B. Collection and Transportation:

B2 Study for the Master Plan

B2. STUDY FOR THE MASTER PLAN

1. Planning Policy

A suitable solid waste collection service can provide a comfortable life for the citizens and keep the scenery of the city beautiful. The service can also improve the public health and the regional environment. The basic planning policies for the collection/transportation system are as follows:

- Introduction of an environmentally friendly collection/transportation system,
- Establishment of a sustainable collection/transportation system in every area, and
- Introduction of high efficiency and low expenditure for the collection/transportation system by adoption of suitable vehicles.

In order to achieve these policies, the strategies are as follows:

- Promotion of a segregated collection system for the 3Rs,
- Incorporation of domestic products into the collection/transportation system,
- Suitable selection and arrangement of waste bins,
- Introduction of a suitable maintenance system for both existing and new collection vehicles,
- Improvement of the existing maintenance workshops, and
- Introduction of a new collection system instead of the horse and cart system.

2. Basic Planning Conditions

2.1 Projected MSW Amount

According to the change in population and predicted population increase in various areas, it is estimated that the collected amount of MSW per day up to 2015 will be maintained at the same value of 940 tons/day as in 2004, as shown in the following Table 1. The projected amounts of waste for each municipality and responsible agency are shown in Table 2.

Table 1 Prediction of MSW Generation (tons/day)

	2004	2005-2010	2011-2015
MSW	940	940	940

Table 2 Projected MSW Amount for each Municipality (2005-2015)

	Municipality	UPPH/DMSC	Projected waste amount (t/d)	Ratio (%)
1	Playa	UPPH	149	15.84
2	Plaza de la Revolución	UPPH	121	12.84
3	Centro Havana	UPPH	74	7.90
4	Habana Vieja	UPPH	71	7.53
5	Regla	DMSC	26	2.75
6	Habana del Este	UPPH	51	5.41
7	Guanabacoa	DMSC	40	4.21
8	San Miguel del Padrón	DMSC	36	3.78
9	Diez de Octubre	UPPH	78	8.31
10	Cerro	UPPH	80	8.52
11	Marianao	DMSC	64	6.80
12	La Lisa	DMSC	48	5.07
13	Boyeros	DMSC	42	4.47
14	Arroyo Naranjo	DMSC	48	5.07
15	Cotorro	DMSC	14	1.51
-	Total	-	940	100

2.2 Future Transportation Plan

According to the CITMA plan in place during the JICA Study in 2005, Guanabacoa and three (3) special period landfills were closed in 2005, Calle 100 (80 ha) will be closed in 2006, and the Calle 100 (24 ha) Expansion landfill site will be opened in 2007. MSW will be transferred to the New Guanabacoa landfill site in 2007 and New Site 1 in 2011.

However, when the M/P was finalized for the F/R in March 2007, these future planning conditions for the M/P were changed with the assumption that no investment for the construction of New Guanabacoa landfill and Calle 100 Expansion landfill or for closure of existing landfills is taken in 2006 and 2007. This means existing landfills will be used until 2009 when new landfill sites will be constructed. The new transportation program is described in Table 3 and Figure 1. Table 4 shows the allocation of waste amounts for each disposal site in 2007 and Figure 2 shows the new transportation routes. Table 5 and Figure 3 show the new routes in 2015. The total amounts of MSW to be collected from UPPH's bins and bags in DMSC areas are estimated as shown in Tables 4 and 5.

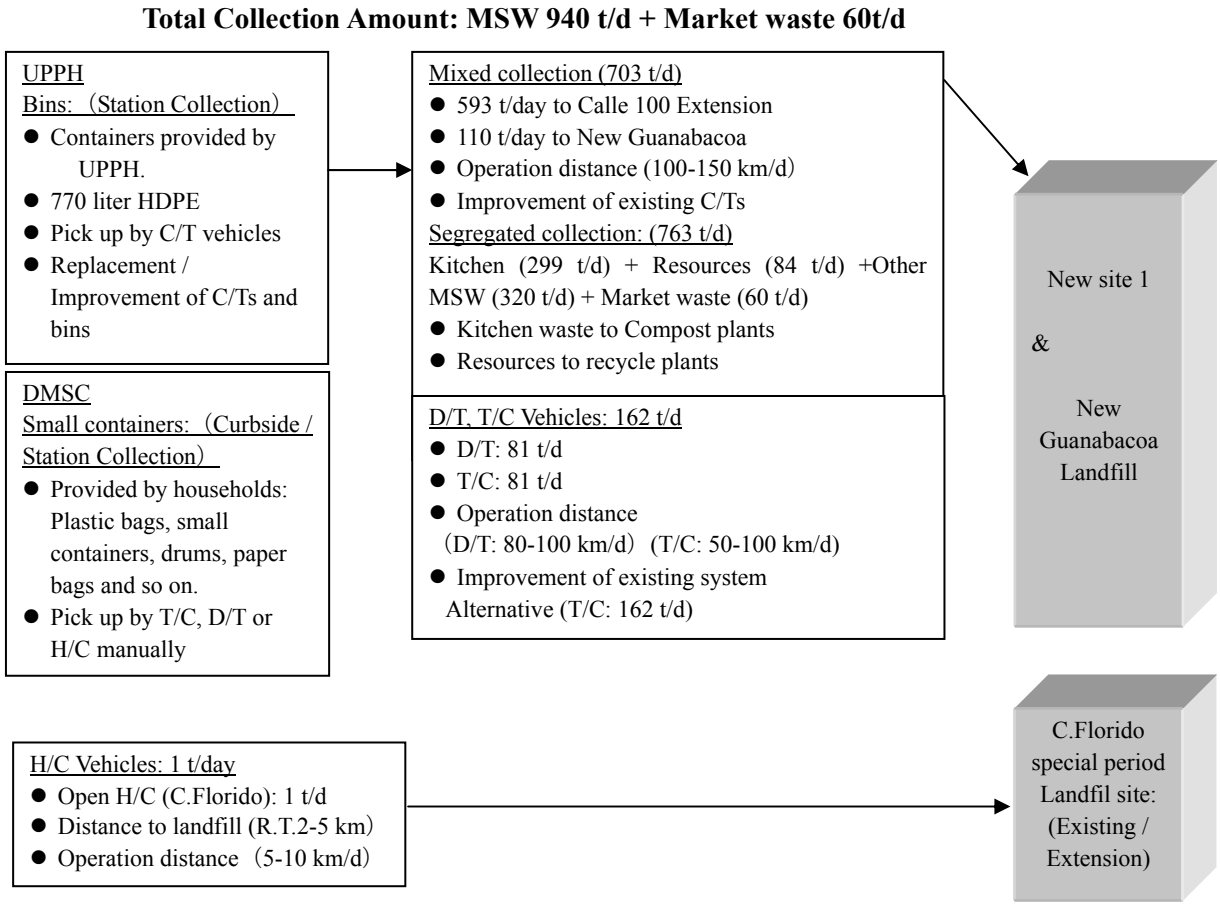


Figure 1 Future Collection and Transportation Systems

Table 3 Landfills Used for Disposal of MSW Generated in Each Municipality (In the Case of Mixed Waste Collection)

	Municipality	2006-08	2009	2010	2011-2012	2013-2015
1	Playa	Calle 100	Calle 100 Ex	Calle 100 Ex	New site1	New site1
2	Plaza de la Revolución	Calle 100	Calle 100 Ex	Calle 100 Ex	New site1	New site1
3	Centro Habana	Calle 100	Calle 100 Ex	Calle 100 Ex	New site1	New site1
4	Habana Vieja	Calle 100	Calle 100 Ex	Calle 100 Ex	New site1	New site1
5	Regla	Calle 100	Calle 100 Ex	Calle 100 Ex	New site1	New site1
6	Habana del Este	Ocho Vias	New G.	New G.	New G.	New G.
7	Guanabacoa	Ocho Vias	New G.	New G.	New G.	New G.
8	San Miguel del Padrón	Calle 100	Calle 100 Ex	Calle 100 Ex.	New site1	New site1
9	Diez de Octubre	Calle 100	Calle 100 Ex	Calle 100 Ex	New site1	New site1
10	Cerro	Calle 100	Calle 100 Ex	Calle 100 Ex	New site1	New site1
11	Marianao	Calle 100	Calle 100 Ex	Calle 100 Ex	New site1	New site1
12	La Lisa	Calle 100	Calle 100 Ex	Calle 100 Ex	New site1	New site1
13	Boyeros	Calle 100	Calle 100 Ex	Calle 100 Ex	New site1	New site1
14	Arroyo Naranjo	Calle 100	Calle 100 Ex	Calle 100 Ex	New site1	New site1
15	Cotorro	Ocho Vias	New G.	New G.	New G.	New G.

Note: New G.: New Guanabacoa, Calle 100 Ex: Calle 100 Extension, Calle 100 RP: Calle 100 Recycle Plant.

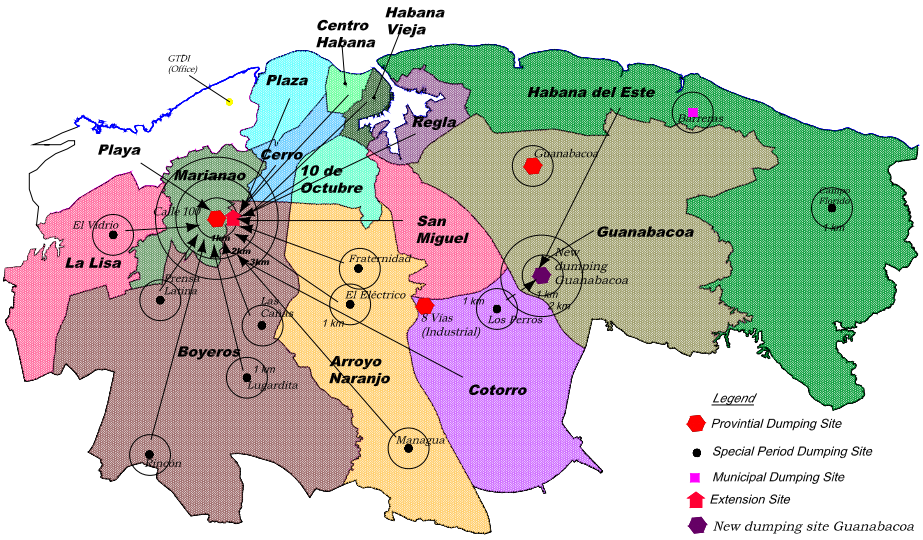


Figure 2 New Transportation Routes in 2007

Table 4 Waste Amount Allocation to Landfill Sites in 2007

Agencies	UPPH	DMSC			Total (t/day)
Name of Landfills/Vehicle in Use	C/T	D/T or New	T/C	H/C or New	
Calle 100 Extension	593	30	54	52	729
New Guanabacoa	110	51	27	24	212
New Site 1	-	-	-	-	-
C. Florido	0	0	0	1	1
Total (MSW t/day)	703	81	81	75	940

Figure 3 New Transportation Routes in 2015

Table 5 Waste Amount Allocation to Landfill Sites in 2015

Agencies	UPPH	DMSC			Total
Name of landfills/vehicle in use	C/T	D/T or New	T/C	H/C or New	(t/day)
Calle 100 Extension	-	-	-	-	-
New Guanabacoa	110	51	27	24	212
New Site 1	593	30	54	52	729
C. Florido	0	0	0	1	1
Total (MSW t/day)	703	81	81	75	940

3. Improvement of the Collection and Transportation System in the Urban Areas under UPPH (Mixed Collection)

3.1 Improvement of the Current Mixed Collection System

UPPH has to establish an education/communication/information system about MSW with residents and implement it continuously. Also, monitoring activities are important for UPPH. These actions will surely improve the manner of waste discharge; good habits by generators can keep surrounding conditions good and extend the life span of bins.

Reliability of collection frequency is important for the collection service. If UPPH can offer a regular service every day throughout the collection service area, the areas surrounding garbage stations will always be kept clean. Therefore, UPPH has to work out a suitable number of workable vehicles to carry out its responsibility. UPPH also has to make good arrangements for storage bins. There are some places where the number of bins is insufficient and thus waste exceeds their capacity.

3.2 Study on the Appropriate Collection and Transportation System

(1) Selection of Collection Vehicles

Suitable collection vehicles for Havana City are to be considered as follows:

- Lower procurement cost and easier acquisition of spare parts,
- High collection efficiency,
- Lower operation and maintenance cost, and
- Lower total cost and higher performance.

Table 6 shows evaluation results of Alternatives 1 to 5. The result shows 18 m^3 C/T collection and 15 m^3 T/C collection vehicles are almost the same in terms of economic conditions. However, the plan will adopt 18 m^3 C/T collection vehicles for collection /transportation in urban areas. The adopted collection vehicles were decided upon from the following additional conditions:

- The number of vehicles of the C/T system is smaller than with the T/C system. This is most important for a tourist area.
- The sanitary conditions of collection/transportation with the C/T system is better than with the T/C system.
- Working conditions with the C/T system are safer than with the T/C system.

Table 6 Evaluation Results of Alternatives 1 to 6

	Alternative **1**	Alternative **2**	Alternative **3**	Alternative **4**	Alternative **5**	Alternative **6**
Type of Vehicle	**18m^3 C/T**	**8m^3 C/T**	**4m^{3}C/T**	**10m^3 D/T**	**15m^3 T/C**	**2m^3 H/C**
Collection System	Station collection	Station Collection	Door to door	Door to door	Door to door	Door to door
Required No. of vehicles	1.0	2.3	4.6	4.8	5.5	570
Vehicle Cost/year	360	456	638	773.5	328.1	680.4
Maintenance	18.0	22.8	31.9	38.7	16.4	0
Operation	6.3	13.2	25.1	285	31.2	1,368
Total	384.3	492.1	695.4	840.7	375.5	2,052
Net Working Rate	0.85	0.85	0.85	0.85	0.85	0.5
Collection Amount (t/year)	3,329	3,329	3,329	3,329	3,329	3,329
Unit Cost (JY/t)	1,358	1,739	2,458	2,971	1,328	12,329
Cost of bins (JY/t)	158	0	0	0	0	0
Total Cost (JY/t)	1,526	1,739	2,458	2,971	1,328	12,392
Total Cost (US$/t)	**13.9**	**15.8**	**22.3**	**27.0**	**12.1**	**112.7**
Rate	**1.00**	**1.15**	**1.62**	**1.96**	**0.88**	**8.13**

- Fuel consumption

The estimated fuel consumption of the 18 m^3 C/T from studies as shown in Table 7 is about 3.0 km/liter, for standard Kamaz vehicles. The fuel consumptions of all kinds of vehicles shown in Table 8 have been provided by UPPH as average fuel consumption from their experience. The fuel consumption of small and medium size C/Ts is 3.5 km/liter and for 15 m^3 T/Cs it is 4.0 km/liter. Also, the number of staff in Table 9 is assumed.

Table 7 Estimated Fuel consumption of 18 m^3 C/T

Descriptions	P.S. (Note-1)	C.Havana (Note-2)	H.Vieja (Note-2)	UPPH STD
Weight (kg)	2,200	15,100	23,200	-
Fuel (liters)	40	48	32	-
Travel distance (km)	110	81.8	68.3	-
Collection points	31	79	114	-
Fuel consumption (kg/liter)	55.0	314.6	725.0	-
Fuel consumption (km/liter)	2.8	1.7	2.1	3.0 (Kamaz)

Note-1: Data from pilot project dated April 30, 2005. Type of vehicles: Pegaso manufacture.
Note-2: Data from time and motion study.

Table 8 Summary of Estimated Fuel Consumption Value (km/liter)

Type of vehicles	Empty load	Full load	Ave.	UPPH's STD
C/T (18 m^3)	3.5	2.5	3.0	3.0
C/T (4-8 m^3) Note-1	5.0	4.0	4.5	3.5
D/T (10m^3: 10 ton)	4.0	3.0	3.5	3.5
T/C (15m^3: 2 ton)	4.5	3.5	4.0	4.0

Note-1: According to manufacturer

Table 9 Estimated Operation Conditions

Type of Vehicles	Load Cap. (t/unit)	Number of collection points per route	Number of staff including driver
C/T	7.4 (18m^3)	150 points	4 (persons)
D/T	1.8 (10m^3)	100 points	5 (persons)
T/C	2.0 (15m^3)		5 (persons)

Note: Data is referred from time and motion study, dated March, 2004

- Unit collection amount (ton/hr)

This shows the collected amount of MSW per hour of loading and moving time. Based on the time and motion study, the estimated unit value for each type of vehicle is shown in Table 10. C/T vehicles will collect 4.5 ton/hr and T/Cs will collect about 1.0 ton per hour of loading and moving. An 18m^3 C/T with 7.4 t/d loading capacity will need about 1.7 hrs to load its 100% capacity (7.4 t ÷ 4.5 t/hr = 1.7 hrs).

Table 10 Estimated Unit Collection Amount (tons/hr)

No.	Descriptions	Unit	18 m^3 C/T (7.4 t/d)						15m^3 T/C (1.8 t/d)	
			Penas Altas	Penas Altas	**C.Havana**	**H. Veija**	Total	Adopted Value	Regla	Adopted Value
			2-Mar-05	30-Apr-05	24-Apr-04	3-Jun-04	Ave		5-Apr-04	
1	Schedule of operation time per day		PLP(Old binS)	PLP(New Bins)	Time& motion	Time& motion			Time& motion	
	Loading time	Hrs.	0.51	0.35	**1.4**	**1.71**	**1.6**	2.3	2.59	2.2
	Moving time	Hrs.	0.18	0.42	**1.75**	**1.14**	**1.4**	2.2	1.12	1.1
	S-total		0.69	0.77	**3.15**	**2.85**	**3**	4.5	3.71	3.3
2	Number of trips	times	1	1	**2.0**	**2.0**	**2.0**	2.0	2.0	1.0
3	Collection stations	points	167	31	**79**	**114**	**96.5**	150.0	176	100
4	Collection amount	t/d	3.34	0.55	**15.1**	**23.2**	**19.2**	14.8	3.41	2.0
5	Amount per bin	kg/bin	167		191.1	203.5	197.3	100.0	19.4	20.0
6	Unit collection amount per time (Loading + Moving)	t/hr	**4.8**	**0.7**	**4.8**	**8.1**	**4.6**	**4.5**	0.9	**1.0**

(2) Required Number of C/Ts

UPPH requires daily collection service, because the waste bin capacity is limited and odor from biodegradable waste offends residents and tourists. The required number of C/Ts is calculated in Table 11 and Appendix-1-1 to 13 in B.1 of Data Book. Calculation conditions are as follows:

- Capacity of collection vehicle: The loading capacity is 18 m^3 = 7.4t.
- Speed of collection vehicle: Traveling speed of transportation is 55 km/hr.

- Collection efficiency: 4.5 t/hour.
- Others: Preparation time is 30 minutes, lunchtime is 30 minutes and dumping time is 15 minutes.
- Working hours: Target working time is 8 hours including all activities.

Table 11 shows the required number of C/Ts for each municipality for mixed waste collection. The required number of vehicles will increase as of 2011 because the new disposal site is further from the center of the City. The calculation incorporates an intended reduction in the average daily working hours from 8 hours to fewer hours, aiming at securing an appropriate maintenance period in order to reduce the frequency of breakdowns.

Table 11 Required Number of C/Ts (Mixed Collection)

Municipalities	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Playa	13	13	13	13	13	13	13	13	13	13	13
Plaza	7	7	7	7	7	7	11	11	11	11	11
C. Habana	5	5	5	5	5	5	7	7	7	7	7
H. Vieja	4	4	4	4	4	4	6	6	6	6	6
H. Del Este	3	3	3	3	3	3	3	3	3	3	3
Diez de Octubre	5	5	5	5	5	5	7	7	7	7	7
Cerro	5	5	5	5	5	5	7	7	7	7	7
Marianao	2	2	2	2	2	2	2	2	2	2	2
La Lisa	2	2	2	2	2	2	2	2	2	2	2
Boyeros	2	2	2	2	2	2	2	2	2	2	2
Arroyo Naranjo	2	2	2	2	2	2	2	2	2	2	2
Total No.	50	50	50	50	50	50	62	62	62	62	62
Total Required No.	**59**	**59**	**59**	**59**	**59**	**59**	**73**	**73**	**73**	**73**	**73**

(3) Procurement Cost of Collection C/Ts

UPPH had 45 workable vehicles in 2005. UPPH will need 549 new C/T vehicles by 2015, according to its replacement plan and for future requirements of vehicles. The required number of vehicles and purchase plan are shown in Table 12. The procurement cost for each fiscal year is shown in Table 13.

Table 12 Required Number of Vehicles and Purchase Plan

Items/Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total required No.	**59**	**59**	**59**	**59**	**59**	**59**	**73**	**73**	**73**	**73**	**73**
Existing No. UPPH	**45**	**39**	**36**	**34**	**32**	**31**	**24**	**24**	**24**	**24**	**24**
To be purchased in 2006	-	**0**	0	0	0	0	0	0	0	0	0
To be purchased in 2007	-	-	**0**	0	0	0	0	0	0	0	0
To be purchased in 2008	-	-	-	**25**	25	25	25	25	25	25	25
To be purchased in 2009	-	-	-	-	**2**	2	2	2	2	2	2
To be purchased in 2010	-	-	-	-	-	**1**	1	1	1	1	1
To be purchased in 2011	-	-	-	-	-	-	**21**	21	21	21	21
Purchase Plan	-	**20**	**3**	**2**	**2**	**1**	**21**	**0**	**0**	**0**	**0**
Deficit	-	**-20**	**-23**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 13 Procurement Cost of Collection Vehicles

(Unit price: US$130,000/Unit)

Capacity (18m^3 C/T)	2005-2010	2011-2015	Total
Number of Vehicles (unit)	28	21	49
Total Cost (US$)	3,640,000	2,730,000	6,370,000

(4) Maintenance Cost

The maintenance cost (spare parts) is 5% of the vehicle purchase cost. The total maintenance cost is shown in Table 14.

Table 14 Maintenance Cost per Phase

Capacity (18m^3 C/T)	2005-2010	2011-2015	Total
Total Cost (US$)	1,150,500	2,372,500	3,523,000

(5) Operation Cost

The total operation cost is summarized in Table 15.

Table 15 Operation Cost per Phase

Capacity (18m^3 C/T)	2005-2010	2011-2015	Total
Total Cost (CUP)	6,595,020	13,599,900	20,194,920

3.3 Waste Bins

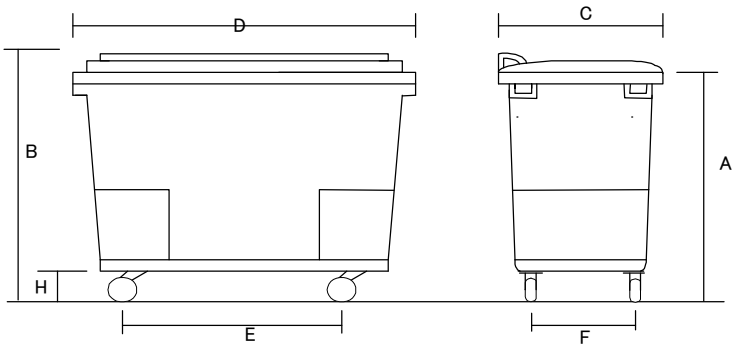
(1) Selection of type of waste bins

The selected collection system uses 770 liter waste storage bins, being the same as the existing ones. One of the alternatives is door-to-door collection using plastic bags. However, that would cause there to be many waste bags on the street before collection and waste bags spoil the city's beauty. Also, too many plastic bags would be scattered around the disposal site. Existing bins are made of HDPE and they are damaged from handling by crew and/or predatory attacks by residents. It is difficult to repair damaged HDPE bins, so UPPH has to replace damaged bins with new ones every year. UPPH wants to replace them with steel bins, because the latter can be repaired easily and it is possible to manufacture them in Cuba. If every bin in the City is replaced with a steel bin, UPPH can repair them in its own workshop. This system is sustainable for Havana City.

Basic ideas of the plan are as follows:

- Adopt 770-liter steel collection bins. UPPH will repair damaged steel bins at its own workshop and will save on procurement costs.
- All existing bins will be replaced within 10 years.

Typical dimensions for bins are shown in Figure 4, and Figure 5 shows photos of typical bins.



Volume （Liters）	Dimensions (HDPE)			
	660	**770	1000	1100
A	1,065	1,125	1,210	1,205
B	1,160	1,305	1,300	1,450
C	772	772	1,070	1,075
D	1,260	1,260	1,265	1,375
E	855	855	870	870
F	475	475	740	740
H	160	160	200	200
Empty Weight(kg)	38	41	56	69
Max Weight(kg)	250	300	350	400

Figure 4 Typical Dimensions of HDPE Bins

(1) Existing HDPE bins

(2) Steel bins

(3) Prototype of metal bin (not galvanized) by local manufacture

Figure 5 Typical Bins (770 litters)

(2) Required number of bins and procurement cost

The required number of bins in the UPPH collection service areas was calculated by taking into account actual results. The estimated average storage weight is about 60kg/unit. To estimate the required number, the plan adopted a 60kg/unit. The total number of bins (for the daily collection system) is 11,720 units (740t/60kg) in the city. The replacement plan for steel bins will require about 1,172 units per year. Based on the price list provided by the manufacturers, the procurement cost for steel bins was calculated as shown in Table 16.

Table 16 Procurement Cost of Waste Bins per Phase

(Unit price: US$)

Capacity (770 liter)	2005-2010	2011-2015	Total
Number of bins (units)	5,860	5,860	11,720
Total Cost (US$)	1,523,600	1,523,600	3,047,200

(3) Maintenance cost

The maintenance cost is 5 % of the total purchase cost. Table 17 shows this cost.

Table 17 Maintenance Cost per Phase

Capacity (770 liter)	2005-2010	2011-2015	Total
Number of bins (units)	5,860	5,860	11,720
Total Cost (US$)	76,180	76,180	152,360

3.4 Total cost of mixed collection system by UPPH

The total cost of the mixed waste collection system by UPPH is summarized in Table 18.

Table 18 Total Cost of Mixed Collection System by UPPH

Items/Year		2005-2010	2011-2015	Total
Procurement Cost of Vehicles (US$)		3,640,000	2,730,000	6,370,000
Maintenance Cost of Vehicles (US$)		1,150,500	2,372,500	3,523,000
Operation Cost (CUP)		6,595,020	13,599,900	20,194,920
Sub-total	(US$)	4,790,500	5,102,500	9,893,000
	(CUP)	6,595,020	13,599,900	20,194,920
Procurement Cost of Bins (US$)		1,523,600	1,523,600	3,047,200
Maintenance Cost of Bins (US$)		76,180	76,180	152,360
Sub Total (US$)		1,599,780	1,599,780	3,199,560
Grand Total	(US$)	6,390,280	6,702,280	13,092,560
	(CUP)	6,595,020	13,599,900	20,194,920

4. Improvement by the Introduction of a Segregated Collection System

4.1 Target Areas and Segregated Waste Amount

In 2010, waste segregation and recycling activities will start. Kitchen waste will be brought into composting yards and recyclable waste will be brought into recycling plants. Tables 19

and 20 show that segregated waste will be brought into the landfill sites. Table 21 shows the amount of segregated MSW. Figure 6 shows transportation routes for segregated waste in 2010 and Figure 7 shows transportation routes for segregated waste in 2015.

Table 19 Landfill Sites and Composting Plants for Kitchen Waste

No.	Municipality	2006-7	2008-2009	2010	2011-2012	2013-2015
1	Playa	Calle 100	Calle 100 Ex	NG	NG	Calle 100
2	Plaza de la Revolucion	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	Calle 100
3	Centro Habana	Calle 100	Calle 100 Ex	Calle 100 Ex	NG	NG
4	Habana Vieja	Calle 100	Calle 100 Ex	Calle 100 Ex	NG	NG
5	Regla	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
6	Habana del Este	Ocho vias,Micro	NG	NG	NG	NG
7	Guanabacoa	Ocho vias,Micro	NG	NG	NG	NG
8	San Miguel del Padron	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
9	Diez de Octubre	Calle 100	Calle 100 Ex	Calle 100 Ex	NG	NG
10	Cerro	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	Calle 100
11	Marianao	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
12	La Lisa	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
13	Boyeros	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
14	Arroyo Naranjo	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
15	Cotorro	Calle 100	NG	NG	NG	NG

Note: N.G.: New Guanabacoa landfill

Table 20 Landfill Sites and Recycling Centers for Recyclable Waste

No.	Municipality	2006-7	2008-2009	2010	2011-2012	2013-2015
1	Playa	Calle 100	Calle 100 Ex	NG	NG	Calle 100
2	Plaza de la Revolucion	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	Calle 100
3	Centro Habana	Calle 100	Calle 100 Ex	Calle 100 Ex	NG	NG
4	Habana Vieja	Calle 100	Calle 100 Ex	Calle 100 Ex	NG	NG
5	Regla	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
6	Habana del Este	Ocho vias,Micro	NG	NG	NG	NG
7	Guanabacoa	Ocho vias,Micro	NG	NG	NG	NG
8	San Miguel del Padron	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
9	Diez de Octubre	Calle 100	Calle 100 Ex	Calle 100 Ex	NG	NG
10	Cerro	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	Calle 100
11	Marianao	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
12	La Lisa	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
13	Boyeros	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
14	Arroyo Naranjo	Calle 100	Calle 100 Ex	Calle 100 Ex	New site	New site
15	Cotorro	Calle 100	NG	NG	NG	NG

Note: N.G.: New Guanabacoa landfill

Table 21 Segregated Waste Amount (tons/day)

Name	Item	2007	2008	2009	2010	2011	2012	2013	2014	2015
Playa	Recyclable	0	0	0	20	20	20	20	20	20
	Kitchen	0	0	0	66	66	66	66	66	66
	Others	0	0	0	63	63	63	63	63	63
	Total	0	0	0	149	149	149	149	149	149
Plaza de la Revolución	Recyclable	0	0	0	0	0	0	17	17	17
	Kitchen	0	0	0	0	0	0	58	58	58
	Others	0	0	0	0	0	0	46	46	46
	Total	0	0	0	0	0	0	121	121	121
Centro Havana	Recyclable	0	0	0	0	0	0	10	10	10
	Kitchen	0	0	0	0	0	0	37	37	37
	Others	0	0	0	0	0	0	27	27	27
	Total	0	0	0	0	0	0	74	74	74
Habana Vieja	Recyclable	0	0	0	0	0	0	10	10	10
	Kitchen	0	0	0	0	0	0	34	34	34
	Others	0	0	0	0	0	0	27	27	27
	Total	0	0	0	0	0	0	71	71	71
Habana del Este	Recyclable	0	0	0	8	8	8	8	8	8
	Kitchen	0	0	0	24	24	24	24	24	24
	Others	0	0	0	19	19	19	19	19	19
	Total	0	0	0	51	51	51	51	51	51
Diez de Octubre	Recyclable	0	0	0	0	0	0	10	10	10
	Kitchen	0	0	0	0	0	0	40	40	40
	Others	0	0	0	0	0	0	28	28	28
	Total	0	0	0	0	0	0	78	78	78
Cerro	Recyclable	0	0	0	0	0	0	11	11	11
	Kitchen	0	0	0	0	0	0	40	40	40
	Others	0	0	0	0	0	0	29	29	29
	Total	0	0	0	0	0	0	80	80	80
Total	Recyclable	0	0	0	28	28	28	86	86	86
	Kitchen	0	0	0	90	90	90	299	299	299
	Others	0	0	0	82	82	82	239	239	239
	Total	0	0	0	200	200	200	624	624	624

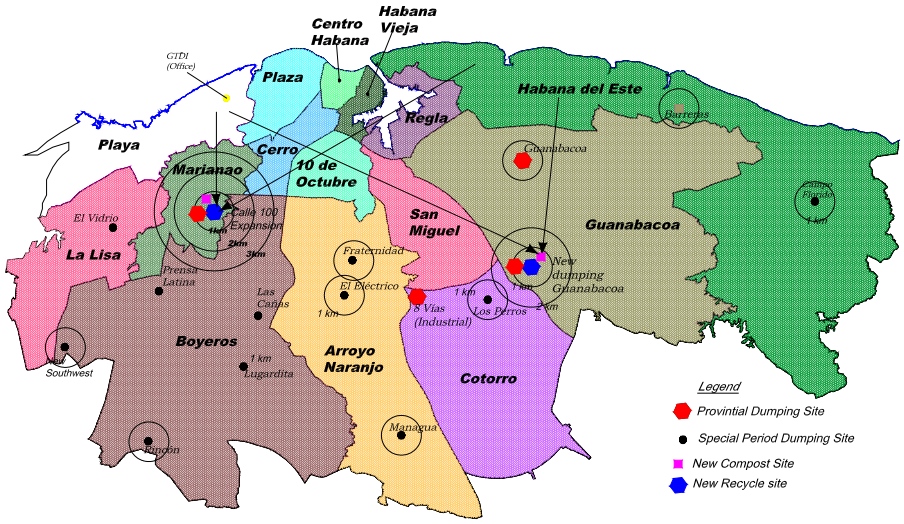


Figure 6 Transportation Routes for Segregated Waste in 2010

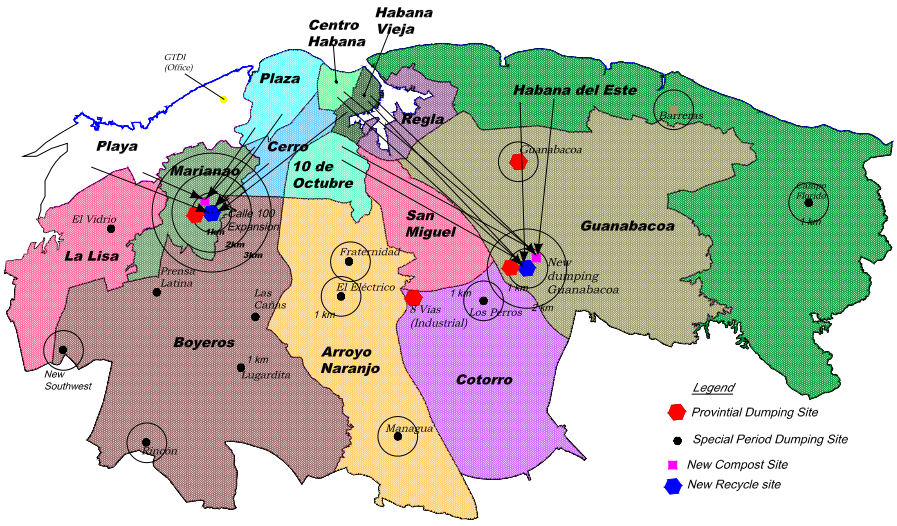


Figure 7 Transportation System for Segregated Waste in 2015

4.2 Transportation of Remaining Waste after Sorting of Recyclable Material

Transportation routes in 2010 are shown in Figure 8, and the routes in 2015 are shown in Figure 9. The landfill sites for residual waste after sorting at the recycling plant are Calle-100 expansion site and New Guanabacoa from 2010 to 2012. After closing of Calle-100 expansion site in 2010, New South 1 will be used instead of the Calle-100 expansion site. The landfill site for the residual waste after sorting at the composting plant of New Guanabacoa is New Guanabacoa up to 2015. The landfill site for the residual waste from the composting plant at Calle 100 is Calle 100 expansion until 2010 and New Site 1 from 2011.

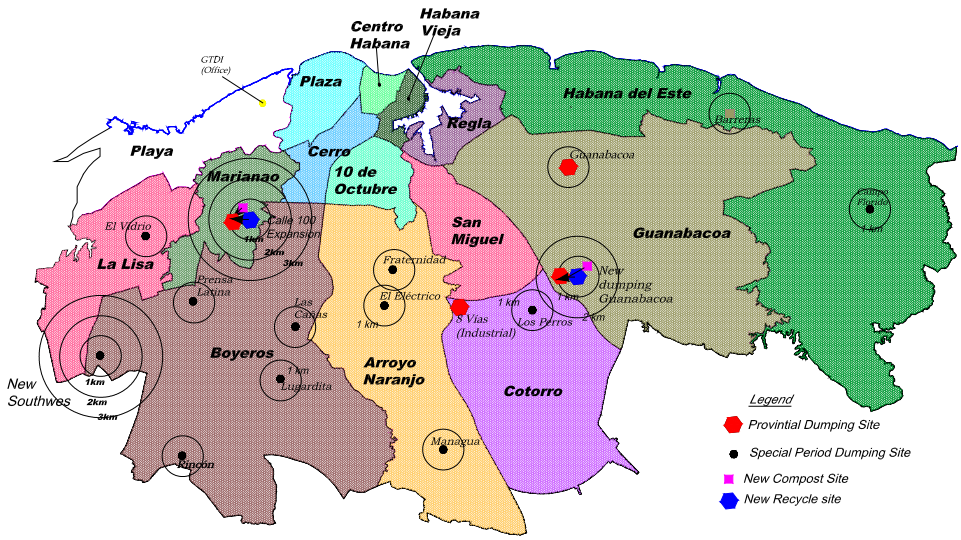


Figure 8 Transportation System for Remaining Waste in 2010

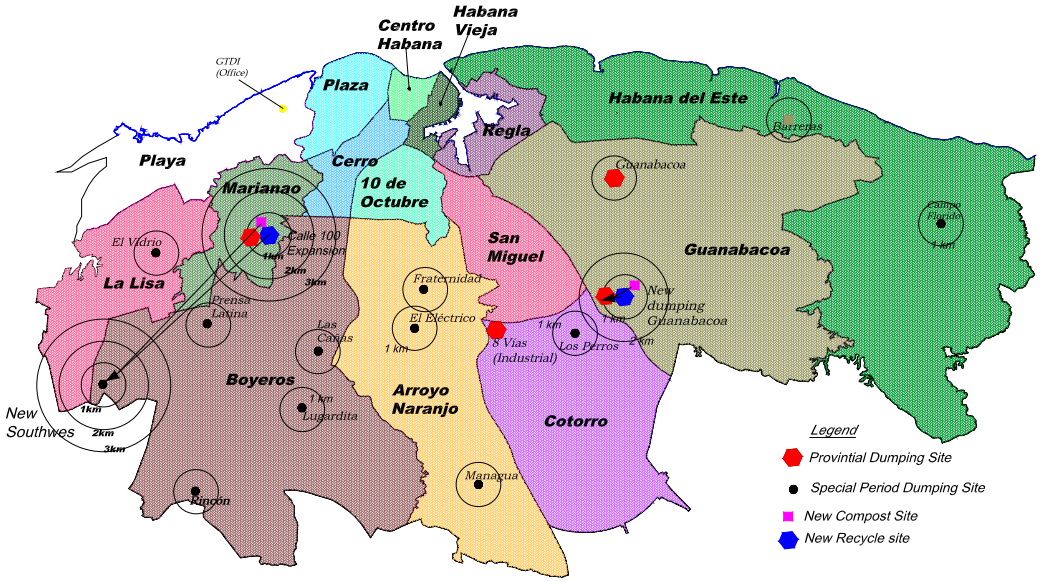


Figure 9 Transportation System for Remaining Waste in 2015

4.3 Segregation Conditions

Outlines of waste segregation and its collection system are as follows:

- The plan will start in two (2) municipalities (Playa, H. Del Este) in 2010 and in five (5) more municipalities (Plaza, C. Habana, H. Vieja, Diez de Octubre and Cerro) in 2013.
- MSW will be segregated into three (3) categories, i.e., kitchen waste, recyclable waste and other waste.
- The frequency of segregated waste collection is as follows: Kitchen waste 7 days per week, recyclable waste 2 days per week and other waste 5 days per week. The reason for collection seven days a week is to reduce the number of collection vehicles. The ratio of other waste to recyclable waste is about 2:5 and thus the collection frequency was decided. A suitable collection frequency allows keeping the amount of waste collection stable.
- The calculation considers that collection will be carried out for a single day's accumulation of kitchen waste and two days' accumulation of other waste because of the maximum collection capacity.
- Capacity of collection vehicles: The loading capacity of an 18 m^3 C/T is 7.4t.
- Speed of collection vehicles: The traveling speed is 55 km/hr.
- Others: Preparation time is 30 minutes, lunchtime is 30 minutes and dumping time is 15 minutes.
- Working hours: Target working time is less than 8 hours including all activities.

4.4 Required Numbers of Vehicles and Procurement Cost

(a) Required number of vehicles

The segregation system requires more vehicles than the mixed collection system. The required number of vehicles will increase in 2010 and 2013 as shown in Table 22.

Appendix 2-1 to 19 in B.1 of Data Book shows the calculation of the required number. Detailed calculation is shown in the Supporting Report. The calculation considers that the average daily working hours are between 9 hours and 8 hours, aiming at securing an appropriate maintenance period in order to reduce the frequency of breakdowns.

Table 22 Required Number of C/Ts

Municipalities	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Playa	13	13	13	13	13	23	23	23	23	23	23
Plaza	7	7	7	7	7	7	7	7	13	13	13
C. Habana	5	5	5	5	5	5	5	5	9	9	9
H. Vieja	4	4	4	4	4	4	4	4	8	8	8
H. Del Este	3	3	3	3	3	7	7	7	6	6	6
Diez de Octubre	5	5	5	5	5	5	5	5	8	8	8
Cerro	5	5	5	5	5	5	5	5	9	9	9
Marianao	2	2	2	2	2	2	2	2	2	2	2
La Lisa	2	2	2	2	2	2	2	2	2	2	2
Boyeros	2	2	2	2	2	2	2	2	2	2	2
Arroyo Naranjo	2	2	2	2	2	2	2	2	2	2	2
Total No.	50	50	50	50	50	64	64	64	84	84	84
Total Required No.	**59**	**59**	**59**	**59**	**59**	**76**	**76**	**76**	**99**	**99**	**99**

(b) Procurement Cost

UPPH had 45 vehicles in 2005. UPPH needs 75 new C/T vehicles by 2015 to be considered in its replacement plan. The required number and purchase plan are shown in Table 23. Procurement costs for each physical year are shown in Table 24.

Table 23 Required Number of Vehicles and Purchase Plan

Items/Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total required No.	**59**	**59**	**59**	**59**	**59**	**76**	**76**	**76**	**99**	**99**	**99**
Existing No. UPPH	45	39	36	34	32	31	24	24	24	24	24
To be replaced in 2006	-	**0**	0	0	0	0	0	0	0	0	0
To be replaced in 2007	-	-	**0**	0	0	0	0	0	0	0	0
To be replaced in 2008	-	-	-	**25**	25	25	25	25	25	25	25
To be replaced in 2009	-	-	-	-	**2**	2	2	2	2	2	2
To be replaced in 2010	-	-	-	-	-	**18**	**18**	**18**	**18**	**18**	**18**
To be replaced in 2011	-	-	-	-	-	-	**7**	7	7	7	7
To be replaced in 2012								**0**	0	0	0
To be replaced in 2013									**23**	**23**	**23**
Purchase Plan	-	**20**	**3**	**2**	**2**	**19**	**7**	**0**	**23**	**0**	**0**
Deficit	-	**-20**	**-23**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 24 Procurement Cost of Collection Vehicles

Capacity ($18m^3$ C/T)	2005-2010	2011-2015	Total
Number of Vehicles (units)	45	30	75
Total Cost (US$)	5,850,000	3,900,000	9,750,000

(c) Maintenance Cost

The maintenance cost is 5% of the purchase cost. The total cost is shown in Table 25.

Table 25 Maintenance Cost per Phase

Capacity ($18m^3$ C/T)	2005-2010	2011-2015	Total
Total Cost (US$)	1,261,000	2,918,500	4,179,500

(d) Operation Cost

The total operation cost is summarized in Table 26.

Table 26 Operation Cost per Phase

Capacity ($18m^3$ C/T)	2005-2010	2011-2015	Total
Total cost (CUP)	7,228,440	16,729,740	23,958,180

4.5 Waste Bins

(a) Required number of bins and procurement cost

The required number of bins in the UPPH service areas for segregated collection is calculated as shown in Table 27. In segregation areas, the minimum number of waste bins to be placed is three bins according to the different segregation categories.

Table 27 Procurement Cost of Waste Bins per Phase

(Unit price: US$259/Unit)

Capacity (770 liter)	2005-2010	2011-2015	Total
Number of bins (units)	12,528	19,994	32,522
Total Cost (US$)	3,257,280	5,198,440	8,455,720

(b) Maintenance Cost

The maintenance cost is 5 % of the purchase cost. The cost is shown in Table 28.

Table 28 Maintenance Cost per Phase

Capacity (770 liter)	2005-2010	2011-2015	Total
Total Cost (US$)	162,864	259,922	422,786

4.6 Total Cost of Segregated Collection by UPPH

The total cost of the segregated waste collection system to be used by UPPH is summarized in Table 29.

Table 29 Cost Comparison of Waste Collection Systems

Items/Year		2006-2010	2011-2015	Total
Procurement Cost of Vehicles (US$)		5,850,000	3,900,000	9,750,000
Maintenance Cost of Vehicles (US$)		1,261,000	2,918,500	4,179,500
Operation Cost (CUP)		7,228,440	16,729,740	23,958,180
Sub-total	(US$)	7,111,000	6,818,500	13,929,500
	(CUP)	7,228,440	16,729,740	23,958,180
Procurement Cost of Bins (US$)		3,257,280	5,198,440	8,455,720
Maintenance Cost of Bins (US$)		162,864	259,922	422,786
Sub Total		3,420,144	5,458,362	8,788,506
Grand Total	(US$)	10,531,144	12,256,862	22,788,006
	(CUP)	7,228,440	16,729,740	23,958,180

Note: (1) For simplification, all costs of procurement and maintenance were estimated in US$ assuming that the major components of the cost are equipment and spare parts.
(2) Waste bins will be manufactured locally, but the raw material is to be imported from abroad. Cost was estimated in US$ assuming that the major component is the cost for material.

4.7 Comparison Between the Existing Mixed Collection System and the Segregated Collection System

Total project quantities and costs are shown in Table 30. The table shows that the total cost for eight (8) years (2008-2015) to collect mixed waste is approximately 13 million US$ plus 20 million CUP. The total cost of segregated waste collection is approximately 23 million US$ and 24 million CUP. Major reasons for the cost difference are the number of collection vehicles and waste bins. The segregated system requires 26 additional vehicles and 20,802 more bins than the mixed collection system. The total cost, including maintenance cost, is almost twice as much as the mixed collection system.

Table 30 Cost Comparison between Mixed Collection and Segregated Collection

Type of collection		Mixed Collection	Segregated Collection
Items/Year		Total	Total
Grand Total	(US$)	13,092,560	22,788,006
	(CUP)	20,194,920	23,958,180

4.8 Recommended Improvement for Collection System in the Urban Areas

The segregated waste collection system is recommended to UPPH in the urban areas, even though the cost is higher than the existing system. The total evaluation has to consider resource recovery profit, compost profit and waste reduction profit. However, introduction of this system is to improve suitable municipal solid waste management. Therefore, it is strongly recommended that UPPH adopt the system.

5. Improvement of the Collection and Transportation System in the Suburban Area under DMSC

5.1 Replacement of Existing Horse and Cart Collection System

There are six DMSC offices in rural areas. H/C vehicles collect 0.06 tons/hr/unit, the speed is about 1.5 to 2.0 km/hr, and they haul waste into special period landfill sites. Special period landfills will be closed by 2006, and then MSW will be transferred to New Site 1 and New Guanabacoa landfill. The new sites are further away than the special period landfill sites, so this suggests that the H/C system cannot be used for transportation as of 2007. DMSC has to introduce a new collection system in this area. Typical H/C vehicles are shown in Figure 10.

$2m^3$ H/C

$2m^3$ H/C

Figure 10 Typical Existing H/C Vehicles

(1) Option A: Partial Replacement with Transfer Stations

Currently, there are 7 steel containers (10-18 m^3) that are used for waste storage located at closed special period disposal sites. Because H/Cs do not have enough transportation capability to haul waste to the new landfill sites, an arm-roll truck is used to transport the waste container filled with waste brought by the H/C to the new disposal site. The container fills the role of a transfer station and has been transferred every day to Calle 100 and Ocho Vias. If the H/C system is kept, well-designed transfer stations will be required because otherwise, they may pose an environmental risk. According to DMSC design data, DMSC needs to cover construction cost and additional costs, i.e., land acquisition and transfer vehicles. The cost of a transfer station system is high so it is suggested that the H/C system has to be replaced with a new collection system.

a) Idea from the Cuban side

The cost of a simple type of transfer station is estimated around US$ 140,800, which equals JY 15,500,000 according to DMSC design. The estimated cost of the transfer

station is shown in Table 31. A drawing of the transfer station is shown in Figure 11. The facility consists of a platform that is 2.15 m high, 2 hoppers, 4 sets of 25 m^3 containers for 2 kinds of segregated waste and a water treatment plant to act as a waste cleaning facility.

Table 31 Cost Estimation for Transfer Station

Items	Unit (US$)	Unit (JY)	3-sets (JY)
Structure	40,869.81	-	-
Foundation	7993.37	-	-
Waste water treatment	3,024.50	-	-
Earth works for roads	74,066.89	-	-
Earth works for pit	14,869	-	-
Total cost	140,823.67	15,490,530	46,471,590

Source: DPSC, 2004 (110 JY/US$)

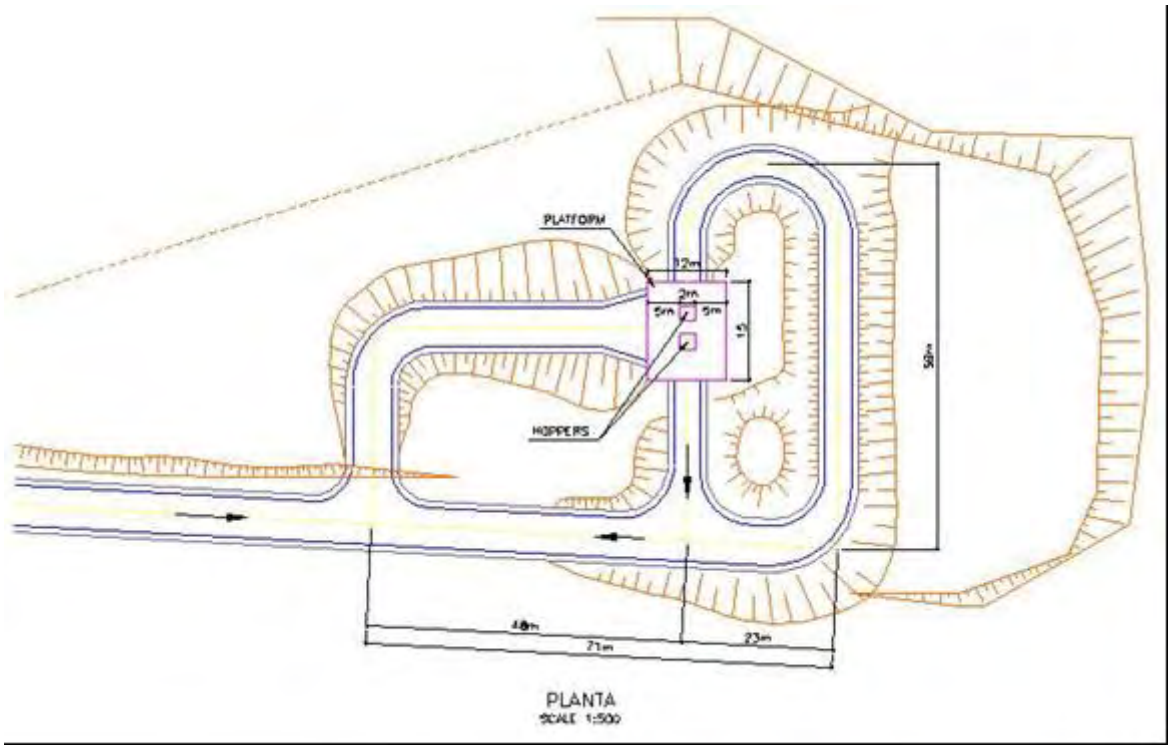


Figure 11 Ground Plan of Transfer Station (Source DPSC, 2004)

As well, DMSC needs to cover additional costs i.e. land acquisition and transfer vehicles. Therefore, the Cuban side decided that a T/S would have a higher cost than a direct transportation system.

b) Various types of transfer station

Typical equipment for the transfer station system is illustrated below and Table 32 summarizes the various types of system. Figure 12 shows various types of transfer station. One will be selected depending on the amount of waste, cost benefits, space and environmental considerations.

Table 32 Various Types of Transfer Station

No. of Systems	Required equipment as load transferring station	Required as transporter	Cost	Maintenance work	Handling volume	Environment Issues
Nos.1/2	Shovel cars/manual	D/T or C/T	Small	Easy	Little	Less odor
Nos.3/4	Hopper/steel containers	D/T or tow car	Expensive	Easy	Little	Needs Odor control
No.5	Compression equipment & closed containers	Tow car	Very expensive	Difficult	Large	Less odor
No.6	Fork lift/container	D/T	Very expensive	Easy	Large	Less odor
No.7	Pit/crane/hoppers	D/T	Very expensive	Difficult	Large	Needs Odor control
N0.8	Crusher/ belt conveyor/hoppers	D/T	Very expensive	Difficult	Large	Needs Odor control

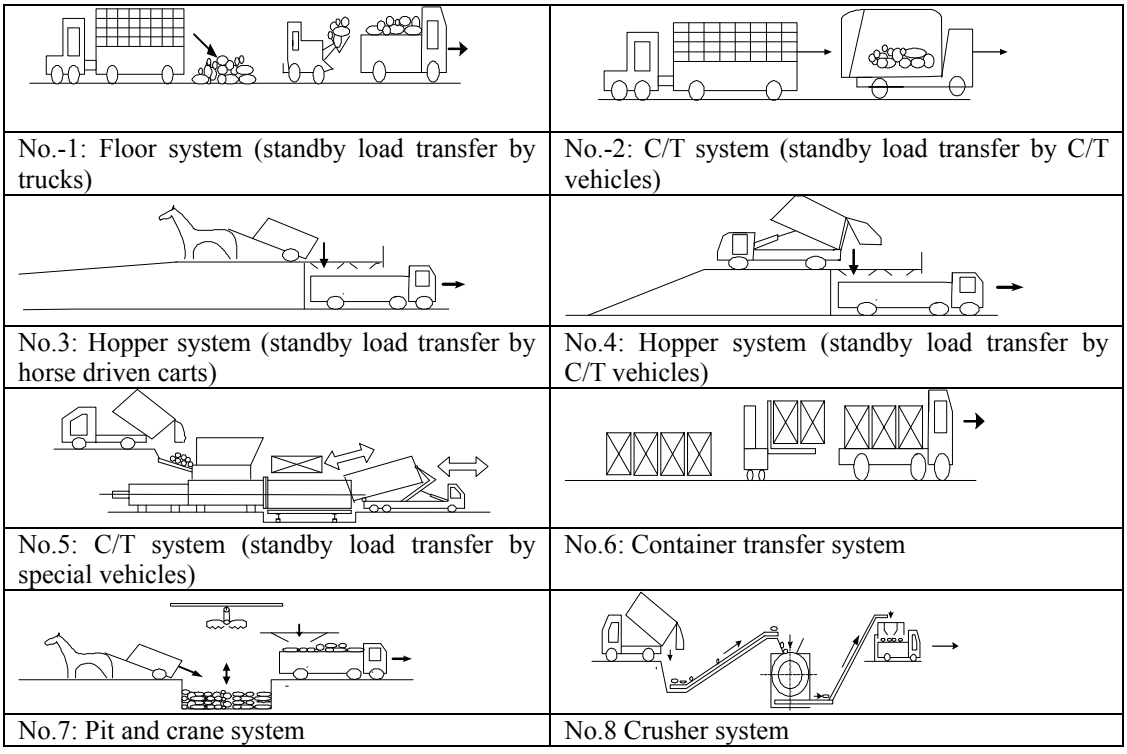


Figure 12 Various Types of Transfer Station

c) Comments

Nine special period landfill sites will be closed in 2006. To meet future relocations, DMSC has planned to prepare a minimum of three transfer stations. According to their plan, the 3 transfer stations will cost around 0.42 million US$ minimum, and the new system will cost around 2.78 million US$ including 30 D/Ts to collect and transport them to new landfill sites as shown in Table 33. The comparison results show that the investment cost for the transfer system is almost the same as alternative 2 (C/T) but its operation cost will be more expensive. A proposed new system is a C/T system that is more efficient

because it has not only high collection/haulage capability but also transportation capability. Therefore, the Plan will select a new system without transfer stations. Also, the cost for 30 D/Ts is calculated in Table 34 and the associated operation cost is shown in Table 35.

Table 33 Cost Comparison between with T/S and without T/S

Description	Alternative-1		Alternative-2
	Collection	Transportation	Collection /Transportation
Proposed system	H/C collection,	T/S and D/T transportation	12 m^3 C/T collection and transportation
Waste Amount	74	74	74
Initial cost	Existing	- T/S (3) 420,000 US$ - 10m^3D/T (5+25 = 30) 2,100,000 US$ - sub-total 2,520,000 US$	12 m^3 C/T (24) 2,600,000 US$
Maintenance Cost	-	256,500 US$ (10 years)	260,000 US$ (10 years)
Operation Cost (CUP)	50,000,000 CUP	10,142,000 CUP (10 years)	5,200,000 CUP (10 years)
Total Cost	50,000,000 CUP	- 2,776,500 US$ - 10,142,000 CUP	- 2,860,000 US$ - 5,200,000 CUP
Unit Cost (t/d)	10.5 US$ + 185.1 CUP + 37.5 CUP		10.6 US$ + 19.3 CUP

Note: 1 t/d out of the 75 t/d of MSW H/C collection goes to Campo Florido

Table 34 Summary of the Total Number of T/Cs Required per Phase

Table III-1.5-4 6-2-2005 Alt. -1 (T/S:11t/d+63 t/d=74 t/d)

New D/T(10ton,10m^3)		Phase-1								Phase-2						Total
		2004	2005	2006	2007	2008	2009	2010	S-Total	2011	2012	2013	2014	2015	S-total	
	Total Scraps (units)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plan of Replacement (unit)	Total New (units)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Replacement (units)	0	0	30	0	0	0	0	30	0	0	0	0	0	0	30
Total In operation Vehicles (units)		0	0	30	30	30	30	30	-	30	30	30	30	30	30	30
Standby (units)		0	0	0	0	0	0	0	-	0	0	0	0	0	0	-
Required Vehicles (units)	*30*															
Unit Price (JY)																
Unit Cost of D/T Vehicles	7,600,000	0	0	228,000,000	0	0	0	0	228,000,000	0	0	0	0	0	0	228,000,000
JY/US$=	110	0	0	2,072,727	0	0	0	0	2,072,727	0	0	0	0	0	0	2,072,727
aintenance Cost =5%*unit cost * No. of Vehicles in operati																
JY/year	0.05	0	0	9,500,000	9,500,000	9,500,000	9,500,000	9,500,000	47,500,000	9,500,000	9,500,000	9,500,000	9,500,000	9,500,000	47,500,000	95,000,000

Table 35 Operation Cost (D/T)

Item (D/T)	Unit cost	Unit cost	Peso Currency			Remarks
Peso	Peso		Quantity	Price(Mon)	Pric(year)	
Labor costs	500	peso/cap	150	75,000	900,000	5cap/d/unit*30units
Water	0.5	peso/m3	1,800	900	10,800	5m3/d/unit*30units
Gas(LPG)	-	peso/liter	0	-	-	
Fuel	0.3	peso/m3	25,714	7,714	92,571	3.5 km/liter per 100km/d*30units
Power rates	0.1	peso/kwh	9,000	900	10,800	
Total				84,514	1,014,171	25peso/U$
Expenses (peso/day)					2,779	
Expenses (peso/t/d)					38	74 t/day(MSW)

(2) Option B: Complete Replacement without Transfer Stations

a) Collection System

Introduction of a C/T collection system instead of the H/C collection system will improve not only the collection efficiency, but also transportation capability. The system does not require transfer stations, so the land for closed sites can be used for other purposes. In the collection areas with low population density, the collection efficiency for T/C is expected to be 1 ton/hour/unit according to the data from the time and motion study. This value is adopted to calculate the required number of T/C and small and medium size C/T vehicles in suburban areas. If working time for collection and transportation would be limited to 8 hours, the maximum collection amount would be 6 ton/day/unit. Therefore, Option B selects 12 m^3 C/Ts with an estimated capacity of 5 tons (actual data shows the capacity of 18 m^3 C/T was 7.5 tons). The replacement has to be done by 2007 before special period landfills are closed. However, UPPH would like to keep the traditional collection system with H/C. To meet their request, the H/C collection system, one ton/day, can be kept in service areas near the Campo Florido landfill site. Typical C/T vehicles are shown in Figure 13.

New 18 m^3 C/T with lifting equipment from Russia (2005)

Figure 13 Typical New C/T Vehicles Imported from Russia (KAMAZ)

b) Required Number of Vehicles and Procurement Cost

The required number of vehicles and procurement cost is shown in Table 36 and Appendix 3-1 to 2 in B.1 of Data Book.

Table 36 Procurement Cost of Collection Vehicles

(Unit price: US$109,090/Unit)

Year	2005-2010	2011-2015	Total
No. of Vehicles	24	0	24
Total Cost (US$)	2,618,182	0	2,618,182

c) Maintenance Cost

The maintenance cost is 5% of the purchase cost. The cost is shown in Table 37.

Table 37 Maintenance Cost per Phase

Year	2005-2010	2011-2015	Total
Total Cost (US$)	392,727	654,545	1,047,273

d) Operation Cost

The operation cost is shown in Table 38.

Table 38 Operation Cost per Phase

Year	2005-2010	2011-2015	Total
Total Cost (CUP)	1,571,739	2,619,566	4,191,305

e) Total Cost

The total cost of a 12 m^3 C/T collection system is shown in Table 39.

Table 39 Total Cost of 12 m^3 C/T Collection System

Year		2005-2010	2011-2015	Total
Procurement Cost 12m^3 C/T (US$)		2,618,182	0	2,618,182
Maintenance Cost (US$)		392,727	654,545	1,047,273
Operation Cost (CUP)		1,571,739	2,619,566	4,191,305
Total cost	(US$)	3,010,909	654,545	3,665,454
	(CUP)	1,571,739	2,619,566	4,191,305

(3) Improvement of the Other Collection Systems in the Suburban Areas

a) Collection System

In the suburban areas, there are two options. One is introduction of the C/T system and the other is the continuation of the existing system with T/Cs. The economic evaluation shows that the cost of both systems is almost the same because of the 62 existing units. However,

if the existing system can use domestic tractor-driven carts, then it has a future. This idea is in keeping with the basic policy of the plan. Therefore, the T/C collection system is adopted as the collection system in suburban areas. The total number of required T/Cs is 122 in 2015 but 62 units already exist in DMSC. Typical conventional vehicles are shown in Figure 14.

10 m^3 D/T (Imported)

15 m^3 T/C (locally made)

Old T/C (Russian)

T/D (Russian)

Figure 14 Typical Existing Conventional Vehicles

b) Required Number of T/C Vehicles and Procurement Cost

The required number of vehicles and procurement cost are shown in Table 40.

Table 40 Procurement Cost of Collection Vehicles (T/C)

(Unit price: US$25,454/Unit)

Year	2005-2010	2011-2015	Total
No. of Vehicles	19	41	60
Total Cost (US$)	483,636	1,043,637	1,527,273

c) Maintenance Cost

The maintenance cost is 5% of the purchase cost. The cost is shown in Table 41.

Table 41 Maintenance Cost per Phase

Year	2005-2010	2011-2015	Total
Total Cost (US$)	309,273	776,363	1,085,636

d) Operation Cost

The operation cost is shown in Table 42.

Table 42 Operation Cost Estimation per Phase

Year	2005-2010	2011-2015	Total
Total Cost (CUP)	8,214,789	20,621,486	28,836,275

e) Total Cost of T/C Collection System

The total cost of a T/C collection system is shown in Table 43.

Table 43 Total Cost of T/C Collection System

Year		2005-2010	2011-2015	Total
Procurement Cost T/C (US$)		483,636	1,043,637	1,527,273
Maintenance Cost (US$)		309,273	776,363	1,085,636
Operation Cost (CUP)		8,214,789	20,621,486	28,836,275
Total Cost	(US$)	**729,909**	**1,820,000**	**2,549,909**
	(CUP)	8,214,789	20,621,486	28,836,275

6. Maintenance of Vehicles and Equipment

6.1 Policy of Equipment Selection

Improvement of maintenance capability will contribute to increasing the operational ratio and life span of collection vehicles. Also, collection-service agencies have to improve their solid waste management capability to keep the city clean. The policy of equipment selection for the maintenance workshop is as follows:

- The necessary units and equipment should be selected from the viewpoints of simple models and manual or semi-automatic operation.
- The main maintenance equipment should be introduced to the central workshop of UPPH, because the central workshop is responsible for maintenance of all C/T vehicles.
- Small-scale machine tools and equipment for daily maintenance should be introduced to DMSC workshops.
- Mechanical cleaning vehicles and monitoring equipment should be introduced to provide a comfortable life for citizens and to keep the scenery of the city beautiful.
- Office equipment is also required as collection-service agencies have to collect and accumulate basic data on solid waste.

6.2 Minimum Required Machines and Equipment for Suitable Operation

a) Maintenance/Monitoring

The first priority is the equipment and various tools for engine overhaul and gas/electricity welding machines to repair the bodies of vehicles as shown in Table 44. The second priority is mechanical tools and mechanical bin washing vehicles. Related overhaul equipment is extremely important because the newest C/T vehicles are 5 years old and second hand ones are 3 to 5 years old. Main equipment includes devices for repairing flat tires, jacks, air compressors and welding machines for body repair. The equipment is to be supplied to UPPH and all DMSC workshops. Machine tools include lathes, radial drills and milling cutters for the UPPH workshop, and hand drills and grinders for both UPPH and DMSC workshops.

Table 44 Priority of Required Equipment and Tools

Priority	Types of equipment	Purpose of use
First	Equipment and tools for engine overhaul and gas/electricity welding machines	Repair the Body
Second	Mechanical tools and mechanical bin washing vehicles.	Daily Maintenance

b) Machine Tools

The required machine tools are listed in Table 45. Machine tools such as lathes, radial drills and milling cutters should be supplied to the UPPH central workshop. Hand drills and grinders should be supplied to UPPH and the 14 DMSC workshops.

Table 45 List of Machine Tools

No.	Name of equipment	UPPH	DMSC
		Units	Units
1-4	Lathes, Radial Drills, Precision Surface Grinding Machine	1	0
5	Bench Grinder	0	14
6-8	Milling Cutter, Electric Saw, Electric Cutter,	1	0
9-15	Bench Drilling Machine, Electric Drill, Electric Grinder, Disc Grinder	1	14

c) Equipment

Related overhaul equipment is the most important because most of the C/T, T/C and D/T vehicles are old. The required machine tools are listed in Table 46. The main equipment consists of flat tire repair equipment, jacks, air compressors and welding machines. The equipment should be supplied to UPPH and all of the DMSC workshops.

Table 46 List of Equipment for Workshops

Name of equipment		UPPH	DMSC
		Units	Units
1-12	AC welding machine, Jack 20t and 10t, Engine arc welder, Engine generator, Oil changer (2), Grease pump, Battery charger, Battery tester, Tool kits, Car washer	1	14
13-18	Argon welding machine, Engine arc welder, Electric trolley chain block, Tire changer, Jack for transmissions	1	0
19	Air compressor	1	8
20	Tire changer	0	8
21-22	Tire repair kit, Impact wrench	2	14
23	Extension type jack, Impact wrench	2	0

d) Tools for Repair and Maintenance Vehicles

In addition, working tools are necessary to adjust the parts of vehicles. The required machine tools are listed in Table 47. The main tools consist of spanners, hammers, wrenches as well as metal materials. These tools should be supplied to UPPH and to all the DMSC workshops.

Table 47 List of Various Tools

Name of Tools		Specification	UPPH	DMSC
			Units	Units
1	Hex Wrenches	-	2	14
2	Spanners	-	2	14
3	Files	Flat/round/triangle file sets	2	14
4	Reamers	Straight/tapered reamer sets	2	14
5 -20	Bits, Screw drivers, Drills, Taps, Dies, Open end wrenches, Nippers, Adjustable wrenches, Bench vises, Sledgehammers, Hammers, Tool Boxes, Cord reels, Shovels, Grindstones, Hacksaws	-	Each 2	14
21	Instruments	Gauges, Tape measures, Calipers, Revolution meter, Compasses, etc.	2	14
22	Safety/ Health Control	Goggles, Gloves, Stretchers, Masks, etc.	2	14
23	Metal Materials	Steel plate, Steel round bar, Aluminum round bar, Bronze bar, etc.	2	2
24	Others	Special tools	2	14

e) Cleaning Equipment

The cleaning work for collection bins is necessary to keep the surrounding area clean and especially to eliminate odors from residual waste in the bins, so cleaning equipment for collection vehicles is required. The required mechanical cleaning equipment is listed in Table 48. The mechanical cleaning vehicle has a water tank of 5,000 to 8,000 liters with high-pressure pumps and a storage tank for washed waste. The bin-washing vehicle can wash about 100 to 200 bins per day. Portable cleaning equipment for collection vehicles is also required as collection vehicles always have to be kept clean.

Table 48 List of Mechanical Cleaning Equipment

Name of Equipment		Specifications	UPPH	DMSC
			Units	Units
1	Mechanical Equipment	Automatic bin washers with 7500L water tank	3	0
2	Portable Washers	Electric pumps	4	14
3	Bins Wash Vehicles	PVC containers, water spray	4	0
4	Dump Trucks	4 ton	4	4
5	Hand Carts	2 -160 liter bins with wheels	1,500	0

f) Inspection and Communication Tools

Inspection of collection stations and monitoring for illegal dumping are the most important tasks of collection service agencies. Motorcycles are useful for inspection and patrolling to check waste problems in the City. Inspectors have to carry communication tools to report the problems to the office and take urgent countermeasures. The required tools are listed in Table 49.

Table 49 List of Inspection and Communication Tools

Name of equipment		Specification	UPPH	DMSC
			Units	Units
1	Motorcycles	50cc	4	15
2	Hand transceiver	Battery-type, Distance 2 to 5km	10	14

g) Office and Other Equipment

Collection and accumulation of basic data on solid waste is very important to improve the management capability for collection and transportation. The items of equipment required are computers and printers as well as hour meters and odometers for collection vehicles, which can record daily operation time and distance. The list is shown in Table 50.

Table 50 List of Office & Other Equipment

Name of Equipment		Specification	UPPH	DMSC
			Units	Units
1	Computer	Desk Top	2	15
2	Printer	With fax machine	2	15
3	Hour meter/Odometers	24 hr. recording (mileage and time)	140	122

6.3 Procurement and O/M Cost

a) Procurement Cost

Based on the price lists obtained in Japan and from UPPH, procurement costs for the workshop equipment are estimated as shown in Tables 51 and 52. The total procurement cost is US$3.35 million (US$2.21 million (2005-2010) and US$1.14 million (2011-2015)). The budget allocation between UPPH and DMSC is 66% to 34%. The required local costs for equipment installation work and electrical work in the workshop are estimated at

CUP 550,000 (Installation cost of equipment is CUP 90,000 and electrical work is CUP 460,000.)

Table 51 Procurement Cost

Items	Cost (US$)		
	UPPH	DMSC	Total
Equipment	66,600	537,655	604,255
Various Tools	23,164	129,418	152,582
S-total	**89,764**	**667,073**	**756,837**
Machine Tools	659,250	38,373	697,623
Cleaning Equipment	1,300,909	200,909	1,501,818
Inspection and communication tools	9,091	29,818	38,909
Office Equipment	151,211	202,427	353,636
S-total	**2,120,459**	**471,527**	**2,591,986**
Total	**2,210,223**	**1,138,600**	**3,348,823**
	66%	34%	-

Table 52 Procurement Cost per Phase

Years	2005-2010	2011-2015	Total
Total Cost (US$)	756,836	2,591,987	3,348,823

b) Maintenance Cost

The maintenance cost is 5% of the purchase cost. The cost is shown in Table 53.

Table 53 Maintenance Cost per Phase

Years	2005-2010	2011-2015	Total
Total Cost (US$)	113,525	837,206	950,731

c) Operation Cost

The operation cost is shown in Table 54.

Table 54 Operation Cost per Phase

Years	2005-2010	2011-2015	Total
Operation Cost (CUP)	3,062,817	5,421,825	8,484,642

d) Total Cost

The total cost of the T/C collection system is shown in Table 55.

Table 55 Total Cost of Workshop

Years		2005-2010	2011-2015	Total
Procurement Cost (US$)		756,836	2,591,987	3,348,823
Maintenance Cost (US$)		113,525	837,206	950,731
Operation Cost (CUP)		3,062,817	5,421,825	8,484,642
Total Cost	(US$)	**870,361**	**3,429,193**	**4,299,554**
	(CUP)	**3,062,817**	**5,421,825**	**8,484,642**

7. Staffing Plan

7.1 UPPH

An improved collection system requires more staff than the existing system. Table 56 shows that the staff of the UPPH will need to increase by 507 in 2015 under the segregated collection system. The basic concept of the schedule is as shown in Appendix 6-1 to 4 in B.1 of Data Book.

Table 56 Staffing Plan for UPPH

Description		Actual No.	2010		2015	
			Required No.	Increase	Required No.	Increase
Mixed Collection	Collection crew	277	332	55	388	56
	Engineers	40	33	-7	39	-1
	Tech. staff	130	125	-5	146	16
	Workmen	45	59	14	68	23
	Bin cleaning staff	6	13	7	25	19
	Inspectors	18	17	-1	20	2
	Data operators	1	2	1	2	1
	Total	517	582	65	688	171
Segregated Collection	Collection crew	277	380	103	560	283
	Engineers	40	52	12	56	16
	Tech. staff	130	195	65	210	80
	Workmen	45	91	46	98	53
	Bin cleaning staff	6	56	50	68	62
	Inspectors	18	27	9	29	11
	Data operators	1	2	1	2	1
	Total	517	803	286	1023	506

7.2 DMSC

In the case of the DMSCs, the improvement in the collection system will help reduce the staff required as collection efficiency will be improved drastically. Table 57 shows that the staff will be able to be decreased by 602 in 2015. DMSCs will have to discuss with UPPH about arrangements for staff.

Table 57 Staffing Plan for DMSC

Description	Actual No.	2010		2015	
		Required No.	Increase	Required No.	Increase
Collection crew	1,276	405	-871	610	-666
Engineers	44	25	-19	37	-7
Tech. staff	106	41	65	61	-45
Workmen	40	41	1	61	21
Bin cleaning staff	0	0	0	0	0
Inspectors	165	162	-3	244	79
Data operators	0	15	15	15	15
Total	**1,630**	**689**	**-941**	**1,028**	**-602**

8. Implementation Schedule and Cost Estimate

8.1 Implementation Schedule

Major events to improve the existing collection system are as follows:

- According to the CITMA plan, Guanabacoa and three (3) special period landfills were closed in 2005, Calle 100 (80 ha) will be closed in 2006 and the Calle 100 (24ha) Expansion landfill site will be opened in 2007. The collected MSW will be transferred to the New Guanabacoa landfill site in 2007 and New Site 1 in 2011.
- Segregated collection for two (2) municipalities (Playa, H. del Este) will start in 2010, and five (5) municipalities (Plaza, C. Habana, H. Vieja, Diez de Octubre y Cerro) will commence in 2013.
- UPPH should use the 18 m^3 C/T vehicles for a segregated waste collection service.
- 770 liter steel bins are to be adopted as collection bins for segregated collection. All existing bins should be replaced within 10 years.
- DMSC will introduce the new 12 m^3 C/T collection system to replace the H/C collection system in 2007.
- The T/C collection system is to be adopted continuously in suburban areas.
- Activities for improvement of maintenance capability should start in 2006. The first priority is to supply gas/electric welding machines to repair the bodies of vehicles, while the second priority is the supply of mechanical tools and mechanical bin washing vehicles.

The implementation schedule is shown in Figure 15.

Implementation Schedule		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Segregation (1)	Playa, H.Del Este					Start					
Segregation (2)	Plaza, C. Havana, H,Vieja, Diez de Ocutubure, Cerro								Start		
18m^3 C/T	Vehicle Purchase Plan	0	0	25	2	19	7	0	23	0	0
12m^3 C/T	Vehicle Purchase Plan	0	0	24	0	0	0	0	0	0	0
15m^3 T/C	Vehicle Purchase Plan	0	0	19	0	41	0	0	0	0	0
770 liter Bin	Waste bin replace Plan	0	0	3,516	1,172	7,840	1,172	1,172	15,306	1,172	1,172
Workshop	Purchase Plan	non	non	Machine tools, Equipment	non	Others	non	non	non	non	non

Figure 15 Implementation Schedule

8.2 Cost Estimate

The total project cost of improvement for the collection system is shown in Table 58. The project cost is estimated according to the implementation schedule described in Figure 15. Appendix 7 in B.1 of Data Book shows a list of quotations from several sources selecting the middle price as a unit price on a CIF Habana basis.

Table 58 Total Project Cost of Improvement for the Collection System

Items/Year		2006-2010	2011-2015	Total
UPPH - Cost of Segregated Collection			-	-
Total Cost	(US$)	10,531,144	12,276,862	22,808,006
	(CUP)	7,228,440	16,729,740	23,958,180
DMSC - Cost of 12m^3 C/T Collection			-	-
Total Cost	(US$)	3,010,909	654,545	3,665,455
	(CUP)	1,571,739	2,619,566	4,191,305
DMSC - Cost of T/C Collection			-	-
Total Cost	(US$)	792,909	1,820,000	2,612,909
	(CUP)	8,214,789	20,621,485	28,836,275
Cost of Workshops			-	-
Total Cost.	(US$)	870,362	3,429,192	4,299,554
	(CUP)	3,062,817	7,019,835	10,082,652
Grand Total	(US$)	15,205,324	18,180,600	33,385,924
	(CUP)	20,077,785	46,990,626	67,068,412

B. Collection and Transportation:

B3 Maintenance Workshops

B3. MAINTENANCE WORKSHOPS

1. Organization and Duties of UPPH and DMSC

UPPH is one of the executive organizations for SWM and it is responsible for maintenance work, collection, transportation and treatment of solid waste in Havana City. The organization chart of UPPH is shown in Figure 1. The other executive organization is DMSC, the organization chart for which is shown in Figure 2. The official duties of each organization are shown in Table 1. Both organizations have maintenance workshops for collection vehicles; Figure 3 shows the location of these workshops. The maintenance work includes the maintenance of vehicles and equipment used for collection and transportation of solid waste.

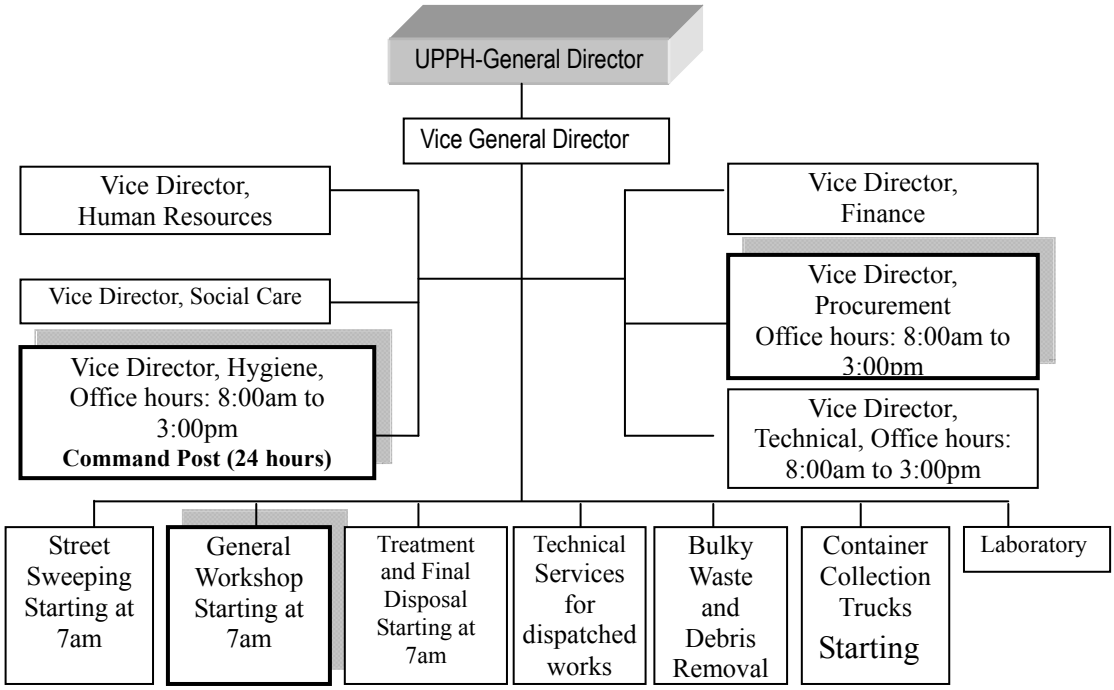


Figure 1 Organization of UPPH

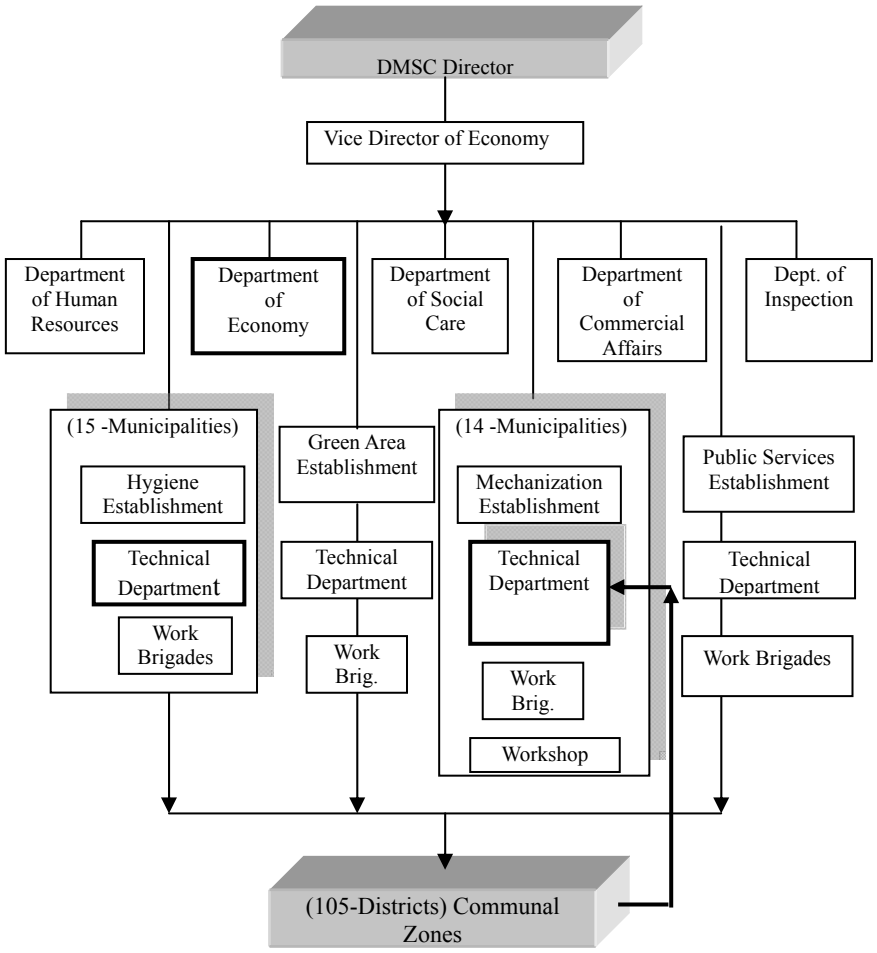


Figure 2 Organization of DMSC

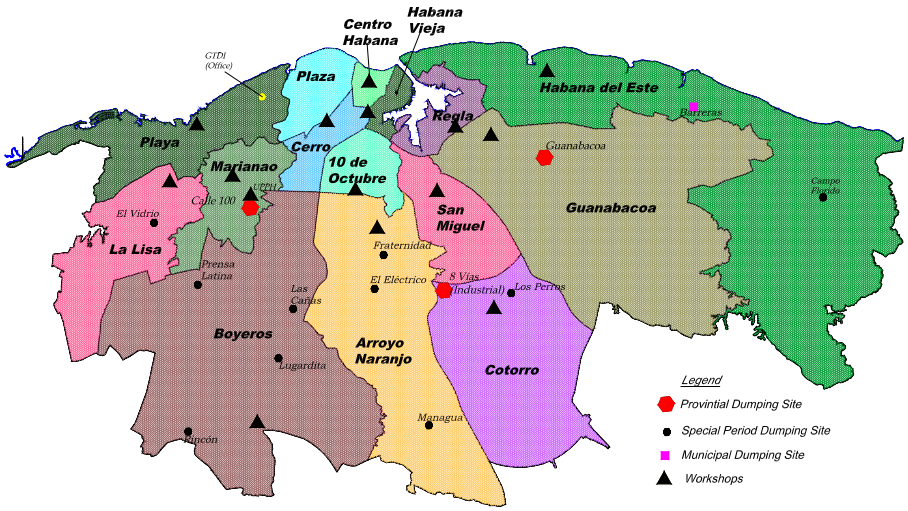


Figure 3 Map of Workshop Locations

Table 1 Major Duties of UPPH and DMSC

Section	Description of Duty	Duty Area
UPPH Headquarters	Operation and management of the entire treatment system for solid waste, supervision and guidance of financial, technical, organizational and institutional matters.	All of Havana City, Service area of UPPH
UPPH Workshop	Maintenance and repair work for vehicles and construction equipment including bins. Repair work that cannot be carried out at the DMSC workshops. Workshop is responsible for O/M of their facilities.	All of Havana City, Service area of UPPH
DMSC workshop (14-District Offices)	Maintenance and repair work for vehicles and construction equipment including bins. Workshop is responsible for O/M of their facilities.	Each DMSC branch is responsible for its own municipal area

Source: UPPH

2. UPPH Staff Numbers and Responsibilities

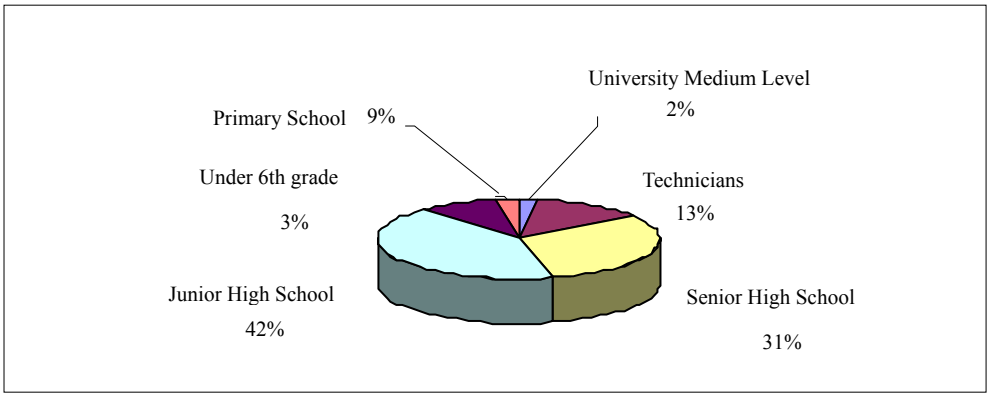
2.1 UPPH Manpower

In 2005, the total number of engineers, technicians and skilled workers was about 517 as shown in Table 2 and Figure 4. There is sufficient experience in the field of maintenance work for collection vehicles and other related equipment. Also, there is vast knowledge of construction equipment. Overall, UPPH has more than 28 years experience in maintenance work so it has gained sufficient technical capability to maintain and keep their equipment operating efficiently.

Table 2 Manpower Allocation for MSW

Description		UPPH
In 2005	Collection Crew	277
	Engineers	40
	Tech. staff	130
	Workmen	45
	Bin cleaning staff	6
	Inspectors	18
	Data Operators	1
	S-total	**517**

Source: UPPH (As of June, 2005)



Source: UPPH (As of January, 2002)

Figure 4 Educational Background

2.2 Capability and Responsibility of the UPPH Workshop

The total workshop area is about 10 ha including space for parking where there are 78 C/T units and 180 vehicles. However, only 41 C/T units are workable and of the other vehicles only 128 are operable.

A daily vehicle condition check is made every morning before the vehicles leave their parking space by a total of 40 people i.e. engineers, technicians and staff from all related departments. Usually, the amount of daily repair work depends on the existence stock parts. The average distance traveled per day by a C/T vehicle is about 130 km.

The workshop carries out daily and monthly routine maintenance work and there is also an annual inspection by the Ministry of Transportation. The work is scheduled by the vice-technical director. Management of the maintenance workshop is organized under the following leading sections:

a) Vice-Director of the Hygiene Section

The most important tasks of the section are to conduct all public relations and to manage ongoing daily collection activities by UPPH staff. There are five controllers who operate from a location called the "Command Post", they control and receive all the information regarding collection and transportation. Each controller must stay in the office for 24 hours in fixed shifts of 3 days on and 3 days off. Another important task is the preparation of a maintenance plan to establish a better and more efficient schedule for solid waste management.

b) Vice-Director of Procurement Section

The procurement section must procure all items needed for proper maintenance such as, parts, tires, fuel/oil, engines and collection vehicles.

c) Vice-Director Technical Section

One of the main activities is checking the mechanical condition of all collection vehicles every morning. Also, regular checkups are scheduled by time and distance as recommended by the manufacturers.

All 31 drivers in the workshop are encouraged by incentives such as a prize of T-shirt and a certificate for the best driver based on the score resulting from an evaluation sheet filled in by section engineers.

d) Central Workshop Section

This section has responsibility for the implementation of all technical matters, for all vehicles and equipment. This section takes care of the overhauling and servicing of engines, brakes, hydraulic compression devices as well as fixing flat tires.

e) Container & Collection Trucks Section

The main task is the arrangement of collection vehicles, drivers and collection routes. The chief comes to his office, which is located in the parking area at 6:30am and stays until 4:00pm. He gets information on the condition of the collection vehicles and if vehicles need repair he reports to the related section that day or at the next morning meeting where they discuss maintenance schedules.

2.3 UPPH Workshop Facilities

An outline of facilities of the workshop is shown in Table 3 with maintenance items shown in Table 4.

Table 3 Major Facilities of Workshop

Items	Units	Description
Parking area	10	200 units such as C/T and included Special and Environmental Sanitation Vehicles
Filling station	3	Oil tanks and filling equipment for diesel
Water tanks	13	-
Vehicles repair yard/Workshop	3	-
Tire repair equipment	3	For dump trucks & all types of vehicles
Machine tool rooms	2	Not enough
Lathes	3	Bad condition
Drills	1	In use
Electric welding machine	1	Bad Technical condition
Gas welding equipment	2	-
Grinder	1	-
Bins Assemble / Stock Yard	1	Stock 200 to 300 bins
Parts Stock Room	2	Insufficient number of parts
Offices/Buildings	8	Administration office, staff office, etc.
Dining room	6	-
Lavatory	11	-
Shower room/Rest room	3	-

Table 4 Lists of Major Maintenance Items

Items	Description	Responsible Section	Required time
Morning checkup	Oil/ fuel, brakes, lights, water level, battery, steering, air pressure, general observation, tighten tire lugs etc	Technical section and all related sections	7 - 10 minutes
Distance by km done	Type 1 to 3 depending on running km: check items were adopted from manufacturers' recommendations.	Technical section and all related sections	-
Monthly checkup	Hydraulically-operated parts, leaking water/oil, viscosity of lubricant, air pressure, water, battery, gauge/level, confirmation of performance of exchanged parts, tighten tire lugs etc.	Central Workshop	1 - 2 days depending on availability of parts
Annual inspection	To obtain permission for driving a vehicle on public areas: Check that items follow the legal requirements.	Ministry of Transportation	-
Most common maintenance items	1) Repair and adjustment of hydraulically-operated parts 2) Replacement of suspension springs 3) Repair flat tires 4) Repair engines	Central Workshop	1 - 2 days depending on availability of parts and items to be repaired
Recording fuel consumption (Diesel oil)	About 31,000 liter/day/90 vehicles	Technical section	-

3. DMSC Staff Numbers and Responsibilities

3.1 DMSC Manpower

The DMSC has 14 workshops, one in each district, except for the Plaza municipality.

In 2005, the total number of engineers, technicians and skilled workers was about 1,630 as shown in Table 5.

There is a maintenance staff of 150 under the Mechanization Establishment. They have sufficient experience in O/M fields and also appropriate knowledge in the reuse of parts.

Table 5 Workers Assigned to the DMSC

Description		DMSC
June, 2005	Collection Crew	1,276
	Engineers	44
	Tech. staff	106
	Workmen	40
	Bin cleaning staff	0
	Inspectors	165
	Data Operator	0
	S-total	**1,630**

3.2 Capability and Responsibility of the DMSC Workshops

The maintenance space of each workshop is around 2 to 4 ha, including a workshop area and parking space. Usually, there are 4 to 22 D/T and T/C collection vehicles in the parking space. A total of 356 vehicles are stationed in the workshops, although about 20% to 30% are usually out of service.

A total of 20 vehicles have been waiting to be repaired for more than one month due to the unavailability of spare parts. A total number of 67 vehicles are in good condition.

Engineers from the Mechanization Establishment carry out maintenance work every morning before the vehicles leave their parking space.

Average mileage per day to collect waste by T/Cs and D/Ts is about 100 to 150 km per unit. Repair and check-up follows the same procedures as those followed by UPPH.

The economy director controls the related financial department and the DMSC director manages hygiene, green spaces, mechanization and public service establishments.

The following leading sections manage each workshop:

a) Director of DMSC

The director has the responsibility of setting up a checkpoint for monitoring collection performance at the most convenient distance from the landfill site in the territory.

b) Economy Department

This department is responsible for procurement control and acquiring all items i.e. parts, tires, fuel/oil, engines and collection vehicles.

c) Hygiene Establishment

The most important tasks of the Hygiene Establishment are public relations and assessment of the current collection activities by DMSC staff on a daily basis.

A supervisory unit called the “Command Post” controls receipt of all information regarding collection and transportation. The person in charge must stay in the office 24 hours a day for his 3-day shift. Another important task is the preparation of an efficient maintenance plan.

d) Technical Department

The Technical Department has responsibility for checking the condition of vehicles, using its own engineers.

e) Communal Zones

This office arranges collection routes, crews and observation posts. It also mobilizes street sweepers and supervises their activities.

Other tasks are 1) to gather information about vehicle performance and 2) to conduct a routine checkup schedule, both monthly and by distance. Also, the office staff makes recommendations on the repair of vehicles to the related sections. The office has a small organization called the "Vanguard Movement", which operates a competition, rewarding the most beautiful zone, the best crew and street sweepers.

f) Mechanization Establishment

This section has the responsibility for implementation of all technical matters, for all vehicles and equipment. It also carries out the overhauling and servicing of engines, brakes and hydraulic compression devices as well as fixing flat tires.

The section also evaluates all drivers for the Best Driver Competition, which is an additional incentive for drivers.

3.3 DMSC Workshop Facilities

Based on the results of the site survey, almost all of the DMSC's workshops have either no facilities or very limited maintenance equipment. Punctures are the most common cause of breakdown of collection vehicles. When a puncture occurs, the vehicle has to be sent to another location to fix the flat tire, which can take up to 3 hours depending on the distance. Other problems are associated with battery fluid, engines, batteries, hydraulic parts, differential shafts, starters, brake friction plates and alternators. The daily occurrence of flat tires is listed in Table 6. Both the UPPH and DMSC requested maintenance equipment from the JICA Study Team, which is shown in the list in Table 7.

Table 6 Estimated Number of Flat Tires

Municipalities	Frequency per day
Playa	4
Plaza (AURORA)	3
Centro Havana	8
Havana Vieja	6
Regla	-
Havana del Este	7
Guanabacoa	5
San Miguel del Padrón	8
Diez de Octubre	6
Cerro	7-8
Marianao	8
La Lisa	9
Boyeros	8
Arroyo Naranjo	7
Cotorro	6

Data source: UPPH

Table 7 List of Maintenance Equipment Requested by DMSC & UPPH

Municipal		Flat Tire Repair Equipment		Machine tool			Parts			Tools/etc	Engine Test Equipment	Battery Liquid & Test Kit
		Small	Big	Lathe	Electric /Gas Welding	Electric drill	Tires	Car Components	Parts of a machine			
DMSC	Playa	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
	Plaza	No	No	No	No	No	No	No	No	No	No	No
	Centro Habana	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Habana Vieja	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Regla	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Habana del Este	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Guanabacoa	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	San Miguel	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	10 de Octubre	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cerro	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Marianao	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	La Lisa	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Boyeros	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Arroyo Naranjo	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cotorro	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
UPPH		No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Data source: UPPH

4. Maintenance Policy

UPPH does not have a guideline describing its vehicle renewal policy, but the UPPH has practical rules as follows:

- New vehicles: Minimum use 9 to 10 years.
- Assembled vehicles: One unit has to be assembled from three different kinds of disabled cars, such as damaged differential shaft, engines and vehicle bodies.

There are no rules regarding mechanical performance, such as emission control, mileage, compression power and so on, because of more important problems such as the shortage or unavailability of spare parts. However, UPPH spends 80% of the total income from collection fees on C/T equipment maintenance.

The Ministry of Transportation issues an Inspection Certificate every year and the certificate is unrelated to the time the vehicle has been in use. Actually, most of the vehicles have been used for a period of 10 to 20 years or even longer and certification by the Ministry of Transportation does not depend on mechanical performance.

From the viewpoint of reliability and efficiency of the vehicles, UPPH and DMSC have to prepare a guideline that describes vehicle life span, overhauls and maintenance.

(1) Lifetime of vehicles

There is no available data regarding the life span of C/Ts and total running distance. However, the number years of operation before and after import of the current vehicles are shown in Table 8. An expected 10-year life span is acceptable based on the data.

The life span with proper maintenance of T/C vehicles is estimated at about 20 years and 15 years for D/T vehicles. For example, there are T/C models from 1982 still in operation. Essential maintenance is a proper overhaul of the engine every 3 to 5 years.

It was noted that because the vehicle numbers are insufficient, their operating efficiency is currently being ignored. Periodic vehicle inspection by the Ministry of Transportation is exempted because solid waste collection is regarded as a community service.

Table 8 Expected Life Span of Vehicles

Condition of vehicles	Number of Vehicles (units)	Ratio %	Range of Life Span before imported (years)	Ave rage of life Span (years)		
	In 2005			New	Secondhand (Before import)	Secondhand (After import)
In Operation	19	25	2 to 10	4	-	-
In Operation	17	22	6 to 17	-	11	2-7
Under Repair	11	14	6 to 20	-	14	-
Proposed for Scrap	19	24	8 to 20	-	15	-
Scrapped	12	15	8 to 32	-	15	-
Total units	78	100		-	-	-

Source: UPPH 2005

4.1 Present Status of Vehicle Units

(1) C/T Vehicles

There were 65 C/T vehicles in UPPH. There were 41 in operation (63%) in August 2004. However, in January 2005, there were only 36 units (53%) workable vehicles. The list of C/T vehicles is shown in Table 9.

Table 9 List of C/T Vehicles

Manufacture	Countries	Sep. 2004				January, 2005			
		New	Used	Total	%	New	Used	Total	%
KAMAZ	Russian	15	3	18	44%	15	0	15	42%
RENAULT	France	1	2	3	7%	1	2	3	8%
MAN	German	2	2	4	10%	2	1	3	8%
PEGASO	Spain	0	7	7	17%	0	6	6	17%
IVECO	Italy	1	1	2	5%	1	1	2	6%
ONYX	France	0	5	5	12%	0	5	5	14%
VOLVO	Swizer	0	1	1	2%	0	1	1	3%
EBRO	?	0	1	1	2%	0	1	1	3%
	Total	19	22	41	100%	19	17	36	100%
	%	46.3%	53.7%	100.0%		52.8%	47.2%	100.0%	

Source: UPPH

During the year of 2004, 12 C/T units were scrapped and their parts were used for other vehicles. 15 C/T units (5 new and 10 used units) were purchased in 2004. Table 10 shows the history of replacement.

Table 10 Numbers of Replacement and Models

Countries	Before 1999	2000	2001	2002	2003	Sep. 2004	Total (units)
Russia	0	0	0	5	10	5	20
Spain	11	6	5	14	10	2	48
Germany	0	0	9	1	0	0	10
France	70	0	0	5	5	7	87
Japan	0	0	0	0	1	0	1
Sweden	0	0	0	2	0	1	3
Total	81	6	14	27	26	15	169

Note: NEW vehicles : 5-units from Russia in 2002
10-uints from Russia in 2003
5-units from Russia in 2004
Used vehicles were donated from foreign countries

UPPH has purchased C/Ts from 8 countries. Tables 9 and 10 show that Russian vehicles are the most popular due to their low price, but the Spanish, French and German vehicles have a better compaction performance compared to the Russian ones.

In September 2004, 78 C/T vehicles were registered. The condition of the registered C/T vehicles is shown in Table 11. There were 36 (46%) workable vehicles and 42 (54%) non-workable vehicles. Also, the numbers of the purchased and scrapped vehicles for the last 5-years is shown in Table 12.

Table 11 Distribution of Registered Vehicles

Date	In operation	Under Repair	Proposed for Scrap	Scrapped	Scrapped	Total (units)
September 2004	41	-	-	-	29	70
January, 2005	36(46%)	11(14%)	19(24%)	19(24%)	12(15%)	97

Source: UPPH

Note: UPPH estimated the life span of an engine to be 6 years, and 4 years is expected after good maintenance work. (158 km/day* 365 days*6 years *12hrs/day=4,152,240 km./hrs/day)

Table 12 Distribution of Vehicles

	Before 1999	2000	2001	2002	2003	Sep. 2004	Total (units)
Renewed	81	6	14	27	26	15	169
Scrapped	62	18	9	10	29	12	140

Source: UPPH

C/T collection vehicles are more likely to face mechanical troubles 4 to 6 years after procurement, particularly damage to brakes, engines, hydraulic systems and rusting of the body depending upon whether the model uses common maintenance parts, as shown in Table 13. The condition of secondhand vehicles imported in 2002 and 2003 is described in Table 14.

During this term, 31 secondhand vehicles were imported. Only 17 units are now in operation, and the rest of them have been disassembled for the recyclable parts. Second hand vehicles need more maintenance and repair work and are more costly in the long run. The detailed specification of the existing C/T collection vehicles is shown in Table 15.

(2) T/C vehicles

The life span of T/C vehicles is expected to be about 20 to 30 years with proper maintenance. For example, there are 1982 models still in operation. Essential maintenance is a proper overhaul of the engine every 3 to 5 years. 23 units were imported from Russia during in the last 5 years as shown in Table 16. 21 T/C vehicles were scrapped during the last 5 years as shown in Table 17**.**

(3) D/T vehicles

The life span of D/T vehicles is expected to be about 15 to 20 years based on the experience of UPPH. Essential maintenance is a proper overhaul of the engine every 3 to 5 years. 73 trucks were replaced in the last 5 years. All units are Russian. Lists of units are shown in Table 13. 16 D/Ts were scrapped in the last 5 years. Table 14 shows the current condition of D/T collection vehicles.

(4) Use of scrapped C/Ts

Insufficient foreign currency makes it difficult to obtain new parts for vehicle operation and maintenance. Subsequently, recycled parts from scrapped vehicles, including imported ones, are precious and collectively stored. The Ministry of Transportation approves vehicle scrapping and disposal.

- In 2004 and 2005, 12 vehicles were completely scrapped and another 19 await being scrapped,
- The serviceability of recycled engines, springs, shafts and hydraulic cylinders is uncertain,
- Tires are changed with new or recycled ones almost every year. Flat tires occur 5 times a day for new tires and 15 to 20 times a day for old tires.

(5) Summary of vehicle lifetimes

- Interviews with UPPH revealed that it had prepared substantial guidelines though they were not fully documented. The lifetime of new C/Ts is 10 years consisting of the first 5 to 6 years with no specific maintenance followed by 3 to 4 years with an annual 5% of the equipment cost for repairs. Old vehicles, on the other hand, are scrapped when their body parts, engines and drive units can be assembled to form a complete vehicle. Otherwise, old vehicles are stored at a parking area waiting for repairs.
- Imported or donated vehicles from France, Spain, Sweden and others have been used for 6 to 17 years judging from their record of manufacture. With repairs, UPPH is able to use those vehicles for a further 3 to 5 years.
- The lifetime of the T/Cs was judged through an interview survey because there was little data available recording their repairs. Tractors (80HP) for T/Cs were made in Russia and have been used for 20 to 25 years with repairs. An interview survey of manufacturing factory showed that the lifetime of carts for T/Cs was some 10 years, but the personnel in charge of actual cart operation and repairs said that the lifetime would exceed 20 years with repairs.
- As is the case of T/Cs little data is available on the lifetime of D/Ts. An interview survey showed that the Russian made ones were used for 15 to 20 years with repairs.
- The mileages of vehicles are rarely obtained because most odometers are broken. They are assumed to travel for 100 to 150 km a day based on the interview survey.
- There are 36 vehicles available and they are operated for 10 to 15 hours a day, whereas 65 are needed, which makes it impossible to take preventive measures for more efficient and effective maintenance.
- Fuel mileage is supposed to be roughly 3 to 4 km/L. No information is available on how the fuel mileage changes, as vehicles get older.

Table 13 Evaluation Results of Existing Vehicles in January, 2005 (Source: UPPH)

Purchasing Date	Secondhand (Donated)	Year of Manufacture	C/T (Units)	Manufacturer	Condition
2004	-	2003	5	Kamaz	Good condition, engines will be replaced after 7 years and the parts will be changed every 2 years up to 2015.
2003	-	2002	9	Kamaz	Good condition, engines will be replaced after 7 years and the parts will be changed every 2 years up to 2015.
2002	-	2001	1	Renault	Damage to the body is significant. The engines will be replaced after 6-years and the parts will be changed yearly up to 2015.
2002	-	1999	1	Iveco	The engine and the hydraulic pressure system have problems. But the cost of parts is too expensive so the unit is scheduled to be scrapped in 2007.
2002	-	1995	1	Kamaz	Damage to the body is significant. The recycled parts will be used for maintenance up to 2009.
2001	-	1997	2	Man	Not good condition due to decay of the body. But the cost of parts is too expensive so the units are scheduled to be scrapped in 2005.
-	2004	1995	2	Volvo/Ebro	Not good condition due to engine and hydraulic pressure system problems, corrosion of the body is a problem; parts will be changed every year up to 2005.
-	2004	1996-1997	5	Onyx	Engine and hydraulic pressure system problems, parts will be changed every year up to 2010.
-	2004	1996	1	Pegaso	
-	2004	1998	1	Pegaso	Engine and hydraulic pressure system problems, the parts will not be changed because they are too expensive. They will be use up to 2007/ 2005/2005.
-	2003	1990	3	Pegaso	
-	2003	1994	1	Pegaso	
-	2003	1985	1	Pegaso	Engine and hydraulic pressure system problems, the parts will not be changed because they are too expensive and they will be used up to 2005.
-	2001	1999	1	Iveco	Engine and hydraulic pressure system problems, the parts will be changed every year up to 2009.
-	2003	1992	1	Renault	Engine and hydraulic pressure system problems, the parts will not be changed because they are too expensive and they will be used up to 2007/2008.
-	2002	1989	1	Renault	
Total			36		

Table 14 List of Donated Vehicles in 2002 and 2003

Date of Imported		Manufacture	Plate Number	Engine Number	Year of Manufacture	Estimated used period (Years)	List of parts Not supplied or broken with used vehicles															General Condition
							Batteries	Lifting Device	Tires	Bumped Body	Lights	Hopper	Spring Blades	Engine	Oil leaking	Compactor Device	Air Compressor	Steering Mechanism	Body Corrosion	Total Number of problems	Other (mirrors, etc)	
1	2003	Renault (France)	330	1113	1991	12	0	0	1	0	1	1	0	0	0	0	0	0	0	3	0	Good
2	2003	Renault (France)	333	1083	1991	12	1	1	1	1	0	1	0	0	0	0	0	0	0	5	0	Good
3	2003	Renault (France)	332	1042	1991	12	1	1	1	1	0	1	0	0	0	0	0	0	0	5	0	Good
4	2003	Renault (France)	334	124851	1993	10	1	1	1	1	0	1	0	0	0	0	0	0	0	5	0	Good
5	2003	Renault (France)	331	1042	1992	11	1	1	1	0	0	0	0	0	0	0	0	0	1	4	0	Good
6	2003	EBRO(Spain)	339	313245	1986	17	1	0	1	0	0	0	0	0	0	0	0	0	1	4	1	Good
7	2003	EBRO(Spain)	340	31264	1986	17	1	0	1	1	0	0	0	0	0	0	0	0	0	3	1	Bad
8	2003	PEGASO(Spain)	336	211	1978	25	1	1	1	1	1	1	0	0	0	0	0	0	0	6	0	Required Repair
9	2003	PEGASO(Spain)	335	89153	1986	17	1	0	1	1	0	0	0	0	0	0	0	0	0	3	0	Good
10	2003	PEGASO(Spain)	337	424	1982	21	1	0	1	1	0	0	0	0	0	0	0	0	1	4	1	Required Repair
11	2003	PEGASO(Spain)	146	50068	1986	17	1	0	1	0	0	0	0	0	0	0	0	0	0	2	1	Bad
12	2003	PEGASO(Spain)	149	50071	1986	17	1	0	1	0	1	0	0	0	0	0	0	0	1	4	1	Bad
13	2003	PEGASO(Spain)	150	50072	1986	17	1	0	1	0	1	0	0	0	0	0	0	0	0	3	1	Required Repair
14	2003	PEGASO(Spain)	148	50070	1986	17	1	0	1	1		0	0	0	0	0	0	0	0	3	1	Bad
15	2003	NIssan(Japan)	338	-	1988	15	1	0	1	1	1	0	0	0	0	0	0	0	0	4	0	Good
16	2003	PEGASO(Spain)	147	50069	1986	17	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	Bad
17	2002	Pegaso (Spain)	305	1217	1977	25	1	0	0	0	0	1	0	0	0	0	0	0	0	2	0	Bad
18	2002	Pegaso (Spain)	310	1098	1975	27	1	0	1	0	0	0	1	0	1	0	0	0	0	4	0	Bad
19	2002	Mercedes Benz(Ge)	304	1622	1990	12	0	0	1	0	0	0	0	0	1	0	0	0	0	2	0	Acceptable
20	2002	Renault (France)	Bad	4148	1980	22	0	1	0	0	0	0	0	0	0	0	1	0	0	2	0	Bad
21	2002	Pegaso (Spain)	308	60231	1983	19	0	0	1	0	0	0	1	0	0	0	0	0	0	2	0	Acceptable
22	2002	Volvo (Sweden)	312	3788211	1995	7	1	0	1	0	0	1	1	0	0	0	0	0	0	4	0	Acceptable
23	2002	Volvo (Sweden)	313	378242	1995	7	1	0	1	0	0	1	1	0	0	0	0	0	0	4	0	Acceptable
24	2002	Pegaso (Spain)	306	11	1983	19	0	0	1	0	0	1	1	1	0	0	0	0	0	4	0	Bad
25	2002	Ebro(Frence)	311	136066	1985	17	1	1	0	0	0	0	1	0	0	1	0	1	0	5	0	In operation
26	2002	Pegaso (Spain)	309	19	1986	16	1	1	1	1	0	0	1	0	0	1	1	0	0	7	0	Bad
27	2002	Pegaso (Spain)	307	10	1983	19	1	0	0	0	0	0	1	0	0	0	0	0	1	3	0	Required Repair
28	2002	Pegaso (Spain)	Bad	210	1983	19	0	0	1	0	0	0	1	0	0	0	0	0	1	3	0	Acceptable
29	2002	Pegaso (Spain)	303	23	1982	20	0	0	1	0	0	0	1	0	0	0	0	0	1	3	0	Acceptable
30	2002	Pegaso (Spain)	302	730	1983	19	0	0	0	0	0	0	1	0	0	0	0	0	1	2	0	Acceptable
31	2002	Pegaso (Spain)	300	121	1984	18	0	1	0	0	0	0	1	0	1	0	0	0	1	4	0	Acceptable
Total						520	22	9	25	10	5	9	12	1	3	2	2	2	9	111		
						17	19.8%	8.1%	22.5%	9.0%	4.5%	8.1%	10.8%	0.9%	2.7%	1.8%	1.8%	1.8%	8.1%	100.0%		

Source: UPPH 2005/02

Table 15 Inventory of Existing Vehicles in January 2005 (Source: UPPH)

NO	Manufacture	New or used	Capacity M3	Year of Manufacture	Year of imported	Operation Period Imported date from 2005	Operation Period Manufactured date from 2005	Number of units			Detail of out of Service's Vehicles		
						2005	2005	In Services	Extemporaneously	Out of Services	Under repair	Scrapped	Proposed for Scrapped
1	KAMAZ 01	New (Russia)	18	2002	2003	2	3	1					
2	KAMAZ 02	Used (Russia)	18	2002	2003	2	3			1	1		
3	KAMAZ 03	New (Russia)	18	2002	2003	2	3	1					
4	KAMAZ 04	New (Russia)	18	2002	2003	2	3	1					
5	KAMAZ 05	New (Russia)	18	2002	2003	2	3	1					
6	KAMAZ 06	New (Russia)	18	2002	2003	2	3	1					
7	KAMAZ 07	New (Russia)	18	2002	2003	2	3	1					
8	KAMAZ 08	New (Russia)	18	2002	2003	2	3	1					
9	KAMAZ 09	New (Russia)	18	2002	2003	2	3	1					
10	KAMAZ 10	New (Russia)	18	2002	2003	2	3	1					
11	KAMAZ 315	New (Russia)	16	1995	2002	3	10			1		1	
12	KAMAZ 316	New (Russia)	16	1995	2002	3	10			1		1	
13	KAMAZ 317	New (Russia)	16	1990	2002	3	15			1	1		
14	KAMAZ 318	New (Russia)	16	1995	2002	3	10			1		1	
15	KAMAZ 319	New (Russia)	16	1995	2002	3	10	1					
16	MAN 01	New (Germany	24	1997	2001	4	8			1	1		
17	MAN 02	New (Germany	24	1997	2001	4	8			1			1
18	MAN 03	New (Germany	24	1997	2001	4	8		1				
19	MAN 04	New (Germany	24	1997	2001	4	8			1		1	
20	MAN 05	New (Germany	25	1997	2001	4	8	1					
21	MAN 06	New (Germany	25	1997	2001	4	8	1					
22	MAN 07	New (Germany	25	1997	2001	4	8			1			1
23	MAN 08	New (Germany	25	1997	2001	4	8			1			1
24	MAN 09	New (Germany	25	1997	2001	4	8			1			1
25	RENAULT 26	Used (France)	17	1978	1997	8	27			1			1
26	RENAULT 27	Used (France)	14	1978	1997	8	27			1			1
27	RENAULT 27	Used (France)	14	1978	1997	8	27			1		1	
28	RENAULT 32	Used (France)	16	1990	2002	3	15			1			1
29	RENAULT 32	Used (France)	10	1989	2002	3	16	1					
30	RENAULT 32	New (France)	19	2001	2002	3	4	1					
31	RENAULT 33	Used (France)	16	1992	2003	2	13			1			1
32	RENAULT 33	Used (France)	16	1992	2003	2	13	1					
33	RENAULT 33	Used (France)	16	1992	2003	2	13			1	1		
34	RENAULT 33	Used (France)	16	1992	2003	2	13			1			1
35	RENAULT 33	Used (France)	16	1992	2003	2	13			1			1
36	PEGASO 147	Used (Spain)	24	1990	2003	2	15			1			1
37	PEGASO 148	Used (Spain)	24	1990	2003	2	15	1					
38	PEGASO 149	Used (Spain)	24	1990	2003	2	15			1			1
39	PEGASO 150	Used (Spain)	24	1990	2003	2	15			1			1
40	PEGASO 175	Used (Spain)	16	1985	2003	2	20			1		1	
41	PEGASO 185	Used (Spain)	18	1985	2003	2	20	1					
42	PEGASO 191	Used (Spain)	18	1985	2003	2	20			1	1		
43	PEGASO 302	Used (Spain)	17	1990	2002	3	15			1			1
44	PEGASO 303	Used (Spain)	14	1973	2002	3	32			1		1	
45	PEGASO 308	Used (Spain)	17	1986	2002	3	19			1		1	
46	PEGASO 320	Used (Spain)	17	1994	2003	2	11		1				
47	PEGASO 321	Used (Spain)	17	1994	2003	2	11			1			1
48	PEGASO 335	Used (Spain)	24	1990	2003	2	15	1					
49	PEGASO 336	Used (Spain)	12	1988	2003	2	17			1	1		
50	PEGASO 341	Used (Spain)	17	1998	2004	1	7	1					
51	DAF 287	Used (Germany	17	1988	2001	4	17			1			1
52	DAF 288	Used (Germany	17	1988	2001	4	17			1	1		
53	DAF 289	Used (Germany	18	1988	2001	4	17			1			1
54	DAF 292	Used (Germany	17	1987	2002	3	18			1	1		
55	DAF 294	Used (Germany	17	1987	2002	3	18			1	1		
56	IVECO 297	New (Italy)	16	1999	2002	3	6			1		1	
57	IVECO 298	New (Italy)	16	1999	2002	3	6			1	1		
58	IVECO 299	New (Italy)	16	1999	2002	3	6	1					
59	IVECO 328	Used (Italy)	16	1999	2001	4	6	1					
60	ERC BENZ 3	Used (Germany	16	1985	2001	4	20			1		1	
61	EBRO 311	Used (France)	14	1985	2001	4	20			1			1
62	EBRO 339	Used (France)	14	1995	2003	2	10			1		1	
63	VOLVO 312	Used Switzerlan	18	1995	2002	3	10			1		1	
64	VOLVO 313	Used Switzerlan	18	1990	2002	3	15			1			1
65	NISSAN 338	Used Japan)	10	1990	2003	2	15			1	1		
66	KAMAZ 11	New (Russia)	18	2003	2004	1	2	1					
67	KAMAZ 12	New (Russia)	18	2003	2004	1	2	1					
68	KAMAZ 13	New (Russia)	18	2003	2004	1	2	1					
69	KAMAZ 14	New (Russia)	18	2003	2004	1	2	1					
70	KAMAZ 15	New (Russia)	18	2003	2004	1	2	1					
71	ONYX342	Used (France)	18	1997	2004	1	8	1					
72	ONYX343	Used (France)	20	1997	2004	1	8	1					
73	ONYX344	Used (France)	20	1997	2004	1	8	1					
74	ONYX345	Used (France)	20	1997	2004	1	8	1					
75	ONYX346	Used (France)	20	1997	2004	1	8	1					
76	PEGASO 18	Used (Spain)	18	1996	2004	1	9	1					
77	VOLVO 347	Used (Switzerlan	18	1995	2004	1	10	1					
78	EBRO 349	Used (Spain)	14	1996	2004	1	9	1					
								34	2	42	11	12	19
	78							36		42		42	

Table 16 Purchase Record of T/C Models

	Before 1999	2000	2001	2002	2003	2004	Total (units)
Russia	120	0	2	21	0	0	143
Spain	0	0	0	0	0	0	0
Germany	0	0	0	0	0	0	0
France	0	0	0	0	0	0	0
Japan	0	0	0	0	0	0	0
Sweden	0	0	0	0	0	0	0
Total	120	0	2	21	0	0	143

Source: UPPH

Table 17 History of T/C Replacement

	Before 1999	2000	2001	2002	2003	2004	Total (units)
Renewed	120	0	2	21	0	0	143
Scrapped	19	6	4	11	0	0	40

Source: UPPH

Table 18 Purchase Record of D/T Models

	Before 1999	2000	2001	2002	2003	2004	Total (units)
Russia	47	52	11	10	0	0	120
Spain	0	0	0	0	0	0	0
Germany	0	0	0	0	0	0	0
France	0	0	0	0	0	0	0
Japan	0	0	0	0	0	0	0
Sweden	0	0	0	0	0	0	0
Total	47	52	11	10	0	0	120

Source: UPPH

Table 19 History of D/T Replacement

	Before 1999	2000	2001	2002	2003	2004	Total (units)
Renewed	47	52	11	10	0	0	120
Scrapped	35	7	3	2	1	3	51

Source: UPPH

4.2 Performance of Collection Systems

The DMSC provides a collection service using the conventional collection system. The system uses D/T, T/C and H/C vehicles. The system is a low-performance collection service.

The number of H/C-type vehicle accounts for over 58% of the total number (see Table 20**).** However, they collected only 9% of the total MSW. The H/C collection needs to be

transferred to D/T and or T/C vehicles and as a result the service is assessed as a low-performance collection system.

The actual collection efficiency by weight (t/hr/day/unit) is presented in Table 21. The C/T mechanical collection vehicles are able to collect about 0.7 tons/hr/day/unit and are performing better than the T/C and H/C collection vehicles.

According to the calculations, the specific gravity of the load in C/T vehicles is the highest due to the collected MSW being mixed with inorganic substance as part of the station collection system. But in remote areas it is mixed with less inorganic substance due to the door-to-door collection system.

The majority of existing C/T vehicles is over 10-15 years old. They sometimes have mechanical problems as well as flat tires and have an average of 10 to 15 years of service life depending on the working condition. The main reason for the unreliability of these vehicles is the use of used parts. The DMSC possesses 87 units for MSW collection with an average of 15 to 20 years of service life. Photographs of damaged vehicles and tires are shown below in Figure 5.

Table 20 Total Number of Vehicles and Amount Collected

Name of Collection Areas		Municipality	Amount of MSW (t/d)						Number of type of vehicles brought to lamdfills per day (units)					
			UPPH	DMSC			H/C	Total Weight (t/d)	UPPH	DMSC			H/C	Total Weight (t/d)
			C/T	D/T	T/C	S-total			C/T	D/T	T/C	S-total		
1	Calle 100	Playa, Plaza de la Revolucion, Cetro Habana, Habana Vieja, Diez de Octubre, Cerro, Marianao, La lisa, Byeros, Arroyo Naranjo	588	-	-	0	0.0	587.7	71	0	0	0	0	71
		Plaza de la Revolucion, Cetro Habana, Habana Vieja, Cerro, Arroyo Naranjo	0	30.0	54.0	84.0	0.0	84.0	0	14	22	36	0	36
		Marianao	0	-	-	0	3.6	3.6	0	0	0	0	20	20
		Sub-Total	588	30.0	54.0	84.0	3.6	675.3	71	14	22	36	20	127
2	Guanabacoa	Habana del Este	110	-	-	0	0.0	109.9	6	0	0	0	0	6
		Regla, Guanabacoa, Cotorro, San Miguel del Padron	0	51.0	27.0	78.0	0.0	78.0	0	22	13	35	0	35
		Sub-Total	110	51.0	27.0	78.0	0.0	187.9	6	22	13	35	0	41
3	8-vias	(Industiral Waste)	4	0	0	0	0.0	3.8	0	0	0	0	0	0
4	Barreras	(Bulk Waste)	0	0	0	0	0.0	0.0	0	0	0	0	0	0
5	Electrico D.S.	Arroyo Naranjo	0	0	0	0	2.8	2.8	0	0	0	0	18	18
6	Fraternid D.S.	Arroyo Naranjo	0	0	0	0	4.5	4.5	0	0	0	0	27	27
7	Managua D.S.	Arroyo Naranjo	0	0	0	0	2.0	2.1	0	0	0	0	16	16
8	Lugardita D.S.	Boyerros	0	0	0	0	4.0	4.2	0	0	0	0	18	18
9	**Prensa Lalina D.S.	Boyerros	0	0	0	0	13.4	13.4	0	0	0	0	43	43
10	Rincon D.S.	Boyerros	0	0	0	0	4.0	4.0	0	0	0	0	20	20
11	Las Canas D.S.	Boyerros	0	0	0	0	2.5	2.5	0	0	0	0	10	10
12	El Vidrio D.S.	La Lisa	0	0	0	0	13.6	13.6	0	0	0	0	40	40
13	Los Perros D.S.	Cotorro	2	0	0	0	24.0	26.0	0	0	0	0	30	30
14	Canpo Florido D.S.	Habana del Este	0	0	0	0	1.0	0.9	0	0	0	0	5	5
S-Total			703	81	81	162	75.4	941.0	77.0	36.0	35.0	71.0	247.0	395.0
%			74.8%	8.6%	8.6%	17.2%	8.0%	100.0%	19.5%	9.1%	8.9%	18.0%	62.5%	100.0%

Table 21 Expected Performance of Vehicles

Type of Vehicles	Total Vehucles In operation (units)	Ave Cap. (m3)	Ave Vehicle Cap. (t/d)①	Spec. Gravity (t/m3)	③S-Total (t)	②Trips (times)	④Total (t/d)	Actual Collection Hours (Hr/d)⑤	Actual Collection Eff. (t/hr/unit)⑥	Targeted Collection Hours (hr/d)	Efficiency Factor (t/hr/unit)
C/T	36.0	18.0	7.4	0.41	266	2.65	704.1	10.0	0.74	6.0	1.23
S-Total	36.0	18.0	7.4	0.41	266	2.65	704.1	10.0	0.74	6.0	1.23
D/T	36.0	10.0	1.8	0.18	64.8	1.3	81.0	7.5	0.24	5.0	0.36
T/C	35.0	15.0	2.0	0.13	68.3	1.2	81.9	7.5	0.26	5.0	0.39
H/C	247.0	2.0	0.3	0.13	64.22	1.20	77.1	4.5	0.06	5.0	0.05
G.Total	318	-					944				

Note: Total collected amount per day④=②×③ Design Capacity 940
Actual Collection Eff. (t/hr/unit)⑥=①/⑤

(1) Vehicle that was left with malfunction

(2) Intense Tire wear

(3) Scrapped T/C vehicles at DMSC's Workshop

(4) Scrapped C/T vehicles at UPPH's Workshop

Figure 5 Typical Condition of Collection Vehicles

4.3 Low Operation Rate of Holding Vehicles

The operation rate was low at 63% in 2004, as shown in Table 22.

The reasons are thought to be as follows:

- Over 53 % of operating vehicles are used-vehicles manufactured before 1995. At least 22 units have been in service for 4 years after being imported into UPPH where they will serve another 4-5 years.
- Often secondhand vehicles had been used in their original countries of origin for more than 10 years and had deteriorated significantly by the time they were donated, as the list in Table 23 shows.
- Therefore, the probability of malfunction and/or poor performance of the vehicles is increasing and they need to be renewed soon or a great deal of labor will be needed to collect MSW to compensate for the malfunctioning vehicles.

Table 22 Operation Rate in Feb.2005

Descriptions	$18m^3$ C/T	$15m^3$ T/C
Number of vehicles held (units)	65	62
Number of vehicles in service(units)	41	23
Operation rate (%)	63	37

Table 23 Country of origin of Vehicles

Countries	Before 1999	2000	2001	2002	2003	Sep. 2004	Total (units)
Russia	0	0	0	5	10	5	20
Spain	11	6	5	14	10	2	48
Germany	0	0	9	1	0	0	10
France	70	0	0	5	5	7	87
Japan	0	0	0	0	1	0	1
Sweden	0	0	0	2	0	1	3
Total	81	6	14	27	26	15	169

Note: NEW vehicles : 5-units from Russia in 2002
10-uints from Russia in 2003
5-units from Russia in 2004
Used vehicles were donated from foreign countries

4.4 Recycling of Scrapped Vehicles

When UPPH or DMSC want to scrap vehicles, the organization has to get an approval from the Ministry of Transportation. MOT evaluates the application and determines whether such approval should be issued or not. .

Secondhand parts are collected from the scrapped vehicles. All parts are registered and stored in the warehouse to be used as replacements for other vehicles in the future.

The most useful recycled parts are gearboxes, differential shafts, dynamos and bodies and so on but not oil seals, bearings, and gaskets. However, the use of recycled parts shortens the mechanical life span of the vehicles and reduces their reliability.

Residual scrap is conveyed to the relevant industries where it is compressed into a small lump before melting. Scrap tires are delivered to recapping factories or buried at the Ocho Vías landfill site. Typical recycled parts are shown in Figure 6.

(1) Typical C/T vehicles under repair

(2) Typical recycled parts of C/T vehicles

(3) Typical recycled parts of C/T vehicles

(4) Warehouse for used parts

(5) Recycled bolts and nuts from C/T vehicles

(6) Warehouse for used engines and others

Figure 6 Typical Recycled Parts (1/2)

	
(7) Typical T/C vehicles under repair	(8) Old tires
	
(9) Typical scrapped T/C(Russian)	(10) Typical T/C under repair
	
(11) Typical scrapped T/C(Russian)	(12) Typical T/Cs under repair

Figure 6 Typical Recycled Parts (2/2)

4.5 Purchase Condition of Vehicles and Parts

Procurements from overseas manufacturers have to follow a formal procedure that is shown in Figure 7.

When the UPPH or the DMSC requires new parts, the organization has to get purchase permission from the CAP (Provincial Administration Council) through the DPSC. Budget allocation has to be prepared before approval by the authority.

The delivery period takes from 3-6 months. In that period the vehicles remain idle.

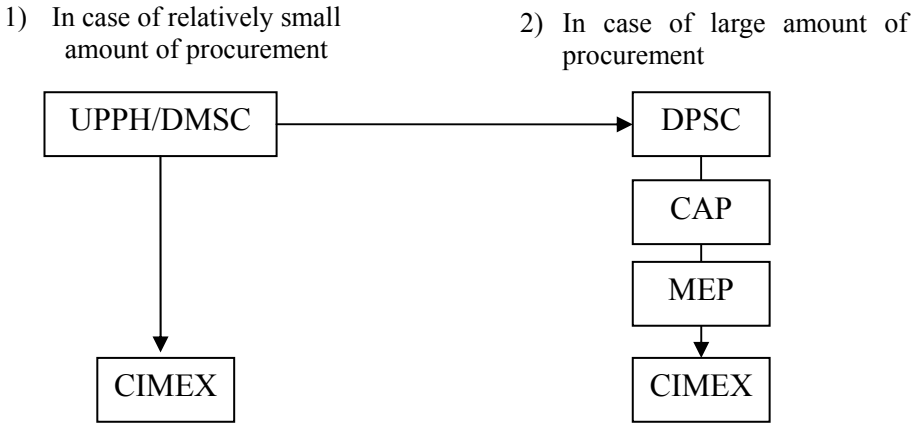


Figure 7 Purchase Procedure

4.6 Stock Control

The UPPH and DMSC have not had enough financial resources to purchase any spare parts for the last four years. As a result, there is no stock in the workshop. Therefore, if vehicles need parts, the maintenance division must order them from the relevant overseas manufacturer each time they are required.

4.7 Washing Equipment

(1) C/T vehicles

The UPPH has its own washing equipment for C/T vehicles near the central maintenance workshop.

The equipment consists of a washing nozzle, water pressure pump and water tank. Washing takes about 20 minutes and is done manually. Basically, the compactor trucks are washed every day.

A typical C/T washing facility is shown in Figure 8.

(1) C/T Washing facility

(2) Workers cleaning C/T

Figure 8 CT Washing Facility

(2) Bins

There are two bin-washing vehicles, but one of them is out of order. Bins are taken inside the washing cabin by means of a lifting device. Water is sprayed automatically.

Bin washing takes about 2 to 3 minutes and the washing capacity is 100 to 150 bins per day. Typical bin-washing vehicles are shown in Figure 9**.**

(1) Bin washing vehicles under repair

(2) Bins washing vehicles under operation

Figure 9 Typical bin-washing vehicles

4.8 Proposed Maintenance Schedule

Manufacturers will prepare their recommended maintenance schedule.

The maintenance schedule is divided into two categories for new and secondhand vehicles as shown in Table 24.

The vehicles from Kamaz (Russian), Iveco (Italian) and Onyx (French) have a high priority because they will be used continuously.

The proposed detailed schedule up to 2015 is shown in Table 25.

Table 24 Maintenance Schedule

	At regular intervals		Estimated Cost (US$)		
	Engine	Parts	Cost of Vehicles	Engine (unit)	Cost of Parts
New	Kamaz: every 6- 7 years	Kamaz: every 2-years	70,000	3,300	10%
	Renault: every 5 years	Renault: every year after 5 years	121,000	5,000	3%
	Man: No schedule	Man: No schedule	160,000	-	-
	Pegaso: -	Pegaso: -	120,000	-	-
	Iveco: No schedule	Iveco: No schedule	10,000	-	5%
	Onyx	-	120,00	-	-
	Volvo	-	120,00	-	-
	Ebro	-	110,00	-	-
Secondhand	Onyx: No schedule	Onyx: every year	78,000	-	6%
	Pegaso: No schedule	Pegaso: every year	120,000	-	10%
	Volvo: No schedule	Volvo: every year	100,000	-	10%
	Ebro: No schedule	Ebro: every year	80,000	-	10%

Source: UPPH

Table 25 Replacement and Maintenance Plan in January 2005 (C/T)

NO	Manufacture	New or used	Capacity M^3	Date of Manufacture	Date of imported	Operation length from 2005 to imported date	Operation length from 2005 to Manufacture date	Number of units			Detail of out of Service's Vehicles			Replacement and Maintenance Schedule													
						2005	2005	In Services	Extemporaneously	Out of Services	Under repair	Scraped	Proposed for Scraped	Sep. 2004	Jan. 2005	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
1	KAMAZ 01	New (Russia)	18	2002	2003	2	3	1						0	1	1		1		1	Engine	1		1		1	7
2	KAMAZ 03	New (Russia)	18	2002	2003	2	3	1							1	1		1		1	Engine	1		1		1	7
3	KAMAZ 04	New (Russia)	18	2002	2003	2	3	1							1	1		1		1	Engine	1		1		1	7
4	KAMAZ 05	New (Russia)	18	2002	2003	2	3	1							1	1		1		1	Engine	1		1		1	7
5	KAMAZ 06	New (Russia)	18	2002	2003	2	3	1							1	1		1		1	Engine	1		1		1	7
6	KAMAZ 07	New (Russia)	18	2002	2003	2	3	1							1	1		1		1	Engine	1		1		1	7
7	KAMAZ 08	New (Russia)	18	2002	2003	2	3	1							1	1		1		1	Engine	1		1		1	7
8	KAMAZ 09	New (Russia)	18	2002	2003	2	3	1							1	1		1		1	Engine	1		1		1	7
9	KAMAZ 10	New (Russia)	18	2002	2003	2	3	1							1	1		1		1	Engine	1		1		1	7
10	KAMAZ 316	New (Russia)	16	1995	2002	3	10			1		1															0
11	KAMAZ 317	New (Russia)	16	1990	2002	3	15			1	1																0
12	KAMAZ 318	New (Russia)	16	1995	2002	3	10			1		1															0
13	KAMAZ 319	New (Russia)	16	1995	2002	3	10	1							1	1	1	1	1	1							6
14	MAN 02	New (German)	24	1997	2001	4	8			1			1														0
15	MAN 03	New (German)	24	1997	2001	4	8		1																		0
16	MAN 05	New (German)	25	1997	2001	4	8	1																			0
17	MAN 06	New (German)	25	1997	2001	4	8	1																			0
18	RENAULT 327	Used (France)	10	1989	2002	3	16	1						2	2	2	2	2	2								12
19	RENAULT 329	New (France)	19	2001	2002	3	4	1										Engine	1	1	1	1	1	1	1	1	8
20	RENAULT 331	Used (France)	16	1992	2003	2	13	1							1	1	1	1									4
21	PEGASO 148	Used (Spain)	24	1990	2003	2	15	1																			0
22	PEGASO 185	Used (Spain)	18	1985	2003	2	20	1																			0
23	PEGASO 320	Used (Spain)	17	1994	2003	2	11		1																		0
24	PEGASO 335	Used (Spain)	24	1990	2003	2	15	1																			0
25	PEGASO 336	Used (Spain)	12	1988	2003	2	17			1	1																0
26	PEGASO 341	Used (Spain)	17	1998	2004	1	7	1																			0
27	IVECO 299	New (Italy)	16	1999	2002	3	6	1																			0
28	IVECO 328	Used (Italy)	16	1999	2001	4	6	1																			0
29	KAMAZ 11	New (Russia)	18	2003	2004	1	2	1							1	1		1		1	Engine	1		1		1	7
30	KAMAZ 12	New (Russia)	18	2003	2004	1	2	1							1	1		1		1	Engine	1		1		1	7
31	KAMAZ 13	New (Russia)	18	2003	2004	1	2	1							1	1		1		1	Engine	1		1		1	7
32	KAMAZ 14	New (Russia)	18	2003	2004	1	2	1							1	1		1		1	Engine	1		1		1	7
33	KAMAZ 15	New (Russia)	18	2003	2004	1	2	1							1	1		1		1	Engine	1		1		1	7
34	ONYX342	Used (France)	18	1997	2004	1	8	1						1	1	1	1	1	1	1	1						8
35	ONYX343	Used (France)	20	1997	2004	1	8	1						1	1	1	1	1	1	1	1						8
36	ONYX344	Used (France)	20	1997	2004	1	8	1						1	1	1	1	1	1	1	1						8
37	ONYX345	Used (France)	20	1997	2004	1	8	1						1	1	1	1	1	1	1	1						8
38	ONYX346	Used (France)	20	1997	2004	1	8	1						1	1	1	1	1	1	1	1						8
39	PEGASO 18	Used (Spain)	18	1996	2004	1	9	1						1	1	1	1	1	1	1	1						8
40	VOLVO 347	Used (Switzerland	18	1995	2004	1	10	1						1	1	1											3
41	EBRO 349	Used (Spain)	14	1996	2004	1	9	1						1	1	1											3
	Total No. of vehicles in operation							34	2	42	11	12	19	10	26	26	10	24	10	22	7	15	1	15	1	15	182
Total	78							36		42	42			36	36	36	30	27	25	23	22	15	15	15	15	15	10
											Expected Scrapped number C/T(units)			-	-	-	6	3	2	2	1	7	0	0	0	0	-
											Expected New C/T (units)			29	5	9	-	-	-	-	-	-	-	-	-	-	

Data: UPPH, Jun. 2005
Note: Engine replacement , number of 1or 2 shows that is number of maintenance time

4.9 Purchase Price (Vehicles and Parts)

The major imported parts and their prices are shown in Table 26. The listed parts will be used for about 3 years. The required delivery period for the main parts of a C/T is about 6 months and for some parts for other vehicles is about 15 days.

Table 26 List of Maintenance Parts

I. For C/T Vehicles (Source: UPPH Feb. 2005)

Name of Parts			Frequency of Replacement	Purchase Price (US$/pcs)	Delivery time (Month)	Repair time (days)	Number to be replaced (pcs/set)	Estimated cost (US$) For 3-years
1	**Engines**							
	1-1	Water Pump	3-years	1,300	3-6 months	1 hr	8	10,400
	1-2	Fuel filters	4-months	10	3-6 months	15 min.	420	4,200
	1-3	Oil filters	4-months	25	3-6 months	10 min.	480	12,000
	1-4	New engines	2-3 years	3,360	3-6 months	5 days	6	20,160
	1-5	Engine piston	5-years	1,500	3-6 months	4 days	6	9,000
	1-6	Oil pumps	3-years	500	3-6 months	3 Hrs	2	1,000
	1-7	Fuel pumps	2-years	3,000	3-6 months	1 hrs	4	12,000
	1-8	Oil seal set	2-year	120	3-6 months	1 hr	6	720
	1-9	Gasket set	2-3 years	500	3-6 months	1 day	6	3,000
	1-10	Alternators	2-3 years	800	3-6 months	20 min.	20	16,000
	1-11	Starters	2-3 years	1,300	3-6 months	16 min.	10	13,000
2	**Drive unit**							
	2-1	Shift Gear Unit	3-4 years	2,500	3-6 months	8 days	15	37,500
	2-2	Transmission	3-4 years	2,000	3-6 months	1 hrs	30	60,000
	2-3	Bearings for wheels set	3-4 years	1,960	3-6 months	1 day	70	137,200
	2-4	Universal joints for shafted	3-4 years	480	3-6 months	8 hrs	115	55,200
	2-5	Differential Gears shafts	5-years	15,000	3-6 months	1 day	5	75,000
	2-6	Clutch disks	2-years	120	3-6 months	12 hrs	30	3,600
	2-7	Clutch plates		300	3-6 months	12 hrs	18	5,400
	2-8	Brake units	1- year	1,200	3-6 months	12 hrs	5	6,000
	2-10	Blade spring set	3-years	1,500	3-6 months	1 hr	60	90,000
3	**Hydraulic power unit**							
	3-1	Hydraulic device unit	3-years	3,300	3-6 months	4 hrs	30	
	3-2	Hydraulic gear unit	3-years	5,500	3-6 months	2 days	25	137,500
	3-3	Lifting / compression pistons	2-years	17,100	3-6 months	3 Hrs	10	171,000
	3-4	Compression unit	5-6 years	3,000	3-6 months	7 days	15	45,000
	3-5	Operation switches	2-years	4,000	3-6 months	2 hrs	10	40,000
	3-6	Waste Discharge plates	5-years	7,000	3-6 months	1 day	8	56,000
	3-7	Hydraulic hoses	2-3 Years	1,080	3-6 months	5 hrs	35	37,800
4	**Other**							
	4-1	Tires	6-months	300	3-6 months	2 hrs	380	114,000
	4-2	Battery	3- years	100	3-6 months	15 min	73	7,300
	4-3	Other	I- year	??	3-6 months		??	
I. Total								1,179,980

II. For T/C Vehicles

Name of Parts			Frequency of Replacement	Purchase Price (US$/pcs)	Delivery time (Month)	Repair time (days)	Number to be replaced (pcs/set)	Estimated cost(us$)
1	**Engines**							
	1-1	Fuel filter	2-months	10	15 days	15 min.	572	5,720
	1-2	Oil filters	4-months	15	15 days	10 min.	572	8,580
	1-3	Engines	2-3 years	6,000	15 days	3 days	27	162,000
	1-4	Starters	2- years	240	15 days	20 min.	18	4,320
	1-5	Alternators	2 -years	120	15 days	15 min	14	1,680
	1-6	Radiator	7 -years	320	15 days	15 min	4	1,280
	1-7	Oil pumps	8- months	150	15 days	2 hrs	8	1,200
	1-8	Fuel pumps	2-years	600	15 days	40 min	31	18,600
	1-9	Oil seals	3-years	120	15 days	1 hr	32	3,840
	1-10	Gaskets	3-years	300	15 days	12 hrs	20	6,000
	1-11	Water Pumps	3 years	380	15 days	1 hr	27	10,260
2	**Drive unit**							
	2-1	Shift Gear Unit	3-4 years	7,000	15 days	8 hrs	76	532,000
	2-2	Gears oil	NA	0	15 days	1 hr	0	-
	2-3	Pulling Joint	10- years	900	15 days	5 hrs	6	5,400
	2-4	Transmission unit???	1-year	900	15 days	1 hr	11	9,900
	2-5	Bearings for wheels set	3- years	900	15 days	8 hrs	55	49,500
	2-6	Differential Gears	5-years	2,000	15 days	1 day	9	18,000
	2-7	Clutch disks	2-years	130	15 days	8 hrs	21	2,730
	2-8	Clutch Plate	4-years	400	15 days	6hrs	11	4,400
	2-9	Brake units	1- year	560	15 days	8 hrs	13	7,280
	2-10	Blade springs set	3-years	680	15 days	hrs	6	4,080
			4-years	400	15 days	8 hrs	11	4,400
3	**Hydraulic power unit**							
	3-1	Hydraulic device unit	6-yeas	2,100	15 days	8 hrs	16	33,600
	3-2	Compression unit	6-years	380	15 days	8 hrs	25	9,500
	3-3	Dumping cylinders unit	10years	1,000	15 days	1 day	12	12,000
	3-4	Dumping piston	2 years	460	15 days	1 day	7	3,220
4	**Other**							
	4-1	Tires (rear tires)	2years	300	15 days	1 hr	171	51,300
	4-2	Tires (front tires)	1-years	300	15 days	1 hr	123	36,900
	4-3	Battery	3- years	100	15 days	10 min	67	6,700
II. Total								1,014,390

III. For D/T Vehicles

	Name of Parts		Frequency of Replacement	Purchase Price (US$/pcs)	Delivery time (Month)	Repair time (days)	Number to be replaced (pcs/set)	Estimated cost(us$)
1	**Engines**							
	1-1	Fuel filter	2-months	10	15 days	15 min.	520	5,200
	1-2	Oil filters	4-months	15	15 days	10 min.	520	7,800
	1-3	New Engines	2-3 years	7,000	15 days	5 days	11	77,000
	1-4	Starters	2 years	300	15 days	15 min	33	9,900
	1-5	Alternators	2 years	120	15 days	20 min.	42	5,040
	1-6	Radiator	7 years	250	15 days	20 min.	9	2,250
	1-7	Oil pumps	8- months	80	15 days	2 hrs	8	640
	1-8	Fuel pumps	8-years	120	15 days	1 hrs	14	1,680
	1-9	Oil seals	4-years	120	15 days	1 hrs	21	2,520
	1-10	Gaskets	3-years	300	15 days	20 hrs	16	4,800
	1-11	Water Pumps	4-years	450	15 days	1 hr	18	8,100
2	**Drive unit**							
	2-1	Shift Gear Unit	3-4 years	7,000	15 days	8 hrs	9	63,000
	2-2	Transmission	4-years	550	15 days	1 hr	64	35,200
	2-3	Bearings for wheels	3 years	1,200	15 days	8 hrs	86	103,200
	2-4	Universal joints for shafts	3-4 years	300	15 days	1day	45	13,500
	2-5	Differential Gears	5-years	9,000	15 days	1 day	12	108,000
	2-6	Clutch disks	2-years	130	15 days	8 hrs	61	7,930
		Clutch Plate	6-years	650	15 days	6hrs	11	7,150
	2-7	Air brake units	2-3years	960	15 days	8 hrs	14	13,440
	2-8	Blade springs	3-years	2,600	15 days	1 hr	18	46,800
3	**Hydraulic power unit**							
	3-1	Hydraulic unit	6-year	1,000	15 days	8 hrs	12	12,000
	3-2	Compression unit	6-years	750	15 days	8 hrs	42	31,500
	3-3	Dumping cylinders unit	10-years	1,200	15 days	4 hrs	35	42,000
	3-4	Dumping piston	2 -years	600	15 days	8 hrs	8	4,800
4	**Other**							
	4-1	Tires	1 -year	300	15 days	2 hrs	946	283,800
	4-2	Battery	3- years	100	15 days	10 min	112	11,200
					15 days			
III. Total								908,450

Source ; UPPH: Feb.2005
Note: Price of Oil is not included due to free supply from Local averment.
Price is estimated from Spain and France