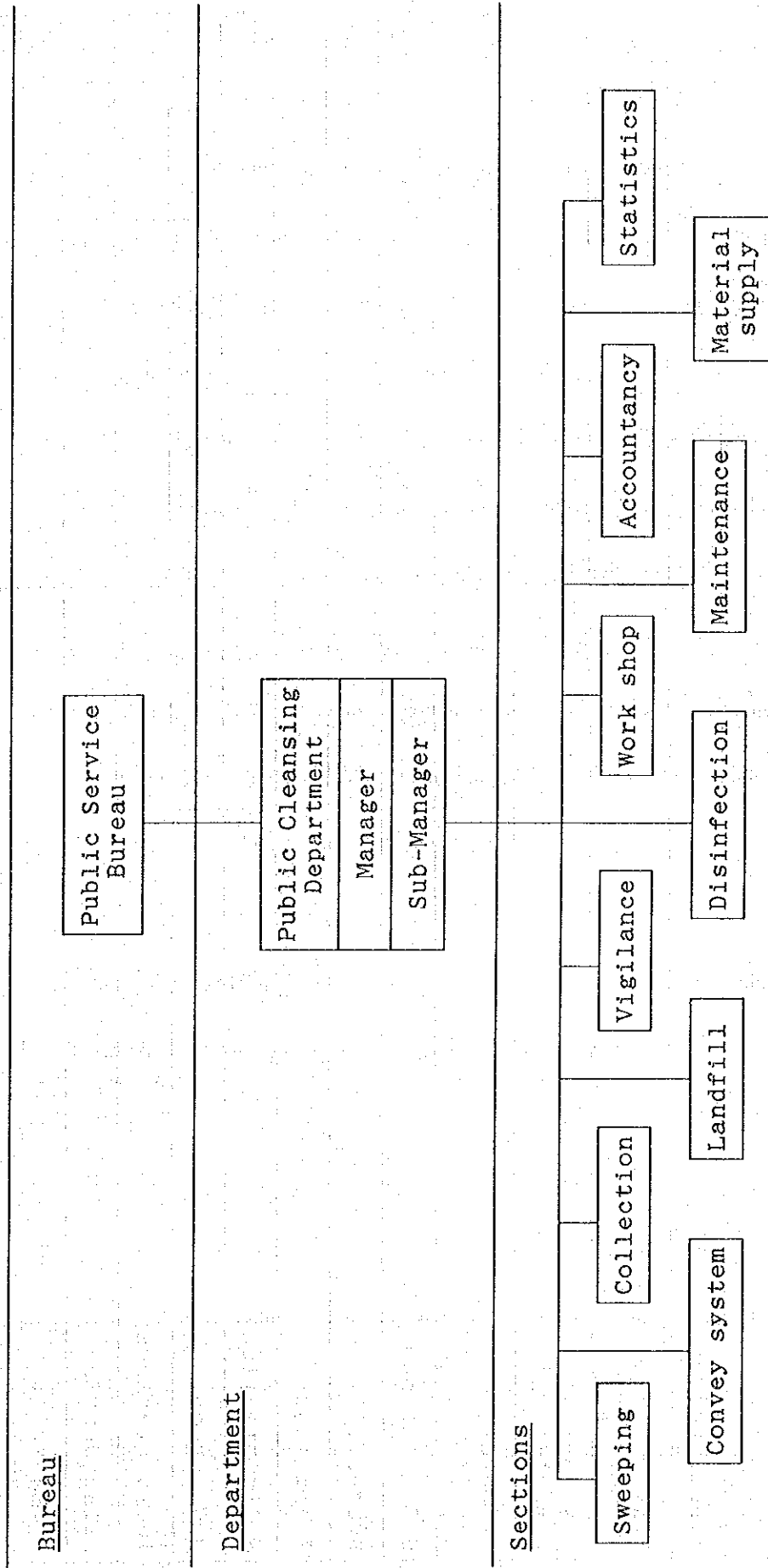


Fig. II-2.7-1

Table II-2.7-1 Personnel of Public Cleansing Department

Personnel of Public Cleansing Department		Personnel of Public Cleansing Department						
Dependence and sections	Professional	Administration and office staff	Engineers and operators (*)	Qualified workers	Non qualified workers	Total	%	
1. Headquarters		6	1	2	1	10	1.5	
2. Sub-headquarters		1	1			2	0.3	
3. Sweeping section		3	11	30	333	377	54.7	
4. Convoy system			5	3	4	12	1.7	
5. Collection		4	45	38	78	165	24.0	
6. Landfill	1	1	7	11	23	43	6.2	
7. Vigilance				21		21	3.0	
8. Disinfection				5		5	0.7	
9. Workshop			1	42	5	48	7.0	
10. Maintenance		1				1	0.2	
11. Accounting		2	1			3	0.3	
12. Material supply			1			1	0.2	
13. Statistics		1				1	0.2	
Total	1	19	73	152	444	689	100.0	

(*) Including Driver

- (1) Public Cleansing Personnel: Table II-2.7-2 shows the number of people involved per ton of garbage collected.

Table II-2.7-2 Relation of the Number of Personnel Involved in Garbage Collection (*)

	MPPP	MPSP	TOKYO	RIO	GUATEMALA
Personnel involved in cleansing service (persons)	1,533	1,000	11,737	7,677	689
Personnel involved in waste collection (persons)	182	350	8,200	2,692	177
Estimated amount of waste collected (ton/day)	360	190	14,480	5,000	708
Estimated amount of waste collected by municipal operations (ton/day)	47	145	10,000	5,000	240
b/d	3.9	2.4	0.8	0.5	0.8
a/d	33.0	6.9	1.2	1.5	2.9

MPPP: Majlis Perbandaran Pulau Pinang, Malaysia
 MPSP: Majlis Perbandaran Seberan Perai, Malaysia

(*) Date of information: 1987, with exception of Guatemala which is 1990.

- (2) Work Experience: 54% of all personnel has less than three years experience, and only 6% is over 30 years old.
- (3) Female Personnel: Only 3% of all personnel is female.
- (4) 15% of all personnel does not have any education, and professional personnel is very scarce.
- (5) The rotation rate of personnel for 1989-1990 was 11.2%.

- (6) The work absentee index is 1.2%.
- (7) The remuneration of personnel in 1990 was in the range between Q.2,600 and Q.550 per month, including social benefits.
- (8) There is no personnel training program.

2.7.4 Administration of Supplies

- (1) Stocks of parts and supplies are not permitted.
- (2) The purchase of supplies involves a very long process.
- (3) Distribution is also a slow process.

2.8 Private Collection

2.8.1 Significance and Present Role of Private Collection

Although the Municipality is the entity responsible for the collection of solid waste in Guatemala City, for more than twenty (20) years there has been a private collection service, which arose from the lack of regular service due to critical shortage of resources on the part of the Municipality to handle this important service. At the beginning small owners of man- and animal-hauled carts, began to provide this service, then it transformed itself into a collection by numerous old trucks belonging to owners who have organized and strengthened themselves in groups. The present significance and role of private collection is synthesized as follows:

- (1) **COVERAGE:** Approximately 50% of domestic waste is collected by private collectors.

- (2) QUANTITY: The above means that approximately 480 tons/working day are collected.
- (3) COST: The cost of collecting this amount of garbage signifies approximately US\$1.6 million per year, which if not carried out by the private collectors, will have to be carried out by the Municipality.
- (4) EMPLOYMENT: Private collection is the source of employment for approximately 1,000 persons.
- (5) CORPORATE APPROACH: Private collectors have managed to organize their business on a corporate basis, although they are very simple having small owners and, in certain cases, the personnel of a low cultural level. They won legal recognition of the Municipality several years ago.
- (6) QUALITY OF SERVICE: House-to-house service. Areas with this type of collection appear clean.
- (7) PUBLIC OPINION: 85% of users who use this service are satisfied, in accordance with the public-opinion poll carried out by JST in July 1990.
- (8) RECOVERY AND RECYCLING: The sorting which is carried out during this private collection is better on a sanitary basis than that subsequently carried out at "El Trebol" landfill.
- (9) CONTINUITY OF SERVICE: There has not been an interruption of private collection service in the last 20 years.
- (10) INFORMALITY: Presently, private collectors constitute one of the most important informal groups in Guatemala. The characteristics are: they operate outside labor laws and minimum wages; the financing, when required,

is obtained privately; accounting is not kept and they do not declare their income or pay income tax. Even so, each private collector plans, operates and maintains his equipment, contracts and charges rates to his users, and directly administers and finances his small company.

2.8.2 Characteristics of Private Collection

(1) Private collector groups

- 1) Private Association of Garbage Collectors of Guatemala which has a group of 307 owners of 248 vehicles, 36 animal-drawn carts and 23 hand carts.
- 2) Integral Cooperative of Special Services of Motor-Driven Garbage Transportation, R.L., COITRAMBA, which has an association of 35 collector vehicle owners.
- 3) Independents formed of 12 owners of vehicles.

(2) Number of households served:

Association	111,000
Cooperative	26,400
Independents	9,600
Total	147,000 households

Table II-2.8-1

COOPERATIVE: NUMBER OF COLLECTORS WHICH SERVE THE DIFFERENT AREAS

ZONE	NO. OF COLLECTORS	ZONE	NO. OF COLLECTORS
1	3	11	12
2	2	12	11
3	2	13	3
4	2	14	3
5	3	15	3
6	6	16	--
7	5	17	--
8	4	18	7
9	3	19	3
10	2	21	1

(3) FREQUENCY: 3 and 2 times per week

(4) FINAL-DISPOSAL TRIPS: Average of 1.1 trips per working day per private collector vehicle.

(5) FEES:

Table II-2.8-2 Tariff of Private Collectors

Service	Collection Fee
Domestic (*)	From Q.3. to more than Q.10./Month/Family
Industrial	From Q.50. to Q.500./Month/Factory
Commercial	From Q.10. to Q.150./Month/Shop
Clinics & others	Variable, according to agreement

(*) The fee is increased if garden wastes are collected.

The users are in agreement with the tariffs paid.

(6) EQUIPMENT USED

Of the 292 automotive vehicles used, 17 vehicles were manufactured in the '50's, 83 in the '60's, 109 in the '70's and there are only two 1980 model trucks.

2.8.3 Present Problems in Private Collection

Although private collection plays a decisive role in the Metropolitan Area of Guatemala City, it also presents problems;

- (1) The first problem is that collection under the responsibility of private collectors is carried out in a disorderly and nonsystematic manner. In other words, although formed in two unions, it does not operate collectively and systematically, but they work simply as individual collectors. This is how they compete between themselves to collect and transport solid waste, and they individually maintain their vehicles, collect tariffs and open new markets among consumers. Consequently, the improvement of cooperation between private collectors and levels of collection service are very difficult tasks.
- (2) Consequently, since private collectors do not collect the solid waste from persons who cannot pay their tariffs, the tendency to dump garbage in public areas, including in the center of Guatemala City, causes sanitary problems.
- (3) The relationship between the DLPM and private collectors is entirely based on relations between individuals, and, consequently, the absence of a unit for handling and supervising private collectors is a big obstacle.

2.9 Finance

2.9.1 Structure

First, the cost structure by DLPM functions is shown below for 1988 to 1990 and this situation seems to be continued even in 1991.

	88	89	90
(1) Administration and others	5.8	6.0	5.5
(2) Sweeping and collection	85.7	85.6	84.8
(3) Final disposal	5.5	5.4	6.3
(4) Maintenance and repair	3.0	3.0	3.4
(5) Total	100.0	100.0	100.0

(Unit: %)

The above figures indicate that:

- (1) Sweeping and collection services accounted for 85% of the DLPM budget. In particular, sweeping accounted for 45% of the budget.
- (2) Shares of final disposal, as well as for maintenance and repair were extremely low.
- (3) Consequently, sanitary landfills have not been developed and vehicle availability is insufficient.

The unit costs of collection and disposal at the year 1990 are calculated as follows:

	Cost (a) (1,000 Q.)	Amount (b) (1,000 t)	Unit cost (a/b) (Q/t) (\$/t)	
(1) Sweeping	1,865	6.3	296	74
(2) Collection	3,132	69.0	45	11
(3) Final disposal	737	420.0	1.75	0.44

(exchange rate = 4 Q/\$ as of 1990)

It is apparent that the cost of the sweeping service was high since it represented more than half of the costs of

sweeping and collection services combined. On the other hand, the unit cost of the final disposal was definitely low.

However, the growth rates of budgets for final disposal, as well as maintenance and repairs, have increased substantially from 1988 to 1990. As such their situation seems to have improved only slightly (refer to the list below).

	88-90
(1) Administration and others	36.5
(2) Sweeping and collection	41.2
(3) Final disposal	62.2
(4) Maintenance and repairs	62.8
(5) Total	42.7

(unit: %)

Next, the cost structure by type of expense is as follows:

	88	89	90
(1) Personnel costs	77.6	77.2	75.3
(2) Material costs	19.5	21.9	22.7
(3) Machine and equipment costs	0.9	0.9	2.0
(4) Total	100.0	100.0	100.0

(unit: %)

The share of machinery and equipment was quite low. Since the DLPM's sweeping service has a policy of hiring poor people to fight against unemployment, this service must continue.

Fuel and lubricant costs represented a large portion of the material costs, and the double increase of machine and equipment costs in 1990 was the result of budget expansion for maintenance and repairs.

2.9.2 Budget

The transition of the budget for DLPM is shown in Table II-2.9-1.

Table II-2.9-1 Transition of SWM's Budget

	1988	1989	1990	1991	91/88
SWM					
DLPM	4,003	4,186	5,250	5,114	--
Landfill	398	787	474	148	--
Other sector	-	-	-	1,412	--
Total (a)	4,401	4,973	5,724	6,674	--
Municipality (b)	47,484	45,196	55,283	68,563	--
Share (a/b, %)	9.3	11.0	10.4	9.7	--
Growth of a (%)	-	13.0	15.1	16.6	14.9
Growth of b (%)	-	-4.8	22.3	24.0	13.0

Footnote:

- (1) The unit for SWM and the municipality is Q1000.
- (2) Real for 1988 and 1989, budget for 1990 and 1991
- (3) Municipality shows "Current revenues". However, "Urban transport subsidy" is omitted in 1991.

In the case of 1991, a DLPM's section that was responsible for the maintenance of vehicles including the fuel supply, has been transferred to the division in charge of the maintenance of machines and vehicles. Therefore, DLPM's budget has decreased as follows:

	1990	1991
DLPM's budget	5,734	5,262
	(Unit: Q1,000)	

However, the personnel and materials budget transferred from DLPM is Q1,412,780, so that the total budget concerned with DLPM's activities is Q6,674,340. The growth rate for 1991/1990, is calculated to be 16.6%, and its portion in the total municipal budget is 9.7%.

The budget will have to be increased again in the future to improve sanitary conditions in the study area.

2.10 Environmental Conditions

The population of the Metropolitan Area of Guatemala City is growing, and people are being exposed to a wide variety of environmental hazards.

Water pollution is a major issue related to environmental improvement in Guatemala. At present, the river water (e.g., Rio Zalia) is literally sewage, with a BOD measured at approximately 500 mg/l. The sewage and leachate released from improper waste management are the reasons for this contamination. Sewage is believed to be the major reason.

Existing conditions make it necessary to consider sewage treatment measures for the future, as well as waste management, to prevent further river water pollution.

The two major environmental problems caused by solid waste are the prevalence of clandestine open-dumping sites and an uncontrolled landfilling practice.

2.10.1 Uncontrolled Landfill Site

(1) El Trebol final disposal site

The disposal site shows absolutely no concern for the environmental protection.

1) Smoke and odor

Adequate measures have not been taken against smoke generated by natural combustion at the dumping site.

These have occasionally triggered traffic congestion in neighboring areas.

Nor have any measures been taken against offensive odors.

2) Noise

The noise level from waste transportation vehicles during peak hours stands at about 70 dB (L50,A)

3) Leachate

Leachate with 12,000 mg/l BOD in rainy season is continuously discharged into a branch of the Rio La Barranca.

From a geological point of view, the surroundings of the disposal site are located within a range of faults that became active in 1976. As a result of this situation it is likely that leachate will contaminate the ground water.

The existence of double-layered ground water zones around the El Trebol disposal site was reported by a previous ground water study. At the point where the study team bored previously, an upper, shallow ground water zone was discovered. The permeability coefficient of this ash bed was $K = 2,928 \times 10^{-4} \text{cm/ sec.}$, and therefore, the effects on shallow ground water are unavoidable.

According to the recent survey of the surrounding wells, it seems that water levels have decreased and the water has become polluted as of four or five years ago.

Table II-2.10-1 Environmental Evaluation of
El Trebol Final Disposal Site

El Trebol	Evaluation
. Possibility of drinking water pollution	B
. Impact of surface water pollution	C
. Impact of flooding	C
. Impact of groundwater pollution	C
. Distance from public facilities	B
. Distance from densely populated areas	C
. Dust hazard	C
. Smoke hazard	C
. Noise hazard	B
. Odour hazard	C
. Landslides	C
. Adjustability of a land use plan and neighbouring land use	C

A: No damage

B: Slight damage

C: Damage

2.10.2 Scavengers

The sanitary environment of scavengers is extremely poor. Disposal sites epitomize uncleanness. Stench is all-pervading, and rodents, flies, mosquitoes, and so on abound; furthermore, zopilotes and wild dogs are all over the site. The existence of human scavengers, however, is one of the main causes blocking the improvement of landfilling practice, and the creation of a sanitary environment.

The average working hours are 7.9 hours per day. Many human scavengers eat and defecate at the disposal site resulting in a high risk of infection from waste and animals.

Since the work environment is extremely poor, there are numerous worker accidents. (For example, getting hit by trucks and bulldozers, falling from slopes, getting caught in landslides.) Furthermore, owing to the direct handling of solid waste, there are dangers inherent in scavenging and the adverse effects on health. Since solid waste is not separated, injuries from broken glass, etc. abound.

Scavengers often burn solid waste to prepare meals, stay warm or dispose of waste. Since this leads to possible fires, it is necessary to stop it and establish specific working hours, so that operations can be supervised to improve the safety and general sanitation conditions.

Most scavengers live near or on the disposal site. Approximately 25% (22 out of 91 surveyed) come to the site by bus. They return home by bus, carrying traces of waste with them carelessly, leading to an extremely unsanitary state of affairs.

2.10.3 Clandestine Open Dumping

Clandestine open dumping sites are distributed throughout the entire study area.

The total number of open dumping sites in official records exceeds 500. Due to the lack of any sanitary control they are dangerous because of the exposure of residents to openly dumped waste.

The clandestine open dumping site seems to be one of the places that causes the transmission of disease such as

digestive system infections etc., by flies, mosquitoes, and other worms gathering there.

2.10.4 Storage and Discharge

For indoor storage, it is necessary that the containers be tightly sealed to prevent the appearance of worms and rodents, and to prevent dogs from pillaging the waste. In the case of outdoor storage, the frequency of collection must be increased to prevent the appearance of insects, pillaging by cats and dogs, the scattering of waste by scavengers, the outbreak of stench, etc. Concrete bins and open stations present storage problems from the point of view of sanitary management. Because of scavengers, scattered solid waste, stench, pollution, vectors, etc., these means of storage are not desirable.

2.10.5 Collection and Transport

At present, solid waste is collected without being separated, and private collectors handle this waste with their bare hands. Injuries from broken glass abound, resulting in unsafe collection operations. Collectors who go from door to door dump solid waste into cloth bags and carry them on their backs to the collection vehicle. As a result, these collectors are handling waste throughout their entire workday. Since collection vehicles (dump trucks, sideloading trucks) are not sealed, leakage flows out onto the road.

3. Evaluation of Present SWM

3.1 Positive Aspects of Actual SWM

Within the institutional and organizational limitations, equipment shortages and financial insufficiency, the Municipality of Guatemala is making possible efforts for cleansing of public roads, waste collection, landfill supervision, etc. The numerous points which can be evaluated therein are as follows:

- (1) The road sweeping service is being carried out directly and actively by the Municipality which is making efforts to keep the shopping streets clean.
- (2) The Municipality is collecting accumulated waste, such as organic waste from markets, and waste scattered around markets.
- (3) The Municipality is collecting waste from public facilities, schools, hospitals, etc.
- (4) Conditions at clandestine open dumping sites are being investigated and waste is being transported to "El Trebol".
- (5) The Bell Collection is operating partially in marginal areas not served by private collectors.
- (6) Experiments in intermediate treatment and recovery of resources aiming at self-disposal like the compost facility at Alameda Norte are under way.

3.2 Problems

In the actual SWM of the City of Guatemala, there are following major problems:

- (1) Partial coverage of collection service, especially in marginal areas

Solid waste collection service by private sector is only available in certain areas and is limited primarily to residents of the middle-income bracket and above.

Particularly in marginal areas, municipal bell collection is only partially carried out.

- (2) No collection or disposal service for isolated areas

In isolated areas under poor traffic conditions, there is absolutely no solid waste collection service by private businesses or municipal authorities.

- (3) More than 500 clandestine open dumping sites

For the reasons cited above, uncollected solid waste is illegally abandoned in more than 500 places, such as roadsides, open spaces, and valleys.

- (4) Unsanitary Trebol landfill site

At the Trebol landfill site, unsanitary conditions have arisen inside and outside the reclaimed areas due to odor, insects, smoke, etc., caused by solid waste.

- (5) Dual collection system problem (Private/Municipality)

Solid waste collection is undertaken by both Municipality and the private sector, but the planning and the zoning are not determined through mutual consultation.

(6) Institutional and organizational problems in DLPM

DLPM has various inadequate institutional and organizational aspects and other programs are insufficient or simply do not exist.

(7) Insufficient DLPM budget

DLPM's budget is insufficient for providing the minimum service.

(8) Maintenance equipment problems in DLPM

Maintenance of DLPM's equipment (such as its collection vehicles) and technology applied are also inadequate.

4. Goals and Targets

4.1 Goals

To contribute to the development of the systematic management of the solid waste in the Metropolitan Area of Guatemala City with an object of improving and safeguarding the public health as well as protecting the environmental quality by the year 2000.

4.2 Targets

In order to reach the above goals, the following targets have been established:

- (1) To raise the current coverage of domestic waste collection service, both municipal and private, from 53% to 86% by the year 2000.
- (2) To improve the sanitary and environmental conditions within and around final disposal site of Trebol converting it into a controlled landfill. To reduce the number of clandestine open dumping sites from 500 at least to the half by the year 2000.
- (3) To enlarge the capacity of final disposal by implementing the construction of a new sanitary Guacamayas landfill site.
- (4) To award concessions to the private collectors for 100% of the zones in easy collection areas by the year 2000.
- (5) To establish a program of preventive maintenance and repair of collection vehicles and other equipments, maintaining a 90% of operation rate to improve the productivity of the collection, sweeping and final disposal.

4.3 Basic Policy to Obtain Objectives and Goals

To obtain the proposed objective by the year 2000, it is necessary to attain all the goals in accordance with the program. Since it is not possible to obtain these goals over the short term, a progressive annual implementation of urgent and basic measures is necessary. Consequently, the implementation of the Master Plan has been scheduled in three stages, to attain the proposed goals by the year 2000: 4.3.1, in the short term; 4.3.2, in the medium term; and 4.3.3, in the long term.

4.3.1 Short-Term Stage

The following points should be implemented by 1992:

- (1) The Master Plan must be approved and support for its implementation must come from the higher authorities of the Municipality of Guatemala City.
- (2) The level of the present Public Cleansing Department must be defined and elevated, giving it the authority to implement the Master Plan and carry out the necessary restructuring, changes and the transfer of personnel required by the new organization.
- (3) The immediate preparation of the annual operating and investment budget draft for public cleansing service for 1992 must be carried out, adjusting to the recommendations, proposals and projects contained in the Master Plan and obtaining the approval of the Municipality.
- (4) Information must be collected, the database must be organized, and an effective plan for the implementation of operations must be established.

- (5) Activities to improve the "El Trebol" landfill must be commenced.
- (6) The first concession of zone to private collectors must be awarded in 1992.
- (7) Operations and programs designed to reduce the number of open clandestine dumps must be implemented and strengthened.
- (8) Permanent community education and participation programs to improve inhabitants' understanding of solid waste problems must be implemented, including video presentations.
- (9) Replacement and purchase of new municipal collection vehicles must begin and a vehicle-preventive maintenance system must be established.

4.3.2 Medium-Term Stage

The medium-term plan includes the period up to 1995, and comprehend the implementation of the following points:

- (1) Complete operational measures to improve and execute the controlled landfill of "El Trebol" and to complete the initial stage of construction and operation of the sanitary landfill at the new site.
- (2) Implement collection by concession for half of the zones of the Municipality.
- (3) Continue the permanent community education and participation program in solid waste management especially for school children and the residents of marginal areas.

- (4) Complete the replacement and purchase of new municipal collection vehicles.
- (5) Revise and modify or adjust the institutional aspects, financial aspects and other proposals of the Master Plan in accordance with the results obtained up to the date in the implementation of the plan.

4.3.3 Long-Term Stage

The long-term plan includes the whole period up to the year 2000, and its main objective is to consolidate the policies implemented up to that time.

- (1) Facilitate collection services in all municipal areas, except in isolated areas, either through private or municipal collectors.
- (2) Continue the "on-site" disposal system in isolated areas.
- (3) Establish a system through which plans to increase the number of necessary collection vehicles to handle the increase in the quantity of waste can be realized.
- (4) Select and plan future sites for sanitary landfills after the year 2000 and carry out any necessary preparations.

5. Planning Conditions

5.1 Population

The departments of the municipality, like city planning, transportation, water and sewage, and economic planning are presently using different future population estimates for the Metropolitan area of Guatemala City. In 1972, the rate of annual population increase was estimated at 4.2% by EDOM and PLAMABAG, and at 5.0% by EMPAGUA. In recent INE and SEGEPLAN estimates, however, the ratio of population increase in Guatemala from 1990 to 2000 is 2.9%, which seems to be the most reliable.

Table II-5.1-1 shows the future population of the 6 municipalities in the study area, according to INE estimates. The national population is estimated at approximately 12,220,000 persons at year 2000, with the population of Guatemala Department at approximately 2,620,000. Consequently, the total population of the study area in the year 2000 can be estimated at approximately 2,050,000.

Table II-5.1-1 Future Population Projection by
Municipalities in the Study Area

	1990			2000		
	Urban	Rural	Total	Urban	Rural	Total
All Guatemala	3,500,910	5,697,538	9,197,345	4,740,867	7,480,839	12,221,706
Guatemala Department	1,675,589	287,364	1,962,953	2,268,596	350,139	2,618,735
Guatemala City	1,076,725	0	1,076,725	1,340,639	0	1,340,639
Mixco	328,854	17,591	346,445	519,490	12,846	532,336
Villa Nueva	116,606	24,282	140,888	196,019	33,347	229,336
Villa Canales	4,544	49,461	54,005	5,482	63,925	69,407
Santa Catarina Pinula	7,052	19,243	26,295	10,343	25,955	36,298
Chinautla	51,770	7,360	59,131	71,997	6,602	78,599
Sub total	1,585,551	117,937	1,703,488	2,143,970	142,675	2,286,645
Metropolitan Area	1,592,000	119,000	1,711,000	2,154,000	154,000	2,308,000
Study Area	1,496,000	36,000	1,532,000	1,999,000	48,000	2,047,000

5.2 Economic Growth

Economic forecasts of the Republic of Guatemala until the year 2000 is estimated as follows:

- (1) The manufacturing structure of the Republic of Guatemala which centers around agricultural and commercial enterprises will not easily change.
- (2) The trade structures of agricultural product exportation, and the import of consumer goods, raw industrial materials, and capital goods will be also expected to change very little.
- (3) Since agricultural products are largely affected by international market conditions, export income from agricultural products will be unstable.
- (4) Looking at past economic growth, the maximum real growth in the GDP is 5% annually at a constant price.
- (5) In the estimation of local economic experts, the stable 4% growth seen in 1988 and 1989 will be expected to continue for 2 or 3 years.
- (6) Thus, real annual growth of the GDP to the year 2000 is projected at 4% from 1990 to 1995 and 3% from 1996 to 2000, an average annual growth rate of 3.5%.

Needless to say, the present democratic form of government will also continue. However, since the population will be expected to increase annually at a rate of 3%, the per capita GDP will not noticeably grow. Such present social problems as the extremities of wealth and poverty, a high illiteracy rate, and residential slums will be expected to continue until year 2000.

5.3 Land Use

Since its establishment in 1776 as the capital, Guatemala City has continued to develop as the center of politics and economics in the Republic of Guatemala. In particular, after World War II, urban areas rapidly expanded, surpassing Guatemala City areas to form the Metropolitan area of Guatemala City. City planning to date, however, has not been constructively implemented according to the advance of urbanization and residential development to accommodate the inflow of people into the Metropolitan area. Major conditions limiting urban development are topography and the transportation system.

General plans for the city have been determined, but plans for land use regulations have not been provided. Construction regulations have been implemented only in Guatemala City. Though maintenance planning of the urban infrastructure such as transportation, water supply, and electricity have either been implemented or are in the process of implementation, progress has been slow due to financial restrictions or limitations.

Regarding the direction of city planning in the future up to 2000, it is thought that along with the reorganization in peripheral areas of urbanization hitherto concentrated in the central urban areas, new residential construction will advance mainly towards Mixco City to the west, the cities of Villa Nueva, Santa Catarina Pinula, and Villa Canales in the south, and to northeast portions of Guatemala City (Zones 17 and 18).

Future road plans are also under way for the construction of the yet incomplete portion of the El Anillo Periferico Beltway.

5.4 Solid Waste Generation Amount

According to the solid waste sampling surveys conducted twice, in 1990 and 1991, fundamental solid waste generation is as follows. These results are adapted as fundamental numerical values.

Table II-5.4-1 Fundamental Solid Waste Generation (1990)

Class	kg/cap. day	l/cap. day
High	0.767	3.62
Middle	0.564	2.24
Low	0.549	2.16
Slum	0.296	1.19

5.4.1 Annual Increase of Population

Annual increase of population of study area was calculated using the statistics of Guatemala City.

Within a 10-year period (1990-2000), the population is divided equally.

The result of calculations is shown in Table II-5.4-2.

Table II-5.4-2 Annual Increase of Population

Zone	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	50,737	49,825	48,913	48,001	47,089	46,177	45,265	44,353	43,441	42,529	41,620
2	24,545	25,192	25,839	26,486	27,133	27,780	28,427	29,074	29,721	30,368	31,015
3	48,756	48,683	48,610	48,537	48,464	48,391	48,318	48,245	48,172	48,099	48,023
4	4,256	4,221	4,186	4,151	4,116	4,081	4,046	4,011	3,976	3,941	3,902
5	83,711	83,894	84,077	84,260	84,443	84,626	84,809	84,992	85,175	85,358	85,541
6	90,829	91,551	92,273	92,995	93,717	94,439	95,161	95,883	96,605	97,327	98,047
7	180,484	185,347	190,210	195,073	199,936	204,799	209,662	214,525	219,388	224,251	229,109
8	20,687	20,519	20,351	20,183	20,015	19,847	19,679	19,511	19,343	19,175	19,009
9	3,988	3,889	3,790	3,691	-3,592	3,493	3,394	3,295	3,196	3,097	3,001
10	15,167	15,101	15,035	14,969	14,903	14,837	14,771	14,705	14,639	14,573	14,507
11	66,311	68,084	69,857	71,630	73,403	75,176	76,949	78,722	80,495	82,268	84,040
12	50,234	51,314	52,394	53,474	54,554	55,634	56,714	57,794	58,874	59,954	61,029
13	35,860	36,876	37,892	38,908	39,924	39,940	40,756	41,572	42,388	43,204	44,021
14	24,832	25,850	26,468	27,286	28,104	28,922	29,740	30,558	31,376	32,194	33,016
15	22,868	24,051	25,214	26,377	27,540	28,703	29,866	31,029	32,192	33,355	34,516
16	12,948	14,955	16,962	18,969	20,976	22,983	24,990	26,997	29,004	31,011	33,016
17	17,268	19,943	22,618	25,293	27,968	30,643	33,318	35,993	38,668	41,343	44,021
18	205,253	213,541	221,829	230,117	238,405	246,693	254,981	263,269	271,557	279,845	288,137
19	37,029	37,328	37,627	37,926	38,225	38,524	38,823	39,122	39,421	39,720	40,019
21	64,510	66,563	68,616	70,669	72,722	74,775	76,828	78,881	80,934	82,987	85,041
24	8,869	9,083	9,297	9,511	9,725	9,939	10,153	10,367	10,581	10,795	11,003
25	7,563	7,707	7,851	7,995	8,139	8,283	8,427	8,571	8,715	8,859	9,004
Mixco	328,854	347,918	366,982	386,046	405,110	424,174	443,238	462,302	481,366	500,430	519,490
Villa Nueva	46,642	49,619	52,596	56,173	59,350	62,527	65,704	68,881	72,058	75,235	78,408
Villa Canales	24,731	25,454	26,177	26,900	27,623	28,346	29,069	29,792	30,515	31,238	31,963
S.C.Pinula	18,598	19,330	20,062	20,794	21,526	22,258	22,990	23,722	24,454	25,186	25,916
Chinautla	36,240	37,656	39,072	40,488	41,904	43,320	44,736	46,152	47,568	48,984	50,398
Total	1,531,790	1,583,294	1,634,798	1,686,302	1,737,806	1,789,310	1,840,814	1,892,318	1,943,822	1,995,326	2,046,814

5.4.2 Solid Waste Generation

Annual increase in solid waste generation is based on sampling surveys.

Recent increases are estimated first by annual economic growth, estimated from 1990 to 1995 as 4%, 1996 to 2000 as 3%, and secondly by annual waste generation growth that was estimated as annual economic growth to the 0.65th power. The results are shown in the following Table II-5.4-3.

Table II-5.4-3 Waste Growth Rate

	Economic growth rate 1.04, 1.03 multiply	Waste growth rate 0.65th power
1990	1.0000	1.0000
1991	1.0400	1.0258
1992	1.0816	1.0513
1993	1.1249	1.0764
1994	1.1699	1.1013
1995	1.2167	1.1319
1996	1.2532	1.1561
1997	1.2907	1.1800
1998	1.3295	1.2037
1999	1.3694	1.2271
2000	1.4104	1.2502

Economic Growth Rate: 1990 - 1995: multiply 1.04
1996 - 2000: multiply 1.03

Annual solid waste generation in weight and in volume is shown in Table II-5.4-4 and Table II-5.4-5.

Above results gained from daily generation of study area are shown in 2.1.

Table II-5.4-4 Annual Solid Waste Generation

Zone and City	Unit: ton/day													
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000			
1	26.26	26.39	26.49	26.56	26.59	26.74	26.71	26.65	26.56	26.45	26.31			
2	13.73	14.46	15.20	15.96	16.73	17.61	18.40	19.21	20.04	20.87	21.72			
3	24.74	25.28	25.81	26.32	26.83	27.47	27.94	28.41	28.87	29.32	29.75			
4	2.39	2.44	2.48	2.51	2.55	2.60	2.63	2.66	2.69	2.72	2.75			
5	44.40	45.55	46.68	47.79	48.89	50.24	51.31	52.36	53.41	54.44	55.46			
6	45.95	47.40	48.84	50.28	51.72	53.44	54.87	56.30	57.72	59.14	60.55			
7	96.41	101.34	106.35	111.42	116.58	122.45	127.75	133.12	138.56	144.05	149.60			
8	11.51	11.72	11.91	12.09	12.27	12.51	12.67	12.82	12.97	13.11	13.24			
9	2.78	2.78	2.78	2.76	2.75	2.75	2.73	2.71	2.68	2.64	2.61			
10	11.17	11.41	11.65	11.87	12.09	12.37	12.58	12.78	12.98	13.17	13.36			
11	38.75	40.81	42.91	45.05	47.23	49.72	51.98	54.28	56.61	58.99	61.39			
12	30.77	32.25	33.74	35.27	36.82	38.59	40.19	41.81	43.45	45.11	46.79			
13	22.30	23.40	24.52	25.65	26.81	28.13	29.32	30.53	31.76	33.01	34.27			
14	18.27	19.36	20.48	21.62	22.78	24.10	25.31	26.55	27.81	29.09	30.40			
15	16.59	17.89	19.21	20.59	22.00	23.56	25.05	26.56	28.11	29.70	31.31			
16	7.21	8.54	9.93	11.37	12.86	14.49	16.09	17.74	19.45	21.20	23.00			
17	9.64	11.42	13.27	15.20	17.20	19.37	21.51	23.72	26.00	28.34	30.75			
18	106.59	113.49	120.55	127.75	135.10	143.34	150.98	158.74	166.63	174.65	182.78			
19	20.61	21.31	22.02	22.73	23.44	24.28	25.00	25.71	26.43	27.16	27.88			
21	36.09	38.21	40.37	42.56	44.83	47.39	49.74	52.13	54.57	57.04	59.56			
24	4.96	5.20	5.45	5.69	5.94	6.23	6.48	6.74	7.00	7.27	7.53			
25	4.21	4.40	4.59	4.79	4.99	5.22	5.43	5.63	5.84	6.06	6.27			
Hixco	165.05	178.70	192.72	207.08	221.80	238.12	253.53	269.25	285.29	301.63	318.24			
Villa Nueva	25.96	28.44	31.01	33.66	36.39	39.41	42.31	45.27	48.32	51.44	54.62			
Villa Canales	13.76	14.53	15.32	16.12	16.94	17.87	18.72	19.58	20.46	21.36	22.27			
S.C.Pinula	10.42	11.11	11.82	12.54	13.29	14.12	14.90	15.70	16.51	17.34	18.18			
Chinautla	20.11	21.44	22.80	24.20	25.63	27.23	28.73	30.25	31.81	33.40	35.02			
Total	830.64	879.25	928.90	979.44	1,031.05	1,089.36	1,142.86	1,197.24	1,252.56	1,308.70	1,365.63			

Table II-5.4-5 Solid Waste Generation(1990~2000)

Unit:m³/day

Zone and City	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	105.68	106.23	106.64	106.93	107.09	107.70	107.60	107.38	107.05	106.60	106.06
2	54.37	57.25	60.19	63.18	66.24	69.71	72.87	76.09	79.36	82.67	86.04
3	98.19	100.35	102.46	104.51	106.53	109.09	111.00	112.87	114.71	116.50	118.23
4	9.49	9.66	9.82	9.97	10.12	10.31	10.44	10.57	10.69	10.80	10.90
5	175.72	180.26	184.75	189.17	193.56	198.94	203.19	207.40	211.56	215.67	219.72
6	182.22	187.99	193.75	199.48	205.22	212.07	217.77	223.45	229.14	234.81	240.45
7	382.32	401.90	421.81	441.99	462.50	485.88	506.98	528.33	549.98	571.88	593.99
8	45.51	46.31	47.08	47.81	48.52	49.46	50.10	50.71	51.29	51.84	52.37
9	12.50	12.51	12.51	12.46	12.40	12.39	12.30	12.19	12.06	11.91	11.76
10	51.73	52.84	53.94	54.96	55.98	57.28	58.25	59.19	60.10	61.00	61.86
11	157.56	165.95	174.49	183.20	192.08	202.19	211.38	220.72	230.23	239.87	249.65
12	129.18	135.38	141.68	148.09	154.59	162.06	168.76	175.56	182.46	189.44	196.50
13	94.55	99.21	103.96	108.77	113.67	119.29	124.35	129.48	134.69	139.97	145.32
14	84.61	89.66	94.82	100.10	105.50	111.60	117.22	122.95	128.80	134.74	140.79
15	76.31	82.27	88.38	94.70	101.17	108.39	115.21	122.18	129.32	136.61	144.05
16	28.48	33.75	39.24	44.94	50.85	57.28	63.62	70.16	76.91	83.84	90.96
17	38.12	45.17	52.51	60.13	68.04	76.63	85.12	93.67	102.89	112.16	121.70
18	422.49	449.92	477.96	506.55	535.77	568.55	598.90	629.77	661.19	693.08	725.44
19	81.45	84.25	87.05	89.85	92.67	96.00	98.84	101.67	104.53	107.39	110.25
21	142.90	151.27	159.84	168.59	177.53	187.64	196.95	206.43	216.09	225.92	235.91
24	19.65	20.60	21.56	22.54	23.53	24.67	25.69	26.72	27.76	28.81	29.86
25	16.64	17.39	18.16	18.94	19.73	20.64	21.45	22.27	23.11	23.95	24.81
Mixco	664.00	719.02	775.57	833.47	892.87	958.72	1,020.95	1,084.44	1,149.26	1,215.27	1,282.41
Villa Nueva	102.60	112.44	122.60	133.08	143.88	155.82	167.27	179.01	191.06	203.40	216.01
Villa Canales	54.40	57.45	60.56	63.73	66.97	70.64	74.00	77.43	80.91	84.45	88.06
S.C.Pinula	41.27	44.01	46.82	49.69	52.64	55.95	59.04	62.19	65.41	68.68	72.02
Chinautla	79.44	84.69	90.07	95.56	101.23	107.56	113.49	119.53	125.69	131.97	138.36
Total	3,351.39	3,547.72	3,748.22	3,952.41	4,160.89	4,396.50	4,612.74	4,832.54	5,056.22	5,283.24	5,513.47

Table II-5.4-6 Results and Forecast of Population by Areas and Solid Waste Quantity (collected, to be collected, to be recovered and to be disposed of)

(1)	YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
(2)	TOTAL POPULATION	1,531,790	1,583,292	1,634,795	1,686,296	1,737,796	1,789,306	1,840,806	1,892,308	1,943,807	1,995,312	2,046,814	
(3)	POPULATION IN ECA	944,330	999,705	1,055,080	1,110,456	1,165,831	1,221,206	1,276,581	1,331,956	1,387,331	1,442,706	1,498,081	
(4)	POPULATION IN PCA	509,235	501,469	493,703	485,937	478,171	470,407	462,638	454,869	447,101	439,332	431,563	
(5)	POPULATION IN IA	78,225	82,119	86,012	89,906	93,799	97,693	101,587	105,480	109,374	113,267	117,161	
(6)	ECONOMIC GROWTH RATE	1.04	1.03	1.0000	1.0816	1.1249	1.1694	1.2167	1.2532	1.2907	1.3295	1.3694	1.4100
(7)	WASTE GROWTH RATE (6)**	0.65	1.0240	1.0478	1.0710	1.0940	1.1223	1.1448	1.1667	1.1883	1.2095	1.2303	
SOLID WASTE GENERATION (FIELD DATA)													
(8)	GENERATION PER CAPITAL KG/D.C PER DAY	0.5434	0.5553	0.5682	0.5808	0.5933	0.6086	0.6208	0.6327	0.6444	0.6559	0.6672	
(9)	TOTAL GENERATION AMOUNT (DOMESTIC) TON/ND	830.69	879.20	928.89	979.40	1,031.03	1,088.97	1,142.77	1,197.26	1,252.59	1,308.73	1,365.63	
(10)	TOTAL GENERATION AMOUNT (DOMESTIC) TON/WD	969.14	1,025.74	1,083.71	1,142.63	1,202.87	1,270.47	1,333.23	1,396.81	1,461.35	1,526.85	1,593.24	
HAUL AMOUNT TO TEBOL (FIELD DATA)													
(11)	DOMESTIC WASTE TON/WD	483.33	575.09	666.84	758.60	850.35	942.11	1,007.13	1,072.15	1,137.18	1,202.20	1,267.22	
	A) BY PRIVATE SECTORS TON/WD	438.21											
	B) BY MUNICIPALITY TON/WD	45.12											
(12)	NON DOMESTIC WASTE TON/WD	301.05	308.28	315.44	322.42	329.35	337.87	344.64	351.24	357.74	364.12	370.38	
	A) SWEEPING/MARKET TON/WD	195.19	199.88	204.52	209.05	213.54	219.06	223.45	227.73	231.95	236.08	240.14	
	B) BUSINESS TON/WD	105.86	108.40	110.92	113.37	115.81	118.81	121.19	123.51	125.79	128.04	130.24	
(13)	CONSTRUCTION WASTE TON/WD	426.20	436.43	446.57	456.46	466.26	478.32	487.91	497.25	506.45	515.49	524.35	
(14)	TOTAL AMOUNT HAULED TON/WD	1,210.58	1,319.80	1,428.85	1,537.48	1,645.96	1,758.30	1,839.88	1,920.64	2,001.37	2,081.81	2,161.95	
(15)	RECOVERY FACTOR TON/WD	0.0500	0.0540	0.0580	0.0620	0.0660	0.0700	0.0720	0.0740	0.0760	0.0780	0.0800	
(16)	RECOVERED AMOUNT TON/WD	29.46	36.91	45.11	54.04	63.70	74.26	81.24	88.48	94.72	103.76	111.80	
WASTE AMOUNT CALCULATION BY LANDFILLS													
(17)	TREBOL TON/WD	1,210.58	1,319.80	1,428.85	1,537.48	1,645.96	1,758.30	1,839.88	1,920.64	2,001.37	2,081.81	2,161.95	
(18)	GUACAMAYA TON/WD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
(19)	ANNUAL WASTE AMOUNT FOR TREBOL TON	378,912	413,097	447,230	330,325	349,762	370,063	384,577	398,897	413,083	427,070	440,907	
(20)	ACCUMULATED WASTE AMOUNT FOR TREBOL TON	378,912	792,009	1,239,239	1,569,564	1,919,326	2,289,389	2,673,966	3,072,863	3,465,925	3,912,996	4,353,903	
(21)	AMOUNT FOR GUACAMAYA TON/WY	0	0	0	0	0	0	0	0	0	0	0	
(22)	ACCUMULATED WASTE AMOUNT FOR GUACAMAYA TON	0	0	0	0	0	0	0	0	0	0	0	

6. Selection of a New Landfill Site

6.1 Necessity of a New Landfill

In a consideration of the solid waste management in the metropolitan area of Guatemala City up to the target year of 2000, the existence of only one official landfill site at EL Trebol is the biggest problem resulting in the various unfavorable situations today. Some examples of the problems are the traffic jam at Trebol area, which is supposed partially due to the number of collection vehicles, and an increasing illegal open dumping sites, which is caused by a long distance between Trebol site and waste generating points, Mixco City for example. In this respect, a new landfill site is required.

6.2 Procedure of Site Selection

To investigate and select a new site a committee was established with following members.

- (1) Establishment of a committee with the following members. The Committee was set up on 9 July, 1990.

The members are:

Lic. Sergio Leal	(Member of counter part)
Eng. Julio Chavez	(")
Licda. Anabella Ceballos	(")
Eng. Marco Tulio Galvez	(")
Arch. Wolfgang Gomez	(")
Mr. Alejandro Diaz	(")
Eng. Edgar de Leon	(Economic Planning Sub-Director)
Eng. Julio Gonzalez	(Municipal Construction Director)
Eng. Rodolfo Gonzalez Morasso	
	(Director of Planification EMPAGUA)

(2) Guideline for site selection

JST prepared the guideline for selecting a new landfill site.

JST and counterpart finalized the guideline based on the guideline made by JST.

(3) Potential sites

Counterpart selected three potential sites as follows:

According to the policy of the Municipality that basically wants to open landfill sites in the northern basin of Guatemala Valley, (because there is the possibility of contaminating the Lake Amatitlan in case of the southern basin) the investigations were effected as the first step according to the selection criteria such as the gully capacity for landfill, the access for landfilling, the residents of the area, the environment surrounding the gully etc. As a result, three potential sites were selected by the counterpart.

- Las Guacamayas Gully by Colony Florida, zone 19, near Mixco City
- Las Vacas Gully
Colony Saravia, Zone 5
- El Campanero Gully
San Cristobal City

(4) JST evaluated the three sites comprehensively as written in item 6.3 and Table II-6.3-1.

(5) JST and counterpart completed the investigation on three sites, and reinforced the evaluation results made by JST.

(6) Through the procedure as stated above Las Guacamayas was selected finally as the new landfill site.

- (7) Both JST and counterpart agreed to the finally selected new site, Las Guacamayas.

6.3 Evaluation

As a result of a general comparison of the various aspects, it was concluded that "Las Guacamayas" is the most appropriate site for the new sanitary landfill. Comparative advantages of the "Las Guacamayas" site include:

- (1) The gully, Guacamayas, is located within the areas having deficiencies in solid waste management. One of the causes of such deficiencies is the long distances between the areas and the landfill site "El Trebol", and a consequence is the creation of a great number of open dumping places because the collection services cannot cover the areas where Las Guacamayas is located.
- (2) According to the data provided by EMPAGUA, the gully "Las Guacamayas" is suffering an erosion due to the flow of ground and surface water. This fact will endanger the parts of the residential area near the gully. Early landfill would protect the areas from the erosion progress.
- (3) After completion of sanitary landfill at the Guacamayas gully, the area will be expected to be used for various purposes.
- (4) The gully "Las Guacamayas" can be a solution to the final disposal of solid wastes for more than 10 years.

Table II-6.3-1 Evaluation of Proposed Sites

Item	Las Guacamayas	Las Vacas	El Campanero	Obs.
1) LAND ACQUISITION POSSIBILITY	Possible	Possible	Need to be checked (Politically)	
A) Land Use Restriction	None	Yes (part is a residential zone)	None	
B) Land Ownership	Mixco city and BANVI share each half of gully dividing gully longitudinally	City of Guatemala	Mixco	
C) Need for "out of sight" measures	None	None	None	
D) Need for noise, bad odor and dust isolation	Less consideration has to be taken.	Much consideration should be needed.	Much consideration should be needed.	
E) Compatibility with Development Plans	Compatible	Compatible with the urban plan but not with the underground drinking water project	Caution should be taken with the high income housing project.	
F) Site Location (Distance from main waste generation areas, km)	Approx. 5 km. if Mixco is considered as the target area.	Approx. 4 km, from center of city.	Approx. 10 km.	The distance is straight, the Trebol landfill usage is the major premise.
G) Site Area	100 ha. Minimum	10. ha. Maximum	50 ha. Approx.	
H) Expected Life	More than 30 years	3 years Maximum	15 years Approx.	
I) Covering Material Availability	Yes (almost obtainable from own site)	Yes (to be bought)	Yes (to be bought)	
J) Access	No problem	No problem	No problem	
K) Public Service Availability	Yes	Yes	Yes	
L) Present Site Conditions (Land usage, type of superficial soil, ground water depth)	No land usage Volcanic ash sedimentation layer Approx. 150 mt.	Some houses in the slope area. Volcanic ash sedimentation layer. Sewage water flows at the bottom of gully.	No land usage. Volcanic ash sedimentation layer.	

Item	Las Guacamayas	Las Vacas	El Campanero	Obs.
M) Technical Considerations	Construction of access road, ground water protection and leachate water recycling system should be done before starting sanitary landfill.	The access road to bottom must first be constructed to start the landfill. Houses on the slope should be considered when initiating such operation. Water treatment is required.	An access road should be constructed from the beginning of the sanitary landfill. The leachate treatment is indispensable due to the location of Lake Amatitlan.	
N) Possibility of Contaminating Ground Water	No problem, long distance from present and projected wells	Care should be taken due to its location aside of EMPAGUA's projected region for drilling new water wells.	Leachate treatment is necessary due to its location in the upstream of Lake Amatitlan.	
O) Impact on Surface Water Contamination	None	Should be considered because the Montagua River is a potential water source in the long term.	Pollution will be resulted in contamination of Lake Amatitlan.	
P) Impact on Ground Water Contamination	Almost None	Possible	Possible	
Q) Distance to Densely Populated Areas	Approx. 4-5 km.	Approx. 4 km.	Approx. 10 km.	
R) Surrounding Land Usage	No any special use	Military base, 4 km. Straight direction	Future Apartment Project	
S) Terrestrial Vegetation and Wildlife	None	None	None	
T) Natural Landscape	Not so nice	Nice	Will be nice in the future	
U) Historical Sites or Structures	None	None	None	

6.4 Environmental Protection

Considering the present environmental conditions of "Las Guacamayas", for example, geology, topography, the surrounding residential areas, the pressing situation by erosions etc., the following countermeasures deemed necessary for the environmental conservation.

The basic policy is to use the sanitary landfill method from the beginning.

The objectives are:

- (1) Control of waste burning, smoke, and bad odor.
- (2) Prevention of ground water contamination by leachate.
- (3) Elimination of scavengers
- (4) Prevention of erosion

A series of measures should be considered in constructing a sanitary landfill to prevent the environment around "Las Guacamayas" area from being adversely affected. These measures will be for the purpose of protecting the health of the people and natural resources in the vicinity of "Las Guacamayas".

- (1) The use of natural soil to cover daily the dumped waste and to prevent fires and unpleasant odors which may originate from the dumped solid waste.
- (2) The construction of a rainwater drainage system to minimize the volume of leachate.
- (3) The construction of a leachate-recycling system, between a storage lagoon and the certain areas of the sanitary landfill site. With this, mainly organic

content (BOD) of the leachate would be reduced and its quantity would be decreased by evaporation.

- (4) The construction of a gutter at the bottom of the gully, with a lining of synthetic rubber sheets and clay to conduct the leachate to a storage lagoon, and thus prevent contamination of the ground water.
- (5) The construction of a pipe line along the gutter which brings spring water at the bottom of the gully to the downstream of the lagoon.
- (6) The construction of the ventilation pipes of the gases generated by the decomposition of solid waste, in order to prevent a migration to neighboring areas, and possible explosion or fire.
- (7) The construction of fences around the perimeter of the landfill site to prevent the entry of persons interested in retrieving goods from the wastes.

6.5 Public Opinion

(1) Respondent's characteristics

- 1) Number of Respondents ... 125 persons
- 2) Men 28.8%, women 65.6%, others 5.6%
- 3) For age distribution, refer to the attached data.
- 4) People living in the LAS GUACAMAYAS valley.
- 5) More than 90% of the residents earn an income of less than Q800/month.
- 6) The respondents' standard of living is from the middle of the lower class to the lower end of the middle class.
- 7) For respondents' length of residency, refer to the supporting report.

(2) Present status

- 1) About 88% of the people polled said they dispose of refuse at fixed places. About 60% of them also said that they throw refuse into the valley.
- 2) About 77% of the people polled expressed concern about refuse being disposed of in areas around their homes. Of these, 74% expressed anxiety over this refuse becoming the cause of disease.
- 3) Only 30% of the respondents think that the environment around their homes is clean; the other 70% think that it is not clean.

These responses indicate that residents have a great interest in the illegal disposal of refuse.

- 4) The majority of respondents acknowledge the need for handling the waste in a proper manner. Furthermore, they expressed a willingness to cooperate to resolve the problem.
- 5) The residents do not seem to be receiving the benefits of municipal collection services. About 13% of the respondents rated existing services satisfactory, while as many as 35% of these respondents expressed dissatisfaction with such services.

The city government provides the area with a bell collection service, which is apparently not sufficient.

- 6) About 38% of the respondents who reside in the valley, LAS GUACAMAYAS, responded that it is bad to throw refuse away in the valley.

- 7) The residents are becoming aware that solid waste in illegal open dumping site is affecting them in some ways and specifically, they cited as the first and the foremost problem offensive odors, followed by smoke, water pollution, soperote and noise, in that order.

Regarding the noise, it is likely that they are confusing this noise with traffic noise.

- 8) Nevertheless, more than 90% of the residents living in nearby areas want waste disposal to be handled somewhere else.

(3) Comments

- 1) In short, in the survey carried out on Feb. 1991, many people mentioned sanitary and environmental problems related with illegal dumping of solid waste at Guacamayas.
- 2) However, the surveyed people said they would cooperate with the Municipality to handle solid waste, in a way to improve the sanitary and environmental conditions in this area if a really sanitary landfill is constructed.
- 3) From the abovementioned, most of the residents want the solid waste to be carried to far sites from residential areas, but the final disposal to be made in a sanitary way at the determined site.

This means that the people will approve a sanitary landfill construction at a certain site of the city. In other hand, people may not want the landfill to be near their houses because of the actual conditions at El Trebol.

For this reason, the residents living in the surroundings of Guacamayas are aware of the need for a landfill in some other site of the city, but it is probable for them to oppose the new landfill construction at the Guacamayas. Therefore, it is necessary to improve first the actual situation at El Trebol, in a way they can feel the benefits of the Guacamayas sanitary landfill project.

7. Institutional Development of DLPM

7.1 Institutional and Organizational Development

Public cleansing service is officially the responsibility of the Municipality. In the case of Guatemala City, this responsibility is under the sphere of action of the Public Cleansing Department, a dependent of the Public Service Bureau, which is partially in charge of the collection and cleaning of public roads, as well as the final disposal of solid waste. The particular characteristics of Guatemala City, which is unlike other capital cities in Latin America, is that it has private collectors who are in charge of a large part of the collection of domestic solid waste. This private service should be maintained and improved, since without its decisive input the Municipality would not have the operating or financial capacity to provide proper services, at least in the present decade.

Consequently, the organizational and institutional development of DLPM basically considers it necessary to maintain this duality of municipal and private collection service.

7.1.1 Recommended Institutional Organization

Two aspects related to the Institutional Organization were consecutively studied:

- (1) Institutional solid waste management in the Metropolitan Area of Guatemala City.
- (2) After the definition of the above, alternatives regarding the institutional organization of DLPM were studied.

(1) Solid waste management in the Metropolitan Area

The results of this study are summarized in the Table II-7.1-1.

ALTERNATIVES:

- 1) All the public cleansing service operations (sweeping, collection, transportation and final disposal) are completely carried out by the direct administration of the Municipality of Guatemala City.
- 2) Dual municipal and private service, similar to the present service, but with higher-efficiency. Independent administrative, operational and financial systems between the two services, but coupled with municipal planning, supervision and control.
- 3) A mixed municipal corporation, which becomes a new autonomous municipal corporation, with municipal and private participation, which could include present private collectors.

CRITERIA:

The criteria used to evaluate and select the most appropriate alternative was the following:

- a. Planning function
- b. Expansion of coverage
- c. Continuity of service
- d. Administration
- e. Financing
- f. Establishment and collection of tariffs
- g. Political influence

h. Public opinion

i. Social costs

EVALUATION

The results of the study indicate that for the present, and over the foreseeable socioeconomic situation for the decade within this country, the second alternative, dual municipal and private service, is the most recommendable.

(2) Institutional Organization of DLPM

After defining the dual municipal and private service as the most recommendable alternative for solid waste management in the metropolitan area, the institutional organization and the level of municipal organization were evaluated. An analysis of the alternatives are summarized in the Table II-7.1-2.

Table II-7.1-1 Alternatives for the Institutional Administration of the Solid Waste Management

	Alternative 1	Alternative 2	Alternative 3
Characteristics	All the operations of the public cleansing service (sweeping, collection, transportation, final disposal) are executed by the direct administration of Municipality.	Mixed Municipal and private service, similar to the current service but with more efficient characteristics than the current one. Administrative, operational, Commercial and financial independence between the two services, but with municipal supervision and control.	Mixed enterprise, forming a new municipal enterprise; with municipal and private participation, which could include the participation of the current private collectors.
a. Planning system	Municipal	Municipal, but with the private group's autonomy to plan its operating, commercial, administrative and financial parts.	Autonomy as a paramunicipal company.
b. Service coverage	Due to administrative rigidity it is difficult to extend coverage quickly.	Fluidity in the private sector in response to the expansion of the coverage.	Theoretically there would be a quick response to expand the coverage, but there is no experience.
c. Continuity of the service	Very exposed; to labor disputes (big disadvantage)	In the past private collection has never been halted (big advantage)	Very exposed to labor disputes
d. Administration	With a tendency toward bureaucracy	Possibility of bureaucratization on the part of the municipality. None in the private sector.	Some possibility of bureaucratization.
e. Financing	Ordinary tax income and the ordinary transferences (8% of national budget) received by the Municipality are limited. There would be a need to charge new fees and taxes.	Municipal service: requires an increase in the municipal budget. Private service is financed by the direct charge of fees to the customers, a commercial system which has worked without problems until now.	In theory it would be the same as Espagua financing; although the company should approve and establish the tariffs which are not charged actually.
f. Establishment and charging of tariffs	Difficult decision	Private collectors do not have problems. It is currently working very well.	Difficult decision
g. Political influence	Very dangerous (disadvantage)	Partially dangerous only for the municipality	Dangerous
h. Public opinion	Unfavorable toward the municipal services	Good toward the private collectors	Unknown
i. Social costs	Great	No	Great
Comprehensive Evaluation	C	A	C

A: Good B: Moderate C: Low

ALTERNATIVES:

- 1) Department, at a similar level to that presently occupied by DLPM in the Municipality of Guatemala City.
- 2) Public Cleansing Bureau, elevating its level within the municipal organization.
- 3) Public Cleansing Corporation, with similar characteristics to the present EMPAGUA.

CRITERIA:

- a. Financing
- b. Autonomy
- c. Administration
- d. Relationship to private collectors
- e. Status within the Municipality, with other official and private institutions, and with the public

EVALUATION:

The second alternative, to elevate the status to a bureau, is the one that will best respond to the situation with regards to financing, and the relationship with private collectors.

(3) Intermunicipal Organization in Solid Waste Management

- 1) In accordance with legal regulations in effect in the country, the Municipalities of Guatemala City, Mixco, Villa Nueva, Chinautla, Santa Catarina Pinula and Villa Canales are responsible for public cleansing service in their corresponding jurisdictions. Their operations may be transferred

Table II-7.1-2 Organization and Level of DLPM

Heading	Alternative 1 Department level as in the present organization	Alternative 2 Public cleansing bureau	Alternative 3 Municipal public cleansing corporation
a) Financial	B	A	C
b) Autonomy	B	B	A
c) Administration	C	B	A
d) Relationship with private collectors	C	A	C
e) Prestige	B	A	B
Evaluation	<p>B</p> <p>-Restriction in autonomy, administration and relationship with private collectors</p> <p>-Moderate possibility of financing</p>	<p>A</p> <p>-Very good image, financing and relationship with private collectors</p> <p>-Moderate autonomy and administration</p>	<p>B</p> <p>-Very good possibilities of autonomy and administration</p> <p>-Moderate image</p> <p>-Obstacles in financing in this decade and unfavorable relationship with private collectors</p>

A: Good B: Moderate C: Low

and/or contracted out, but the responsibility for the rendering of the services is not delegable.

Table II-7.1-3

Intermunicipal Organization in Solid Waste Management in Metropolitan Area of Guatemala City

Function	Responsible
1. Responsibility for public cleansing	Each of the municipalities of Guatemala, Mixco, Villa Nueva, Chinautla, Santa Catarina Pinula and Villa Canales in the area of its jurisdiction.
2. Collection and sweeping	Each municipality in the area of its jurisdiction.
3. Granting of concessions to private collectors	Each municipality in the area of its jurisdiction.
4. Final disposal at "El Trebol" and "Las Guacamayas" landfills	
4.1 Planning and financing	Will be regulated, supervised and coordinated by the "Metropolitan Solid Waste Committee".
4.2 Operation and administration	DLP of the Municipality of Guatemala City

2) Consequently, the sweeping and collection services are rendered by each municipality within its jurisdiction.

3) Having selected the dual system for collection service (municipal/private), the granting of concessions will be carried out by the corresponding municipality in its jurisdiction. However, the necessary conditions for the awarding of concessions should be followed and fulfilled by all municipalities within the metropolitan area.

4) Final disposal (sanitary landfill)

- a. The operation and administration will be under the responsibility of the DLP of the Municipality of Guatemala City.
- b. The planning and financing will be regulated, supervised and coordinated by "the Metropolitan Solid Waste Committee (CMDS)".

5) "The Metropolitan Solid Waste Committee", will have the following objectives: Regulate, supervise and coordinate the planning and financing of the metropolitan sanitary landfill; coordinate and solve cases of jurisdictional conflict in the handling of collection services; the sole application of the conditions for granting concessions to private collectors for all the municipalities; all other matters related to solid-waste management, requiring intermunicipal coordination by the Committee.

7.2 Concessions to Private Collectors

Having selected the dual collection system, municipal and private, it is necessary to provide guidelines so that this private collection will operate efficiently, under the supervision and control of the DLP. The concession process is the path selected and basically consists of the formalization of present concessions to private collectors. This process of granting concessions should be a gradual process because of the conditions and factors analyzed in details.

For many years, the municipality accepted that private collectors would provide this service in different areas of the city, practically establishing a concession system. This was ratified and approved through the Environmental

Cleaning and Sanitation Regulation for the Municipality of Guatemala in effect as of April 16, 1982. The stipulation of this regulation have not been fully implemented, as such it is necessary to formalize the gradual awarding of concessions to private collectors.

7.2.1 Concession Process

(1) Zoning

- 1) Maintain the jurisdiction of the 22 existing zones in Guatemala City.
- 2) Of these 22 zones, concessions may be granted in 20 zones, either totally or partially, throughout this decade. Zones 24 and 25 are excluded since these areas are rural. In addition, the zones corresponding to the municipalities of Mixco, Villa Nueva, Chinautla and Villa Canales should also be included.
- 3) The zone corresponding to Santa Catarina Pinula will be treated as an isolated area, for which a specific approach will be taken.
- 4) The city of Mixco, with its large population, may be subdivided into as many as three areas for concession purposes.

(2) Concession conditions

1) General conditions

- a. In accordance with Article 31 of the Municipal Code, municipal public services are to be rendered directly by the departments or privately through granted concessions.

- b. The municipality has the authority to grant concessions for the rendering of public services exclusively within its jurisdiction to individuals or companies, through a public-law contract and for a specified duration, in which the nature and conditions of the service and the guarantees of the operation are established (Art. 32, Municipal Code).
- c. The municipality will establish contributions and rates deriving from the contract which the receiver of the concession will be granted (Art. 32, Municipal Code).

2) Nature of the Service

- a. The service which will be provided in the concession areas will be limited exclusively to the collection of solid waste generated within the concession zone.
- b. It will be strictly prohibited for the receiver of a concession within a zone to collect or transport hazardous waste.

3) Service Conditions

- a. The DLP will clearly define the concession zone and its area.
- b. Express acceptance on the part of the receiver of the concession of the municipal ordinances and regulations which regulate this service.

7.2.2 Gradual Granting of Concessions

(1) The gradual granting of concessions should be subject to the following criteria;

- 1) The zones should be included in easy collection area.
- 2) Potential profitability of the zone should be high.
- 3) Possibility of conflicts among private collectors should be minimal.
- 4) The number of illegal open dumping sites existing in the zone should be large.

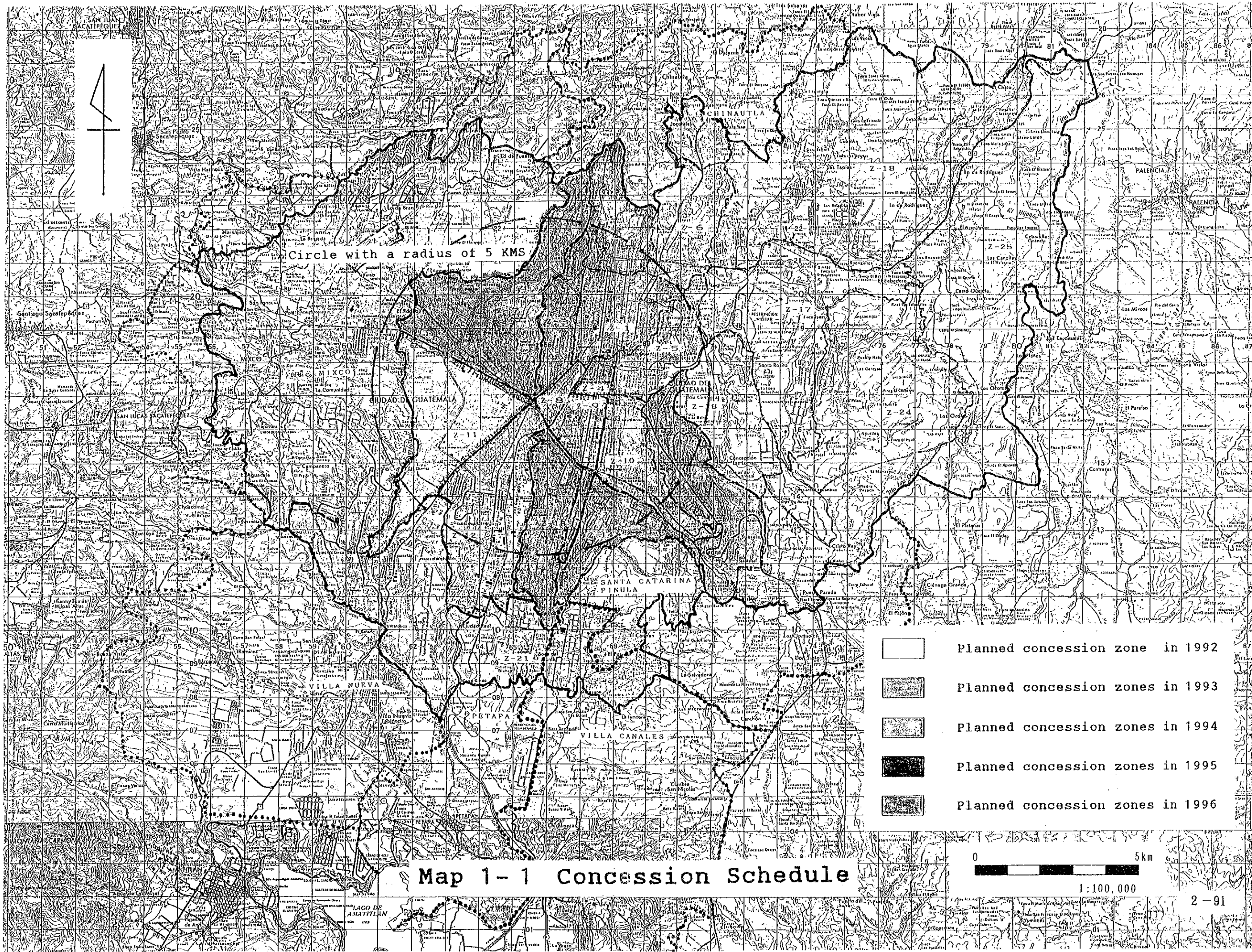
(2) Tentatively, the following scheduling has been presented for the awarding of concessions:

1992	One zone
1993	Three zones
1994	Three zones
1995	Four zones
1996	Four zones






(3) These first fifteen zones should be granted as concessions in the 1992-1996 period. These include Zones 1 through 15.

7.2.3 Supervision and Control of Concessions

The operation and functioning of private collection, in zones granted as the concession and zones not yet assigned will be monitored, supervised and controlled by the Private Collection Department. The new organization proposed for the DLP includes the creation of this Department since it is considered to be indispensable within the organization to be established.



Circle with a radius of 5 KMS

-  Planned concession zone in 1992
-  Planned concession zones in 1993
-  Planned concession zones in 1994
-  Planned concession zones in 1995
-  Planned concession zones in 1996

Map 1-1 Concession Schedule

0 5 km
1:100,000

7.3 Personnel Training

In order to facilitate the implementation process of the DLP, improve the training of its employees and, additionally, prepare them for the new tasks which will be introduced by the new public cleansing organization, a training program should be developed and carried out during the decade. Furthermore, the program should cover the different personnel levels.

7.3.1 Justification

The new DLP requires trained personnel for both the management and operating levels. Since the DLP will use the present DLPM personnel and other personnel which will be transferred from other municipal departments, and since new personnel will only be contracted in exceptional cases, the personnel instruction and training program is fully justified, and should, therefore, be permanent, realistic and practical.

7.3.2 Training Levels

The proposed training should be carried out at three levels:

- (1) Management - for the Director, Assistant Director, Department Heads and Section Chiefs.
- (2) Intermediate - for employees responsible for control, supervision and support activities. This will be directed toward training related to the control of the collection system operations, including sweeping streets, maintaining equipment, the final disposal at sanitary landfills, and community-education activities and administration.

- (3) Operational - for drivers, mechanics, equipment operators and workers in general. This training should concentrate on strictly practical skills for the purpose of improving the efficiency of routine operations in street sweeping, collection, transportation and final disposal.

7.3.3 Program Development

- (1) For management level training, it is mainly recommended that service training in similar foreign entities be carried out over periods of approximately one (1) month. Several industrialized countries and certain Latin American countries can provide this type of training. Trainees should also participate in short courses abroad such as those periodically prepared by the PAHO/WHO and other international organizations. The goal would be to send 1 or 2 officials at this level annually, beginning in 1991.
- (2) For the intermediate level, the strategy will concentrate the development of short courses within the country with the support and backing of international organizations such as PAHO, and bilateral organizations such as JICA which has just organized a preventive maintenance seminar together with the Municipality of Guatemala City or other national, public or private organizations or universities. The training of 15 individuals per year would be a desirable goal. These should be short courses, of a practical nature, and supported with instruction manuals, which would serve as a permanent reference.
- (3) The training program for the operational level should basically be carried out through sessions in work areas and workshops. These sessions may be supported by audio-visual aids, such as films or video cassettes. They will learn new, more efficient work methods. The

goal is two of these activities per year for 80 persons, beginning in 1992.

7.3.4 Training Costs

Specific budgetary resources have not been considered in the DLP for training, since it is considered that International Organizations, Bilateral Cooperation Agencies and other national organizations may provide scholarships and other aid to support these training activities.

The municipal contributions will, above all, be those corresponding to the installed capacity with respect to human resources and the physical infrastructure. The execution of the training program will be the responsibility of DLP's Planning Unit.

7.4 Community Education and Participation

The state of cleanliness in the city is directly related to the aspirations of the inhabitants and to their "motivation" in reaching this condition. If the inhabitants do not feel the need to keep their city clean, the DLP will have to spend a lot of money and make great efforts just to keep the city clean.

In fact, as sanitary conditions improve, costs will decrease as long as there is community participation.

Social communication is the best way to obtain the participation of the community in the adequate management of solid waste. Therefore, the instituted program should include:

- (1) Dialogue with the residents
- (2) Community motivation
- (3) Effective presentation of the DLP to the public.

7.4.1 Dialogue with the residents

- (1) This activity will be carried out so that neighbors will be aware of the benefits of the sanitary and environmental order that would result from good SWM (the JICA video could be of help in this respect).
- (2) Without information, the community has no way of knowing how to collaborate (the JICA video can also help here).
- (3) The regulations and municipal demands should address the socio-economic reality of Guatemala.
- (4) It is necessary to erase the concept that the Municipality should supply all of the communities' needs, without the collaboration of residents.
- (5) It is necessary to keep in mind that some of the inhabitants, especially those in marginal areas, do not value cleaning work, since it is a subjective concept.
- (6) The delivery of efficient service by DLP is fundamental. The community's participation should be requested only after the service has been offered at the necessary level.
- (7) The continuity and regularity of the service, attention to complaints, and the public relation of the nature of services form part of DLP's image.
- (8) Simply written presentations with nice visual illustrations will help this dialogue process.

7.4.2 Motivation of the Community

Efforts for mass communication should consider the following elements:

- (1) The message is information on solid waste management which is desirable to be transmitted.
- (2) The medium or instrument of transmission
 - The video prepared by JICA represents an appropriate instrument.
 - Radio (transmissions) represents another appropriate instrument. Almost all of the homes on the outskirts have a radio.
 - Written press communications which are always very interested in news about urban sanitation.
 - Talks and conferences would also prove to be efficient.
 - School cleanliness contests and campaigns.
 - Service Clubs.
 - Public opinion surveys to make the proper refuse handling known.
 - The support of the APT program would be an important medium.
- (3) The addressee is the one who should be affected by the message.
 - Residents and housewives, especially those living in marginal areas.
 - School students and teachers
 - The DLP sanitation workers, and private collection workers.
 - Specifically selected groups: Workers in markets, street vendors, etc.

7.4.3 Effective Presentation of the DLP to the Public

- (1) Working day and night on the streets, DLP personnel and equipment will represent permanently visible promotion elements (both positive and negative).

- (2) Light colors, associated with the feeling of cleanliness, should predominate in uniforms, vehicles, containers.
- (3) Courtesy and respect to the public would be a good proportional element which would, furthermore, facilitate the reciprocal respect and consideration that the public should show public sanitation workers.

7.4.4 Responsibility of the Community Promotion Program

After having carefully analyzed the different alternatives, JST has concluded that the DLP, through its planning unit, will be the part responsible for the planning, execution and evaluation of this M/P. For this task, it should count on the participation of professionals, social workers and educators. This recommendation must be emphasized if real results are desired.

7.5 Maintenance of Equipment

To solve the problem of maintenance of vehicles owned by the Municipal Public Cleansing Department, it is necessary to carry out several actions which are expressed sequentially below.

In the first place, it is necessary to create a maintenance unit with a chief with authority and resources to implement a preventive maintenance program.

The chief will be a professional, preferably engineer with knowledge in mechanics and electricity of the vehicles, understanding clearly the maintenance concept and with the capacity to implement it and control it. He will be assisted in this work by an assistant and a secretary.

In the second place, it is necessary to provide appropriate car barns to keep vehicle and workshop to carry

out preventive maintenance and carry out minor corrective maintenance. Also equipment and tools should be supplied in quantity and quality enough to carry out maintenance. The maintenance unit shall eliminate heaps of junk in the yard.

This infrastructure has a very low initial cost compared with the service it provides. With less than the price of a new collection vehicle, it would be possible to repair and fit adequately the Public Cleansing Department Workshop. This investment would be recovered in a short term considering only the increase of vehicle life. Increasing of only one year of each vehicle's life of 35 justifies the investment. At the same time, there are benefits of preventing excessive breakdown of vehicles which leaves zones without services, because currently it is not possible to rent vehicles for substitution. That is to say, the quality of service would be improved. An improvement of this nature can be made through the introduction of module units for preventive maintenance and minor corrective maintenance. It is recommended to have 1 module as base for preventive maintenance and 2 modules for corrective maintenance for each 24 vehicles. Cost of these modules and tools for maintenance amounts to about US\$20,000.-

Important corrective maintenance for collection vehicles, that requires to replace, repair or change definitely parts of the motor system or command train for example, must be carried out in private workshops which offer great comparative advantages for this type of maintenance.

In the Public Cleansing Department, spare parts not in stock and not expensive take currently three months or more from the purchase request until acquisition. This is because such request must be approved by many persons.

This system not only lowers the average number of vehicles in operation, but also sometimes puts a vehicle in

bad condition to continue the operation, causing greater damage and making the repair more expensive affecting in greater proportion the budget.

In the third place, the chief of the maintenance unit will develop the following:

- (1) A periodic inspection program for vehicles, daily, monthly, biannual and yearly with the respective records, from which the most important information shall be transferred to the life sheet of the vehicles.
- (2) Design of a record system including the amount of information required and enough to obtain standard values or design parameters. Also to record information for selection of collection vehicles, in addition to information required to prepare yearly budget.

In the fourth place, after confirmation that the equipment and tools are available for a preventive maintenance program in operation, it is convenient to start a training program for the personnel of the workshop. To this purpose, educational level, educational background and professional background will be considered. The course should clarify and update knowledge regarding the activity which will be carried out. It could be convenient to reinforce the maintenance unit with qualified personnel.

For logistical reasons, the heavy equipment maintenance (bulldozers, loaders, etc.) operating at El Trebol will be carried out at the El Trebol landfill, where the appropriate facilities will be constructed, and the administration of these facilities will be carried out by the DLP Maintenance Section.