Chapter 7

The Master Plan

7 The Master Plan

7.1 Outline of the Mater Plan

7.1.1 Discharge and Storage System

At present, source separation is not realized in the DF. Taking account of the future consequence of SWM in the DF, however, source separation is indispensable. The following is the plan for source separation proposed by the M/P.

a. Time Schedule

Separate discharge is to be introduced step by step into the sub-system aiming at 100% separation rate in 2004 in the M/P.

On the other hand, a "source separation" program is to be introduced in later years to the generators whose waste collection services are currently provided by the delegations more gradually with due attention by making use of experience gained in the sub-system aiming at a 50% separation rate by 2010.

The separate discharge and collection program in the M/P is presented in Figure 7-1.

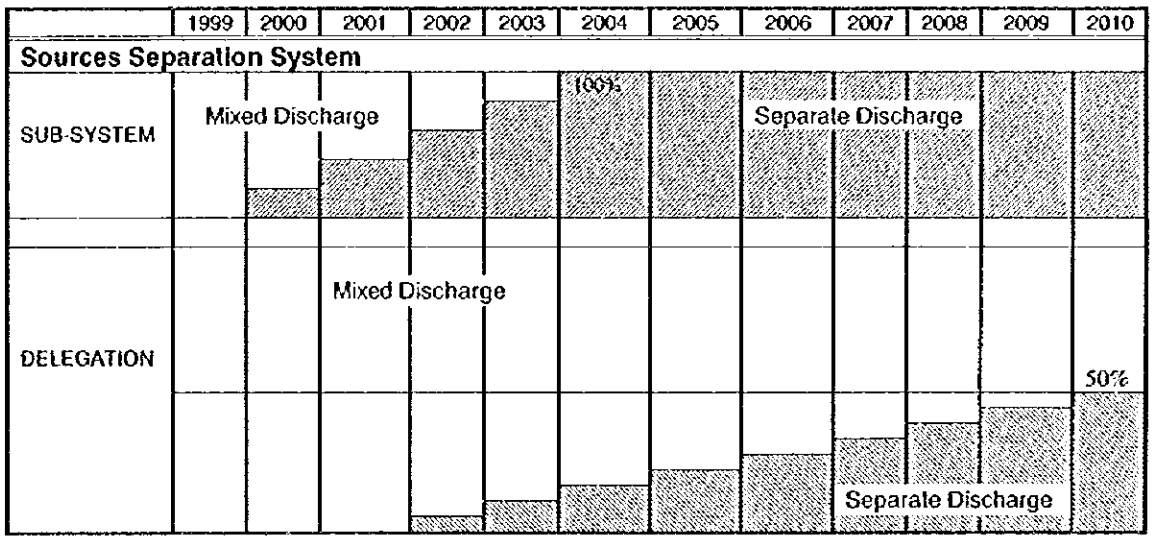


Figure 7-1: Separate Discharge and Collection Program

b. Separation Categories

The success in shifting the generators' behavior from mixed waste discharge to source separation largely depends on morals and devotion of themselves. Namely, **the fewer** the separation categories are, **the higher** possibility of **success** they may have in the source separation.

Since 1996, the DGSU has been carried out a pilot program of three categories source separation in some public institutions and housing units, in which totally about 8,500 people are cooperating. 92% source separation was achieved on average in 1998.

In view of this result, the source separation categories in the sub-system are proposed to be **three** (organic, recyclable, and others).

The above pilot project might possibly have gained a good devotion of rules observance from the generators, since they were public institutions and housing units where the collective cooperation were easily expected, and in turn unanimously responded to the project.

On the other hand, the collection services by the delegations are provided for individual generators, whose laborious commitments in source separation are difficult to seek. Since it is anticipated that the same three categories source separation (as the pilot project) can not be easily achieved by generators in the delegation services, it is proposed to employ the simplest separation categories (i.e., **two categories:** recyclable, and others) for the source separation in the delegation services.

Table 7-1: Source Separation Item

System	Separation type	Waste category
Sub-system	3 categories separation	organic, recyclable, and others
Delegation	2 categories separation	recyclable, and others

7.1.2 Collection and Haulage System

a. Collection Methods

Collection methods for separately discharged wastes comprise such as:

- **Normal vehicle collection**
- **Point collection**
- **Special vehicle collection**

In view of an advantage of utilizing the existing collection system (i.e., maximum use of current resources and cost saving), **normal vehicle collection** appears to be most recommended as the separate collection method in the M/P. Meanwhile, as for the separate collection for markets, in which limited in number of major generators are put together, **point collection** could be recommended, if the collection point can be managed as part of market facilities.

b. Haulage System

b.1 Transfer Station

Currently visual waste inspections are carried out at the transfer stations, in order to determine the optimum waste destination (S/P or final disposal site) for respective incoming wastes. Therefore, even in a case where separate collection is implemented in the future, it is judged that the present system of transfer stations can cope with the change.

b.2 Transportation

Separate transport routes by which wastes are transported one: from station to S/P, from station to final disposal, and from S/P to final disposal. Therefore, it is judged

that present system can be adapted to the future transportation system in which mixed waste and separate waste are to be transported independently.

7.1.3 Intermediate Treatment System

The objectives of the intermediate treatment system are the minimization of waste volume to be disposed of and material recycling. There are three selection plants in the DF, but their material recovery ratio is not high enough.

In the M/P, the efficiency upgrading of these S/Ps and the installation of a new compost facility are planned. The compost facility will be fed with organic waste from the sub-system and its capacity is expanded as the source separation program proceeds.

In Phase 3, the latter half of the M/P (2005-2010), when and if the shortage of the final disposal site is anticipated to emerge, possibility of the introduction of an incinerator should be examined.

7.1.4 Final Disposal System

The standard of the final disposal method employed by the GDF at present is high and the minor improvement of the leachate treatment system should be enough to operate the Bordo Poniente final disposal site technically satisfactorily.

However efficiently the Bordo Poniente final disposal site is used, it is certain that the GDF needs another new final disposal site around 2013 in addition to Etapa V. Under the present land use condition in the DF, however, obtaining a new land for the final disposal within the DF is very likely to encounter serious difficulty.

As it is anticipated that substantially long time of discussion will be required before its implementation, the coordination with municipalities outside of DF for the future landfill (to be used after the year 2013) should be started at latest in the year 2007 or around by the GDF and other entities.

7.1.5 Outline of the Master Plan

Table 7-2 shows outline of the master plan.

Table 7-2: Outline of the Master Plan

		Data of 1997	Phase 1 (1999 - 2001)	Phase 2 (2002 - 2004)	Phase 3 (2005 - 2010)
Population		8,610,000	8,654,000-8,747,000	8,796,000-8,896,000	8,946,000-9,206,000
Waste generation amount (ton/year)					
Household		1,926,000	1,946,000-1,965,000	1,976,000-1,998,000	2,009,000-2,072,000
Commercial		1,210,000	1,217,000-1,223,000	1,229,000-1,236,000	1,244,000-1,267,000
Service		636,000	642,000-649,000	652,000-657,000	659,000-669,000
Special		130,000	131,000-134,000	134,000-136,000	136,000-140,000
Others		267,000	268,000-270,000	271,000-275,000	276,000-282,000
Total		4,169,000	4,204,000-4,241,000	4,262,000-4,302,000	4,324,000-4,430,000
Discharge/Storage					
	Sub System	-	Introduction of source separation	Introduction of source separation	Maintaining source separation
	Delegation	Mixed	Mixed	Introduction of source separation	Introduction of source separation
Collection					
Amount (ton/year)	Sub System	-	853,000-858,000	861,000-867,000	870,000-884,000
	Delegation	4,169,000	3,293,000-3,325,000	3,342,000-3,376,000	3,395,000-3,485,000
Method	Sub System	-	Introduction of separate collection	Introduction of separate collection	Maintaining separate collection
	Delegation	Mixed	Mixed	Introduction of separate collection	Introduction of separate collection
Transfer Station and Transport					
Transfer Station and Transport			• Installation of weighbridges for every station. • Utilization of a single common format for data compilation	• Utilization of the transport monitoring and control system (for 5 flows[1]) based on the accurate incoming/outgoing weight measuring • Efficient transport allocation by the monitoring and control system	
Transfer amount (ton/year)		3,123,000	3,725,000-3,757,000	3,776,000-3,812,000	3,830,000-3,922,000
O&M cost(U$/year)		43,547,000	51,941,000-52,387,000	52,652,000-53,154,000	53,405,000-54,688,000
Intermediate Treatment					
Selection plant			• Experiment of operation modification to incorporate an objective of quantity oriented picking. • Experiment of "storage system" for recovered materials to cope with market prices fluctuation.	• Implementation of operation control with 2 objectives of: - revenue oriented picking; -quantitative picking, • Establishment of "storage system" for recovered materials to cope with market prices fluctuation, in view of experiment results.	• Implementation of operation control with the major objective of "quantity oriented picking". • Utilization of the optimum "storage system" for recovered materials to cope with market prices fluctuation.
Input amount (ton/year)	Mixed	1,794,000	1,650,000-1,546,000	1,288,000- 725,000	567,000 - 0
	Recyclable	-	0 - 98,000	210,000-438,000	504,000-844,000
Recycle amount(t/y)		182,000	166,000-224,000	277,000-380,000	409,000-591,000
Recovery rate (%)		10.0	10.0-13.6	18.5-32.7	38.2-70.0
O&M cost (US$ 1,000)		11,232	10,565- 10,537	9,857 - 8,296	7,867 - 6,809
Composting plant		-	Design and construction	Starting operation	Operation and maintenance
Input amount (ton/year)		-	-	253,000 - 424,000	425,000 - 431,000

[1] 5 flows refer to current waste flows (from the transfer stations to the S/Ps, from the transfer stations to the final disposal sites, and from the S/Ps to the final disposal site) and additional flows from the transfer stations to the NIF and the NIT to the final disposal site.

		Data of 1997	Phase 1 (1999 - 2001)	Phase 2 (2002 - 2004)	Phase 3 (2005 - 2010)
Compost production amount (ton/year)		-	-	34,000 - 57,000	57,000 - 58,000
Investment (U$D)		-	3,959,000	1,315,000	1,334,000
O&M cost(US$/year)		-	0 - 33,000	1,185,000 - 1,313,000	1,343,000 - 1,313,000
Final Disposal					
Final Disposal Site		BP "Etapa IV" Santa Catarina	BP "Etapa IV" vertical expansion Design & construction of BP "Etapa V"	Operation of BP "Etapa V"	Operation of BP "Etapa IV" & "Etapa V"
Disposal amount (ton/year)	GDF	3,489,000	3,619,000 - 3,592,000	3,325,000 - 3,101,000	3,089,000 - 2,994,000
	State of. Mexico	262,000	284,000	284,000	284,000
	Total	3,751,000	3,903,000-3,876,000	3,609,000-3,385,000	3,373,000-3,278,000
Investment (US$)		-	12,708,000	-	-
O&M cost (US$/year)	Bordo Poniente	9,925,694	8,570,000 (2001)	9,400,000 (2003)	4,072,000 (2005)
	Santa Catarina	?	-	-	-
Others					
Street sweeping	Length (km/day)	1,273.4	1,285-1,296	1,303-1,316	1,323-1,357
	O&M cost (US$/y)	3,293,000	3,323,000-3,352,000	3,369,000-3,403,000	3,421,000-3,509,000

Note: US$ 1 = 9.1 pesos.

7.2 Description of the Master Plan

7.2.1 Projection until 2010

a. Population

Table 7-3 presents the population data and forecast from 1997 to 2010, which are officially approved by DGSU.

Table 7-3: Population Forecast

Year / Delegation	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Alvaro Obregon	688,923	691,954	694,999	698,057	701,338	704,634	707,946	711,273	714,616	717,975	721,349	724,739	728,145	731,600
Azcapotzalco	439,188	440,286	441,387	442,490	443,729	444,971	446,217	447,466	448,719	449,975	451,235	452,498	453,765	455,100
Benito Juarez	376,576	377,517	378,461	379,407	380,469	381,534	382,602	383,673	384,747	385,824	386,904	387,987	389,073	390,200
Coyoacan	703,086	706,250	709,428	712,620	716,753	720,910	725,091	729,297	733,527	737,781	742,060	746,364	750,693	755,100
Cuajimalpa	147,340	149,874	152,452	155,074	157,788	160,549	163,359	166,218	169,127	172,087	175,099	178,163	181,281	184,500
Cuauhtemoc	538,315	539,930	541,550	543,175	544,967	546,765	548,569	550,379	552,195	554,017	555,845	557,679	559,519	561,400
Gustavo A.Madero	1,214,625	1,215,840	1,217,056	1,218,273	1,219,857	1,221,443	1,223,031	1,224,621	1,226,213	1,227,807	1,229,403	1,231,001	1,232,601	1,234,300
Iztacalco	413,048	414,172	414,296	414,420	416,119	417,825	419,538	421,258	422,985	424,719	426,460	428,208	429,964	431,800
Iztapalapa	1,717,259	1,726,360	1,735,510	1,744,708	1,756,572	1,768,517	1,780,543	1,792,651	1,804,841	1,817,114	1,829,470	1,841,910	1,854,435	1,867,100
M.Contreras	221,463	224,298	227,169	230,077	231,480	232,892	234,313	235,742	237,180	238,627	240,083	241,548	243,021	244,600
Miguel Hidalgo	367,495	368,597	369,703	370,812	372,036	373,264	374,496	375,732	376,972	378,216	379,464	380,716	381,972	383,300
Milpa Alta	75,866	76,921	77,990	79,074	80,205	81,352	82,515	83,695	81,892	86,106	87,337	88,586	89,853	91,200
Tlahuac	264,349	268,050	271,803	275,608	280,321	285,114	289,989	294,948	299,992	305,122	310,340	315,647	321,045	326,600
Tlalpan	600,703	606,590	612,535	618,538	624,785	631,095	637,469	643,907	650,410	656,979	663,614	670,317	677,087	684,000
V.Carranza	471,241	472,456	473,694	474,926	476,303	477,684	479,069	480,458	481,851	483,248	484,649	486,054	487,464	488,900
Xochimilco	326,658	331,231	335,868	340,570	343,942	347,347	350,786	354,259	357,766	361,308	364,885	368,497	372,145	375,900
DF Total	8,567,135	8,610,336	8,653,901	8,697,829	8,746,664	8,795,896	8,845,533	8,895,577	8,946,033	8,996,905	9,048,197	9,099,914	9,152,063	9,205,600

b. Waste Generation Amount and Composition

b.1 Waste Generation Amount

b.1.1 Waste Generation Ratio

The waste generation ratio of OECD member countries ranges from 800 to 1,900g/person/day, and its average is about **1,370g/person/day**[2].

On the other hand, the waste generation amount in DF is calculated as 11,422 ton/day and its population is forecast at 8,567,135. The waste generation ratio derived from these figures is **1,333g/person/day**, which is as high as the average of the OECD member countries.

The waste generation ratio ranges widely depending on the cultural practices, economical situations, and consumption trends in respective societies, among which economical situation will mainly determine the magnitude of the waste generation ratio. People in economically developing countries, in which the living standards are low, generate less waste and reuse and recycle more, therefore, their waste generation ratios are in a low range (Table 7-4).

Table 7-4: Example of Waste Generation Ration in Developing Countries

Country/City	Year	Generation Amount (ton/day)	Population	Generation Ratio (g/person/day)
Paraguay/ Asuncion	1994	793	1,163,598	682
Tanzania/ Dar es Salaam	1996	1,771	2,030,000	872
Honduras/ Tegucigalpa	1997	480.7	848,859	566

source : results of JICA study

[2] Environmental Indicators, OECD 1994

On the other hand, the economy level of DF is already higher than the average of middle income countries and its waste generation ratio is at the same standard as other industrialized countries. It is expected that the municipal SWM by DF in the future will focus on waste minimization programs. Therefore, the future trends of waste generation ratio in DF will be toward a little increase or a little decrease of that of today. Consequently in this M/P, the future waste generation ratio is set up at the present waste generation ratio.

The generation ratio at each source surveyed by the DGSU is shown in Table 7-5.

Table 7-5: Waste Generation Ratio

Type of Source Generation	Classification	Generation Ratio	
Domestic	Household	0.616	kg/Person/Day
Commercial	Commercial Establishment		
	- Auto Service Shop	637.000	kg/Establishment/Day
	- Department Store	368.000	kg/Establishment/Day
	- Commercial Place	6.650	kg/Establishment/Day
	Market		
	- Meat Market	4.430	kg/Stall/Day
	- Vegetable Market	7.920	kg/Stall/Day
	- Grocery store	1.025	kg/Stall/Day
	- Food Preparation	14.960	kg/Stall/Day
	- Various	0.803	kg/Stall/Day
	- Shifting Market (Tianguis)	575.800	kg/Tianguis/Day
Service	Restaurant and Bar	25.442	kg/Establishment/Day
	Amusement and Sports Center		
	- Amusement Center	1.230	kg/Employee/Day
	- Sports Center	2.620	kg/Employee/Day
	- Cultural Center	0.330	kg/Employee/Day
	Public Service		
	- Services Office	3.460	kg/Establishment/Day
	- Repair and Maintenance Service	1.940	kg/Establishment/Day
	- Gas station	53.120	kg/Establishment/Day
	Hotel		
	- Five-star hotel	1,016.900	kg/Establishment/Day
	- Four-star hotel	218.500	kg/Establishment/Day
	- Three-star hotel	16.810	kg/Establishment/Day
	Education Center		
	- Kindergarten	0.040	kg/student/Day
	- Elementary School	0.055	kg/student/Day
	- Job Training Center	0.060	kg/student/Day
	- Junior High School	0.065	kg/student/Day
	- Technical School	0.060	kg/student/Day
	- Senior High School	0.060	kg/student/Day
	- University	0.070	kg/student/Day
	Public Office	0.413	kg/Employee/Day
Special	Medical Institution		
	- 1st. Level	1.279	kg/Consultation Room/Day
	- 2nd. Level	4.730	kg/Bed/Day
	- 3rd. Level	5.390	kg/Bed/Day
	Laboratory	6.340	kg/Laboratory/Day
	Veterinary	1.700	kg/Employee/Day
	Bus Terminal	2,103.000	kg/Terminal/Day
	Airport	28,887.000	kg/Airport/Day
	Road Sweeping	125.530	kg/km/Day
	Social Rehabilitation Center	0.540	kg/Person/Day
Others	Green Area	0.00993	kg/m^2/Day
	Bulky Waste	28.850	kg/Ton-Solid Waste/Day
	Demolition Waste and Small Repair	20.850	kg/Ton-Solid waste/Day

b.1.2 Waste Generation Amount

The future waste amount is forecast by multiplying the waste generation ratios listed in Table 7-5 by factors such as population, employees and number of shops listed in Table 7-6. The factors such as employees and number of shops are estimated to increase in proportion to the population. However, as for the large-scale public facilities such as airports and bus terminals, the factor (the future quantity) is estimated to be the same as present.

Meanwhile, future wastes brought from the 10 municipalities in the Mexico State are assumed to be the same as present (i.e., 284,000 ton/year) based on the DGSU's estimation.

Table 7-6: Factors for Waste Generation

Year	Commercial			Market						Service			
	Auto service shop	Department store	Commercial place	Meat	Vegetable	Grocery	Food preparation	Various	Shifting market (tianguis)	Restaurant & Bar	Amusement center	Sports center	Cultural center
	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Employee	Employee	Employee	Employee
1999	759	350	168,063	6,469	21,979	8,451	9,093	26,413	1,217	29,470	25,950	13,009	481
2000	761	352	168,795	6,493	22,058	8,487	9,131	26,511	1,225	29,581	26,060	13,080	487
2001	764	352	169,572	6,516	22,143	8,524	9,169	26,610	1,230	29,695	26,175	13,155	491
2002	769	354	170,449	6,548	22,231	8,566	9,213	26,730	1,238	29,831	26,307	13,235	494
2003	772	357	171,258	6,571	22,317	8,605	9,253	26,830	1,246	29,955	26,427	13,308	498
2004	773	359	172,066	6,602	22,403	8,645	9,293	26,935	1,251	30,081	26,540	13,380	503
2005	778	359	172,957	6,630	22,500	8,684	9,340	27,056	1,260	30,218	26,673	13,465	507
2006	781	362	173,763	6,654	22,578	8,726	9,377	27,157	1,267	30,341	26,794	13,540	512
2007	783	364	174,613	6,681	22,668	8,767	9,420	27,271	1,272	30,469	26,924	13,620	515
2008	787	367	175,483	6,712	22,759	8,806	9,458	27,379	1,280	30,600	27,047	13,697	522
2009	790	368	176,329	6,738	22,847	8,848	9,503	27,489	1,290	30,729	27,169	13,776	525
2010	797	369	177,229	6,769	22,940	8,890	9,546	27,608	1,294	30,868	27,303	13,858	529

Year	Public Service			Hotel				Education						
	Service office	Repair & maintenance service	Gas station	Five stars	Four stars	Three stars	Public office	Kindergarten	Elementary school	Job training center	Junior high school	Technical school	Senior high school	University
	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.	Employee	Students	Students	Students	Students	Students	Students	Students
1999	31,034	26,045	237	32	46	489	1,354,903	291,292	1,091,532	91,270	518,767	63,580	327,285	277,959
2000	31,153	26,152	237	32	46	490	1,360,399	292,755	1,100,008	91,577	521,287	63,886	328,599	279,301
2001	31,277	26,267	239	32	46	491	1,366,161	294,295	1,105,845	91,917	523,970	64,204	329,954	280,635
2002	31,423	26,399	239	32	47	493	1,372,823	296,004	1,112,316	92,325	526,964	64,555	331,541	282,167
2003	31,555	26,521	240	32	47	494	1,378,904	297,618	1,118,411	92,690	529,777	64,887	332,995	283,663
2004	31,683	26,640	242	32	47	496	1,384,972	299,221	1,124,475	93,050	532,578	65,216	334,432	285,144
2005	31,830	26,774	243	32	47	498	1,391,743	300,966	1,131,075	93,468	535,641	65,579	336,050	286,702
2006	31,964	26,894	246	32	47	501	1,397,781	302,605	1,137,261	93,832	538,494	65,915	337,516	288,203
2007	32,102	27,019	249	33	47	503	1,404,173	304,266	1,143,536	94,218	541,388	66,258	339,004	289,688
2008	32,241	27,149	250	33	47	504	1,410,645	306,007	1,150,131	94,599	544,427	66,611	340,559	291,318
2009	32,376	27,277	250	33	47	506	1,417,009	307,711	1,156,585	94,978	547,408	66,957	342,106	292,894
2010	32,525	27,412	251	33	47	509	1,423,780	309,479	1,163,255	95,392	550,497	67,325	343,700	294,441

Year	Medical Institution			Laboratory	Veterinary	Bus Terminal	Airport	Road Sweep	Social Rehabilitation Center	Green Area
	Level 1	Level 2	Level 3	Nos.	Employee	Nos.	Nos.	km	Center	m^2
	Consultation room	Bed	Bed							
1999	6,853	10,668	17,349	627	947	6	1	1,285	11,676	21,453,000
2000	6,899	10,701	17,421	632	954	6	1	1,290	11,742	21,539,000
2001	6,945	10,746	17,493	635	957	6	1	1,296	11,808	21,629,000
2002	6,986	10,796	17,575	637	961	6	1	1,303	11,878	21,740,000
2003	7,031	10,838	17,655	638	969	6	1	1,310	11,946	21,831,000
2004	7,074	10,879	17,733	643	973	6	1	1,316	12,012	21,925,000
2005	7,119	10,930	17,816	645	976	6	1	1,323	12,083	22,037,000
2006	7,162	10,976	17,892	647	981	6	1	1,330	12,151	22,132,000
2007	7,212	11,021	17,976	650	987	6	1	1,336	12,219	22,233,000
2008	7,257	11,072	18,052	651	993	6	1	1,343	12,292	22,332,000
2009	7,299	11,115	18,132	656	998	6	1	1,350	12,363	22,433,000
2010	7,346	11,164	18,218	657	1,004	6	1	1,357	12,434	22,542,000

Table 7-7: Forecast of Waste Generation Amount in DF

unit : ton/year

Year	Total	Household	Commercial	Market	Restaurant & Bar	Sports & Amusement center	Public service	Hotels	Public office	Education center	Hospital	Laboratory	Veterinary	Bus terminal	Airport	Road sweeping	Solid exhibition center	Green Area	Bulky waste	Demolition waste
1999	4,204,000	1,916,000	630,000	587,000	273,000	26,000	63,000	19,000	204,000	57,000	54,000	1,000	0	6,000	11,000	56,000	3,000	77,000	111,000	80,000
2000	4,222,000	1,953,000	632,000	588,000	275,000	26,000	63,000	19,000	206,000	58,000	55,000	1,000	0	6,000	11,000	56,000	3,000	77,000	112,000	81,000
2001	4,241,000	1,965,000	633,000	590,000	276,000	26,000	63,000	19,000	207,000	58,000	55,000	1,000	0	6,000	11,000	58,000	3,000	77,000	112,000	81,000
2002	4,262,000	1,976,000	638,000	591,000	276,000	26,000	63,000	19,000	210,000	58,000	55,000	1,000	0	6,000	11,000	58,000	3,000	78,000	112,000	81,000
2003	4,283,000	1,989,000	642,000	592,000	278,000	26,000	63,000	19,000	210,000	58,000	56,000	1,000	0	6,000	11,000	58,000	3,000	78,000	112,000	81,000
2004	4,302,000	1,998,000	643,000	593,000	280,000	26,000	63,000	19,000	210,000	59,000	56,000	1,000	0	6,000	11,000	59,000	3,000	79,000	115,000	81,000
2005	4,324,000	2,009,000	650,000	594,000	281,000	26,000	63,000	19,000	211,000	59,000	56,000	1,000	0	6,000	11,000	59,000	3,000	79,000	115,000	82,000
2006	4,341,000	2,021,000	652,000	596,000	282,000	26,000	63,000	19,000	211,000	60,000	57,000	1,000	0	6,000	11,000	60,000	3,000	79,000	115,000	82,000
2007	4,365,000	2,033,000	656,000	597,000	283,000	26,000	63,000	19,000	212,000	60,000	57,000	1,000	0	6,000	11,000	61,000	3,000	80,000	115,000	82,000
2008	4,385,000	2,045,000	658,000	597,000	285,000	26,000	65,000	19,000	212,000	60,000	57,000	1,000	0	6,000	11,000	62,000	3,000	81,000	115,000	82,000
2009	4,408,000	2,060,000	661,000	600,000	285,000	26,000	65,000	19,000	212,000	60,000	57,000	1,000	0	6,000	11,000	62,000	3,000	81,000	116,000	83,000
2010	4,430,000	2,072,000	667,000	600,000	286,000	26,000	65,000	19,000	212,000	61,000	57,000	1,000	0	6,000	11,000	62,000	3,000	81,000	117,000	84,000

b.2 Waste Composition

The waste composition, as well as waste generation ratio, varies widely with the cultural practices, economical situations, and consumption trends in respective societies. Table 7-8 shows examples of waste composition in OECD countries and Table 7-9 shows waste composition at source in the DF.

Table 7-8: Example of Waste Composition in OECD Countries

Composition / Country	Paper and paperboard (%)	Plastics (%)	Glass (%)	Metal (%)	Food & garden waste, etc. (%)	Other (%)
Japan	38	11	7	6	32	7
USA	38	8	7	8	25	15
France	31	10	12	6	25	17
Denmark	22	4	5	3	55	9
Portugal	25	9	4	3	NA	59
Spain	20	7	8	4	49	10

source : OECD Environmental Data 1993, OECD

Table 7-9: Waste Composition of DF

Composition / Area	Paper and paperboard (%)	Plastics (%)	Glass (%)	Metal (%)	Food & garden waste, etc. (%)	Other (%)
GDF	24	12	7	4	43	10

source : DGSU

Comparing the above two tables, the waste composition at source in the DF are similar to those in European countries. The waste composition in the DF, as well as the waste generation ratio, turns out to be in the level of industrialized economies. Therefore, it can be estimated that the future waste composition remains same as that of today even taking the future economic growth into the consideration. Consequently in this M/P, the future waste composition is set at the present one.

Table 7-10: Waste Composition

unit : %

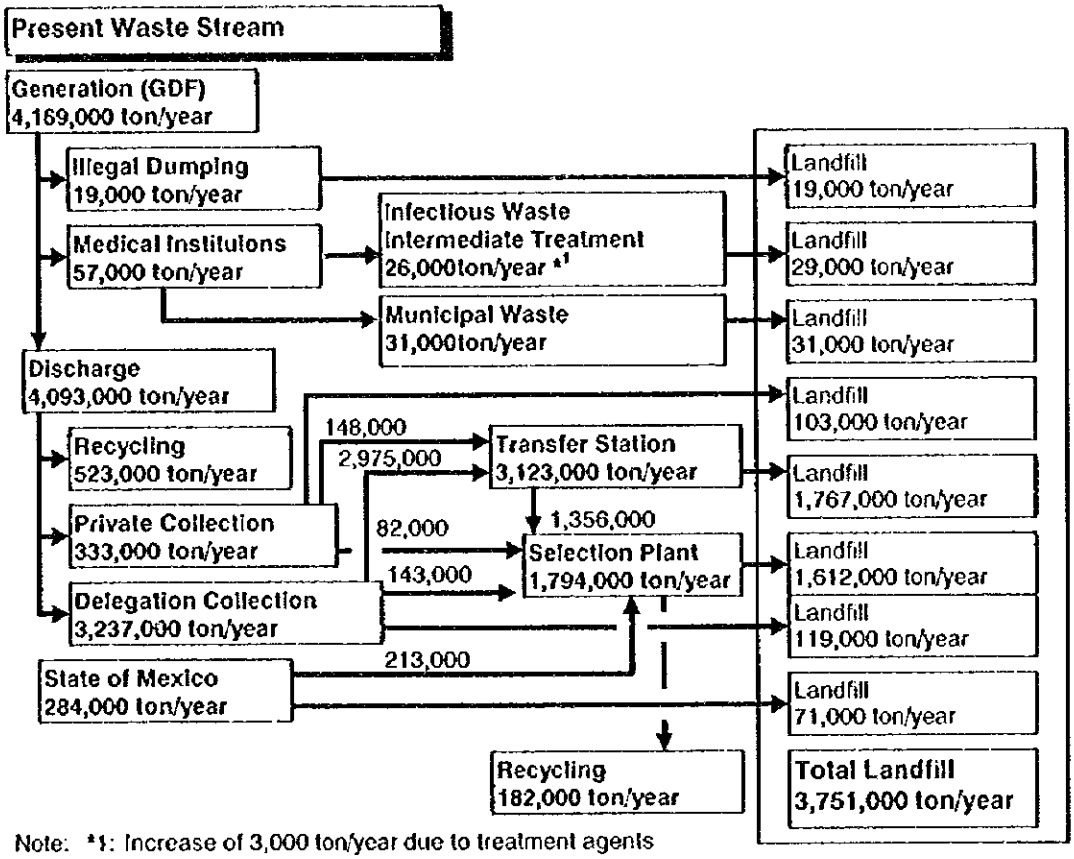
Generation sources / Composition	Domestic	Commercial		Service						Special							Others			Total
	Household	Commercial	Market	Restaurant	Sports and amusement center	Public service	Hotel	Public service office	Education center	Hospital	Laboratory	Veterinary	Bus terminal	Airport	Road	Social rehabilitation center	Green area	Bulky waste	Demolition waste	
Spatula										1.970										0.030
Cotton	2.350	0.070	0.830			0.380	0.030	2.990	0.170	1.970	10.380	5.570								1.300
Cardboard	5.360	11.510	5.290	5.970	11.040	23.180	3.770	11.200	8.980	8.300	8.010	2.560	4.340	5.310	3.660	5.060	4.000			6.680
Leather	0.110			0.020		3.690			0.040											0.110
Paper container	1.960	1.970	2.220	1.430	5.180	1.980	0.760		6.050	1.070		0.690	0.550		6.530	0.520	3.120			1.910
Vegetable fiber	0.060	1.790	2.630			1.130	0.080	0.010	0.780	0.200										0.690
Synthetic fiber	1.430	0.290	0.890	0.040			0.010	0.240		0.270	3.100				0.100					0.850
Gauze										3.770	5.740	5.940								0.050
Bone	0.080	0.440	1.110			0.210			0.670	0.070		0.380								0.270
Vinyl	0.200	1.070	0.160			0.360	0.180	0.830	1.330	2.070										0.370
Disposable syringe										2.800	1.310	1.380								0.090
Guns	1.580	0.310	1.470	0.250	1.230	3.100	0.520	0.280	4.890	1.730		2.310	4.530	3.170	4.770					1.240
Ceramics	0.370	0.120	0.090	0.450	0.290		0.180	0.080	2.010										2.090	0.300
Wood	0.100	1.200	1.170	0.670		6.720		0.010	3.920	0.430		4.820	0.290				5.120	20.000	1.530	1.240
Construction waste	0.630			0.520	0.090		2.890						1.240						95.270	2.140
Metal	1.390	2.590	0.070	0.920	5.650	0.710	1.790	0.150	0.400	1.900		0.690			0.410		2.860	50.000		2.560
Nonferrous metal	0.060	0.510				1.300		6.540		0.070	1.180	1.310					2.290			0.490
Paper	1.190	5.310	1.870	1.540	3.570	18.750	9.210	37.610	14.330	6.570	17.230	9.880	9.100	6.410	5.410	3.110	6.820		0.970	4.410
News paper	4.610	5.950	4.540	0.950	3.170	15.500	5.240	11.910	6.990	4.370	11.970	20.640	6.070	15.340	9.710	7.730	2.220			4.960
Toilet paper	8.780	1.940	4.270	3.400	9.590	4.200	8.160	1.990	10.720	11.000	9.620	7.380	15.200	8.920	9.520	4.650				5.890
Disposable diaper	3.370	0.140		0.080	0.090	0.320	0.890		0.300	1.430			1.940							1.620
X-ray film										0.300										0.000
Plastic film	6.240	5.380	1.500	3.080	7.130	2.140	3.580	0.160	1.950	3.270		0.440	5.340	3.910	5.380	2.000	9.290		0.140	4.530
Hard plastic	4.330	3.940	2.960	1.260	15.340	1.390	1.690	0.880	2.690	0.970	8.640	1.630	3.080	5.460	6.620	1.260	4.000			3.490
Polyurethane	0.160	0.110	0.080	0.030		2.700			0.670	0.760	2.170	2.560								0.160
Foamed polyurethane	0.780	0.120	0.460	0.350	0.720	1.850	0.160	0.110	0.460	1.700	2.270	1.060	1.100	1.180	1.220		1.230			0.580
Food waste	34.660	38.720	63.080	74.430	16.170	5.710	43.230	21.220	16.020	26.960	1.740	3.310	30.440	16.320	7.670	42.490				37.700
Garden waste	5.120	0.150	0.050	0.080	0.420	0.590	3.660	0.300	6.320	1.300	1.890	0.560		1.530	11.460	7.460	25.360			3.180
Sanitary napkin		0.170						0.040	0.630		1.610		0.010			2.000				0.040
Rags	0.640	0.200	0.300	0.120	1.140		1.720	0.310	1.020	0.500	1.840			4.880		3.000		30.000		1.220
Bandage										0.360					0.020					0.010
Color glass	4.000	1.770	0.300	1.530	4.670	2.810	3.090	0.260	2.440	6.700	4.860	2.000	3.450	8.070	8.640	0.420				2.620
Transparent glass	6.770	5.180	0.440	2.820	11.760	1.280	8.520	0.760	4.660	5.630	3.050	0.940	7.790	7.140	8.370	0.950	0.850			4.610
Fine fraction	1.210	0.070	3.970	0.030	2.750		0.260	0.010	0.730	0.430	0.030			3.610	4.020		26.300			1.710
Others	2.660	8.960	0.250	0.030			0.380	2.110	0.830	1.130	3.350	23.950	5.520	8.750	6.500	19.380	6.540			3.080
Total	100.000	99.990	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	99.990	100.000	99.990	100.000	100.010	100.030	100.000	100.000	100.000	100.000

7.2.2 Technical System

a. Optimum Waste Stream

Figure 7-2 illustrates the present waste stream and Table 7-11 presents the current annual operation and maintenance cost of transportation from transfer stations to final disposal facilities management of which is under the responsibility of the DGSU.

unit: ton/year



Note: *1: Increase of 3,000 ton/year due to treatment agents

Figure 7-2: Present Waste Stream

Table 7-11: Present Annual Operation and Maintenance Cost

	Transfer	Selection Plant	Final Disposal	Total
Waste amount (ton/year)	3,123,000	1,794,000	3,751,000	-
*O&M cost (pesos)	411,690,240	107,718,026	105,647,918	625,056,184
Unit cost (pesos/ton)	131.8	60.0	28.2	-
**Unit cost (U$/ton)	14.5	6.6	3.1	-

*O&M cost: Cost of Urban Services, 1997 DGSU, **Unit cost: 9.1 pesos per dollar

Although O&M of the selection plants (S/Ps) costs about 108 million pesos/year, the amount of materials recovered by the selection plants remains only 182,000 ton/year. If the selection plants are closed, although the final disposal amount will be increased

by 182,000 ton/year, the GDF can save the operation and maintenance cost of the S/Ps as much as about 102 million pesos (as shown in Table 7-12).

On the other hand, this will encounter other problems such as below:

- Social problems of unemployed S/Ps workers.
- No material conservation.

Therefore, neither the status quo nor the closure of the S/Ps is acceptable in the M/P. Consequently, the M/P should seek to make the best of the S/Ps.

Table 7-12: Annual Operation and Maintenance Cost in Case of S/Ps Closure

	Transfer	Selection Plant	Final Disposal	Total
Waste amount (ton/year)	3,123,000	0	3,933,000	-
*O&M cost (pesos)	411,690,240	0	110,910,600	522,600,840

*O&M cost: Cost of Urban Services, 1997 DGSU

The problem of the very low material recovery rate of the S/Ps is due to the excessive feeding of mixed municipal wastes. Hence, if wastes are previously sorted and input amount to the selection plants is decreased, working condition on sorting lines will be improved and material recovery efficiency will be raised.

Therefore, waste separation at source is proposed in the M/P through which recyclable waste is separately collected and fed to the S/Ps. The feeding level can be adjusted to its optimum as the rest of wastes is not fed to the plants. As a result, the material recovery ratio will be improved to such an extent that final disposal waste amount is much reduced in spite of the lowered feeding level. However, in order to keep the material recovery ratio constantly high, in addition to the physical improvement of input composition and feeding level of the S/Ps, it is necessary to establish the mechanism of controlling the flow of recovered materials to the market and maintaining the stable selling prices of recyclable materials. Obviously, collection systems should be instrumented to guarantee that separate materials are delivered to S/Ps.

Therefore, it is necessary (i.) to build recovered materials storage facilities so that the materials can be stored and sold in view of the market trends, (ii.) to establish a management system to determine appropriate timing of selling the recyclable materials, (iii.) to foster industries that re-use the recovered materials and/or process them into certain new products, and (iv.) to promote usage/consumption of recycled products.

The proposal of waste separation at source is also justified by the large amount of organic waste generated at the Central de Abasto (about 231,000 ton in 1997), which is to be collected in the sub-system. Composting treatment is strongly recommended for such homogeneous organic wastes because of two main benefits. First, composting treatment can contribute to the waste volume reduction, and second, it converts waste to usable resources, if the compost product attains such quality that can be used as the soil conditioner.

Until 1993 a composting facility was operated by a delegation. Since the facility was receiving the mixed wastes for composting, however, compost product delivered

had an inferior quality to be used as soil conditioner, its demand was limited and the facility was finally shut down. Separate collection should be able to avoid this former failure and make the compost production viable.

As can be seen from the above, in planning the future municipal SWM by the GDF, it is judged that the source separation and the separated collection are indispensable. The M/P raises the target of separate collection: for the sub-system to be achieved 100% in the year 2004; and for the other part to be 50% in the year 2010.

The number of separation items for the sub-system and the other part, as presented in Table 7-13, should be reasonably acceptable, in view of the considerations expressed above. Table 7-14 defines item categories to be separated in both systems.

Table 7-13: Source Separation Item

System	Separation type	Waste category
Sub-system	3 categories separation	organic, recyclable, and others
Delegation	2 categories separation	recyclable, and others

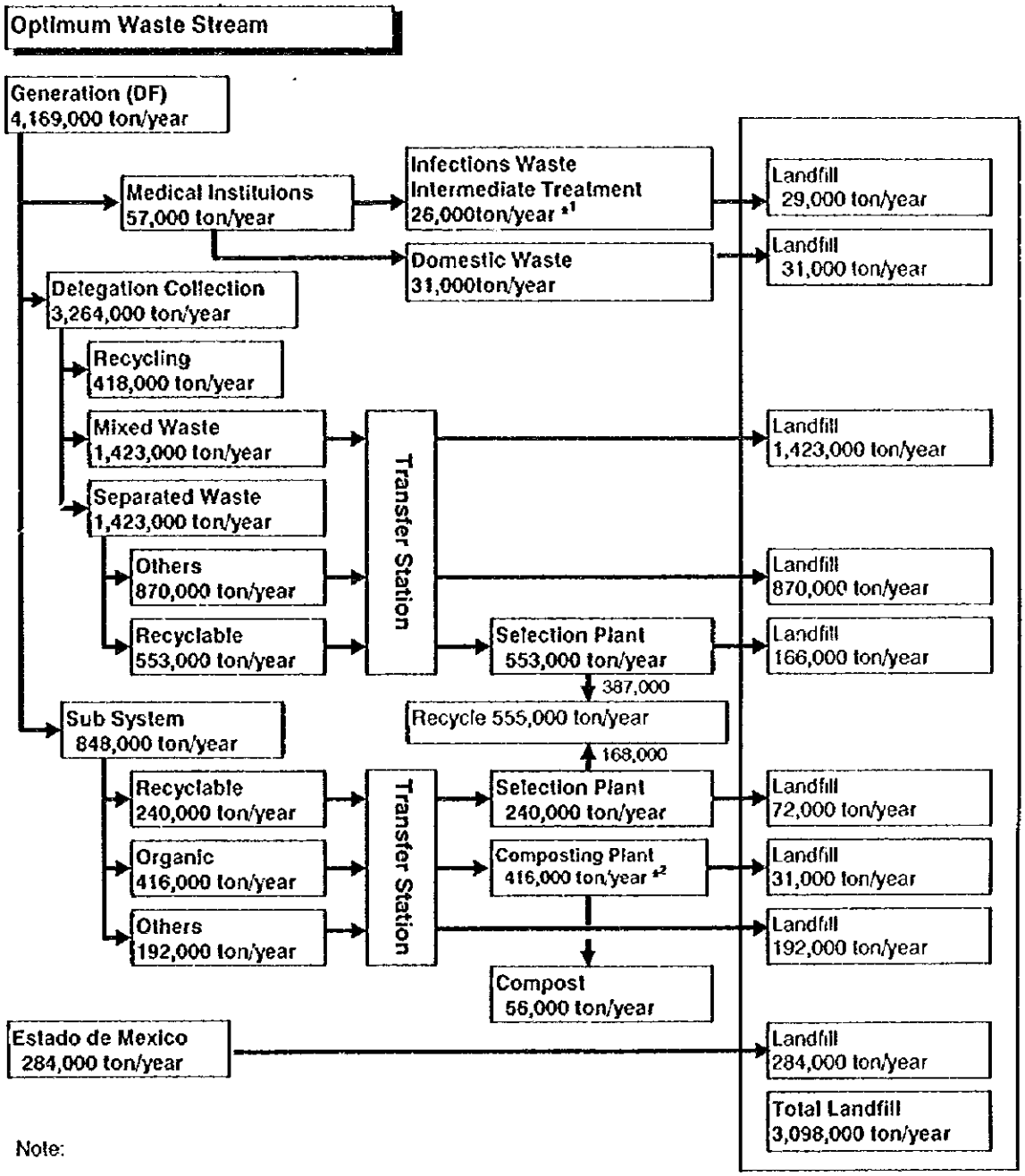
Table 7-14: Definition of Item Categories to be Separated

For Sub-system	For Delegation	Category	Composition
Organic	Others	Organic	Vegetable fiber
			Bone
			Food waste
			Garden waste
Recyclable	Recyclable	Recyclable	Cardboard
			Synthetic fiber
			Vinyl
			Cans
			Metal
			Nonferrous metal
			Paper
			News paper
			Plastic film
			Hard plastic
			Color glass
			Transparent glass
Others	Others	Others	Spatula
			Cotton
			Leather
			Paper container
			Gauze
			Disposable syringe
			Ceramics
			Wood
			Construction waste
			Toilet paper
			Disposable diaper
			X-ray film
			Polyurethane
			Foamed polyurethane
			Sanitary napkin
			Rags
			Bandage
			Fine fraction
			Others

In view of the above examination, the optimum waste stream estimated for the GDF, on the bases of the waste amount in 1997, is illustrated in Figure 7-3.

By converting the present waste stream into this optimum waste stream, the material recovery ratio at S/Ps will be improved from 10% (present) to 70% (optimum stream), and about 653,000 ton/year of final disposal amount will be reduced.

unit: ton/year



Note:

*1: increase of 3,000 ton/year due to treatment agents
*2: reduction of 329,000 ton/year due to the evaporation and gas generation through decomposition

Figure 7-3: Optimum Waste Stream

b. Collection and Haulage System

b.1 Collection Methods

Collection methods for separately discharged wastes comprise such as:

- **Normal vehicle collection**
- **Point collection**
- **Special vehicle collection**

In view of an advantage of utilizing the existing collection system (i.e., maximum use of current resources and cost saving), **normal vehicle collection** appears to be most recommended as the separate collection method in the M/P. Meanwhile, as for the separate collection for markets, in which limited number of major generators are put together, **point collection** could be recommended, if the collection point can be managed as part of market facilities.

b.2 Haulage System

b.2.1 Transfer Station

Currently visual waste inspections are carried out at the transfer stations, in order to determine the optimum waste destination (S/P or final disposal site) for respective incoming wastes. Therefore, even in a case where separate collection is implemented in the future, it is judged that present system of transfer stations can cope with the change.

b.2.2 Transportation

Separate transport by which wastes are transported from station to S/P, from station to final disposal, and from S/P to final disposal is already in practice. Therefore, it is judged that present system can be adapted to the future transportation system in which mixed waste and separate waste are to be transported independently.

c. Intermediate Treatment System

Purposes of intermediate treatment are, in general, such as:

- reduction of final disposal amount
- material recovery from wastes
- lowered hazardousness of wastes to the permissible level.

Within the actual scope of municipal SWM by the GDF, the "lowering the waste hazardousness to the permissible level" can be exercised for the medical waste treatment. Whereas, intermediate treatment for the municipal waste other than the medical waste in the DF should be along with the purposes of "final disposal amount reduction" and "material recovery".

Intermediate treatment currently carried out in the DF consists of:

- sterilization, chemical treatment or incineration of medical wastes, which are separately collected, and

- material recovery at the S/Ps from municipal wastes other than the medical wastes, whose operation is managed by the DGSU.

c.1 Selection Plant

The problem of the S/Ps is the low ratio of material recovery, in spite of high O&M costs spent. It is mainly attributable to the facts that:

- mixed waste are fed to the plants, and
- waste input amount is more than the double of the appropriate plant capacity.

Therefore, the following measures are recommended in order to solve the problems.

- Separate collection as illustrated in Figure 7-3 should be introduced and only recyclable materials should be fed to the facilities
- The time allowed for picking should be increased by lowering velocity of the sorting lines from present 20m/min to 10m/min
- Sufficient number of picking workers for the separation should be analyzed.

Table 7-15 shows a comparison of the current performance and reasonable recommended capacity with line velocity of 10m/min.

Table 7-15 : Current Performance and Reasonable Capacity of Selection Plant

	Current Performance		Reasonable Capacity	
	Velocity of sorting line (m/min)	Treatment capacity (ton/day)	Velocity of sorting line (m/min)	Treatment capacity (ton/day)
Bordo Poniente S/P	20	2,000	10	1,000
San Juan de Aragon S/P	20	2,000	10	1,000
Santa Catarina S/P	20	1,500(2,500)	10	750(1,250)
Total	-	5,500(6,500)	-	2,750(3,250)

( ): when the capacity at SC is expanded as scheduled.

It is estimated that the recyclable wastes separately collected amount to about 844,000 ton/year in the year of 2010. On the other hand, in the case where the capacity recommended above is adopted, the annual capacity is calculated at 858,000[3] ton/year, which approximately corresponds to the recyclable wastes amounts to be collected in the year 2010. Therefore, in this M/P, existing all three S/Ps are maintained to be operated, and the total waste input amount to the three S/Ps should be gradually decreased to the reasonable level for those three in the year 2010. In other words, mixed wastes input to the three S/Ps is gradually reduced and will be zero and only recyclable waste is fed in the year 2010 (see Table 7-16).

[3] Working days of the S/Ps are set as 312 days/year (52 week/year, 6 days/week).

Table 7-16 : Selection Plant Waste Input Amount

Unit : ton/year

		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Mixed waste		1,516,000	1,650,000	1,598,000	1,546,000	1,288,000	1,043,000	725,000	567,000	423,000	294,000	181,000	83,000	0
Recyclable		0	0	49,000	98,000	210,000	324,000	438,000	504,000	570,000	638,000	706,000	774,000	844,000
Total input	With plan	1,516,000	1,650,000	1,647,000	1,644,000	1,498,000	1,367,000	1,163,000	1,071,000	993,000	932,000	887,000	857,000	844,000
	With out plan	1,587,000	1,593,000	1,601,000	1,608,000	1,616,000	1,623,000	1,630,000	1,639,000	1,647,000	1,655,000	1,662,000	1,671,000	1,679,000
Current performance level		1,653,500	2,190,500	2,190,500	2,190,500	2,190,500	2,190,500	2,190,500	2,190,500	2,190,500	2,190,500	2,190,500	2,190,500	2,190,500
Reasonable Capacity		926,750	1,095,250	1,095,250	1,095,250	1,095,250	1,095,250	1,095,250	1,095,250	1,095,250	1,095,250	1,095,250	1,095,250	1,095,250

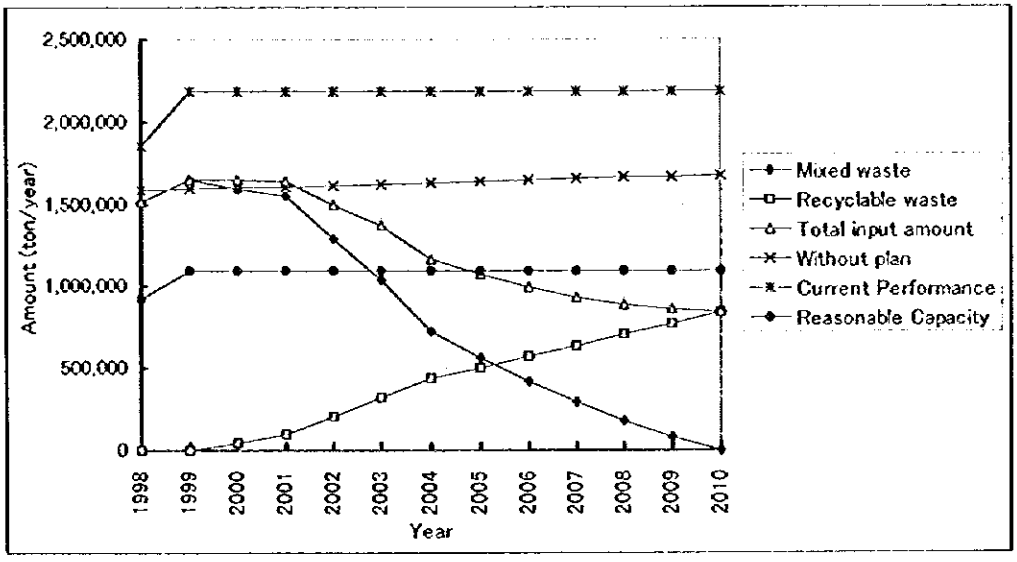


Figure 7-4: Relation Between Selection Plant Capacity and Input Amount

c.2 New Intermediate Treatment

Intermediate treatment with the purpose of reducing final disposal amount comprises:

- resources recovery from the wastes (e.g., selection plant), and
- application of certain processing measures to chemically change the feature of waste.

The GDF already owns S/Ps as the facility categorized in the former, which efficiency will be improved and consequently to reduce the final disposal amount by following the measures recommended above.

The measures categorized in the latter consists of:

- volume reduction by decomposition of organic contents (i.e., composting), and
- volume reduction of combustible matters (i.e., incineration).

c.2.1 Incinerator

Incineration treatment can reduce the amount to 15% in weight, however its construction costs and O&M costs are enormous.

An incinerator capacity, corresponding to the amount of the wastes categorized as "Others" in Figure 7-3, and its incineration residue amount to be disposed of are shown in Table 7-17. The required capacity of the incinerator in 2010 works out at about 3,400 ton/day.

Table 7-17: Prospective of Incineration Amount

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Others (ton/year)	853,000	722,000	592,000	560,000	528,000	496,000	599,000	703,000	806,000	912,000	1,020,000	1,128,000
*Required capacity (ton/day)	2,559	2,166	1,776	1,680	1,584	1,488	1,797	2,109	2,418	2,736	3,060	3,384
Disposal amount (ton/year)	127,950	108,300	88,800	84,000	79,200	74,400	89,900	105,500	120,900	136,800	153,000	169,200

notes :* assuming annual operation hours of 8,000 hours/year

The investment and O&M costs required for the incinerator of such level are summarized in Table 7-18. (These figures are for an ordinary incineration facility to be constructed on a normal solid ground. In case of the incinerator construction on a soft ground such as Bordo Poniente, an additional investment costs of about 20% will be necessary.)

Table 7-18: Investment and O&M Cost of Incineration Facility

Investment (U$)	374,000,000
Annual O&M cost (U$/year)	11,220,000
Required land area (ha)	51

The investment amount required largely exceeds the available funds shown in Section E.4 in Annex E. Thus, introduction of an incinerator with such a capacity is impossible in view of the present financial capacity of the GDF. Therefore, an introduction of an incinerator should be examined in a long term strategy taking the growth of financial capacity of the DF into consideration.

c.2.2 Composting

Residues derived from a composting process are mainly attributable to the impurities (inorganic contents and hardly decomposable matters) of the input wastes. Therefore, the residue amount largely depends on the input waste composition (organic content/impurities content).

Even when a market demand for compost products is small or nil, it can be used as cover soil for sanitary landfilling operation, and can contribute for:

- cost reduction in cover soil procurement; and
- reduction in the total final disposal amount.

Organic matter wastes to be separately collected in the sub-system in the year 2010 is estimated at about 431,000 ton/year. Of which, about 13% will be decomposed in the composting process, compost production from them will amount to about 58,000 ton/year.

Presently, a composting facility is operated by the DGSU for processing the pruned tree branches and grasses brought from GDF's public park maintenance. Although the compost product is all utilized as soil conditioners for public park maintenance, its production is as small as 10 to 20 ton/month. Therefore, it is not known whether or not a large market demand for compost product can be expected in DF or nearby areas.

On the other hand, population are day by day settled near to the ex-landfill areas of Bordo Poniente I, II, and III (about 260 ha), where landscaping with aforested green area are awaited. However, the areas are in the ex-lake Texcoco area with high salinity in the soil, thus soil improvement will have to be needed in order to restore the green areas. Therefore, if soil conditioner of 30 cm thick is to be provided annually in these areas, compost demand of about 780,000 m^3can be expected.

Furthermore, if composts are needed to be also applied in the other areas of ex-lake Texcoco, its demand will become considerably large.

e.2.3 Composting Method

Composting methods in principle consist of:

- mechanical composting (represented by DANO digester); and
- open area composting (namely windrow method).

Investment for a mechanical composting facility (per tonnage of input waste amount) costs as high as that of an incineration facility or just a little cheaper than that. Therefore, first of all, in view of size of funds available for the GDF, the option of mechanical composting is very difficult to be adopted in the M/P.

An investment cost required for the windrow composting facility (for the input capacity of 431,000 ton/year organic wastes) will be about 6,950,000 US$, which is within the scale of funds available for the GDF. Therefore, the windrow method should be the optimum selection for the composting in this M/P.

d. Final Disposal System

Municipal solid waste final disposal sites presently in service in DF are Santa Catarina and Bordo Poniente "Etapa IV". Santa Catarina site is expected to be closed in 1999. Bordo Poniente "Etapa IV" is estimated to serve until January or February 2001. Therefore, sites for new final disposal need to be assured soon.

Although the landfill elevation of Bordo Poniente "Etapa IV" is presently regulated up to 8 meters height under an agreement with the CNA, if this agreement is revised to allow further landfilling up to 24 meters elevation, by paying specific technical attention to the geological conditions, additional landfill capacity of about 25,849,000m^3 could be assured.

Further, if a municipal solid waste final disposal site similar to the Bordo Poniente Etapa IV is constructed in a 256 ha area (as Bordo Poniente Etapa V) up to 24-meter elevation, which can provide about 29,032,000m^3 landfill capacity. The new final disposal site (i.e., Etapa V) together with the vertical expansion of the existing landfill (Etapa IV) will provide the space for future landfilling up to about the year 2013 in the Bordo Poniente area (Table 7-19).

Meanwhile, as Etapa IV and V stand on a highly compressible clayey layer of about 60 meters depth in Bordo Poniente, it is necessary to provide sufficient measures to ensure stable landfilling operations in both sites. In practice, it will be required to landfill Etapa V up to only +8.0-meter elevation and to suspend the further landfilling for a certain period of time to let the land be safely compressed. In the meantime, Etapa IV should be landfilled. In order to carry out sound landfilling on the vertical expansion and to allow stable compression of subsoil, the alternate use of Etapa IV and Etapa V is recommended (Figure 7-5).

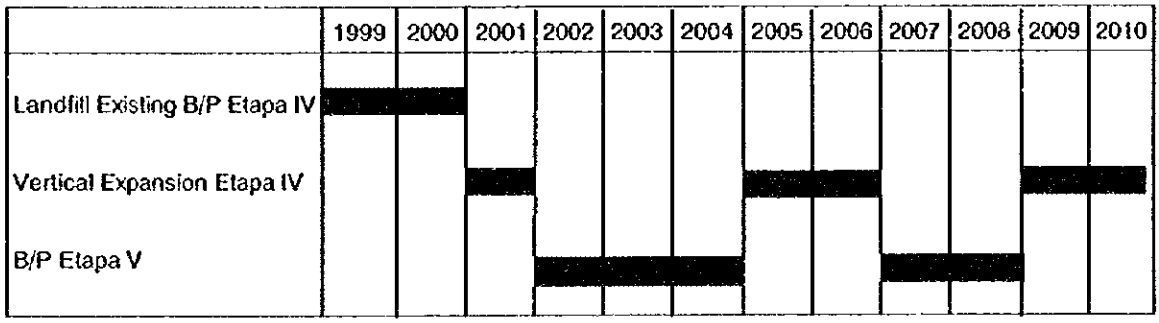


Figure 7-5: Landfill Time Schedule

Table 7-19: Prospect of Landfill Capacity

Site	Filling Level	Estimated Volume	Landfilling Period
Etapa IV	+8.00 to +16.00	16,447,000 m^3	2001, 2005 to 2006, first half of 2009
	+16.00 to +24.00	9,402,000 m^3	Middle of 2009 to 2011
Etapa V	0 to +8.00	14,720,000 m^3	2002 to 2004, first half of 2007
	+8.00 to +16.00	9,220,000 m^3	middle of 2007 to 2008, first half of 2012
	+16.00 to +24.00	5,092,000 m^3	Middle of 2012 to 2013

It will be anticipated that a future landfill site for disposing the waste after the year 2013 is very difficult to locate in the DF jurisdiction area or in the CNA land. Therefore, it will be inevitable to examine the possibility to locate the final disposal site on the land in the State of Mexico, and to examine the possibility of regional use of a landfill by the GDF, the host municipality and others. As it is anticipated that coordination among those parties for the future landfill establishment may require substantially long time of discussion before its implementation, the coordination for the future landfill (to be used after year 2013) should be started at latest in the year 2007 or around by the GDF and other entities.

As previously mentioned, the Bordo Poniente area stands on the 60-meter thick highly compressible clayey layer of the ex-lake Texcoco area. Soil characters are presented in Table 7-20. In view of that, the landfill height of Etapa IV is restricted at 8 meter under an agreement with the CNA.

Table 7-20: Soil Condition of Bordo Poniente "Etapa IV"

	Elevation (m)	Soil	Layer thickness (m)	Unit Weight (ton/m^3)	Cohesion (ton/m^2)	Internal Friction Angle (degree)	m_v (10^{-3} cm^2/kg)	Cv (10^{-3} cm^2/s)
1	+8.0 to 0.0	Waste	8.0	1.00	1.0	35	-	-
2	0.0 to -4.0	Clay	4.0	1.23	0.8	1.8	216.7	4.85
3	-4.0 to -8.5	Clay	4.5	1.16	0.6	2.8	200.9	2.35
4	-8.5 to -9.0	Sandy silt	0.5	1.40	0	5.0	-	-
5	-9.0 to -17.0	Clay	8.0	1.21	1.2	2.0	276.7	5.55
6	-17.0 to -26.0	Clay	9.0	1.22	1.8	1.5	200.0	9.00
7	-26.0 to -26.5	Sandy silt	0.5	1.40	0	5.0	-	-
8	-26.5 to -34.5	Clay	8.0	1.23	2.0	2.6	150.0	38.50
9	-34.5 to -36.0	Sandy silt	1.5	1.90	12.0	10.0	-	-
10	-36.0 to -45.0	Clay	9.0	1.24	2.6	4.0	50.6	3.25

source : DGSU

When and where solid wastes are landfilled on a highly compressible ground layer, attentions should be paid to the stability of landfill slope and the settlement due to ground consolidation in effect of the waste load.

Soil characteristics parameters presented in Table 7-20 are employed in the Bishop Method for calculating the slope stability. The results are presented in Table 7-21.

The calculation revealed that the minimum safety factor of the slope from 0 to 8 meters height of the landfill is 0.809, which is the least among others. Theoretically speaking, the slope failure could take place as it is less than 1.0, although it has not occurred so far.

On the other hand, minimum safety factors of slopes over 8 meter to 24 meter elevation range more than 1.0, therefore where conditions of slow landfilling are observed, the risk of slope failure in those elevations will be minimal.

Table 7-21: Result of Slope Stability Calculation (Bishop Method)

Slope	Landfill Height	Minimum Safety Factor	Coordinates of the Rotational Slip (m)		Radius of the Rotational Slip(m)	Resist Moment (ton-m)	Slip Moment (ton-m)
			X	Y			
1	0.0 to 8.0	0.809	15.00	15.00	23.91	1,162.60	1,436.68
2	8.0 to 16.0	1.173	146.00	16.00	32.37	4,395.99	3,747.21
2-1	8.0 to 12.0	2.038	138.00	13.00	22.40	1,898.34	931.69
2-2	12.0 to 16.0	2.093	173.00	62.00	79.00	21,982.59	10,500.69
3	16.0 to 24.0	1.537	280.00	24.00	41.88	10,129.10	6,588.93

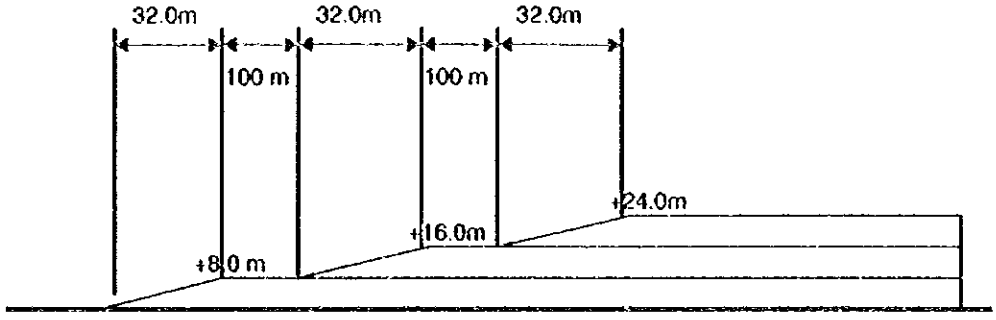


Figure 7-6: Landfill Section

Ground settlement caused by landfill load, calculated based on the soil characteristics parameters shown in Table 7-20, is estimated to be about 6 meters subsidence at maximum for each 8-meter landfill. Time required for its 95% settlement is calculated as 1, 280 days.

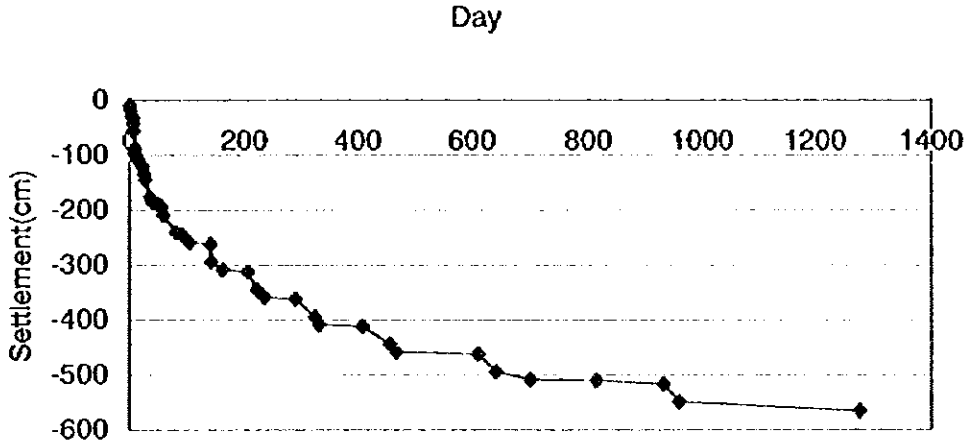


Figure 7-7: Time-Settlement Curve of "Etapa IV"

e. Future Waste Stream

Table 7-22 shows forecast of future disposal amount and recycling amount, till the year 2010, respectively for the cases of without the M/P and with the M/P.

Table 7-22: Forecast of Future Waste Disposal and Recycling Amount

unit : 1,000 ton/year

		1998	2001	2004	2007	2010
Generation *		4,469	4,525	4,586	4,649	4,714
Without plan	Landfill	3,765	3,811	3,861	3,912	3,970
	Recycle	182	184	186	189	191
With plan	Landfill	---	3,876	3,385	3,340	3,278
	Recycle	---	224	380	476	591

Note *: Generation amount of DF and what brought from the municipalities in the State of Mexico.

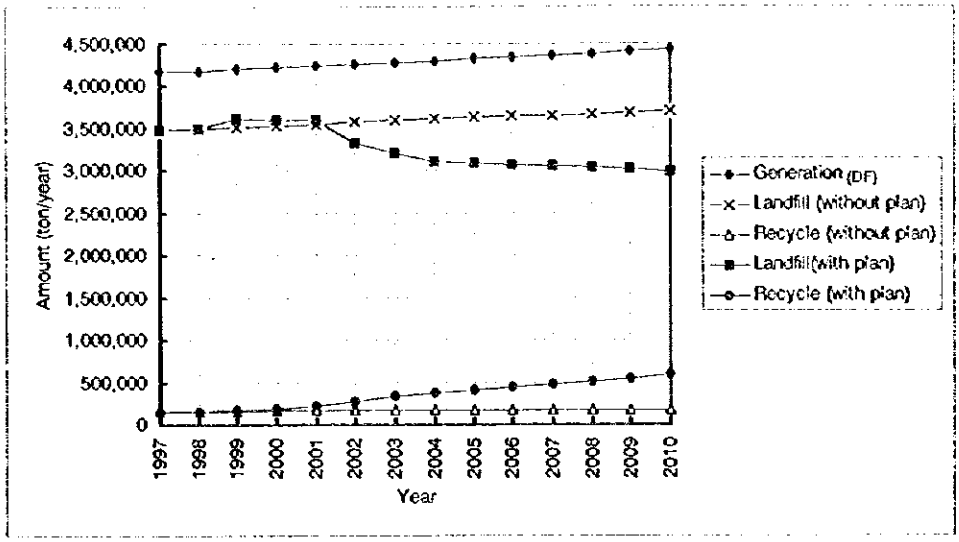
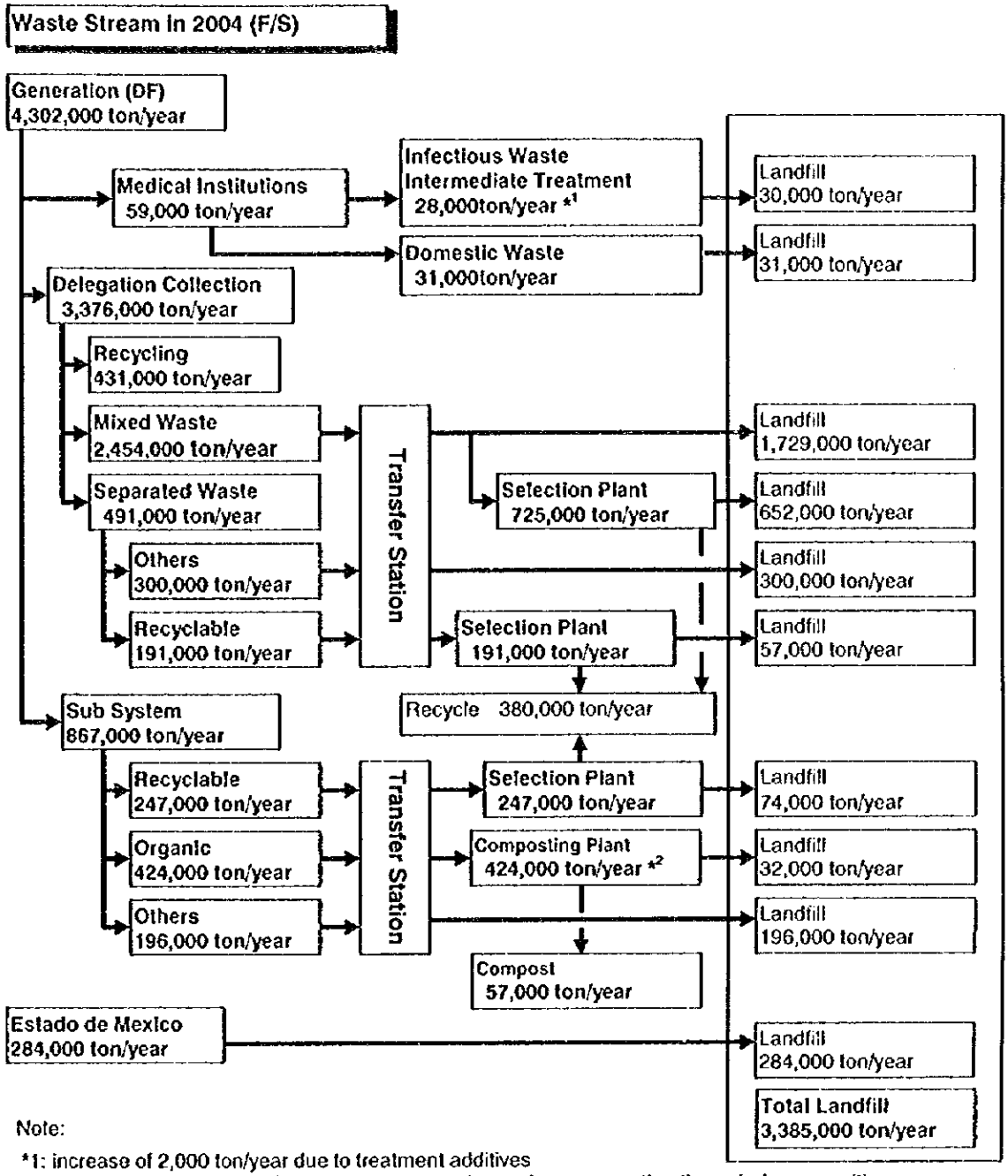


Figure 7-8: Forecast of Future Waste Disposal and Recycling Amount

The recycling amount in the year 2010 with the M/P will be 3.5 times of that in the same year without the M/P. Furthermore, the M/P will reduce the final disposal amount of about 714,000 ton/year in that year in comparison with the case of without the M/P.

Waste streams in the F/S target year (2004) and in the M/P target year (2010) are illustrated below.

unit: ton/year

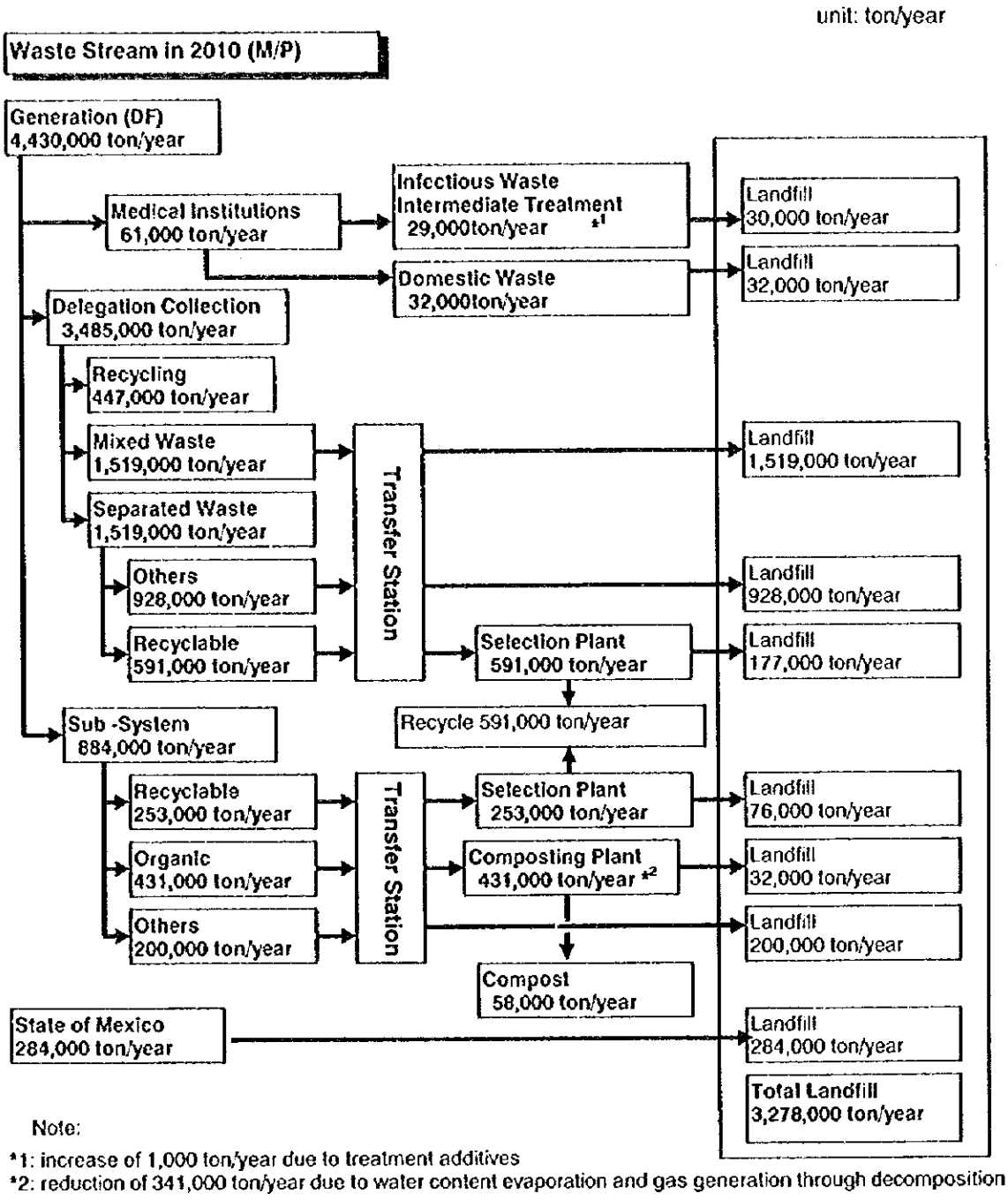


Note:

*1: increase of 2,000 ton/year due to treatment additives

*2: reduction of 335,000 ton/year due to evaporation and gas generation through decomposition

Figure 7-9: Waste Stream in 2004 (F/S)



Note:
*1: increase of 1,000 ton/year due to treatment additives
*2: reduction of 341,000 ton/year due to water content evaporation and gas generation through decomposition

Figure 7-10: Waste Stream in 2010 (M/P)

7.2.3 Institutional System of the M/P

a. Institutionalization from the Downstream Components

The institutionalization of the SWM components should be in a step-by-step manner in the M/P framework. It is recommended that institutionalization should be proceeded from those "downstream (in the waste flow)" components toward the "upstream" components as shown in the Table 7-23.

Table 7-23: Institutionalization Alternative for the M/P

	Waste Flow	Institutionalization Flow	Phase 1 1999 - 2001	Phase 2 2002 - 2004	Phase 3 2005 - 2010	 2011 -
Sub-system		↓	Contract out to Private Entities	(Preparation of Concession) Contract out to Private Entities	Concession to Private Entities	Concession to Private Entities
Collection	↓		Examination of Concession (Examine conditions for institutionalizing Section 1 into private entities)	Preparation of Concession/Permission (Formalize the Section 1 as private entities with necessary funding) **2nd Priority Financing**	Start Concession and Permission to Private entities	Concession and Permission
S/Ps	↓		Examination of Concession (Examine conditions for institutionalizing Ex-pepenadores Groups into Cooperatives)	Preparation of Concession (Formalize the Ex-pepenadores Groups as Cooperatives with necessary funding) **2nd Priority Financing**	Concession	Concession
T/Ss and Transport	↓	↑	Contract out	Contract out	Contract out	Contract out
NIT	↓	↑	Investment by the DGSU **1st Priority Financing**	**A1.** DGSU direct operation or **A2.** Operation contracted out by DGSU. Examination of four options: A. Status quo (DGSU) A1. DGSU direct operation A2. Contract out operation B. Parastatal C. Concession and preparation for B or C if it is chosen.	A1, A2, B or C.	A1, A2, B or C.
Final Disposal		↑	Investment by the DGSU **1st Priority Financing**	**A1.** DGSU direct operation or **A2.** Operation contracted out by DGSU. Examination of three options: A. Status quo (DGSU) A1. DGSU direct operation A2. Contract out operation B. Parastatal and preparation for B if it is chosen.	A1, A2, or B	A1, A2, or B

Note:
This table shows alternatives proposed by the JICA team which will be subject to further examination by the GDF.

a.1 From Final Disposal to the Upstream

As the vertical expansion of Etapa IV as well as the new construction of Etapa V are selected as priority projects (subject to F/S), the financing and institutionalization of **Final Disposal** component will be the **1st priority** among others.

It is desirable in the M/P framework that waste tipping fee (unit rate per ton) be established in the final disposal component, and both the DF and municipalities need to pay the tipping fee.

a.2 NIT (Composting Plant) to the Upstream

Where tipping fee (unit rate per ton) in the **Final Disposal** component is established, it will then be the best criteria for justifying certain minimum costs to be spent by the GDF for processing selected organic wastes at the **composting plant**, since if the wastes are received by and processed at the composting plant it will contribute to reduce final disposal amount namely save such disposal cost represented by "quantity reduced times tipping unit rate per ton". It will also help to structure the compost product selling price.

Maybe GDF (DGSU and/or other directions) will have the minimum quota of purchasing the compost product at that price in order to maintain stable consumption of compost products for example for greening the huge dusty areas in the ex-lago Texcoco.

It is important to structure the **cost and price** for the compost, even though the compost products would mainly be consumed by the project owner (i.e. GDF) under his discretion, in order to be aware of and to improve cost-effectiveness of the projects.

a.3 Transfer Stations and Transport

Where both tipping fees of the **NIT** and **Final Disposal** components are established, it will then establish the tipping fee (unit rate) of **Transfer Stations** to be charged on waste amounts from private collectors and/or no-hazardous industries who dispose of at the transfer stations.

a.4 S/Ps and Collection

As the down stream component(s) will have the 1st financing priority and the **S/Ps** and **Collection** components have sensitive social aspects, institutionalization of **S/Ps** and **Collection** components has to be prepared with due care and more time, and will be the 2nd financing priority.

a.5 Sub-System

The special collection for the **Sub-System** is decided to be managed by delegations through employing private sector from 1999. Institutionalization of the sub-system will be prior to the institutionalization of the **Collection** component.

b. Institutionalization Processes for Priority Projects

b.1 Final Disposal

The priority projects for the final disposal comprise "vertical expansion of Etapa-IV" and "new construction of Etapa-V", which are expected to be used alternately until about year 2013. Therefore, it is recommended that both sites should be managed by a single institution.

On the other hand, as the both sites stand on the federal territory managed by the CNA, GDF should always assume responsibility as projects owner with regard to long term environmental protection. Therefore, **investment** of the two projects should be realized by the DGSU in the short term (1999 to 2001) of the M/P, although institutional alternatives for **operation and maintenance** of the two disposal sites in medium (2002-2004) and long (2005-2010) term of the M/P may range: "DGSU direct operation", "contract out operation" or "by parastatal entity".

b.2 Composting Plant

As the site of another priority project (composting plant) is also expected to be located in the federal territory managed by the CNA, GDF should assume responsibility as project owner. Therefore, **investment** of the compost plant should be realized by the DGSU in the short term (1999 to 2001) of the M/P, although institutional alternatives for **operation and maintenance** of the plant in medium (2002-2004) and long (2005-2010) term of the M/P may range: "DGSU direct operation", "contract out operation", "by parastatal entity" or "concession to a private entity".

c. Role of Transfer Station and Transport

Aiming at the sustainable SWM by GDF, the M/P proposes source separation and separate collection for the successful production of compost and recovery of recyclable materials, which consequently will reduce the final disposal amount. Wastes have to be delivered to proper destinations according to their categories in order to achieve those targets. In this sense, the transfer stations and transport play a key role for the successful SWM by the GDF.

Therefore, it is recognized that the contracting out would be maintained as the appropriate institutional form for the transfer stations and transport component in the M/P period.

7.2.4 Social Approach toward the M/P

7.2.4.1 Outline of the Approach

Table 7-24 shows applicable criteria and strategies proposed in the different components of the M/P to solve, to minimize or to mitigate social critical points.

Table 7-24: Criteria and Strategies to Solve Critical Social Aspects

Component	Objectives	Criteria and Strategies to solve, minimize or mitigate critical social aspects
1. Management at the Source	• Hygienic waste management at home • Waste reduction, reuse and recycling • Separation at the Source • Raising recognition in population as waste generators	◆ Community education program ◆ Demonstration Program under current execution ◆ Encouraging environmental education at primary schools
	• Crating and Packing minimization by industries	◆ Education (Conscience and awareness of Industries) ◆ Approval and Reinforcement of Regulatory Laws
2. Collection	• Informal workers incorporate to the formal system.	◆ Worker Harmonization and Promotion ◆ Regularization of informal activities ◆ Identification of local characteristics
	• Separate collection	◆ Recognition of local characteristics ◆ Environmental education in communities and schools ◆ Employment promotion ◆ Harmonization (associations and Sección 1)
	• To maintain payment culture	◆ Harmonization (to formalize current system)
	• Attention to peripheral sectors with difficult access	◆ Community participation and sustainability ◆ Supervision and control
	• Occupational Health and security against accidents	◆ Training ◆ Supervision and Control
3. Selection Plants (S/Ps)	• To conclude closure at Sta. Catarina sanitary landfill	◆ Harmonization (Negotiation with waste picker organization)
	• To reduce cost caused by the GDF	◆ Harmonization
	• More efficiency in Selection	◆ Education and Harmonization
4. T/S, Haulage and Final disposal	• Fulfillment of contracts with enterprises	◆ Supervision and control

7.2.4.2 Public Education Program

Among the strategies shown above, public education should be commenced in the short term and the following describes its outline.

a. Basic Concepts

Society as a whole can barely grasp superficially the magnitude of the solid waste problem; as a result, it has been observed that participation from the population in SWM is limited. However, it should be noted that citizen participation does not happen spontaneously. For participation beyond rhetoric, a mechanism should be established, space should be created, and some basic input should be financed.

Within the possible participatory level, education and information can be identified as basic components to achieve participation and to develop responsible behavior on solid waste with regard to health and the environment.

With the exception of isolated demonstrative experiences, e.g., solid waste separation at public buildings which is done by the DGSU, it is not frequent to find programs which have considered the sensitization of participants through inductive talks and education which can instruct them to appropriately manage solid waste separation.

A crucial factor that precludes the population from joining consciously and voluntarily SWM program is the limited environmental culture. This limitation does not allow residents to weigh the negative effects that waste can have on their health and the environment (water, air, and soil); this is even more critical in the adult population who have just received general knowledge on the topic.

During the recent years, school educational programs have included environmental care issues; even some good quality primers and books have been produced. Although it is correct that study plans consider continuity on dealing with the environmental topic throughout six years of primary education, good habits to appropriately deal with SW cannot be instilled into children if this is only taught theoretically for one year. Classroom teaching should be complemented with demonstrative practices, such as visits to cleansing service, S/Ps, transfer stations and sanitary landfills. Even if it is true that education of new generations will give positive permanent results, this does not exempt today's adults from responsibility.

It is evident that little information and training has been given to the GDF cleansing workers; contractors at the transfers stations, S/Ps, haulage and sanitary landfill; informal workers, sweeping and collection volunteers; on issues such as health, environmental protection, occupational health and safety. This situation should be rectified.

Furthermore, it is necessary to provide training and tools to the GDF units in charge of supervision and control of an ever increasing number of contractors from the private sector.

In other words, a public education program cannot be only limited to the indispensable task of promoting cleansing and hygiene among the population but it should also be able to fill some voids, for example, citizen participation, information, training and the updating of personnel linked to the cleansing service inside and outside the GDF.

b. Guidelines to Develop an Educational Program

An educational program largely depends on human activities and other cultural activities, in addition to values and existing perceptions among the different components of the urban society. The following guidelines are preliminary; keeping always in mind that a community education program will have to be developed in detail by the GDF, with the assistance of Mexican professionals with vast experience.

b.1 General Objectives

- To promote within the DF citizenship an environmental culture so that each resident assumes his/her corresponding responsibility as a solid waste generator.

b.2 Specific Objectives

1. To educate the waste generators on appropriate solid waste management practices and the negative impact on health and the environment derived from the inadequate management of SW.
2. To promote the current environmental educational program in schools, with an emphasis on adequate SWM along all school levels.
3. To promote the solid waste separation at source and the reuse of separated materials.
4. To encourage waste minimization by reducing packages and crates at industries.
5. To inform permanently the community of new projects, proposals, or changes on the cleansing service provided by the GDF.
6. To train and to update personnel working for the cleansing service of the GDF as well as these working outside the GDF, but linked to the service.
7. To encourage community participation in SWM and to promote closer links with the GDF.

b.3 Components and Scope

i. To Educate the Population on SWM

This component aims to raise citizens' consciousness with respect to solid waste, to let them understand that they are all waste generators, and to put responsibility for appropriate management of their own waste. Some important points of the educational component are the following:

- To raise conscience and awareness on urban environmental issues and benefits derived from a cleaner environment.
- Relation between inappropriate SWM and the incidence of some type of diseases (typhoid, paratyphoid, hepatitis, respiratory diseases, cholera).
- Harmful fauna proliferation (rats, flies, cockroaches, mosquitoes) which are vectors for transmissible diseases.
- Pigs are often fed with waste, without any control. This situation can affect the health of persons who consume infected pig meat. (cistercosis, teniasis).
- Acute and chronic diseases which are derived from being exposed to toxic substances contained in the waste (detergents, batteries, heavy metals and others).
- Water, air, and soil contamination due to inadequate SWM.

- Rational use of non-renewable natural resources.
- Need to minimize solid waste generation.
- Community participation to achieve the "three Rs" objective: solid waste reduction, reuse and recycling.

ii. Encourage Current School Program on Environmental Education

When promoting aspects related to SWM through the environmental education within the school program, it is intended to generate new habits among children who will multiply this knowledge once they reach their adulthood. Even though environmental education within the school program (through the six years of primary education) is well structured, including good quality primers and books, some proposals are presented next to encourage the children education on adequate SWM.

- The effort to instruct continuously on SW within the environmental education program during each one of the six years of primary education, not only during third grade as it currently takes place. A behavioral change regarding the appropriate management of solid wastes requires a long process.
- Cleansing, more than any other public service, depends fundamentally on individual and community behavior. As such, this service should be known in more detail. Consequently, theoretical courses should be promoted along with demonstration visits to the cleansing department of the GDF, transfer stations, S/P's and final disposal sites.
- It is necessary to complement teachers' training on this field, specially for those teachers covering Natural Science and Civic education, which subjects are linked to this issue.
- To incorporate, the fourth R, Responsibility of Citizen, into the educational programs in addition to the three Rs.

iii. To Promote Waste Separation at the Source:

- Need to minimize solid waste generation.
- Rational use of non-renewable natural resources.
- After sensitization and community education take place, solid waste separation at the source will be promoted for its utilization.
- Promotion of separated waste at the DF should correspond to technical decisions made in regard to collection, destiny, and commercialization of the materials segregated.
- To inform the community on the advantages related to separation and utilization of waste.
  - ♦ Optimization of collection operation
  - ♦ Reduction in the use of non-renewable resources.
  - ♦ Expansion of sanitary landfill life span.
- Emphasis should be placed on hazardous waste separation at the source.
- Training should be provided to personnel in charge of the collection of separated material.

- To promote the use of items made of recycled materials.

iv. Promote Waste Minimization of Packages or Crates

- To promote and reinforce regulatory laws on the minimization of packages or crates.
- To promote package and crate minimization during the production process as well as during its utilization. This will be done with the help of the INE and Chambers of Industries.
- To negotiate with the authorities about granting economic and/or fiscal incentives to industries which take part in waste minimization programs.

v. To Inform the Community Permanently

- The GDF should inform about:
  - ♦ Change of collection frequencies and schedules
  - ♦ Stop points for collection vehicles
  - ♦ The use of containers and bags in houses and acceptable procedures during collection.
  - ♦ The use of waste boxes in public roads and areas.
- The organization of the cleansing service in the GDF (DGSU and delegations) as well as works done related to: sweeping, collection, haulage, material selection and final disposal.
- DGSU's complaint offices and delegations where neighbors can express their complaints about the deficiencies in the service; these complaints can be expressed personally or by telephone.

vi. Training

- Training and updating GDF's cleansing service personnel.
- To cooperate in training workers of contractors and informal workers.
- To prepare a set of prevention and risk control instructions for environmental, occupational and health problems which could be derived from inadequate SWM; it will be targeted to the workers' sector.
- To take into account the outfit and personal protection elements required for the use of DGSU worker and contractors as shown in Table 7-25.

Table 7-25: Clothes and Elements for Personal Protection and Use

Element	Purpose
Security footwear	To prevent injuries to the foot.
Security helmet	To prevent injuries to the head from objects that fall out.
Gloves	To prevent injuries from sharp objects, chemical and abrasive wastes.
Reflecting jacket	For works in public roads, compulsory in night shifts.
Rubber boots	To prevent wet feet (ankle boots are recommended).
Work clothes	For all workers.
Waterproof suit	For rainy days.
Facial protection	To prevent eventual splash and particles.
Mask	To prevent workers form inhaling toxic elements and dust.

vii. To Promote Community Participation in SWM

Because of the intrinsic characteristics of public cleansing, it is indispensable that citizens become involved positively. Consequently, an appropriate behavior related to solid waste is closely linked to civic conscience for human living. Adequate SWM is part of every citizen's rights and duties. Community participation, among other things, refers to:

- Community participation actions: solid waste minimization, separation at source, management at source of origin, reuse, recycling and others.
- Close supervision by the Community of the services provided by the GDF (sweeping, haulage, and solid waste final disposal), so that they are rendered satisfactorily.
- Monitoring so that society's components fulfill the regulations and provisions on SWM and cleansing in public roads.
- To inform the office of complaints in the GDF about infractions or failures in SWM in public roads.
- Active participation of the associations of residents and other groups within the community structure and the civil society in the community education program.

b.4 Educational Program Phases

The different components of the educational program would have the following phases:

- Sensitization phase: This phase creates effective conditions so that citizens can perceive SWM situation in the DF as a real problem. Citizens are part of the problem and solution.
- Information phase: This phase spreads the information to the different types of service recipients to whom the component on education program about SWM is targeted.
- Education phase: This phase intends to cause internal behavioral changes in order to make SWM sustainable. This phase includes: training and updating

human resources working in the SW area; education at the school level; community participation in all different cleansing projects, etc.

- Evaluation phase: This phase assesses the program annually and the attainment of goals at the end of the project.

c. Executing Unit Program

The Environmental Department (SMA) of the Government of the Federal District is planning the creation of a General Direction for Environmental Education, which will be aiming at educational subjects on air, water and soil, and solid waste items will be developed too within this context.

Currently, representatives of the General Direction of Urban Services (DGSU), that belongs to the Department of Works and Services, integrate the Executive Committee called by the SMA, in order to promote coordination and integration of the increasing efforts by the GDF on environmental education.

d. Programming

1. Constitution of Executing Unit: 1999
2. Preparation of Plans and Projects: 1999
3. Projects Begin: 1999
4. Execution of Projects: 2000-2010
5. Evaluation: Yearly until 2010

7.3 Projects Cost Estimates

This section estimates costs of projects that are required in the master plan. They are as follows:

1) Vertical expansion of the existing landfill (Etapa IV)
2) A new landfill development (Etapa V)
3) Composting plant
4) O&M cost of transfer stations and transport
5) O&M cost of selection plants

7.3.1 Basic conditions

a. Design Conditions

The preliminary design of the projects was conducted based on the waste amount from 2001 to 2010 estimated in a previous section.

a.1 Key Design Data

- ASG (apparent specific gravity) of waste after compaction in landfills: 800 kg/m^3
- Operation time of the landfills : 24 hours/day
  365 days/year
- Operation time of the composting plant: 8,000 hours/year

a.2 Service Life

- Trucks and heavy equipment: 7 years
- Building and civil works: 30 years

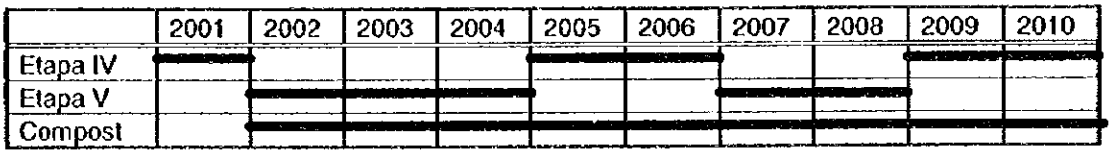
a.3 Remaining Life Year of the Existing Equipment

It was assumed that the remaining life years of all the existing equipment would be expired until 2000, then, new equipment would be purchased in 2000 for the projects.

a.4 Operation Schedule

It was assumed that the operation schedule of the facilities would be as shown in Table 7-26.

Table 7-26: Operation Schedule of the Facilities



a.5 Waste Amount Forecast

- **Landfills**

The forecast of waste amount disposed of in the landfills from 2001 to 2010 are shown in Table 7-27.

Table 7-27: Waste Amount Forecast

Year	Total		Etapa IV		Etapa V	
	1000 ton	1000 m^3	1000 ton	1000 m^3	1000 ton	1000 m^3
2000						
2001	3,876	4,845	3,876	4,845		
2002	3,609	4,511			3,609	4,511
2003	3,493	4,366			3,493	4,366
2004	3,385	4,231			3,385	4,231
2005	3,373	4,216	3,373	4,216		
2006	3,358	4,198	3,358	4,198		
2007	3,340	4,175			3,340	4,175
2008	3,321	4,151			3,321	4,151
2009	3,300	4,125	3,300	4,125		
2010	3,278	4,098	3,278	4,098		
Total	34,333	42,916	17,185	21,482	17,148	21,434

- **Composting Plant**

The forecast of compostable waste amount in 2010 is 431,000 ton/year.

b. Conceptual Design

b.1 Vertical Expansion of the Existing Landfill (Etapa IV)

The height of the existing landfill is 8m from the ground. The landfill will be expanded to 24m from the ground vertically. Phased landfilling will be executed every 8m. The estimated capacity of the expanded part is about 26 million cubic meter.

The major contents of this project are shown in Table 7-28.

Table 7-28: Conceptual Design of Etapa IV

Items	Facilities
Landfill capacity	25,849,000m^3(20,679,000ton) is available for waste disposal.
Access	at 0m elevation outer road: 8,285m (existing) inner road: 26,675m (existing) at 8m elevation outer road: 7,075m inner road: 19,623m at 16m elevation outer road: 5,160m inner road: 6,453m
Leachate management	Leachate extraction wells concrete pipe with 600mm diameter: 24 nos. Leachate extraction pumps: 24 nos. Leachate collection lines at 0m elevation: 26,675m at 8m elevation: 26,708m at 16m elevation: 11,613m
Landfill gas management	Gas extraction wells concrete pipe with 600mm diameter: 198nos. Gas extraction pipes - PVC200 at 8m elevation: 141 nos. at 16m elevation: 102 nos.
Surface water management	Daily/intermediate soil cover: 30cm depth (Compost is also usable.)
Monitoring	Monitoring items: -settlement of the landfill -leachate quality -landfill gas quality
Aesthetic design	Mobile screen Daily/intermediate soil cover: 30cm depth (Compost is also usable.)
Closure and post-closure	Final soil cover: 60cm depth Greening by seeding the final cover with grass
Landfill equipment	Bulldozers (300hp class): 4 nos. Sprinkler trucks (15,000liter class): 2 nos. Excavators (85hp class): 2 nos.

b.2 A New Landfill Development (Etapa V)

It was assumed that the site being available for the final disposal activities will have 256 ha, the area usable as a landfill area will be 194 ha and completed landfill height will be 24m. Phased landfilling will be executed every 8m as well as the existing landfill. The estimated capacity of the new landfill was about 24 million cubic meter.

Table 7-29: Conceptual Design of Etapa V

Items	Facilities
Area	Site area: 256ha Filling area: 194 ha
Landfill capacity	29,032,000m^3(23,226,000ton) is available for waste disposal.
Access	Access road: 605m Ring road: 5,950m at 0m elevation outer road: 5,950m inner road: 19,155m at 8m elevation outer road: 4,878m inner road: 11,743m at 16m elevation outer road: 3,854m inner road: 3,991m
Waste transport control facilities	gate: 1 (existing) weighbridge: 2 tire washing pit: 1 site office: 1 garage: 1 car park:1 parking area for heavy equipment and/or storage yard: 1
Leachate management	Leachate extraction wells concrete pipes with 600mm diameter: 15 nos. Leachate extraction pumps: 15 nos. Leachate collection lines at 0m elevation: 25,105m at 8m elevation: 16,621m at 16m elevation: 7,845m
Landfill gas management	Gas extraction wells concrete pipes with 600mm diameter: 116nos. Gas extraction pipes - PVC200 at 0m elevation: 118 nos. at 8m elevation: 91 nos. at 16m elevation: 55 nos.
Surface water management	Daily/intermediate soil cover: 30cm depth (Compost is also usable.)
Monitoring	Monitoring items: -settlement of the landfill -leachate quality -landfill gas quality -groundwater -surface water Monitoring facilities -monitoring well: 4 nos.
Aesthetic design	Mobile screen Daily/intermediate soil cover: 30cm depth (Compost is also usable.)
Closure and post-closure	Final soil cover: 60cm depth Greening by seeding with grass
Landfill equipment	Bulldozers (300hp class): 4 nos. Sprinkler trucks (15,000liter class): 2 nos. Excavators (85hp class): 2 nos.

b.3 Composting plant

The forecast of compostable waste amount is 431,000 ton/year. The operation time of the plant will be 8,400 hours/year. Then, required capacity of the plant will be about 1,230 ton/day. And, it was assumed that required area for the plant will be 36 ha.

(431,000 ton/year) / (8,400 hours/year) x (24 hours/day) = 1,231 ton/day

Approximately 1,230 ton/day

c. Exchange Rate

The following exchange rate as of October 1998 was used for the cost estimation.

US$ 1.00 = 9.1 pesos

7.3.2 Cost Estimation

The costs that are examined here are basically what will be needed from 2000 to 2010.

a. Vertical Expansion of the Existing Landfill (Etapa IV)

The estimated total cost for the vertical expansion of the existing landfill is US$ 29,860,000. The estimated unit cost per ton of waste is US$ 1.74 /ton.

Table 7-30: Investment Schedule for the Vertical Expansion of the Existing Landfill

Unit: US$ 1,000

Item	Costs
Initial investment (1999 - 2000)	8,233
O&M (2001-2010)	21,627
Total (1999 - 2010)	29,860

Table 7-31: Unit Costs of the Vertical Expansion of the Existing Landfill

Total costs	US$ 29,860,000
Disposal amount of waste	17,185,000 ton
Unit cost per ton of waste	US$ 1.74 /ton

b. A New Landfill Development (Etapa V)

The estimated total cost for new landfill development is US$ 42,249,000. The estimated unit cost per ton of waste is US$ 2.46 /ton.

Table 7-32: Investment Schedule for a New Landfill Development

Unit: US$ 1,000

Item	Costs
Initial investment (1999 - 2001)	12,708
O & M (2002-2010)	29,541
Total (1999 - 2010)	42,249

Table 7-33: Unit Costs of the New Landfill Development

Total costs	US$ 42,249,000
Disposal amount of waste	17,148,000 ton
Unit cost per ton of waste	US$ 2.46 /ton

c. Composting plant

Table 7-34: Investment Schedule for the Composting Plant

Item		Costs (US$ 1,000)
Initial investment (2001 - 2003)		5,304
O & M (2002-2010)	Personnel, fuel, power supply, etc.	13,296
Total costs		18,600
Composting plant input amount (2002 - 2010)		3,584,000 ton
Unit cost (total costs/ total input)*		US$ 5.19 /ton

Note *: Unit cost per ton of organic material input

d. Summary of the Costs

Table 7-35: Summary of the Costs

Unit: US$ 1,000

Item	Etapa IV	Etapa V	Compost	Total
Initial investment (1999-2003)	8,233	12,708	5,304	26,245
O & M (2001-10)	21,627	29,541	13,296	64,464
Total	29,860	42,249	18,600	90,709

Table 7-36: Summary of Investment and Operation and Maintenance Cost

Unit : US$ 1,000

Item	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
BP Etapa IV	B/D	33												33
	D/D&S/V		293											293
	Con		7,902											7,902
	OP			4,109	536	446	536	3,828	3,909	446	536	3,718	3,563	21,627
	BP IV total	33	8,200	4,109	536	446	536	3,828	3,909	446	535	3,718	3,563	29,660
BP Etapa V	B/D	41												41
	D/D&S/V		204	162										366
	Con			4,068										4,068
	OP			231	9,194	8,954	8,825	244	301	5,658	3,822	244	301	37,774
	BP V total	41	204	4,461	9,194	8,954	8,825	244	301	5,658	3,822	244	301	42,249
Landfill total		74	8,404	8,570	9,730	9,400	9,361	4,072	4,210	6,104	4,358	3,962	3,864	72,109
Composting facility	B/D	50												50
	P/P	10	10											20
	D/D&S/V		164	99	33	33				13	2			344
	Con			2,376	551	551								3,478
	Equipment			1,250	177						1,142	177		2,746
	OP			33	1,185	1,343	1,343	1,343	1,343	1,343	1,343	1,343	1,343	11,962
	Total	60	174	3,758	1,916	1,927	1,343	1,343	1,343	1,356	2,487	1,520	1,343	18,600
Landfill, composting total		134	8,578	12,328	11,676	11,327	10,704	5,415	5,553	7,460	6,845	5,482	5,207	90,709

Notes : B/D : basic design, D/D : detailed design, Con.: construction, OP : operation, P/P: Pilot project
S/V : supervision

e. Operation and Maintenance Cost of Transfer Station and Transport

Operation and maintenance (O&M) of the transfer stations and transport cost the DGSU 396,276,313pesos in year 1997, while its transport amount being 3,123,000ton/year. It derived 126.9pesos/ton (13.94U$/ton) as the unit O&M cost of transfer stations and transport.

O&M costs for transfer stations and transport till the year 2010 are estimated based on the above unit cost and estimated transfer amount in respective years (see Table 7-37).

Table 7-36: Summary of Investment and Operation and Maintenance Cost

Unit : US$ 1,000

Item		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
BP IV Expansion	B D	[illegible]												33
	D D&S V		[illegible]											236
	Con.		[illegible]											7,900
	OP			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21,627
	BP IV total	33	8,200	4,109	536	416	536	3,828	3,909	416	536	3,718	3,563	29,860
BP V Expansion	B D	[illegible]												41
	D D&S V		[illegible]	[illegible]										356
	Con.			[illegible]										4,066
	OP			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	37,774
	BP V total	41	201	4,461	9,191	8,954	8,825	241	301	5,658	3,822	241	301	42,239
Landfill total		74	8,401	8,570	9,730	9,400	9,361	4,072	4,210	6,101	4,358	3,962	3,864	72,109
Composting facility	B D	[illegible]												50
	P P	[illegible]	[illegible]											20
	D D&S V		[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]			311
	Con.			[illegible]	[illegible]	[illegible]								3,476
	Equipment			[illegible]	[illegible]						[illegible]	[illegible]		2,716
	OP			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11,962
	Total	60	174	3,758	1,946	1,927	1,343	1,343	1,343	1,356	2,487	1,520	1,343	18,600
Landfill composting total		134	8,578	12,328	11,676	11,327	10,701	5,415	5,553	7,460	6,845	5,482	5,207	90,709

Notes : B D : basic design, D D : detailed design, Con. : construction, OP : operation, P.P: Pilot project
S V : supervision

e. Operation and Maintenance Cost of Transfer Station and Transport

Operation and maintenance (O&M) of the transfer stations and transport cost the DGSU 396,276,313pesos in year 1997, while its transport amount being 3,123,000ton/year. It derived 126.9pesos/ton (13.9JUS/ton) as the unit O&M cost of transfer stations and transport.

O&M costs for transfer stations and transport till the year 2010 are estimated based on the above unit cost and estimated transfer amount in respective years (see Table 7-37).

Table 7-37: O & M Cost of Transfer Station and Transport

Year	Transfer amount(ton/year)	O&M Cost(pesos)	O&M Cost(U$)
1997	3,123,000	396,276,313	43,547,000
1999	3,725,000	472,665,250	51,941,000
2000	3,740,000	474,568,600	52,150,000
2001	3,757,000	476,725,730	52,387,000
2002	3,776,000	479,136,640	52,652,000
2003	3,795,000	481,547,550	52,917,000
2004	3,812,000	483,704,680	53,154,000
2005	3,830,000	485,988,700	53,405,000
2006	3,848,000	488,272,720	53,656,000
2007	3,866,000	490,556,740	53,907,000
2008	3,884,000	492,840,760	54,158,000
2009	3,903,000	495,251,670	54,423,000
2010	3,922,000	497,662,580	54,688,000

f. Operation and Maintenance Cost of Selection Plant

O&M costs for selection plants are categorized into five by DGSU as shown in the Table 7-38. It is assumed that the costs irrelevant to the waste input amounts are those of "cleansing", "control of harmful fauna" and "transportation of persons", while costs variable in accordance with the changes of input wastes amount are those of "technical control" and "operation of machinery and equipment". The unit O&M costs in 1997 for the five categories are calculated from the costs and input amounts recorded in that year.

O&M costs for selection plants till the year 2010 are estimated based on these unit costs and estimated input amount in respective years as summarized in Table 7-39.

Table 7-38: Present O&M Cost of Selection Plants (1997)

	Bordo Poniente (pesos/year)	Aragon (pesos/year)	Santa Catarina (pesos/year)	Total (pesos/year)	unit cost (pesos/ton)*
Technical control	6,168,830	4,946,703	8,158,923	19,274,456	10.75
Operation of machinery and equipment	18,518,508	23,155,168	15,081,199	56,754,875	31.65
Cleansing	1,970,149		2,350,199	4,320,348	2.41
Control of harmful fauna	3,457,591	2,471,316	9,747,536	15,676,443	8.74
Transportation of persons	3,727,349	2,453,741		6,181,090	3.45
Total	33,842,427	33,026,928	35,337,857	102,207,212	57.00

Note *: Tons of waste input to the S/Ps.

Table 7-39: Operation and Maintenance Cost of Selection Plants

year	Input amount (ton/year)	Operation and Maintenance Cost (peso/year)						
		Technical control	Operation of machinery and equipment	Cleansing	Control of harmful fauna	Transportation of persons	Total	Total (US/year)
1997	1,793,245	19,274,456	56,754,875	4,320,348	15,676,443	6,181,090	102,207,212	11,232,000
1999	1,650,000	17,738,000	52,223,000	4,320,000	15,680,000	6,180,000	96,141,000	10,565,000
2000	1,647,000	17,705,000	52,128,000	4,320,000	15,680,000	6,180,000	96,013,000	10,551,000
2001	1,644,000	17,673,000	52,033,000	4,320,000	15,680,000	6,180,000	95,886,000	10,537,000
2002	1,498,000	16,104,000	47,412,000	4,320,000	15,680,000	6,180,000	89,696,000	9,857,000
2003	1,367,000	14,695,000	43,266,000	4,320,000	15,680,000	6,180,000	84,141,000	9,246,000
2004	1,163,000	12,502,000	36,809,000	4,320,000	15,680,000	6,180,000	75,491,000	8,296,000
2005	1,071,000	11,513,000	33,897,000	4,320,000	15,680,000	6,180,000	71,590,000	7,867,000
2006	993,000	10,675,000	31,428,000	4,320,000	15,680,000	6,180,000	68,283,000	7,504,000
2007	932,000	10,019,000	29,498,000	4,320,000	15,680,000	6,180,000	65,697,000	7,219,000
2008	887,000	9,535,000	28,074,000	4,320,000	15,680,000	6,180,000	63,789,000	7,010,000
2009	857,000	9,213,000	27,124,000	4,320,000	15,680,000	6,180,000	62,517,000	6,870,000
2010	844,000	9,073,000	26,713,000	4,320,000	15,680,000	6,180,000	61,966,000	6,809,000

7.4 Evaluation of the Master Plan

7.4.1 Technical Evaluation

It has been examined whether the technical systems proposed in the M/P are compatible and enforceable in comparison with the technical skills maintained by the GDF.

The technical systems proposed in the M/P mainly comprise:

- stepwise introduction of separate discharge and collection.
- establishment of monitoring and control system on transfer and transport.
- improvement of material recovery ratio at S/Ps.
- composting of organic wastes.
- vertical expansion of the Bordo Poniente Etapa IV disposal site.
- construction of the Bordo Poniente Etapa V new disposal site.

a. Separate Discharge and Collection

Pilot projects on 3-category separate discharge and collection have been implemented since 1996. The pilot project in 1998 achieved separation ratio of 92%. It indicates that technical and empirical know-how on separate discharge and collection have been accumulated in the DGSU. Therefore, it will be judged that stepwise introduction of the separate discharge and collection should be technically viable.

b. Transport Monitoring and Control System

Trailers assignment has an intensive control with GPS monitoring by the DGSU, however, transfer amount is individually controlled by respective transfer stations and report formats are different from each other.

The M/P proposes that a single common format should be introduced for data compilation and comprehensive monitoring of transfer amount, together with the

trailer assignment control, which has already established the central monitoring and control system.

The DGSU already reserves technical capability of central monitoring and control on trailers assignment. By developing the existing control system (on trailer assignment), another control (on transfer amount) will be realized. This proposal in the M/P is surely judged as a workable measure.

c. Improvement of Selection Plant Recovery Ratio

The proposal on improvement of S/P recovery ratio recommends, as technical aspects, the input amount reduction and lowering of sorting line velocity. This does not require any new technical renovation nor technology introduction. It only requires plant operation changes. Therefore, this proposal in the M/P is also workable from the technical aspects.

d. Composting

The DGSU is currently operating a small windrow compost plant for processing the gardening wastes (e.g., pruned tree branches and grasses), and the compost products are with satisfactory quality. It proves that the DGSU already reserves technical capability on operating a windrow composting plant. Therefore, in utilizing and developing the DGSU's technical capabilities on composting, the proposal in the M/P i.e., composting of separated organic wastes, becomes viable.

e. Vertical Expansion of the Bordo Poniente Etapa IV

This proposal in the M/P is in line with the current technical practices of landfill operation by the DGSU. It is judged that the DGSU could comply with the technical requirements of this proposal.

f. Construction of New Final Disposal Site (Bordo Poniente Etapa V)

Etapa V is proposed to be constructed with the same technical components as what are employed in the present landfill (Etapa IV). Therefore, it is obviously judged that no technical problem is foreseen.

7.4.2 Financial Evaluation – In Search of Project Affordability

The analysis and the work deliverables in this subsection are focused on the assessment of (i) the cost of solid waste management currently in place, (ii) the finance needs associated with the possible institutional alternatives and funding sources, and (iii) fiscal impacts on DGSU. This brings about the sequential discussions and possible prioritization of the implementation alternatives under the binding conditions of coherent constraints of macro-disequilibrium that Mexico currently faces and corresponding fiscal positions of GDF.

Immediately following the initiating remarks, a summary of macro management of the economy as well public finance in the country and the DF, and the change in budget allocation to DGSU is provided in 7.4.2.1 in a bid to articulate the financial environment where the project takes place. The discussion on the cost accrued to the current solid waste management (SWM) in DF is shown in C.6.5 in Annex C to articulate the financial background of the project. In E.4.1 in Annex E, affordability analyses that seek for the sizes of fund outlay of avail and affordable for DGSU

during the Master Plan period are prepared on a set of presumptions being taken for quantitative analysis while incorporating the information on the institutional, technical, and macroeconomic segments of the prospective project, as appropriate. The conclusive remarks on the financial affordability of DGSU take place in connection with the alternatives of self-reliance on the budgetary arrangement within GDF and the possible involvement of the private sector in fund contribution to the public service in concern.

The detailed analyses of macro management of the economy in the country and regional economy in DF, as well as the analytical framework, model configuration, and the assumptive parameters in use for the affordability analysis are set forth in Data M of the Data Book.

7.4.2.1 Macro and Regional Indicators of Economy, Public Finance in DF, and Budgetary Segment of DGSU

a. Recent Trend in Economic Performance

With jitters over Russia and fears that Venezuela could be forced to follow Moscow's lead and devalue against the US currency, the shock wave swept Mexican and other Latin American markets in the end of August 1998. The Mexican peso, battered to a new historic low of 9.78 per dollar on 21 August 1998, was being quoted at a sliver under 10.0 to the US currency at the international airport foreign exchange booths over the weekend, while culminating in a sharp outflow of funds and raising the prospect of further hemorrhaging. Provided that the trend in the finance markets liners for sometime to come, imports become costly, forcing local prices upward. With this in view, few analysts foresee inflation coming in below 14 percent for 1998, while the government has thus far declined to revise the country's inflation target of 12.0 percent for the same year. In the financial market, the benchmark 28-day government treasury certificates (*cetes*) rose to 36.94 percent, a dramatic 978 basis point leap, on 8 September 1998 to a 28-months high, while the stock market (*Bolsa*) IPC index rose for a second day and the peso remained unchanged at 10.26 per US dollar.[4]

In the meantime, the government seems currently nor ready for market intervention by way of injecting more dollars from the reserves to support the exchange rate. Also, the government has already been forced to cut $4 billion in spending from its 1998 budget due to the 10-year lows of crude oil prices. Oil prices have not yet recovered to the point that would allow Mexico to avoid further budget adjustments. Nonetheless, Under-Secretary for Revenue is quoted as saying that the Ministry of Finance has virtually ruled out further budget cuts this year because the 1999 budget has to be sent to Congress by mid-November.

Meanwhile, the government announced a macroeconomic scenario in November 1997, namely, the National Program for Financing Development 1997-2000 (PRONAFIDE), thus setting forth the policy framework for the remaining period of the administration currently in place. The program articulated an explicit statement of principles, coupled with a quantitative baseline scenario, for policy makers to adopt over the 3-4 year period ahead in a bid to maintain a stable macroeconomic environment in the country. The baseline scenario envisages a gradual return of GDP

[4] Source: *The News*, 9 September 1998

growth rate of 5.6 percent at the end of the period, led by exports and investment, while consumption picks up at a leisurely pace. Inflation is targeted to keep on a declining path, while falling to 7.5 percent by 2000 from 15.7 percent in 1997. In line with the increase in foreign savings to 3.2 percent of GDP, gross domestic saving is envisaged to reach 22.2 percent of GDP in 2000, both arising from 1.6 percent and 20.6 percent of GDP in 1997, respectively. Current account deficit in 2000 is presumably benchmarked at US$15.3 billion arising from $6.0 billion in 1997, whereas the public sector deficit downsizes to 0.3 percent of GDP from 0.5 percent during the same time framework.[5]

Table 7-40: Key Economic/Social Indicators[6]

Public Expenditure as per GDP (1997, estimate)	23.1 %
Central Gov. Fiscal Deficit as per GDP (1997)	-0.5 %
Current Account Balance as per GDP (1997)	-1.7 %
Debt Service Ratio (1997, estimate)	31.3 %
Population Growth, (Annual Average 1993-97)	2.52 %
Population Growth, (End of Period, 1997)	1.7 %
Compensation of Employees as % of GDP (Current, 1995)	31.1%
Unemployment Rate (December 1997)	2.8 %
Income Share of Richest 20% (1992)	55.6 %

Chronological change in the macro indicators is illustrated in Figure 7-11.

[5] To be noted that macroeconomic variables as given in PRONAFIDE are presented not as forecasts but rather as trend evolutions that serve as a benchmark, while developments from one year to another could fluctuate around the baseline. (Ref: OECD, *Economic Surveys 1998, Mexico*, 1998, Banco de Mexico, *The Mexican Economy*, 1998, June 1998)

[6] (Sources: EIU, *Country Profile*, Dec 1997, Institute of International Finance, *Mexico Economic Report*, Feb 1998, World Bank, *Country Assistance Strategy*, Nov. 1996, OECD, *Economic Survey 1998*, Mexico, February 1998, Banco de Mexico, *The Mexican Economy 1998*)

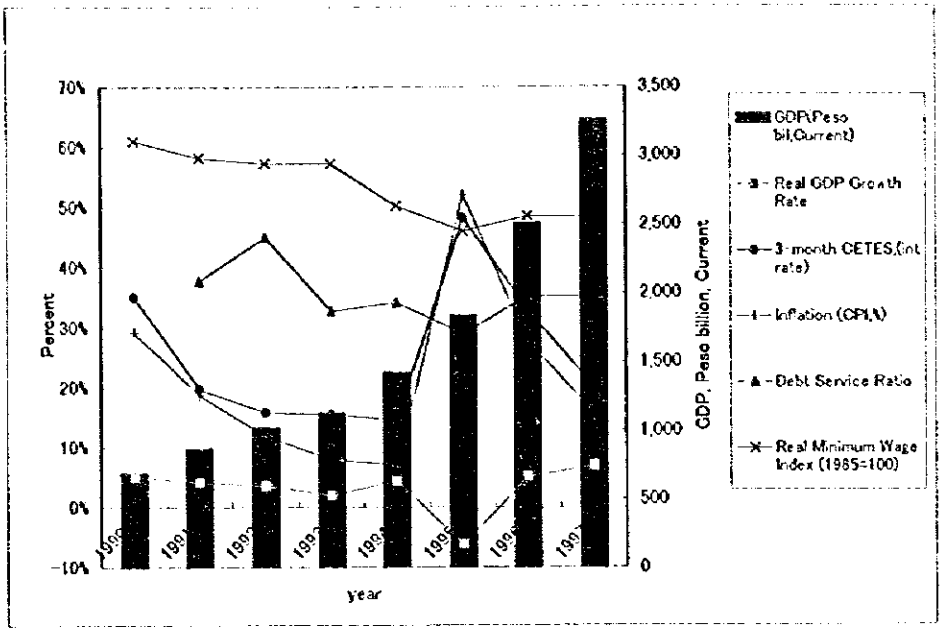


Figure 7-11: Chronological Change in Macro Indicators, 1990 - 1997

b. Regional Economy in DF

On the economic front, the nominal Gross Regional Product (GRP) was $ 97.0 billion in 1997 while accounting for 24.1 percent of the aggregate supply of the country. As regards the industrial structure, little contribution has been made to GRP from the primary sector that comprises the Agriculture and Livestock, and the Mining sub-sectors. With the total population of a little less than 8.5 million (9.3 percent of the country's total population), the nominal Gross Regional Product (GRP) per capita of DF was about $11,426 in 1997 which stands at around 2.6 times higher than the aggregate national products per capita. Annual growth rate of GRP in average over the period of 1990 through 1996 was 2.1 percent, whereas that remained 3.5 percent during the period of pre-currency crisis in the end of 1994.

State profiles in numerical and visual information are attached in Data M of the Data Book, respectively.

c. Public Finance and Debt in DF

The DF government budget coinciding with the calendar year comprises recurrent revenue and expenditure with no "development budget" being stipulated explicitly in the official documents. Current revenue sources for the DF government pertains to (i) own revenue and (ii) contribution from the Federal government, with the line items of the former including (a) Taxes (*Impuestos*), (b) Service Fees (*Derechos*), (c) Contribution not included from Federal Government (*Contrubuciones no Comprendidas*), (d) Products (*Productos*), (e) Good Use (*Aprovechamientos*), (f) Debt Carry-Forwards from Previous Year (*ADEFAS*), and (g) Others (*Otros Ingresos*). The latter pertains to (a) contribution for improvements (*Contribuciones de Mejoras*), (b) auxiliary items of contribution (*Accesorios de las Contribuciones*), (c) federal tax revenue share (*Parcipaciones en Ingresos Federales*), and (d) share due to coordination activities (*Participaciones por Actos de Coordinación*). Of the funds

transferred from the Federal government, tax revenue shares (*participaciones*) transferred from the Federal government constitutes the major source of income for DG government and other local (state and municipality) governments as well.

Inclusive of all sources of funds as noted above, gross revenue of DF for the fiscal year 1998 is set at P. 38,712 million arising from respective of P. 31,105 million, P. 25,097 million, and P. 18,153 million in 1997, 1996, and 1995, with the average annual growth rate of 28.7 percent in nominal term.[7] The share of own revenue has slightly been downsizing over the same period from 60.3 percent in 1995 to 55.4 percent in 1998. Amongst the sources of own revenue of DF, Taxes dominates with 21.0 percent of the gross revenue, followed by Others, Products, Service Charges, Debt from Previous Year, Good Use, and Contribution not Included with 13.2 percent, 9.2 percent, and 9.1 percent, 1.5 percent, 1.4 percent, and 0.0 percent respectively. Tax revenue sharing transferred from the Federal government accounts for 34.9 percent in 1998 and has been somewhat declined from the highest 42.2 percent share in gross revenue in 1996. The balance amongst the transfer items is shared by Share due to Coordination, Auxiliaries, and Contribution for Improvements accounting for 7.7 percent, 1.6 percent, and 0.4 percent, in that order.

Overall expenditure of DF comprises three parts, vis-à-vis, expenditures of DF government, transfer expenditures to Delegations, and expenditures for semi-state entities. In 1998 gross fiscal expenditure was P.42,574 million of which DF government, Semi-state Entities, and Delegation accounted for 60.6 percent, 23.9 percent, and the balance 15.6 percent, while arising from P.33,566 million, P. 27,664 million, and P.19,865 million in respective of 1997, 1996, and 1995. As regards the expenditure attributed solely to the DF government, it grew annually 28.9 percent in nominal terms with P.17,682 million in 1995 to P.25,784 million in 1998. Budget deficit of DF of P. 3,862 million, or around respective of 0.47 percent and 0.1 percent of GRP and GDP in 1997, was financed by public borrowings (deuda publica), as detailed in the ensuing sub-section.

As of the end of fiscal year 1997, the aggregate amount of external debt of DF government was P.11,786 million which was equivalent to around 0.36 percent of GDP. In a bid to round out the fiscal gap in 1998, the Congress of the Union authorized DF, as per the Article No.2 of the Income Law for the Federation and the Income Law for the District of Federal (DF), to exercise a net borrowing of P. 7.5 billion at maximum.[8] With this, the consolidated debt has since the end of 1997

[7] DF revenue in real term is declining while considering the high level of inflation during and post-Peso crisis period of 1995-1998.

[8] Reference: Instituto Nacional de Estadística, Geografía, e Informática (INEGI), Report on the status of public debt of the Federal District government is to be submitted to the Congress of the Union three times a year in compliance with what is set forth in article No. 73 sections VIII and 122, Letter C of the second base, and Letter F of the Constitution of the United Mexican States; in article 67, section XV of the Statute of the Government of District of Federal; in article 23 of the General Law on Public Debts of the DF Government. Also, SHCP has a judicial obligation to submit a report, inter alia, *Informes sobre la Situaóción Económica, las Finanzas Públicas y la Deuda Pública*, to Congress for review on the evolution of the economy, public finance and public debts that contains statistics regarding income and expenditures taken place over the quarter within 45 days after the end of a quarter. Annual report of public account (*Cuenta de la Hacienda Pública Federal*) is also due for review by Congress.

grown by 1.97 percent reaching to a total figure of P.12,019.9 million, or would be 0.35 percent of GDP[9].

Financial healthiness of entities is a function of an expense accrued each year but also the share of debt services out of the funds generated in a year. Viewed in this light, debt service ratio (*DSR*) is highlighted as a proxy index to represent soundness in financial management. With P. 2,609.4 million of debt service authorized by Congress for the year 1998[10], DSR in terms of the whole revenue and own revenue worked out 6.7 percent and 12.2 percent, respectively. Of the authorized debt service, P. 1,907.9 million[11], equivalent to 73.1 percent of the aggregate, is set forth to meet interest payments in the year.

d. Budget Allocation to SWM

In nominal terms, fund allocated to SWM in DF increased in average by 17.8 percent annually arising from P. 950.2 million to P. 1,560.4 million. Of this, the budget of DGSU grew 10.0 percent in average with P. 742.1 million in 1997 to P. 992.1 million in 1999. The remaining balance was funneled to the *Delegations*. With the general price hikes that took place in the country in view, the budget for SWM in DF virtually downsized.[12]

7.4.2.2 Conclusive Remarks

The proposed sector investment plan, which covers a wide range of activities concerned with the beautification of the environment and prevention of human health damage, is to efficiently and effectively improve the solid waste management service needed for the plan. This is because:

- the annual revenue of the DGSU in 1997 was 742.1 million pesos (US$ 81.5 million)
- the expenditure used for the O&M of the present landfill (Etapa IV) in that year was about 105.7 million pesos (US$ 11.6 million), which was about 14.2% of the total expenditure of the DGSU
- the DGSU's annual revenue in 1999 is estimated to be about 992.1 million pesos (US$ 109.0 million)
- suppose that 14% of the revenue can be used for the priority projects, about US$ 15 million is available
- US$ 15 million can cover the estimated largest annual expenditure of US$ 12.3 million for the priority projects in 2001.

Therefore, the investment plan is considered to be financially appropriate and to maximize benefits and welfare of people.

[9] Assuming 5 percent of GDP growth in 1998 in nominal terms.
[10] Source: HACIENDA, *Informes sobre la Situacion Economica, las Finanzas Publica y Deuda Publica, Acciones y Resultados del Primer Trimestre de 1998*, May 1998
[11] Source: *Cuenta Publica* del DF 1998
[12] Inflation rates as born out by the change in the consumer's price index (CPI) are 52.0 percent, 27.7 percent, 15.7 percent in 1995 through 1997. (Source: Banco de Mexico, *The Mexican Economy 1998*)

7.4.3 Economic Evaluation

With the incremental supply of efficient and effective services for solid waste management in the region, the prospective investment plan is the least-cost and environmentally sound solution to mitigate sanitary and ambience degradation and to enhance the habitat and financial basis that is conducive to an improved level of people's welfare and urban beautification. In addition, the project will help augment both the availability and reliability in the provision of solid waste management services in DF, thus providing one of the basic prerequisites for possible investment programs from domestic and external resources and welfare growth therein.

7.4.4 Institutional Evaluation

Institutionalization of SWM components (i.e. collection, sub-system, transfer stations, transport, S/Ps, NIT and final disposal) should be carefully examined and proposed in the M/P, in view of the Goals of the Master Plan, which aims to:

- promote the citizens' health and well-being (including those who work for SWM).
- implement cost-effective SWM.
- contribute to environmental conservation.

a. Institutionalization Sequence

The components' institutionalization (either private, parastatal, or other) is inevitably required in view of seeking cost-effective SWM, although there are large variance in timing of the transformation by component.

With respect to cost-effective SWM, the institutionalization process **(from the downstream)** proposed in the M/P is recommendable. It will help to structure prices for respective components of the SWM, and enable the DGSU to start monitoring the cost-effectiveness of respective components.

Since the NIT (supported by citizens' separate waste discharge) and final disposal sites play the key function to "contribute to environmental conservation", their institutionalization proposed in the short term phase will be an appreciable achievement in the M/P.

Therefore, it is a right decision that in the M/P the sequential transition is planned to occur backward in the waste stream, i.e. from downstream to upstream.

b. Sufficient Time Allowance for Institutionalization

On the other hand, one of the M/P goals includes:

- "promoting well-being of those who work for SWM".

In this connection, the M/P suggests that a longer time should be spent for the institutionalization of upstream components at which a lot of people work for SWM.

The institutional transition showed in the M/P is, therefore, deemed to be recommendable and pertinent to the GDF.

c. Shift of the DGSU's Role in the Longer Term

For the success of SWM institutionalization in the longer term, it will also be necessary for the DGSU to gradually shift its role from as an implementation body to as a supervisor. The key requisites for the DGSU as a supervisor should include the following.

- encourage competition.
- monitor the activities of the service providers.
- regulate service quality.

As a result, an entire SWM system will be ensured to be fair and sustainable, and satisfactory for the beneficiaries.

7.4.5 Social Evaluation

Social evaluation of the Master Plan is based on the following criteria:

a. Improvement of public health

The improvement of public health of DF's population is the main objective in the M/P. Health benefits are being pursued through the following proposals by the M/P:

- A public education program aimed at fostering the proper management of solid wastes by the DF population, which will prevent the negative impact on health that might be caused by an inappropriate management.
- Improvement of the collection services so as to solve the shortage of these services of some marginal population groups in squatter settlements.
- Establishment, operation and maintenance of Etapa IV and V of Bordo Poniente Sanitary Landfill to prevent the proliferation of vectors that may transmit diseases, as well as the possible population exposure to toxic substances in garbage.
- Establishment of a leachate recirculation process at Bordo Poniente sanitary landfill, which prevents the future pollution of the aquifer lying far beneath the landfill.
- Step-by-step introduction of the separation of wastes at the generation source, which will gradually educate the population in the internal-household sanitary management of solid wastes.

b. Population's well-being

The M/P proposals for the discharge and storage, collection, transfer stations and transport, selection plants, new intermediate treatment and final disposal of solid wastes will bring the following benefits for the population:

- With the public education program, the population acknowledges on urban environmental issues, which in turn creates an environmental culture aimed at the recognition of its responsibility as a generator of solid wastes.
- Cleaner public roads and areas.
- Protection of landscape and natural sites.

- Introduction of separate collection that will allow cleaner and tidier management, without disturbing pedestrians and neighbors.
- Noise and dust control at the transfer stations, S/Ps, NIT and Bordo Poniente sanitary landfill, which does not affect neighboring populations.
- Promotion of the existing school environmental education program, focusing on the instillation of appropriate solid waste management since childhood.

c. Employment and Working Conditions

The following are highlighted:

- The expansion and upgrading of Bordo Poniente sanitary landfill, the implementation of a new Intermediate Treatment Facility and sub-system collection will constitute new employment sources.
- The proposal for personnel's training and re-training will benefit the capacity of workers and thus will increase the efficiency of the service.
- The progressive regularization of workers will be a goal that will benefit a substantial part of the informal sector.
- The proposed supervision for the compliance of labor, occupational health and industrial safety regulations by private contracted enterprises involved in SWM will imply benefits for private sector workers, as well as the prevention of labor conflicts that would affect the course of the service.
- During the implementation of the M/P, separation of recyclable material and its further recovery would reduce the unit price of recyclable elements (with the exception of cardboard, paper and aluminum), which in turn would bring about a negative social impact on the pickers.

d. Participation and Sustainability

- The public education program, along with the step-wise separation program for solid wastes at the source will initiate beneficial citizenry participation in the DF's SWM; this in turn will allow a close relation of population with the GDF.
- Another benefit will be citizenship participation in the solid wastes' Reduction, Reuse and Recycling purposes, which will also bring as a result a sustainable environment.
- Finally, the strict and clear supervision and control to meet the contract and legal provisions will protect the population, GDF and the workers' interests.

Table 7-41 shows the possible social benefits that can be achieved in the diverse components of SWM if the proposals in the Master Plan are applied.

Table 7-41: Social Evaluation of the Proposed M/P

Components	Public Health	Population's well-being	Employment and Working Conditions	Citizen participation and Sustainability
Storage and Discharge	• Internal household sanitary management • Prevents proliferation of harmful fauna at the source	• Improves the tidiness and aesthetics in the discharge • Prevents offensive odors • Reduces annoyances to pedestrians and to the traffic	• No negative impact on employment since it is an activity of the community	• Direct community participation • Sustainable for its being based on public education
Separation at the source	• Sanitary management of 2 or 3 categories of garbage	• Raises the population's environmental education • Reduction, Reuse and Recycling of solid wastes	• Does not affect employment since it is an internal household activity • With a greater recovery, more possibilities to be employed at the recycling industry (*)	• Direct community participation • Sustainable activity • Benefit for the environment and natural resources
Collection	• Reduction of the risk of accidents through staff training	• A cleaner, tidier and more aesthetic process • A more efficient collection	• Progressive regularization of informal personnel • Increase of employment by separate collection of sub-system	• Strengthened relation between citizenry and GDF
Transfer Stations and Transport	• Improvement of occupational health	• A cleaner, tidier and more aesthetic process	• Possible increase of employment • Improvement of labor conditions	• Greater participation of private sector
S/Ps	• Sanitary management of facilities by reducing noise, dust and other disturbances • Reduction of the risk of accidents	• A cleaner, tidier, more aesthetic and more efficient process	• Possibility of more employment in the recycling industry • Improvement of labor conditions	• Greater participation of private sector
NIT (Composting Plant)	• Controlled and sanitary management of organic wastes	• Preservation of natural resources	• Possibility of more employment • Improvement of labor conditions	• Greater participation of private sector
Final Disposal	• Prevention of vector proliferation at the sanitary final disposal • Prevention of waste burning	• Prevention of groundwater pollution • Protection of landscape and natural sites	• Possibility of more employment • Improvement of labor conditions	• Greater participation of private sector

Note (*): However, it should be noticed that further recovery of recyclable material might lead to a reduction in the unit price of these elements, which in turn would have a negative impact on the group of pickers.

7.4.6 Environmental Evaluation

The following should be highlighted in the M/P from the environmental point of view.

- The satisfactory SWM service is sustained.
- The optimum location for final disposal site is chosen.
- Resource conservation is attempted.
- Environmental awareness of people is to be raised.
- Separated organic waste is to be treated by composting.

These are further discussed below.

a. The Satisfactory SWM Service to be Sustained

SWM has been already effectively carried out in the DF. Most of wastes discharged from households are collected by the delegations. Even if wastes which are not collected by the normal operation are disposed of at open spaces, they are eventually collected by the GDF. Therefore, the negative effects which could be caused by the uncollected wastes, such as health threat to the general public, odor, blockage of drains, litters in rivers and aesthetically poor city environment, are considered to be small. Therefore, the M/P will dedicate for continuous provision of the satisfactory SWM service to the public.

What should be reminded here is that the SWM service can never stop. It must be reliable and sustained indefinitely. In this sense, the M/P bears a significant implication that the continuity of the SWM service is ensured.

b. Location of the Final Disposal Site

The M/P proposes the vertical expansion of the Bordo Poniente Etapa IV and the construction of Etapa V.

The development of a final disposal site is one form of land modification. It is intensive geological manipulation which requires prudent investigation about possible environmental impacts in advance, otherwise the environment could be damaged irreversibly. The most common and realistic measure to be taken to avoid unnecessary damages is selecting a site whose environment is less valuable and more resistant.

Considering this, the both locations appear to be the most suitable for final disposal site development. They are within the ex-Lake Texcoco area where soil and surface groundwater are so saline that their usage is considerably restricted. Reusing the site of Etapa IV by vertical expansion should significantly reduce the environmental effect that could be brought by development of other new final disposal site with the same landfill capacity.

It is certain that the environmental impact can not be eliminated completely, but the proposal of the site location by the M/P should minimize the impact.

c. Resource Conservation

Material recovery has been carried out in the DF mostly by the waste collection crew and at the S/Ps. Their activities are, however, largely driven by individual interest and lack organization or a holistic view as a whole SWM system.

The M/P aims to transform such inefficient material recovery to a systematic approach towards resource conservation by promoting waste separation at source, improving the S/Ps and introducing a composting plant. Wastes are to follow respective routes from their generation points to the final destinations according to their categories. Therefore, recovery efficiency and cost performance should be significantly improved.

d. Public Environmental Awareness

The waste separation at source is possible only if waste generators, i.e. the general public, are encouraged to do so. This may require the GDF an enormous effort, but once people acknowledge the importance of the scheme, it is expected that their interest in environmental issues, not necessarily regarding only waste problems, would be expanded. For example, they might be motivated to use recycled goods, to save energy, or to pay critical attention to the consumption-oriented society.

Only point sources, such as factories and power plants, have often been required to have environmental conscientiousness so far. On the other hand, the environmental awareness of the general public is, if sufficiently raised, spatially dispersed and can be a driving force for the good environment of the DF.

e. Introduction of Composting

A composting facility is to be introduced as an intermediate treatment of solid waste. It will bring the following environmental benefits.

i. Organic waste, which is the most reactive component in the non-hazardous waste, is stabilized through aerobic decomposition faster than when it is disposed of at the final disposal site which is anaerobic.

ii. Aerobic decomposition generates less methane gas, which is the most efficient contributor to the global warming, than the anaerobic landfill. It should be noted that the high water table of the surface aquifer render the landfill environment of the Bordo Poniente final disposal site particularly anaerobic.

iii. The output may be used as environmentally friendly soil conditioner to promote vegetation. This will raise environmental and aesthetic value of the area, create a buffer zone around the final disposal site, or prevent a soil dust effect in the ex-Lago Texcoco area, depending on its application.

7.4.7 Overall Evaluation

In this section, the validity of the M/P for the SWM in the DF has been assessed from the point of technical, institutional, social, environmental, financial and economical views.

Technically, the M/P was revealed to be appropriate taking into account of the current technical level of the GDF. Institutional building and social approaches proposed in the M/P were considered to well agree with the technical system and to be recommendable. The implementation of the M/P was justified environmentally with positive perspectives for the betterment of the urban environment.

Financially and economically, it was shown that the increase of financial cost arising from the M/P would not give excessive burden to the GDF and that the M/P would bring economical benefit to the DF society.

Accordingly it is concluded that the execution of the M/P is judged to be viable and appropriate for the SWM in the DF.

7.5 Phased Implementation Plan

The proposed implementation plan of the Master Plan is shown in Figure 7-12.

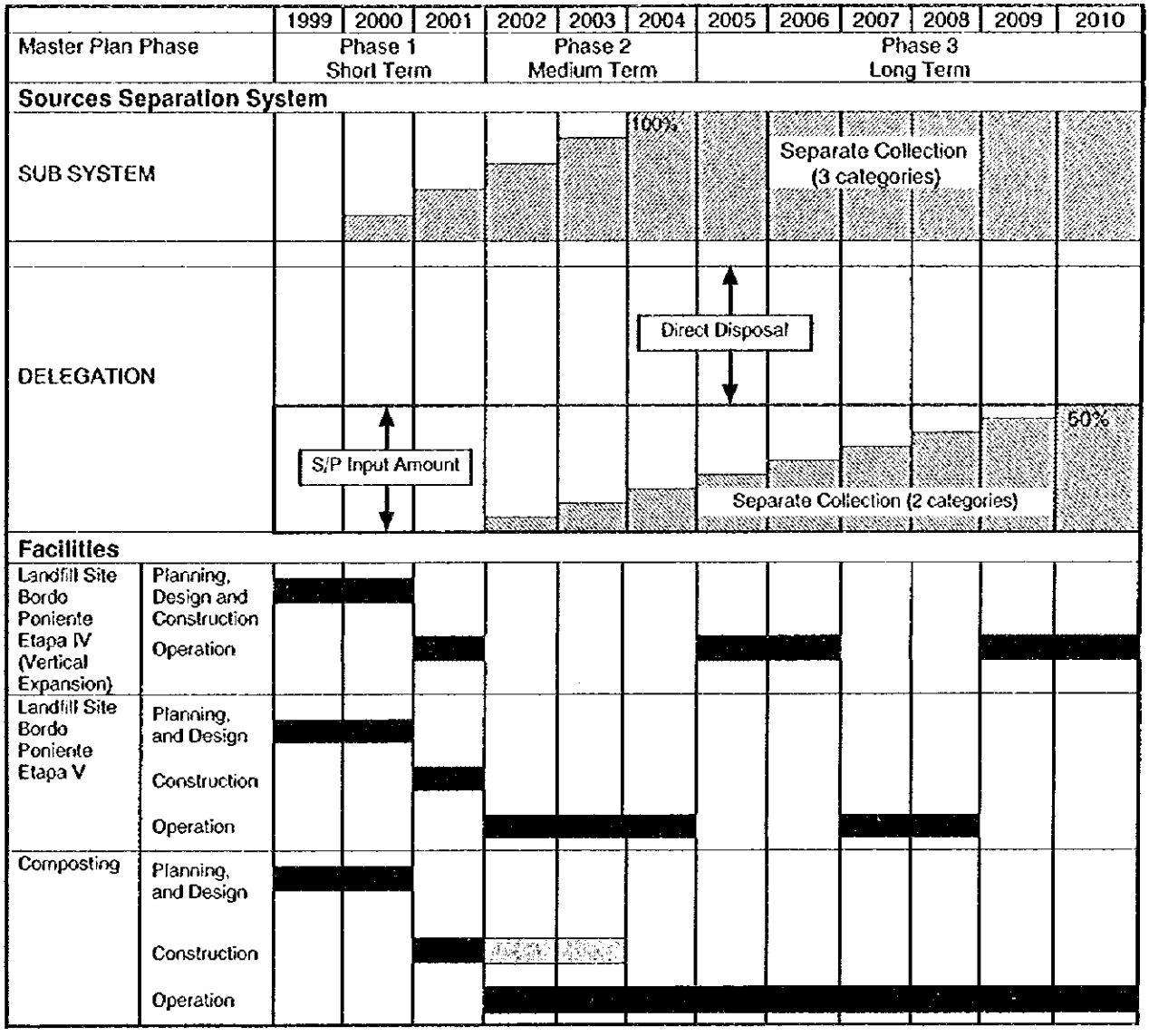


Figure 7-12: Phased Implementation Plan

7.6 Selection of Priority Projects

The projects, which are planned to be constructed in the short term (Phase 1: year 1999 to 2001), i.e., vertical expansion of Etapa IV, new establishment of Etapa V and a composting facility, should be selected as the priority projects of the Study.

7.7 Initial Environment Examination

7.7.1 IEE Outline and Objective

The IEE (Initial Environmental Examination) of the proposed three projects, i.e. new establishment of Bordo Poniente Etapa V, vertical expansion of Etapa IV and introduction of a composting plant, was attempted.

IEE is a process aiming to determine (i) whether detailed EIA (Environmental Impact Assessment) is required and (ii) if so, what types of impacts should be further studied. The former is often called "screening" and the latter "scoping". Generally, screening is done by a competent authority according to relevant laws and regulations. Therefore, screening shown in this chapter should be interpreted as a process to have a vision regarding on which project the EIA study should concentrate during the second study work in Mexico of the team. Therefore, IEE has an objective to allot available resources to selected problematic issues and to deliver the study as efficiently as possible.

7.7.2 IEE Process

In Mexico, the guidelines issued by INE are available for the preparation of an EIA report based on Article 9 and 10 of the EIA regulation[13]. Although they are focusing on the projects which are subject to an EIA process at the national level, it is assumed that most governmental bodies at local levels follow the same, or even less strict, guidelines.

EIA of Mexico is categorized into three modalities: general, moderate and special. Moderate and/or special EIA reports are required only when the authority considers, by reviewing general EIA, that more precise EIA is needed. At present, however, the alteration of such categorization structure is in progress within the SEMARNAP. Under this condition, it should be enough for this moment to refer to the EIA guideline for general modality.

This guideline specifies the structure of the EIA report as below and it is, however, not necessarily tailored for a SWM project.

Chapter 1: General Data

Chapter 2: Description of Projected Activities

Chapter 3: General Aspects of Natural and Socioeconomic Environment

Conclusions.

In regard to "Impact Assessment", Chapter 3 is a prime concern for the team's EIA and it is considered that the method instructed by the JICA Guideline[14] can be used for IEE. It employs a matrix approach where 23 environmental items are listed so that attention is paid to all aspects from the initial stage. The items shown above under the

[13] El Regulamento de la Ley General del Equilibrio Ecologico y la Protección al Ambiente en Material de Impacto Ambiental

[14] *Environmental Guidelines for Infrastructure Projects No. VI, Solid Waste Management*, JICA, September 1992.

title of Chapter 3 are all inclusive. Using the JICA Guideline, the following steps are then followed.

Step 1: For each items listed, the possibility of environmental impact is considered as far as possible within information available at this stage. Evaluation is ranked from A to D as follows.

Rank A: Serious impacts might be caused.

Rank B: Some impacts might be caused.

Rank C: Extent of impact is unknown because sufficient information is lacking, and/or it depends on the project location.

Rank D: There will be no impact.

Step 2 (Screening): EIA study for which projects should be carried out is considered.

Step 3 (Scoping): From items ranked as A, B or C, those which should be studied further during the second study work in Mexico are chosen and the contents of the work are defined.

7.7.3 Evaluation of Environmental Items (Step 1)

Environmental items of the JICA Guideline are listed in the first column of Table 7-42. In the second and third columns, possible effects are explained in general terms which could be occurred during the construction and operation stages of a SWM project. During the construction stage, land acquisition, land occupation, use of construction equipment and traffic of construction tracks will be the main causes of impacts. During the next operation stage, activities such as waste transport of trailers, and operation of the concerned facility are the causal factors. It is to be noted that "operation stage" does not mean only a stage of actual operation but includes a stage where any significant influence caused by the project remain even after the closure of the project.

The right half of the table shows the evaluation by A-D ranking of each environmental item for the three F/S projects together with reasons for the evaluation.

Table 7-42: Evaluation of Environmental Items

Notes:

- Activities "During Construction" include land acquisition, land occupation, use of construction equipment and traffic of construction tracks.
- Activities "During Operation" include traffic of waste trailers and operations of the concerned facility (i.e. landfilling and composting).
- Evaluation of possible environmental impact is expressed by ranks from A to D.

  Rank A: Serious impacts might be caused.
  Rank B: Some impacts might be caused.
  Rank C: Extent of impact is unknown because sufficient information is lacking, and/or it depends on the project location.
  Rank D: There will be no impact.

	Possible Cause and Effect (General guide for SWM project)		BP V		BP IV		Composting Facility	
Evaluation Items	During Construction	During Operation	Rank	Reasons	Rank	Reasons	Rank	Reasons
Social Environment								
Resettlement	Resettlement of people living in the proposed land or on the access route.		D	There is no need to resettle any residents.	D	Same as for BP V.	D	Same as for BP V.
Economic Activities	Disturbance of economic activities.		D	No economic activities take place in the area which could be affected by the project.	D	Same as for BP V.	D	There will be even a positive impact on the local economy because composting is an economic activity of resource recovery.
Transport	Increase in traffic and accidents.	Increase in traffic and accidents.	D	The change in traffic should be minimum because the new site is near the present site.	D	There is no change in traffic.	D	As the composting facility will be near the BP V and BP IV, there will be no major change of waste transport route.
Public Facilities	Impacts on schools, hospitals, etc. by traffic and noise.	Impacts on schools, hospitals, etc. by traffic and noise.	D	There is no public facilities affected.	D	Same as for BP V.	D	Same as for BP IV.
Division of Community	Geographical separation of community or interruption of its communication.		D	The site is in the federal zone, where is no community.	D	Same as for BP V.	D	Same as for BP V.

	Possible Cause and Effect (General guide for SWM project)		BP V		BP IV		Composting Facility	
Evaluation Items	During Construction	During Operation	Rank	Reasons	Rank	Reasons	Rank	Reasons
Historical Heritage/Cultural Properties	Loss and/or devaluation of historical heritage or cultural properties such as churches, archeological remains and historical assets.	Devaluation of them by waste trailers passing nearby.	D	There are no historical heritage or cultural properties affected.	D	Same as for BP V.	D	Same as for BP IV.
Water Rights/Access Rights	Obstruction of fishing rights, water rights and rights of common access.		D	The site is owned by the Federation, and neither water rights nor access rights is associated with the land.	D	The site has been used for waste landfilling by the GDF.	D	Same as for BP IV.
Public Health		Degradation of public health due to wastes fallen from the trailers, the existence of a great amount of wastes in a limited area, and/or vermin/ pathogens proliferation there.	B	Wastes are transported by trailers with sheet covers to minimize the litter. Landfill operation practice should be well planned so that the site does not attract unduly vermin or pathogens.	B	Same as for BP V.	B	Same as for BP V.
Waste (from the project)	Generation of construction wastes and debris.		D	No excavation work is planed, thus there is minimal construction waste generated.	D	Same as for BP V.	D	Residue will be transported to BP IV or BP V both of which are close to the composting point.
Accidents/Risks		Landfill gas (CH_4) explosion, intrusion of CO_2 into residence, refuse fires, landslides, lateral pressure on land.	B	As the site receives only non-hazardous wastes, chemical reactions will not be caused. The landfill design and practice will minimize possible risks. A due distance from any physical structures should minimize the effect on them by lateral pressure.	B	Same as for BP V.	B	The facility receive only separated organic waste. The facility design should ensure aerobic decomposition so that gas generation will be minimized.
Natural Environment								
Topography and Geology	Change in valuable topography and geology due to excavation.	Change in valuable topography and geology due to landfill works.	D	Change in topography is inevitable, but the topography and geology of the site is not particularly valuable.	D	Same as for BP V.	D	Same as for BP V.
Soil Erosion	Increase in soil erosion due to land preparation and/or deforestation.		D	Vegetation, if any, will be removed for landfill cell preparation. But the landfill work starts right after the cell preparation, thus it is unlikely to cause soil erosion.	D	The cover soil was applied to the site and the work is essentially piling up the waste.	D	No major modification is given to the land.

	Possible Cause and Effect (General guide for SWM project)		BP V		BP IV		Composting Facility	
Evaluation Items	During Construction	During Operation	Rank	Reasons	Rank	Reasons	Rank	Reasons
Groundwater		Change in quality and level of groundwater due to leachate.	B	The level of surface aquifer is almost same as the ground level and its water is too saline to be used. But there is another deeper aquifer. Groundwater hydrology and technologies to be practiced at the site should be understood.	B	Appropriate leachate management technique should be employed.	B	When it rains excessively, leachate-containing water could seep out from the waste and has to be dealt with appropriately.
Hydrological Conditions	Changes in river discharge and riverbed condition.	Changes in river discharge and riverbed condition due to in-flow from the site.	D	There are no surface water bodies to be affected.	D	Same sentence.	D	There are no surface water bodies to be affected.
Coastal Zone	Impacts on coastal environment.	Impacts on coastal environment.	D	There is no coast near the site.	D	Same as for BP V.	D	Same as for BP V.
Fauna and Flora	Obstruction of breeding of natural species and/or extinction of them due to interruption or loss of their habitats.		C	It should be examined whether there are any important species of fauna and/or flora to be protected, what the level of their importance is and what the distance is between the site and their habitat.	D	As the land is already occupied by the landfill, there is no important wildlife.	D	There is no important wildlife.
Meteorology	Changes in temperature, wind direction and/or intensity, etc.	Changes in temperature, wind direction and/or intensity, etc.	D	The scale of the project is not large enough to cause any change in meteorology.	D	Any meteorological change is envisaged.	D	Same as for BP IV.
Landscape/ Aesthetics	Change in landscape.	Decrease in aesthetic values due to the existence of landfill.	B	The landfill work may result in a change in landscape.	B	Same as for BP V.	D	Any major change in landscape is not envisaged.
Pollution								
Air Pollution	Deterioration of air quality due to the increased traffic.	Deterioration of air quality due to the increased traffic and dust from wastes delivered by tracks, the landfill gases and/or smoke/dust from the site operation.	B	Traffic does not increase from the current level, but the mode of traffic may change depending on the BP V site location. Dust from landfill works should be minimized. Landfill gases control should be considered.	B	Traffic does not increase from the current level. Dust from landfill works should be minimized. Landfill gases control should be considered.	B	Traffic does not increase from the current level. Dust from plant operation should be minimized.

	Possible Cause and Effect (General guide for SWM project)		BP V		BP IV		Composting Facility	
Evaluation Items	During Construction	During Operation	Rank	Reasons	Rank	Reasons	Rank	Reasons
Water Pollution	Deterioration of water quality of surface water and/or groundwater due to the inflow of sand/silt from land preparation work.	Deterioration of water quality of surface water and/or groundwater due to the inflow of sand/silt and leachate from the site.	B	Hydrological linkage of surface water and the leachate control measures should be examined.	B	Appropriate leachate management technique should be employed.	B	When it rains excessively, leachate-containing water could seep out and has to be dealt with appropriately.
Soil Contamination		Contamination of soil by leakage of leachate.	B	Soil characteristics and the leachate control measures should be examined.	B	Appropriate leachate management technique should be employed.	B	When it rains excessively, leachate-containing water could seep out and has to be dealt with appropriately.
Noise and Vibration	Noise and vibration caused by the construction operation and/or the construction tracks.	Noise and vibration caused by the waste trailers and/or the landfill site equipment.	D	There is a sufficient distance from the site to the adjacent population.	D	The level of noise and vibration should be the same as the present.	B	A turner and a shredder may cause loud noise.
Land Subsidence	Land subsidence due to the land deformation.		D	Land subsidence is only limited to the landfilled area. (Lateral pressure is taken care of under the item of "risk" above.)	D	Same as for BP V.	D	Land subsidence is only limited to the facility area.
Offensive Odor		Odor caused by scattered wastes from waste trailers and/or wastes landfilled at the site.	B	Waste is transported with sheet covers. After landfilled, waste is covered with soil. Wind direction and location of residential area should be examined.	D	There will be no change in odor effect.	B	The facility should be located and designed to minimize the odor effect.

7.7.4 Screening (Step 2)

Examining the two columns of the table corresponding to the Bordo Poniente Etapa V project and the Etapa IV project and understanding the similarity of their characteristics, however, it will be reasonably considered that the study on environmental impact of the former will give sufficient implication about environmental impact of the latter. Therefore, the JICA study team concluded that the EIA study exclusively for the Etapa IV vertical expansion project is not carried out by them.

7.7.5 Scoping (Step 3)

In Step 3, what works should be done with prudent attention during the following EIA process were considered. They are summarized in Table 7-43.

As the table shows, there are two types of works. One is information collection and its examination with a purpose to well understand the possible cause and effect and to figure out the countermeasures, if needed (listed with black dots). The other is the elaboration of facility designs to mitigate anticipated environmental impacts (indicated by white dots and a italic type font).

Considering the restriction of available resources and time during the second study work, it is reasonably recommended to mainly take care of the issues requiring first type of work, i.e. information collection and problem understanding. The second type of work will be incorporated to the technical design works and final review and viability judgment will be attempted later on as part of EIA.

It should be stressed that scoping shown here does not strictly delineate the range of the study but imply the reasonable allocation of resources into issues of relative importance.

Table 7-43: Scoping

	BP V		Composting Facility	
Evaluation Items	Rank	Work Description	Rank	Work Description
Public Health	B	□ *To ensure appropriate landfill operation to prevent unduly proliferation of vermin and/or pathogens.*	B	□ *To ensure appropriate plant operation to prevent unduly proliferation of vermin and/or pathogens.*
Accidents/Risks	B	• To check the distance from the site to residential area. • To examine the influential area of lateral earth pressure and whether any facilities are within there. □ *To ensure appropriate landfill operation minimize possible risks.*	B	□ *To ensure aerobic decomposition to minimize gas generation.*
Groundwater	B	• To examine groundwater hydrology. • To obtain baseline data of groundwater quality. □ *To ensure landfill technologies to be appropriate for groundwater hydrology.*	B	□ *To ensure an appropriate surface drainage.*
Fauna and Flora	C	• To collect information about wildlife in the area. • To study the level of impact on them by the project if important species are within the influential area.		
Landscape/ Aesthetics	B	• To examine a change in landscape and assess its impact.		
Air Pollution	B	• To collect information about the route of waste transport. • To study meteorology. □ *To ensure landfill practice to minimize dust from waste and to control landfill gases.*	B	□ *To ensure plant operation practice to minimize dust from waste and to gas generation.*
Water Pollution	B	• To collect information about surface water hydrology. • To obtain baseline data of surface water quality. □ *To ensure landfill design to control leachate.*	B	□ *To ensure plant design to control leachate.*
Soil Contamination	B	• To collect information about soil characteristics. • To obtain baseline data of soil quality □ *To ensure leachate control measures to be employed.*	B	□ *To ensure appropriate drainage.*
Noise and Vibration			B	• To analyze noise level on the site and on its periphery.
Offensive Odor	B	• To collect information about wind direction and location of residential area. • To assess impacts on residential area if it is within the influential area.	B	• To collect information about wind direction and location of residential area. • To assess impacts on residential area if it is within the influential area. □ *To ensure appropriate operation to minimize the odor effect.*

Notes:
- • denotes items to be done in order to understand the possible causes and effects.
- □ denotes items to be done in order to elaborate facility design for impact mitigation.