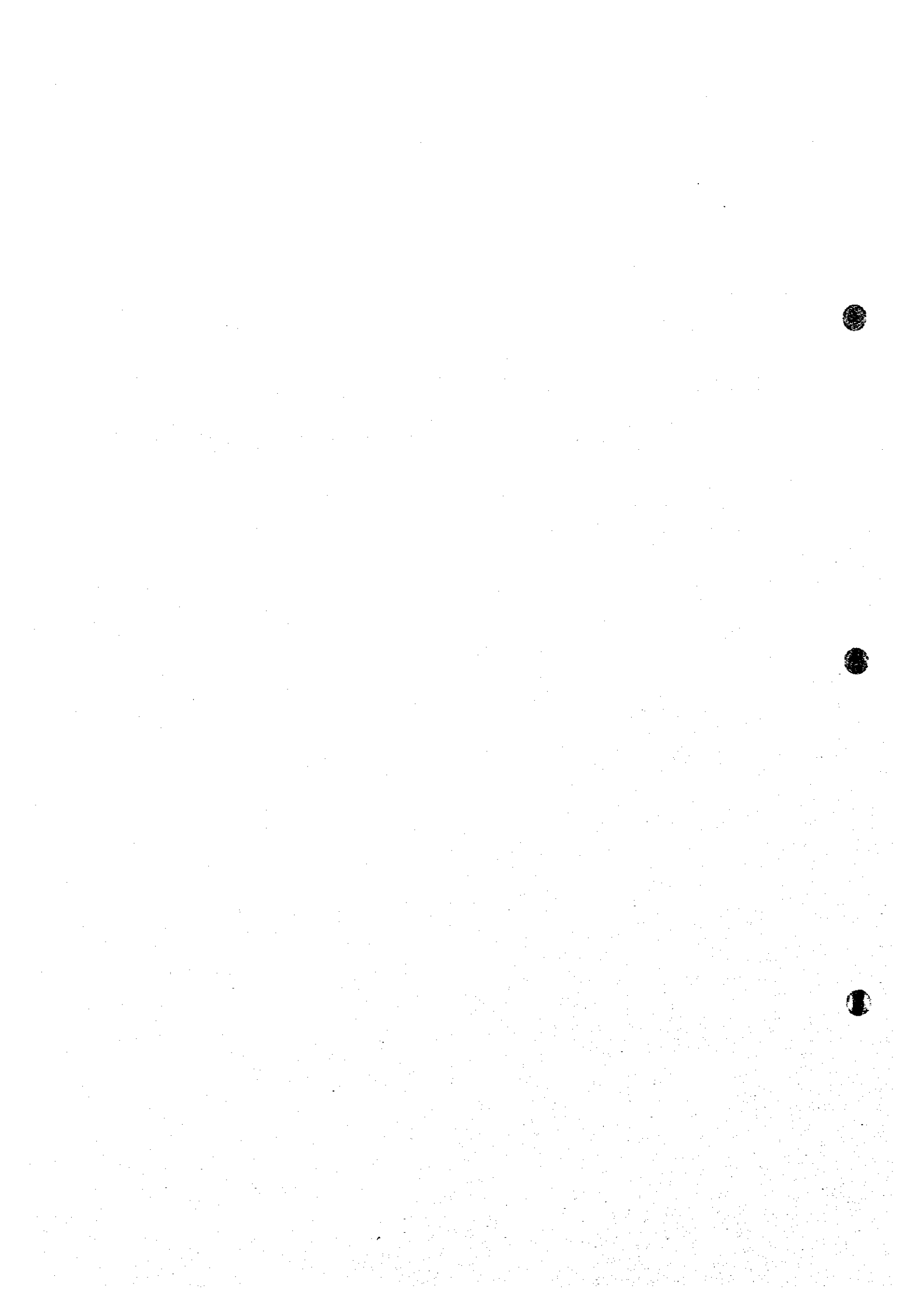


Chapter 3

Field Investigations



3 Field Investigations

3.1 Waste Amount and Composition Survey

3.1.1 Survey Schedule and Sampling Points

a. Survey Schedule

The survey was implemented following the schedule shown in Table 3-1.

Table 3-1: Schedule of Sampling

Sampling Points		August						September				
		25 Tue.	26 Wed.	27 Thu.	28 Fri.	29 Sat.	30 Sun.	31 Mon.	1 Tue.	2 Wed.	3 Thu.	4 Fri.
Final Disposal Site	Bordo Poniente											
	Santa Catarina											
Selection Plant	Bordo Poniente											
	Santa Catarina											
	San Juan de Aragon											

b. Sampling Points

The entrances and exits of the S/Ps and two final disposal sites were the sampling points (see Figure 3-1).

Samples were taken three times a day (in the morning, at noon and in the evening) for seven days.

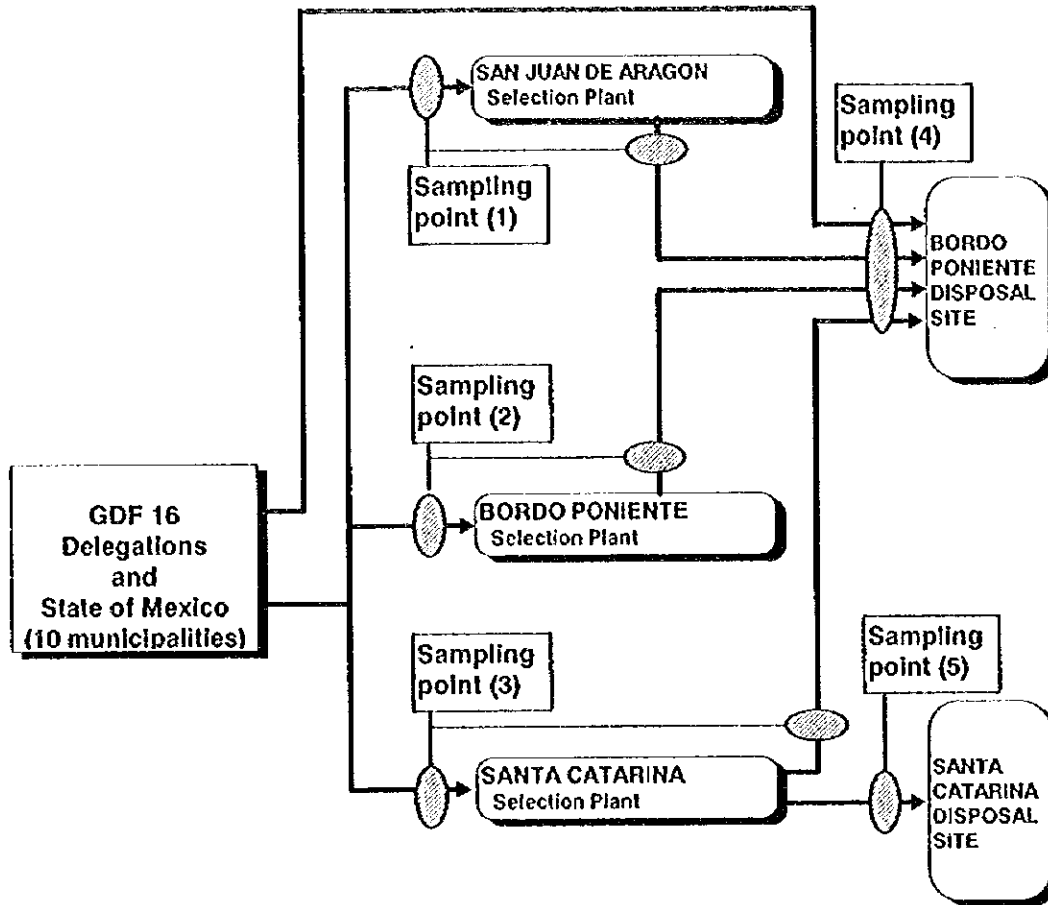


Figure 3-1: Sampling Points

3.1.2 Waste Amount Survey

a. Survey Method

The waste amount survey was carried out by using the existing weighbridges and the number of waste vehicles (in case where a weighbridge is not available) for seven days at eight sampling points (entrances and exits of the three S/Ps and the two final disposal sites) as shown in Figure 3-1.

Table 3-2 shows measuring method of each sampling points.

Table 3-2: Measuring Method of Each Sampling Point

		Entrance	Exit
Selection plant	Bordo Poniente	by weighbridge	by weighbridge
	San Juan de Aragon	by number of vehicles	by weighbridge
	Santa Catarina	by number of vehicles	by number of vehicles
Final disposal site	Bordo Poniente Etapa IV	by weighbridge	-
	Bordo Poniente Etapa III	by number of vehicles	-
	Santa Catarina	by number of vehicles	-

b. Result of the Survey

Table 3-3 shows the amount of wastes carried to and out from the facilities recorded during the survey period.

Table 3-3: Waste Amount Carried-in and Carried-Out

No.	Date	Selection plant (ton/day)						Final disposal site (ton/day)		
		Bordo Poniente		San Juan de Aragon		Santa Catarina		Bordo PTE. ETAPA IV	Bordo PTE. ETAPA III	Santa Catarina
		Entrance	Exit	Entrance	Exit	Entrance	Exit			
1	25/08/98	2,427.100	1,836.820	2,094.314	1,474.710			9,495.096	244.400	
2	26/08/98	1,883.979	2,028.182	2,305.937	510.150			6,155.460	233.658	
3	27/08/98	2,328.030	3,405.689	2,207.129	1,785.960	1,805.228	1,587.840	10,233.060	220.922	3,437.286
4	28/08/98	1,405.070	3,080.250	2,050.249	2,034.370	1,832.232	1,627.536	9,828.802	249.401	3,242.200
5	31/08/98	2,475.820	1,932.150	1,384.999	1,203.820	1,377.440	1,488.600	5,282.064	291.658	3,061.186
6	1/09/98	2,304.555	2,743.771	2,174.895	1,909.840	1,335.337	1,429.056	4,471.447	287.919	2,910.732
7	2/09/98	2,265.210	382.140	2,352.444	1,733.280	1,961.243	1,548.144	8,812.996	468.441	3,114.002
8	3/09/98					1,845.844	1,984.800			3,021.154
9	4/09/98					1,914.403	1,627.536			3,210.570
Total		15,089.764	15,409.002	14,570.017	10,652.130	12,071.727	11,293.512	54,278.925	1,996.399	22,027.130
Daily average		2,155.681	2,201.286	2,081.431	1,521.733	1,724.532	1,613.359	7,754.132	285.200	3,146.733

Table 3-4 presents average loading amount of carrying-in vehicles/trailers and carrying-out trailers calculated from the survey data.

Table 3-4: Average Loading Amount of Haulage Vehicle

unit : ton/vehicle

No.	Date	Selection plant						Final disposal site		
		Bordo Poniente		San Juan de Aragon		Santa Catarina		Bordo PTE. ETAPA IV	Bordo PTE. ETAPA III	Santa Catarina
		Entrance	Exit	Entrance	Exit	Entrance	Exit			
1	25/08/98	9.56	20.64	5.54	24.18			20.07	4.14	
2	26/08/98	9.56	19.69	6.27	23.19			20.52	4.58	
3	27/08/98	9.46	21.97	5.98	24.47	15.98	19.85	20.88	5.52	19.42
4	28/08/98	7.17	21.24	6.70	22.60	15.66	19.85	20.96	4.16	19.53
5	31/08/98	10.27	22.47	6.33	22.71	15.30	19.85	19.21	5.61	19.50
6	1/09/98	10.29	23.45	6.51	25.46	13.09	19.85	20.70	5.14	19.35
7	2/09/98	10.07	23.88	6.39	24.76	14.75	19.85	21.65	6.01	19.46
8	3/09/98					14.89	19.85			19.37
9	4/09/98					15.07	19.85			19.46
Daily average		9.48	21.91	6.25	23.91	14.96	19.85	20.57	5.02	19.44

c. Findings

c.1 Selection Plant

Table 3-5 illustrates the daily average amount of wastes that enter and exit from the S/Ps during the survey period. At the Bordo Poniente S/P, the average exiting amount is a little larger than the average entering amount. This is considered to be

mainly attributable to that the standing amount of wastes/rejects in the plant yard is decreased in the survey period (i.e., the total standing amount of “wastes after entrance and before process” and “rejects after process and before exit” in the plant yard on the last day of the survey was much smaller than that amount of the first day of the survey.).

Where it is assumed, ignoring the variation of yard standing amount, that the material recovery amount is “entering amount minus exiting amount”, the material recovery ratio of the three S/Ps works out at 10.5%. It almost corresponds to the estimated material recovery ratio (about 10%) that was calculated for the waste stream analysis based on the plants operation records, and is adopted in the present waste stream of the DF (see Section C.2 in Annex C). The average entering amounts recorded for respective S/Ps approximately correspond to the current performance (design) level set for the S/Ps operation.

Table 3-5: Waste Amount Carried-in and Carried-out of Selection Plants

	Current Performance (Design) (ton/day)	Enter (ton/day)	Exit (ton/day)	Enter - Exit (ton/day)
Bordo Poniente	2,000	2,156	2,201	- 45
San Juan de Aragon	2,000	2,081	1,522	559
Santa Catarina	1,500	1,725	1,613	112
Total	5,500	5,962	5,336	626
Ratio (%)	-	100	89.5	10.5

c.2 Final Disposal Site

Daily average final disposal amount recorded in the survey is 11,186 ton/day, which approximately corresponds to the estimated amount (10,313 ton/day in the year 1998) that was calculated based on the existing information and is adopted in the present waste stream of the DF.

c.3 Waste Stream

The waste stream of the S/Ps to final disposal sites calculated from the seven days survey data is illustrated in Figure 3-2.

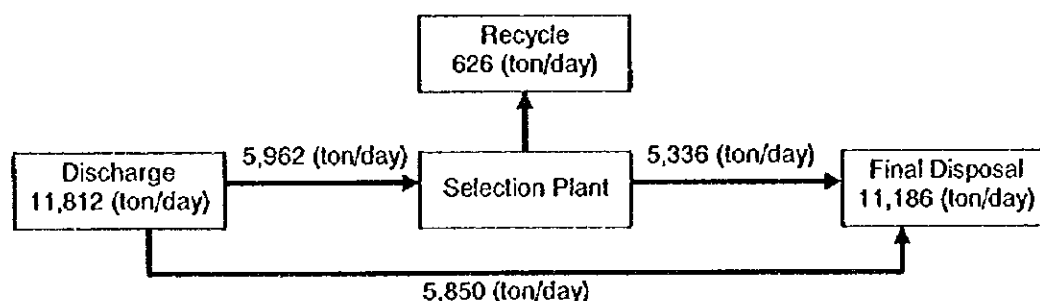


Figure 3-2: Waste Stream Calculated From Waste Amount Survey

3.1.3 Waste Composition Survey

a. Survey Items and Number of Samples

The waste composition survey included determination of bulk density, wet base physical composition survey, the three components analysis (water, combustibles, and ash), and ultimate analysis (carbon and nitrogen). The classification of physical composition consisting 35 categories used by the GDF was followed in order for the study's analyses to bear some resemblance with previous data. A sample for the three components analysis was prepared by compounding three samples collected in a day. The weight/volume ratio was calculated from the haulage truck loading capacity (70 m³) and the weighbridge outputs. The numbers of samples are shown in Table 3-6.

Table 3-6: Summary of Waste Composition Survey

	Waste Composition Survey			
	Physical Composition		Three Components, C and N Survey	
	Entrance	Exit	Entrance	Exit
Sampling Point 1: San Juan de Aragon S/P	3 times per day x 7 days = 21 samples	3 times per day x 7 days = 21 samples	1 sample per day x 7 days = 7 samples	1 sample per day x 7 days = 7 samples
Sampling Point 2: Bordo Poniente S/P	3 times per day x 7 days = 21 samples	3 times per day x 7 days = 21 samples	1 sample per day x 7 days = 7 samples	1 sample per day x 7 days = 7 samples
Sampling Point 3: Santa Catarina S/P	3 times per day x 7 days = 21 samples	3 times per day x 7 days = 21 samples	1 sample per day x 7 days = 7 samples	1 sample per day x 7 days = 7 samples
Total	63 samples	63 samples	21 samples	21 samples
	126 samples		42 samples	

b. Survey Methods

b.1 Sampling Methods

Since the volume of landfill wastes is so large (approx. 11,000 ton) heavy machinery was used to collect the samples. The sampling methods are summarized in Table 3-7.

Table 3-7: Sampling Methods

At Entrance	At Exit
Approximately 1,000 kg of waste is taken as a sample at the entrance platform; the volume is reduced* to about 100 kg by the method described below for the physical component survey.	Approximately 1,000 kg of waste that is unloaded is removed as a sample. The volume is reduced* to about 100 kg by the method described below for the physical component survey.
Three such samples taken in a day are mixed and reduced to 20-30 kg by the method below to prepare a sample for the three components survey.	Three such samples taken in a day are mixed and reduced to 20-30 kg by the method below to prepare a sample for three elements survey.

* Volume reduction method:

First, the waste is mixed; if it contains bulky items, they have to be cut into pieces. Once the mixture is heterogeneous, it is divided into four piles of approximately the same volume. The two portions at diagonally opposite ends are removed and the rest is mixed. This process is repeated until the intended volume remains.

b.2 Wet Base Physical Composition

For the physical composition survey, sampling yards were prepared at each sampling point. The wastes are classified into 35 categories following the GDF's method and waste of each category was weighed.

b.3 Three Components Analysis

Out of the samples which have used for the physical composition survey, organic materials were mixed and reduced to 20-30 kg and the three components (water, combustibles, and ash) were analyzed in a laboratory.

b.4 Ultimate Analyses

In the ultimate analysis, carbon and nitrogen contents of the samples from the three component analysis were quantified.

c. Results of the Survey

c.1 Physical Composition

Table 3-8 shows the summary of physical composition.

Table 3-8: Summary of Physical Composition

unit : (%)

No	Composition	Name of S/P	Bordo Poniente S/P		San Juan de Aragon S/P		Santa Catarina S/P	
			Entrance	Exit	Entrance	Exit	Entrance	Exit
1	Abatelenguas	Spatula	0	0	0	0	0.04	0
2	Algodon	Cotton	0.42	0.08	0.07	0.25	0.09	0.02
3	Carton	Cardboard	5.41	5.53	5.54	7.33	5.43	5.35
4	Cuero	Leather	0.46	0.93	0.4	0.48	0.45	0.72
5	Envase de Carton	Paper container	1.36	1.59	0.87	1.09	0.82	1.01
6	Fibra Dura Vegetal	Vegetable fiber	0.04	0.49	0.4	0.1	0.24	0.16
7	Fibra Sintetica	Synthetic fiber	0.23	0.5	0.13	0.39	0.59	0.95
8	Gasa	Gauze	0	0.09	0	0	0.29	0
9	Hueso	Bone	0.39	0.88	0.41	0.71	0.39	0.4

No	Composition	Name of S/P	Bordo Poniente S/P		San Juan de Aragon S/P		Santa Catarina S/P	
			Entrance	Exit	Entrance	Exit	Entrance	Exit
10	Hule	Vinyl	0.12	0.13	1.49	0.9	0.73	0.6
11	Jeringa Desechable	Disposable syringe	0.01	0	0	0	0.39	0
12	Lata	Cans	0.62	0.8	0.4	0.68	0.85	0.49
13	Loza y Ceramica	Ceramics	0.75	0.28	0.15	0.28	0.6	0.13
14	Madera	Wood	2.01	2.16	2.56	3.24	2.41	3.36
15	Material de Construccion	Construction waste	3.44	4.52	6.68	6.38	3.33	4.9
16	Material Ferroso	Metal	1.23	1.8	1.6	0.7	1.63	1.79
17	Material No Ferroso	Nonferrous metal	0.16	0.37	0.12	0.02	0.64	0.01
18	Papel Bond	Paper	1.58	1.7	5.89	6.48	5.04	10.03
19	Papel Periodico	News paper	4.28	4.57	1.29	0.76	3.46	1.88
20	Papel Sanitario	Toilet paper	4.14	5.05	5.43	3.87	3.14	2.24
21	Panal Desechable	Disposable diaper	5.46	4.69	4.6	4.27	4.49	5.14
22	Placas Radiologicas	X-ray film	0.04	0.04	0	0	0.78	0.01
23	Plastico de Pelicula	Plastic film	9.29	9.09	7.81	8.23	7.03	7.73
24	Plastico Rigido	Hard plastic	4.62	5.28	3.64	2.1	3.35	3.19
25	Poliuretano	Polyurethane	0.54	0.3	0.15	0.14	0.95	0.18
26	Poliuretano Expandido	Foamed polyurethane	0.22	0.19	2.25	0.91	2.44	2.23
27	Residuo Alimenticio	Food waste	16.11	13.25	14.36	12.47	15.03	13.63
28	Residuo de Jardineria	Garden waste	19.56	17.23	8.35	6.44	10.55	8.46
29	Toallas Sanitarias	Sanitary napkin	0.64	0.29	0	0.02	1.05	0
30	Trapo	Rags	4	3.97	4.59	4.66	4.57	5.23
31	Vendas	Bandage	0	0.1	0	0	1.1	0
32	Vidrio de Color	Color glass	2.43	1.31	0.33	0.5	1.49	0.49
33	Vdrio Transparente	Transparent glass	1.15	0.61	2.15	0.7	3.06	1.52
34	Residuo Fino	Fine fraction	3.14	3.84	5.45	7.11	5.26	7.58
35	Otros	Others	6.15	8.36	12.92	18.82	8.32	10.59
Total			100.0	100.0	100.0	100.0	100.0	100.0

c.2 Bulk Density

Table 3-9 shows the summary of bulk density.

Table 3-9: Summary of Bulk Density

Date	No.	Bordo Poniente		San Juan de Aragon		Santa Catarina	
		Entrance (kg/m ³)	Exit (kg/m ³)	Entrance (kg/m ³)	Exit (kg/m ³)	Entrance (kg/m ³)	Exit (kg/m ³)
25/08/98	1			255	330	315	272
	2	-----		207	258	363	390
	3			210	249	231	423
26/08/98	1			331	281	310	165
	2	-----		340	281	250	255
	3			288	362	250	345
27/08/98	1	245	378	298	356	300	275
	2	202	298	391	334	395	295
	3	---	377	244	353	230	285
28/08/98	1	145	254	344	299	275	355
	2	173	260	228	272	260	355
	3	183	327	328	346	370	300
31/08/98	1	351	410	238	307	320	335
	2	322	418	246	241	245	270
	3	252	283	234	270	280	335
1/09/98	1	226	462	389	307	380	345
	2	332	316	283	270	300	370
	3	325	317	270	352	370	330

Date	No.	Bordo Poniente		San Juan de Aragon		Santa Catarina	
		Entrance (kg/m ³)	Exit (kg/m ³)	Entrance (kg/m ³)	Exit (kg/m ³)	Entrance (kg/m ³)	Exit (kg/m ³)
2/09/98	1	267	417	204	251	285	390
	2	160	227	304	365	360	340
	3	270	342	299	392	392	321
3/09/98	1	350	358				
	2	235	316				
	3	311	304				
4/09/98	1	229	378				
	2	229	425				
	3	309	301				
6/09/98	1	292	---				
Average		257	341	282	308	309	321

c.3 Tree Components and Ultimate Analysis

Table 3-10 shows the summary of three components and ultimate analysis.

Table 3-10: Summary of Three Components and Ultimate Analysis

		Selection plants						Average	
		Bordo Poniente		San Juan de Aragon		Santa Catarina			
		Ent.	Exit	Ent.	Exit	Ent.	Exit	Ent.	Exit
Carbon	(%)	46.09	39.64	42.30	47.50	42.67	42.05	43.69	43.06
Nitrogen	(%)	1.82	1.58	2.06	1.74	1.88	1.95	1.92	1.76
C/N Ratio	-	25.3	25.1	20.5	27.3	22.7	21.6	22.8	24.5
Ash	(%)	10.13	13.53	6.90	9.12	11.01	9.58	9.35	10.74
Water	(%)	67.14	60.03	67.93	69.94	67.75	64.85	67.61	64.94
Combustible	(%)	22.73	26.44	25.17	20.94	21.24	25.57	23.04	24.32

3.1.4 Findings

In view of physical composition, garden waste, food waste and plastics account for a substantial proportion, and the entering wastes and exiting wastes show the mostly same tendency in physical composition in respective S/Ps. Even though in comparing item by item of physical composition between the entering wastes and exiting wastes, an item of major proportional change is not found. This implies that the S/Ps' recovery ratios are low.

In categorizing the physical composition items into three (organic, recyclable, others) as shown in Table 3-11, recyclable wastes account for about 30%. Therefore, theoretically speaking, if the whole amount of recyclable matter in the S/Ps are recovered, the recovery ratio is raised to 30%.

Table 3-11: Categorized Waste Composition Items at S/Ps

	Composition		Bordo Poniente		San Juan de Aragon		Santa Catarina	
			Ent.	Exit	Ent.	Exit	Ent.	Exit
Organic								
O	Fibra Dura Vegetal	Vegetable fiber	0.04	0.49	0.4	0.1	0.24	0.16
O	Hueso	Bone	0.39	0.89	0.41	0.71	0.39	0.4
O	Residuo Alimenticio	Food waste	16.11	13.25	14.36	12.47	15.03	13.63
O	Residuo de Jardineria	Garden waste	19.56	17.23	8.35	6.44	10.55	8.46
		Organic total	36.1	31.85	23.52	19.72	26.21	22.65
Recyclable								
R	Carton	Cardboard	5.41	5.53	5.54	7.33	5.43	5.35
R	Fibra Sintetica	Synthetic fiber	0.23	0.5	0.13	0.39	0.59	0.95
R	Hule	Vinyl	0.12	0.13	1.49	0.9	0.73	0.6
R	Lata	Cans	0.62	0.8	0.4	0.68	0.85	0.49
R	Material Ferroso	Metal	1.23	1.8	1.6	0.7	1.63	1.79
R	Material No Ferroso	Nonferrous metal	0.16	0.37	0.12	0.02	0.64	0.01
R	Papel Bond	Paper	1.58	1.7	5.89	6.48	5.04	10.03
R	Papel Periodico	News paper	4.28	4.57	1.29	0.76	3.46	1.88
R	Plastico de Pelicula	Plastic film	9.29	9.09	7.81	8.23	7.03	7.73
R	Plastico Rigido	Hard plastic	4.62	5.28	3.64	2.1	3.35	3.19
R	Vidrio de Color	Color glass	2.43	1.31	0.33	0.5	1.49	0.49
R	Vdrio Transparente	Transparent glass	1.15	0.61	2.15	0.7	3.06	1.52
		Recyclable total	31.12	31.69	30.39	28.79	33.3	34.03
Others								
	Abatelenguas	Spatula	0	0	0	0	0.04	0
	Algodon	Cotton	0.42	0.08	0.07	0.25	0.09	0.02
	Cuero	Leather	0.46	0.93	0.4	0.48	0.45	0.72
	Envase de Carton	Paper container	1.36	1.59	0.87	1.09	0.82	1.01
	Gasa	Gauze	0	0.09	0	0	0.29	0
	Jeringa Desechable	Disposable syringe	0.01	0	0	0	0.39	0
	Loza y Ceramica	Ceramics	0.75	0.28	0.15	0.28	0.6	0.13
	Madera	Wood	2.01	2.16	2.56	3.24	2.41	3.36
	Material de Construccion	Construction waste	3.44	4.52	6.68	6.38	3.33	4.9
	Papel Sanitario	Toilet paper	4.14	5.05	5.43	3.87	3.14	2.24
	Panal Desechable	Disposable diaper	5.46	4.69	4.6	4.27	4.49	5.14
	Placas Radiologicas	X-ray film	0.04	0.04	0	0	0.78	0.01
	Poliuretano	Polyurethane	0.54	0.3	0.15	0.14	0.95	0.18
	Poliuretano Expandido	Foamed polyurethane	0.22	0.19	2.25	0.91	2.44	2.23
	Toallas Sanitarias	Sanitary napkin	0.64	0.29	0	0.02	1.05	0
	Trapo	Rags	4	3.97	4.59	4.66	4.57	5.23
	Vendas	Bandage	0	0.1	0	0	1.1	0
	Residuo Fino	Fine fraction	3.14	3.84	5.45	7.11	5.26	7.58
	Otros	Others	6.15	8.36	12.92	18.82	8.32	10.59
		Others total	32.78	36.48	46.12	51.52	40.52	43.34

Bulk density as an average of entering wastes is: Bordo Poniente S/P 257 kg/m³; San Juan de Aragon S/P 282 kg/m³; and Santa Catarina S/P 309 kg/m³. That of exiting wastes is: Bordo Poniente S/P 308 kg/m³; San Juan de Aragon S/P 282 kg/m³; and Santa Catarina S/P 321 kg/m³. It resulted that the exiting wastes generally have higher bulk density than the entering wastes.

"Three components" and "ultimate analysis" of both entering and exiting wastes at respective S/Ps show same features, which are on average: carbon 43.06%; nitrogen 1.92%; ash 9.35%; humidity 67.61%; and combustible 23.04%. It resulted with extremely high water content. This is considered to be attributable to that the samples for analysis are limited to organic wastes.

On the other hand the C/N (carbon/nitrogen) ratio turns out to be 22.8 (average of entering wastes) to 24.5 (average of exiting wastes), showing a little diversified range of ratio. However, it is judged that the organic wastes that enter and/or exit the S/Ps have good quality to be used for compost production.

3.2 Time and Motion Survey

3.2.1 Objectives

Currently, the waste from the 16 delegations are transported to one of the 13 transfer stations; from there they are hauled to the S/Ps or the final disposal sites in large haulage trailers with loading capacities of 70 m³ or 19 tons. These large trailers are equipped with a Global Positioning System (GPS) so that their movement can be monitored from the Central Supervising Center that controls their routes and timing to avoid traffic congestion. The center should have data useful for this study.

Waste collection leading up to the transfer stations are a combination of processes either using handcarts -- that deliver the waste to collection vehicles -- or collection vehicles, that pick up the waste from specified locations.

The purpose of this survey is to obtain data of working efficiency of waste collection vehicles in Mexico city.

3.2.2 The Survey Schedule

Survey areas and their numbers were set as shown in Table 3-12.

Table 3-12: Outline of Time & Motion Survey

Name of delegation	Number of surveyed trip	Survey period	Total surveyed hours
Benito Juárez	11	25/Aug - 7/Sept.	44.4
Cuauhtemoc	4	31/Aug. - 3/Sept.	27.3
Venustiano Carranza	4	29/Aug. - 31/Aug.	23.3
Miguel Hidalgo	4	2/Sept. - 3/Sept.	14.8
Iztapalapa	6	26/Aug. - 28/Aug.	18.5
Gustavo A. Madero	7	7/Sept. - 15/Sept.	41.7
Total	36	-	170.1

3.2.3 Survey Records

Table 3-13 shows the summary of the Time and Motion survey.

Table 3-13: Summary of Time and Motion Survey

Data	Benito Juárez	Cuauhtemoc	Gustavo A. Madero	Iztapalapa	Miguel Hidalgo	Venustiano Carranza	Total
Number of trips	11	4	7	6	4	4	36
Travel distance (m)	153,070	62,975	115,650	33,730	64,460	31,660	461,545
Travel distance for collection (m)	110,498	57,630	81,500	25,130	45,960	23,710	344,428
Number of collection points	272	65	49	53	118	83	640
Number of beneficiary	3,696	833	5,057	2,962	737	1,632	14,917
(1) Total working hours (hr)	44.443	27.337	41.734	18.511	14.814	23.289	170.128
(2) Travel hours of depot to collection point (hr)	7.541	3.486	5.991	1.755	2.433	1.239	22.445
(3) Actual working hours (hr)	36.902	23.851	35.743	16.756	12.381	22.05	147.683
(4) Unloading time at T/S (hr)	3.176	0.714	0.277	0.461	0.282	0.724	5.634
(5) Moving hours (hr)	0.938	1.399	3.567	1.532	2.905	1.599	11.94
(6) Total stay on (hr)	32.788	21.738	31.899	14.763	9.194	19.727	130.109
(7) Other purposes (hr)	9.937	8.339	8.977	3.23	4.143	7.47	42.096
(8) Total collection hours (hr)	22.851	13.399	22.922	11.533	5.051	12.257	88.013
Average stopped time (hr/point)	0.12054	0.33443	0.651	0.27855	0.07792	0.23767	0.203
Average collection time (hr/point)	0.08401	0.20614	0.4678	0.2176	0.04281	0.14767	0.138
Average collection time per beneficiary (hr/ben.)	0.00618	0.01609	0.00453	0.00389	0.00685	0.00751	0.006
Total average velocity (m/hr)	3,444	2,304	2,771	1,822	4,351	1,359	2,713
Average velocity for collection (m/hr)	2,994	2,416	2,280	1,500	3,712	1,075	2,332
Number of beneficiary per point (ben./point)	13.6	12.8	103.2	55.9	6.2	19.7	23.3

Figure 3-3 shows the components of working hours.

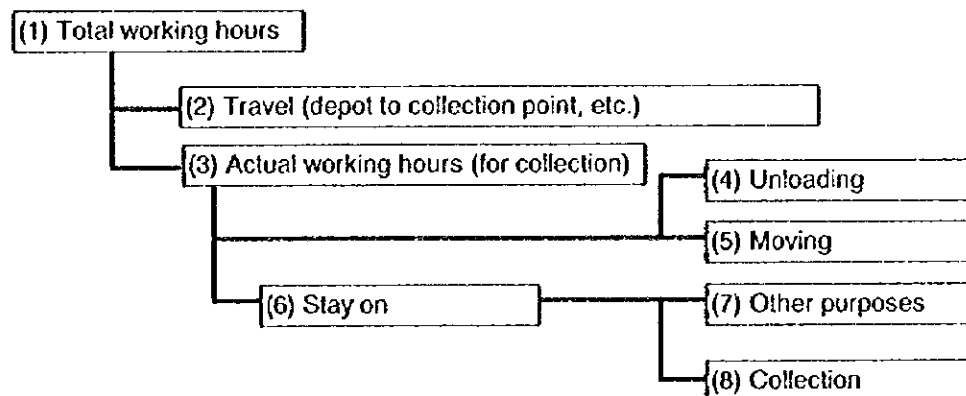


Figure 3-3: Components of Working Hours

3.2.4 Findings

Since it was impossible to weigh the collection waste amount, it was impossible, either, to examine collection efficiency based on the collection amount. Instead, collection efficiency in terms of working hours allocation of the collection vehicles was investigated.

The analysis of the working hours shown in Table 3-14 indicates the following.

- The time spent for traveling from the vehicle depot to the collection area, and from the T/S to the original depot accounts for about 13% of the total working hours on average. ((2) of Figure 3-3)
- The time for unloading collected wastes accounts for about 3% of the total on average. ((4) of Figure 3-3)
- The time for moving within the collection area accounts for about 7% of the total on average. ((5) of Figure 3-3)

Therefore the time for these activities sums up to about 23%, and the rest, 77%, is the time while the vehicle stays for collection. The latter is further divided into actual collection works (52%) and other works for non-collection purposes (25%).

It follows that half of the total working time is occupied with works for purposes other than collection. The reduction of these hours and the improvement of collection efficiency are required.

Table 3-14: Breakdown of Working Hours

	Benito Juárez	Cuauhtemoc	Gustavo A. Madero	Iztapalapa	Miguel Hidalgo	Venustiano Carranza	Total
(1) Total working (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
(2) Travel (%)	17.0	12.8	14.4	9.5	16.4	5.3	13.2
(3) Actual working (%)	83.0	87.2	85.6	90.5	83.6	94.7	86.8
(4) Unloading time at T/S (%)	7.1	2.6	0.7	2.5	1.9	3.1	3.3
(5) Moving (%)	2.1	5.1	8.5	8.3	19.6	6.9	7.0
(6) Stay on (%)	73.8	79.5	76.4	79.8	62.1	84.7	76.5
(7) Other purposes (%)	22.4	30.5	21.5	17.4	28	32.1	24.7
(8) Collection (%)	51.4	49	54.9	62.3	34.1	52.6	51.7

3.3 Public Opinion Survey

3.3.1 Objectives

A public opinion survey was carried out to determine present waste discharge conditions and observe the attitude of the society towards recycling. The opinion of the residents and companies, concerning solid waste management services, their needs and waste discharge manners were aimed to be determined through this survey.

a. Targets of Survey

The survey targets were households and institutions that generate municipal waste which has to be handled by the DGSU.

3.3.2 Number of Samples

a. Households

The number of samples required to obtain a 90 % confidence limit for a population of 100,000 is 382, and for a population of 1,000,000, it is 384. The required samples will

therefore be approximately 386 for the study area with a population of about 8.7 million. Accordingly four hundred samples were considered to be sufficient.

Questionnaires were distributed taking into account the distribution of population and the divergence of economic status throughout the city. Table 3-15 summarizes the number of questionnaires by delegation and by income level of the interviewee's family. Questions were asked by interview.

Table 3-15: Number of Samples by Delegation

Delegation	Total	Monthly Income (pesos)					
		<1,600	1,601 - 4,000	4,001 - 6,400	6,401 - 19,200	19,201<	n.a.*
Alvaro Obregón	32	16	10	2	2	1	1
Azcapotzalco	24	6	9	5	3	0	1
Benito Juárez	20	2	9	6	1	2	0
Coyoacán	32	11	9	5	5	0	2
Cuajimalpa	4	1	1	2	0	0	0
Cuauhtémoc	28	9	11	4	3	0	1
Gustavo A. Madero	68	20	28	15	2	3	0
Iztacalco	20	4	9	4	2	1	0
Iztapalapa	72	20	23	14	12	1	2
M. Contreras	8	4	2	0	1	0	1
Miguel Hidalgo	20	4	8	3	2	0	3
Milpa Alta	4	1	3	0	0	0	0
Tlahuac	8	3	5	0	0	0	0
Tlalpan	24	1	6	5	10	1	1
V. Carranza	24	12	9	2	1	0	0
Xochimilco	12	4	6	1	1	0	0
DF Total	400	118	148	68	45	9	12

*no answer

Main characters of the household interviewees are summarized as follows.

- Male : 131 (33%), Female : 269 (67%)
- Average age : 44.2
- Average number of family members : 4.57
- Average monthly income : 4,697.2 pesos

b. Institutions

Questionnaires were distributed as follows:

- 20 questionnaires to factories.
- 40 questionnaires to offices.
- 40 questionnaires to universities and primary schools.
- 40 questionnaires to markets and shops.
- 20 questionnaires to hospitals.

Similarly to the case of the household questionnaire, those questionnaires were distributed according to the distribution of size and location of each institution in the DF so that the collected answers would well represent the city as a whole.

Questions were asked by interview.