Republic of Cuba
Provincial Direction of Communal Services in Havana City

Republic of Cuba
Project for
Improvement of Capacity on Solid Waste Management in Havana City

Project Completion Report

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Abbreviations

A/P	Action Plan
CD	Capacity Development
CITMA	Ministry of Science, Technology and Environment
C/P	Counterpart
Cuba	The Republic of Cuba
DMSC	Municipal Direction of Communal Services
DPSC	Provincial Direction of Communal Services
EMED	Executive Company of Donations
FDS	Final Disposal Site
GEYSEL	Generating Equipment and Electric Service Company
FY	Fiscal Year
IC/R	Inception Report
ISWM	Integrated Solid Waste Management
GoC	Government of Cuba
GoJ	Government of Japan
JET	Japanese Expert Team
JCC	Joint Coordination Committee
JICA	Japan International Cooperation Agency
MINAGRI	Ministry of Agriculture
MINCEX	Ministry of Foreign Trade and Investment
MINSAP	Ministry of Public Health
MINVEC	Ministry of Foreign Investment and Economic Cooperation
M/M	Minutes of Meeting
M/P	Master Plan
PD	Project Director
OJT	On the Job Training
Off-JT	Off the Job Training
ONE	National Statistic Office
PDM	Project Design Matrix
PGD	Distribution Board
PM	Project Manager
PO	Plan of Operation
P/R	Progress Report
R/D	Record of Discussion
SW	Solid Waste
SWM	Solid Waste Management
UPPH	Provincial Unit of Hygiene
UNIDO	United Nations Industrial Development Organization

Project Completion Report

Section 1: Main Report

1 Introduction/ Background of the Project

1.1 Background of the Project

After collapse of the Soviet Union in beginning of 1990's, economy of the Republic of Cuba (hereinafter referred to as Cuba) fell and it affected proper implementation of solid waste management. In Havana, it was difficult to transport the solid waste to the suburbs due to the lack of fuel and the solid waste was dumped in emergency disposal sites which were temporarily installed in several areas in Havana city. It caused some problems such as deteriorated living environment of the population. In addition, landfill capacity of major disposal sites was about to reach the limit, and also construction of new landfill site was an urgent issue.

Based on the background above, Government of Japan implemented a JICA Development Study entitled "The study on integrated management plan of municipal solid waste in Havana city (2003-2006)" based on the request from Government of Cuba, and the "Master Plan for Integrated Management Plan of Municipal Solid Waste in Havana City" (M/P) which aimed for major improvement on solid waste management works in Havana. Based on the M/P, Government of Cuba and City of Havana realized some matters such as closure of most of the emergency disposal sites, improved existing disposal sites, self-procured waste collection vehicles and containers, and made decision for construction of new Guanabacoa final disposal site.

On the other hand, the budget for administration of solid waste was not sufficient due to lack of resource caused by economic blockade, nor was systematic human capacity development. Due to lack of capacity not only on technical aspect but also on institutional aspect and social system aspect, proper implementation of M/P was disturbed.

Based on the situation above, Government of Cuba requested to Government of Japan a technical cooperation project entitled "the Project for Improvement of Capacity on Solid Waste management in Havana city" for the purpose of reinforcement of integrated solid waste management, production of compost, reinforcement of vehicle maintenance workshop, improvement of existing final disposal site, and assistance for construction of new sanitary landfill. The technical cooperation was officially agreed on between two governments, and the Project was commenced from September 2009 as a JICA technical cooperation project.

1.2 Outline of the Project

1.2.1 Objectives and Outputs

The Project design is drawn in the Project Design Matrix (or PDM). The Project framework is as follows:

Overall Goal:	Urban solid waste management is properly implemented in Havana City and sanitary environment of the City is improved.
Project Purpose:	Capacity of DPSC on urban solid waste management in Havana City is strengthened through collaboration among cooperative organizations.
Outputs:	1. Comprehensive management capacity on solid waste of DPSC is improved. 2. Solid waste source separation at Pilot Project Site is promoted and capacity of UPPH in organic waste reduction at the source is strengthened. 3. Capacity of UPPH in the collection and transportation of solid waste

is strengthened.

4. Capacity of UPPH and DPSC on landfill design and operation of final disposal sites is strengthened.

1.2.2 Duration of the Project

Five years and one month from September 2009 to September 2014

1.2.3 Implementing Agency of the Project

DPSC/UPPH

1.2.4 Target Areas, Target Groups of the Project

Target Area of the Project:	Havana
Target Groups of the Project:	Staff of DPSC/UPPH, designers of state designing companies

2 Project Outputs and Achievements

2.1 Outputs

1. Comprehensive management capacity on solid waste of DPSC is improved.
2. Solid waste source separation at Pilot Project Site is promoted and capacity of UPPH in organic waste reduction at the source is strengthened.
3. Capacity of UPPH in the collection and transportation of solid waste is strengthened.
4. Capacity of UPPH and DPSC on landfill design and operation of final disposal sites is strengthened.

2.2 Main Activities

1. Comprehensive management capacity on solid waste of DPSC is improved.

1-1 To conduct the capacity assessment of DPSC in line with the M/P

1-2 To make the action plan in order to strengthen the management capacity of DPSC such as to plan, monitor and evaluate the detailed content of the project including coordination of the related organizations

1-3 To provide the training/OJT for UPPH to strengthen necessary SWM capacity except for activities relating to Output 2, 3 and 4 based on capacity assessment

1-4 To prepare the program of solid waste education both for sanitary workers and for the public including local residents, schools etc.

1-5 To implement the program based on Activity 1-4 by introducing on-site composting in school and other measures

1-6 To review and revise the M/P

2. Solid waste source separation at Pilot Project Site is promoted and capacity of UPPH in organic waste reduction at the source is strengthened.

2-1 To consider the measures for waste reduction

2-2 To plan the Pilot Project for organic waste composting

2-3 To implement the Pilot Project activities on source-separated waste from large-scale generators such as hotels and restaurants in Pilot Project Site in collaboration with cooperative organizations such as the Soil Institute of the Ministry of Agriculture, DMSC, etc.

2-4 To implement the Pilot Project activities to produce compost in the compost yard in collaboration with cooperative organizations such as the Soil Institute of the Ministry of Agriculture, DMSC, etc.

2-5 To evaluate the Pilot Project activities

3. Capacity of UPPH in the collection and transportation of solid waste is strengthened.

3-1 To review the waste collection plan and to implement the revised plan

3-2 To equip the maintenance workshop in UPPH

3-3 To conduct the related activities to improve the operation of collection vehicles and containers

3-4 To provide the training for staff of UPPH

4. Capacity of UPPH and DPSC on landfill design and operation of final disposal sites is strengthened.

4-1 To coordinate the vehicles' entrance to the existing final disposal sites

4-2 To conduct the related activities to improve the heavy machinery maintenance at the existing final disposal sites in collaboration with cooperative organizations such as CITMA Habana, Water Resource Institute, Sanitary Research Institute of the Ministry of Health, etc.

4-3 To provide advice on the design of New Final Disposal Landfill in East in collaboration with cooperative organizations such as CITMA Habana, Water Resource Institute, Sanitary Research Institute of the Ministry of Health, etc.

4-4 To prepare the training materials for operation and management of final disposal site including revision of existing operation guidelines and provide the training.

2.3 Achievement of Outputs

The achievement of the Outputs is summarized as follows;

a. Output 1: Comprehensive management capacity on solid waste of DPSC is improved.

Summary: Output 1 was mostly achieved within the project period. Comprehensive management capacity on solid waste of DPSC was improved, through the activities of Output 1. The M/P prepared by the JICA Development Study (2003-2006) was updated, management process was improved, trainings were carried out for core group of DPSC, various manuals were prepared, and process of solid waste education was enhanced. However, one of priority projects planned in M/P, “construction of the new landfill in east” was not completed due to external factors. Detailed evaluation using the targeted Objectively Verifiable Indicators in PDM is as follows:

a.1. Indicator 1-1: Master Plan is updated by the end of the Project with 2 component projects, namely “construction of the new landfill in the East” and “Innovation of the workshops for vehicles & heavy machineries” physically completed at the rate of completion of 100% and 100% respectively.

The target of Indicator 1-1 has been partly achieved and 100% completion was not achieved before the end of the Project.

Revision of M/P was completed.

One of the “2 components projects” could not be completed before the end of the Project. One component project, procurement of all equipment for “innovation of the workshops for vehicles & heavy machineries,” which was identified as the priority project in M/P, was completed in June 2013. However, even though the civil engineering works of access road and designing works for the 1st phase has been finished, the other component project “construction of the new sanitary landfill in east” could not be completed within the Project period.

The delay was mainly caused by external factors like a) the failure to disburse budget allocated, b) all construction companies were occupied by other construction works and could not find an alternative company to enter into a contract, and c) heavy equipment for construction works were not available.

a.2. Indicator 1-2: Management process is improved in 3 aspects, Plan, Monitoring and Evaluation.

The target of Indicator 1-2 was achieved under the intensive efforts of DPSC and UPPH.

To reinforce three aspects (Plan, Monitoring and Evaluation in detail) in municipal solid waste management, following efforts were made by DPSC and UPPH management bodies. Since changes in organizational improvement have been made, three aspects are improved.

Table 2-1: Improvement of management process on three aspects

Aspects	Contents of improvement
Plan	- DPSC and UPPH became an axis of relevant departments, and a project team was organized to integrate the procurement department, the construction department, and the design department to implement projects. Weekly meetings for the organization were also regularly held to discuss budget allocation, management of the progress, etc. - Action Plan was developed to enhance the project execution capability of DPSC. - The Project Team proposed DPSC/UPPH to develop a “project planning sheet” when a new project is implemented in general.
Monitoring	- DPSC could overcome the difficult stages of material procurement by incorporating upper-level negotiation with authorities. - The Project Team proposed DPSC/UPPH to develop a “project monitoring chart” before execution when a new project is implemented in general. - For the monitoring of projects, the Project Team proposed DPSC/UPPH to submit a “Progress check sheet” at least once in a month. - In the case of having meetings such as construction, licensing procedures and contract with partner organizations for carrying out projects, the Project Team proposed DPSC/UPPH to prepare “minutes of meeting” and it should be approved by next day.
Evaluation in detail	- For project mid-term and terminal evaluation, four criteria have been developed: period of construction works, collaborations with organizations, quality of construction, and budget for construction.

Source: Prepared by Terminal Evaluation Team based on the information from progress reports.

a.3. Indicator 1-3: Quality of DPSC management-related report on plan, monitoring, and evaluation is improved by establishing two kinds of management reports.

The targets of Indicator 1-3 were achieved.

In order to improve management process of DSDP and UPPH from three aspects (Plan, Monitoring and Evaluation in detail), five management-related reporting formats were introduced such as “project planning sheet,” “project monitoring chart,” “Progress check sheet,” “minutes of meeting” and “Indicators for project evaluation” by the Project. Among these five reporting formats, more than two kinds of management-related reports were introduced and routinely utilized by DSDP and UPPH.

a.4. Indicator 1-4.1: Core Group: approximately 520 people are trained.

1) **15 Directors in technical and economic management for supervision, integrated management and work safety.**
2) **106 Heads of Communal Zones in integrated management (waste collection-transportation-final disposal) and work safety.**
3) **Approximately 400 technicians in integrated management (waste collection-transportation-final disposal) and work safety.**

The targets of Indicator 1-4.1 have been mostly achieved.

By July 2014, number of trainings had been conducted and following number of staff attended. As for the trainings for heads of 15 administrative zones and zone chiefs, the targeted indicator was achieved in excess, 320% and 129% (see Table 2-2). However, trainings for technicians has not completed yet at rate of 91.3%. This is due to the insufficient resource inputs and delay of approval for implementation of the trainings caused by personnel change of upper level management.

Table 2-2: Result of trainings for DPSC staff

Target of trainings	Objective (person)	Actual (person)	Achievement (%)
Heads of 15 administrative zones	15	48	320.0
Zone chiefs	106	137	129.2
Technicians	400	245	61.3

Source: Information given by the last JCC.

a.5. Indicator 1-4.2: Manuals (Textbooks) are prepared (3 kinds)

The target of the Indicator 1-4.2 was achieved.

Three manuals, “Economical management and management techniques”, “Comprehensive solid waste management” and “Work safety” were developed.

a.6. Indicator 1-5.1: Solid waste education is conducted for 6 elementary schools and 2 junior high schools of the Popular Council of Miramar through the "Red de Formación Ambiental" while there was no such activity at the beginning of the Project.

The target of Indicator 1-5.1 was achieved.

Currently, solid waste education activities are regularly carried out in six primary schools and two secondary schools as follows.

Table 2-3: Educational organizations which conduct environmental education on solid waste management

Targets	Style of activities	Frequency
Primary school Renato Guitart Rosell Republica de Cambodia Seguidores de Ejercito Rebelde Cesareo Fernandez Martinez Solidaridad con Chile Vo Thi Than	Club activities	Every two week
	Special morning gathering	Every month
	School gardening	Every week
	Dialogues on solid waste	Every month
	Contests	Every year
Secondary school Manuel Octavio Bisbe Alberni Anton Semionovich Makarenko	Special morning gathering	Every month
	Dialogues on solid waste	Every month
	Art related activities	Every month

Source: Progress Report No.6

a.7. Indicator 1-5.2: Solid waste education for the employees of the hotels and agricultural markets in Havana City is conducted at 10 entities while there was no such activity at the beginning of the Project.

The target of Indicator 1-5.2 was achieved.

By July 2014, trainings in the Pilot Project workshops were conducted for staff in 10 organizations.

Table 2-4: Number of organizations which Solid waste education were conducted

No.	Nombre ame of organizations
1	Tulipan agricultural market
2	Cerro agricultural market
3	Milagro agricultural market
4	17 y K agricultural market
5	Caballo Blanco agricultural market
6	Virgen del Camino agricultural market
7	Trigal agricultural market
8	Hotel Chateau Miramar
9	Hotel Comodoro
10	Cigarette factory

Source: Material provided by Project Team

b. Output 2: Solid waste source separation at Pilot Project Site is promoted and capacity of UPPH in organic waste reduction at the source is strengthened.

Summary: Applicability and effectiveness of the organic waste reduction practice through composting of source-separated biodegradable organic waste from large-scale generators are positively verified. Output 2 is basically achieved as a pilot project, and the results suggested that the composting practice for organic waste reduction will become sustainable if certain conditions are fulfilled.

Solid waste source separation at Pilot Project Sites was promoted and a pilot-scale collection system of biodegradable organic waste was established from selected generators such as agricultural markets, hotel and cigarette plant etc. However, the supply of biodegradable organic waste was not stable which affects the production amount of compost. If necessary countermeasure is taken by Cuban side to stabilize the amount of collected organic waste, the Pilot Project will become a sustainable project.

b.1. Indicator 2-1: Organic waste for composting in Pilot Project Site is collected by 1,500 kg per day.

The target of Indicator 2-1 can be achieved in the near future, if certain conditions described below are fulfilled.

The average of amount of collected organic waste is 1,133 kg/day (as of January 2014), although the collected amount greatly varies from one day to another. This large variation was caused by following reasons:

- A truck for organic waste collection, which is one of the JICA's donating equipments, had been damaged by a traffic accident on 28 April 2012, and there was a certain period that the truck had not been available.
- Small drum cans and containers to deposit the organic waste were insufficient.
- At the beginning of the Project, it was planned to collect organic waste from agricultural markets and hotels. However, the amount of organic waste from both sources (agricultural markets and hotels) was too small in comparison with initial expected amount as there seemed to have a conflict with pig farmers.
- The frequency of collection by UPPH was sometimes irregular mainly due to limited number of collection vehicles. Therefore, organic waste was mixed and discarded as a general waste.

Though there are some problems mentioned above, there is a possibility that the indicator can be achieved in the near future, if the following conditions are fulfilled and sustained:

1) UPPH allocates enough resources for collection.
2) Staffs who are aware of the importance of compost production and separate collection increase.
3) In order to stabilize the supply amount of source-separated biodegradable organic waste, DPSC has the support of the cigarette manufacturing factory that promises to provide large-scale supplies. If supply-chain is coordinated / organized with this factory, the composting project will be sustainable.
4) At present, the cost of organic waste treatment by compost production is about five times (in CUC portion) and 10 times (in CUP portion) as much as cost of direct disposal of organic waste at the final disposal site. If the produced compost can be sold as a soil conditioner, the cost-benefit balance for compost production will be improved and it is expected that the importance of compost production as means of disposing organic waste will be better understood.
5) The composting can reduce the greenhouse gas (GHG) emissions potential of organic waste, which contributes to mitigate the Climate Change issue.

b.2. Indicator 2-2: Compost in Pilot Project Site is produced to 650 kg per day.

Indicator 2-2 have been achieved.

Since November 2011, compost was produced 667kg/day on average (in July 2013). However, the production of compost is unstable and it depends on the amount of collected organic waste. Collection of organic waste has been suffered from various problems described above (see previous section Indicator 2-1). However, if the conditions mentioned in the previous section "Indicator 2-1" are fulfilled successfully, daily compost production of 650kg/day on average can be possible.

b.3. Indicator 2-3: Percentage of foreign material in organic waste to compost plant is reduced by 50 % as compared to the percentage at the beginning of the pilot project.

Indicator 2-3 can be achieved in the near future, if certain conditions are fulfilled.

As of January 2014, the proportion of the amount of foreign matter is 25.4% at agricultural markets, 2.3% at a cigarette plant and 0% at hotels (target value is 8.3%). In order to promote the source separation practice, the Project installed small drum cans for separation and large containers for non-organic waste at the agricultural markets, then the amount of foreign matters decreased once almost zero.

However, waste collection by UPPH was unstable in agricultural markets and non-organic waste was sometimes discarded in the separation container. In some agricultural markets, situation is somehow improved by means of waste separation tag installed on containers.

If the conditions as mentioned for Indicator 2-1, particularly 1) and 2) are fulfilled successfully, it may be possible to reduce the contamination of foreign matters from organic waste.

b.4. Indicator 2-4: Behavior change of local institutions in pilot project Area on waste reduction and separated collection reaches 5 institutions while there was no such institution at the beginning of the project

Indicator 2-4 was achieved.

Five organizations in Pilot Project Area have joined the Pilot Project on waste reduction and separated collection practices.

c. Output 3: Capacity of UPPH in the collection and transportation of solid waste is strengthened.

Summary: Output 3 was achieved within the project period. Even though procurement and installation of equipment for vehicle maintenance workshop was delayed, necessary equipment was procured and trainings were conducted for mechanics. As a result, all indicators to measure improvement of vehicle maintenance techniques was achieved with the effort of C/Ps and Japanese experts. In addition, 22 manuals were prepared.

c.1. Indicator 3-1: Average downtime of working collection vehicles is improved to the level of CDT (Coeficiente de Disponibilidad Técnica) at 63.2 %, to the level of TR (Time for Repair) at 8.38 hrs/month, and to the level of TE (Time for waiting to be repaired) at 5.46 hrs/month. *External factors: Spare parts and materials necessary for repair and maintenance of collection vehicles are supplied.

The target of Indicator 3-1 is achieved.

The data on the indicator 3-1 is regularly measured by C/P and the result is as follows.

Table 2-5: Change of average downtime of working collection vehicles (CDT), Time for Repair (TR), Time for waiting to be repaired (TE)

	Target value	Dec 2010	Mar 2012	Oct 2012	Oct 2013	Jan 2014
CDT-1	More than 63.2%	50.7%	82.8%	81.5%	64.9%	63.8%
CDT-2[1]	More than 63.2%	58.6%	85.7%	85.13%	78.7%	77.5%
TR	Less than 8.38 hours	10.67 hours	6.5 hours	6.38 hours	6.38 hours	6.38 hours
TE	Less than 5.46 hours	6.37 hours	1.67 hours	1.57 hours	1.57 hours	1.57 hours

Source: Progress Report and internal information

In the earlier stage of measurement starting from December 2010, there was steady improvement until October 2012. However, the value of CDT slightly decreased in October 2013, although the value still exceeded the target value. This change was caused by a limitation of availability of spare parts.

c.2. Indicator 3-2: Frequency of waste collection and transportation by UPPH is optimized with the index of VF (Rate of Functioning Vehicle to Number of collection route) at 90% and NC (Rate of Necessity of Container to planned number of container) at 15%. * External factors: It is possible to obtain reliable weighbridge data.

The target for Indicator 3-2 is partially achieved as VF was achieved while NC was not.

Change of waste collection vehicle allocation rate (VF index = rate of functioning vehicles / Number of collection route) and necessary container rate (NC index = number of necessity of container / planned number of container) are as follows:

Table 2-6: Change of VF index and NC index for waste collecting vehicles

	Target value	2012	2013
VF index	More than 90%	71%	94%
NC index	Less than 15%	10%	16 %

Source: Progress Report No. 6 and answer of questionnaire from Project Team

In 2012, NC index exceeded the target value though VF index was not achieved. Contrarily, in 2013 VF index exceeded the target value though NC index was not achieved.

[1] CDT-1 is the result of calculation for all target vehicles, while CDT-2 is the result of calculation only for vehicles excluded disused vehicles.

To accurately calculate the VF index and NC index, it is necessary to utilize the weighbridge to measure weight of waste collection vehicles, and then reexamine the efficiency of collection route and number of necessary containers. However, weighbridge installed in Calle100 was often malfunctioned and the reliable data was not available. Therefore, improvements of VF index and NC index for the Indicator 3-2 are calculated only from rate of functioning vehicles and planned number of containers, not based on the weighbridge data.

c.3. Indicator 3-3.1: At the 7 main areas of the maintenance workshop (chassis, welding, machine tool room, tire repair shop, electricity, hydraulics, and injection lab), 20 mechanics are trained to correctly operate the equipment donated by the Project.

The target of Indicator 3-3.1 was achieved.

The technicians improved their skills related to maintenance of the vehicle after receiving intensive trainings by Japanese experts and by adjunct trainings of the C/Ps, even though procurement of equipment and installation of equipment were delayed. In 2013, exams for eight main subject areas were conducted in order to measure the level attained. As a result, all of 55 technicians[2] who took exams on eight areas passed them.

c.4. Indicator 3-3.2: Seven (7) maintenance manuals are prepared for the main areas mentioned in 3-3.1.

The target of Indicator 3-3.2 was achieved.

The Project successfully prepared 22 maintenance manuals for UPPH workers as follows:

Table 2-7: List of maintenance manuals developed in the Project

	Name of manuals
1	Maintenance manual for hydraulic system
2	Maintenance manual for clutch
3	Maintenance manual for electric system
4	Manual for operation of arc welding
5	Manual for gas welding
6	Maintenance manual for of air tools
7	Maintenance manual for tires
8	Manual for operation of tire changer
9	Maintenance manual for differential gears
10	Maintenance manual for machine tools
11	Maintenance manual for engine cooling system
12	Maintenance manual for engine lubrication system
13	Manual for TIG welding machine
14	Maintenance manual for engine fuel system
15	Maintenance manual for engine intake and exhaust system
16	Manual for safety and hygiene works
17	Operation manual for fuel injection pump tester
18	Manual for engine maintenance
19	Operation manual for greasing pump
20	Maintenance manual for brake
21	Maintenance manual for steering, accelerator and suspension
22	Maintenance manual for transmission

Source: Progress report No.8 and answer of questionnaire from Project Team

[2] A person in charge of trainings and a person in charge of maintenance took the test more than once, and number of actual successful technicians are 50.

d. Output 4: Capacity of UPPH and DPSC on landfill design and operation of final disposal sites is strengthened.

Summary: Output 4 is partly achieved but not completely within the Project period.

During the designing stage of a new landfill site, valuable recommendations were made by Japanese expert and the designing of new landfill site were improved. For improvement of management capacity of existing final disposal site, a monitoring was carried out and progress was seen to some extent. However, the level of improvement did not attain expected level due to suspension of the construction process of new sanitary landfill caused by lack of resources.

d.1. Indicator 4-1: The existing final disposal sites are properly operated and managed in dumping, surface compaction, soil cover, slope protection and leachate treatment at 3 sites while only 1 site at the beginning of the Project.

The target of Indicator 4-1 was partly achieved.

As for monitoring the improvement of existing disposal site, second monitoring was carried out in 2014 for 15 items on improvement situation of existing disposal sites. The result is as follows.

Table 2-8: Improvement situation of existing disposal sites

	Calle100		Ocho vias		Tarara		Campo Florido	
	ST*	EV*	ST	EV	ST	EV	ST	EV
Outsider intrusion	1	1	1	1	1	1	1	1
Administration office	1	1	0	1	1	1	0	0
Scale**	0.5	1	0	0	0	0	0	0
Lighting	0	0	0	0	0	0	0	0
Fire preventive equipment	1	1	1	1	1	1	0	0
Inside road pavement	1	1	1	0	1	1	1	1
Allocation of record keepers for collection vehicles	1	1	1	1	1	1	1	1
Waste compaction**	1	1	1	1	1	1	0.5	1
Slope Protection	1	1	1	1	1	1	0	0
Implementation of covering soil		0.5		0.5		0.5		0.5
Areas covered with soil	1	1	1	1	1	1	1	1
Leachate treatment	0	0	0	0	0	0	0	0
Valuable waste collection	1	1	1	1	1	1	1	1
Compost production	1	1	0	0	0	0	0	0
Utilization of biogas/degassing	1	1	0	0	0	0	0	0
Score	11.5	12.5	8	8.5	9	9.5	5.5	6.5

*ST: Starting Situation, EV: Situation at the Second Evaluation conducted on 14th March 2014
** In case, scale exists but is not function, the score is 0.5.
*** In case, waste compaction is not carried out every day, the score is 0.5.
Source: Project team

In the evaluation, disposal sites graded more than 11 points are regarded as an environmental friendly final disposal site. A disposal site which exceeded 11 points was only Calle 100 site. The leachate treatment was not installed in all four dumping sites which is a future challenge in particular for Calle 100 site.

Monitoring was continued by C/Ps and Japanese experts and some progress was seen in three final disposal sites, except Campo Florido. Therefore, it is difficult to prospect improvement of all of the four landfill/final disposal sites within the project period.

Since remaining years in service are two years for Ocho vias, Tarara and Campo Florido (Progress report No.8), it is necessary to consider whether all disposal sites really need to achieve all evaluation items under limited resources and budget.

d.2. Indicator 4-2: The design of New Landfill in East is revised in an environmentally friendly way for 11 improvements while zero at the beginning of the Project.

The target of Indicator 4-2 was achieved.

After the training in Mexico in December 2012, modification of design were conducted; modification of number of cell taking into account improvement in lining works and service life of each cell (the number of compartments has been modified from six to four), modification of cell figures taking into account sequence of cell construction and final shape of landfill, and changing embankment materials into more cost-effective ones. A number of outputs (design plan) which reflected the improvements were counted as 12.

Table 2-9: Number of improved outputs

No	Improved items	Target organization	Number of improved outputs*	
			1st Evaluation	2nd Evaluation
1	Improved items on designing from the beginning of the project to the time of evaluation	DCH[3]	2	5
		EIPHH	1	3
		IPROYAZ	0	0
2	Progress management	DCH	1	1
		EIPHH	1	1
		IPROYAZ	1	1
3	Improvement or change during the construction period	DCH	0	0
		EIPHH	0	0
		IPROYAZ	1	1
Number of Improvement			7	12

* First Evaluation: 7th July 2014, Second Evaluation: 14th March 2014
Source: Project team

2.4 Prospect for Achievements of the Project Purpose

a. Project purpose: Capacity of DPSC on urban solid waste management in Havana City is strengthened through collaboration among cooperative organizations.

The Project Purpose is achieved by the end of the Project as appropriate efforts from Cuban side continue.

Capacity of DPSC on urban solid waste management in Havana is strengthened through collaboration among cooperating organizations in each Output. Although Output 1 has not fully been achieved, it is expected to be accomplished in the near future -- possibly within 2014 -- if there are appropriate efforts of Cuban side.

[3] DCH, EIPHH and IPROYAZ are the name of state designing companies.

a.1. Indicator 1: The training program is formulated and begins to be implemented for DPSC/UPPH's members based on the experience with the trained Core Group regarding Output-1

The target of Indicator 1 is expected to be achieved in the near future, possibly within 2014.

Based on the results of the questionnaire survey for DPSC staff, training programs for staff were formulated. The training for the core group was conducted based on the program, and the experience has been accumulated in DPSC. Progress of training for technicians is slightly delayed but the effect spreads even to non-core group through voluntary programs which were carried out by DPSC. Through such trainings, cooperation with 15 administrative districts in Havana and DPSC zone chiefs was enhanced steadily.

a.2. [Additional indicator for Output 1][4] Capacity of DPSC staff is strengthened for integrated solid waste management through the activities;

There have been collaboration with relevant organizations through such activities as development of action plan, monitoring activities and evaluation, cooperation with six primary schools and two middle schools in the pilot area through solid waste education with collaboration with CITMA and nine organizations.

Therefore, it can be said that the solid waste management capacity of DPSC was enhanced through collaboration with partner organizations. The progress can also be observed from the result of the capacity assessment conducted by the Project in March 2014. At the initial stage of the Project, most of the assessment capacity levels were rated as 1.5-2.0 out of 5.0 in score.

However, according to the final evaluation conducted in March 2014, most of the levels became as 4.0-5.0 in score, which showed that the capacity of DPSC has been significantly enhanced.

a.3. Indicator 2: Organic waste reduction achieved in the pilot project (to be about 1.5 ton/day) to be maintained regarding Output-2

The Output 2 is basically achieved as a pilot project for verification of applicability and effectiveness of waste reduction through composting of organic waste from large-scale generators.

At the time of terminal evaluation, average 1,133 kg/day of organic waste was collected and compost was produced, although it has not achieved the target value of 1.5 ton/day yet. However, experience and new findings on compost production were accumulated through the process of the pilot project. The utilization of cigarette rubbish for composting is new finding by the Project. Cooperation system among UPPH, hotels, agricultural markets, and cigarette plant was also established.

Even there have been difficulties to collect sufficient organic waste from hotels and agricultural markets, the Project found other sources such as cigarette rubbish, pruning waste, and fallen leaves etc. Techniques to produce compost were successfully transferred from Japanese Expert to C/Ps and produced compost was used for horticulture by municipality.

[4] This indicator has been added by the Joint Evaluation Team in order to verify the Output 1 appropriately.

a.4. Indicator 3: Vehicle repair and maintenance system upgraded (about 10% reduction of time required for several representative repair/maintenance works in the Workshop) by trained mechanics using equipment donated by the project to be maintained

The target of Indicator 3 is achieved.

The time required for the major repair and maintenance is reduced on the following major repair works by procurement of the equipments and implementation of training in the Project, and also strengthening the overall maintenance facilities by the Cuban side etc.

Through construction of such facilities and installation works, coordination capabilities of DPSC/UPPH with contractors and other organizations were also improved.

Table 2-10: Change of necessary time for major repair and maintenance works

	Necessary time before the Project implementation (hour)	Necessary time after the Project implementation (hour)*	Rate of Improvement
Welding works of container lifter	3.0	1.05	65% reduction
Repair of clutch	3.45	2.1	39% reduction
Repair of tire	1.2	0.3	75% reduction
General greasing work	1.1	0.25	77% reduction

Source: Progress Report No. 7

All of the works showed significant time savings compared with the target value “10% of time reduction”[5].

a.5. Indicator 4: Improvement of collection and transportation by means of the upgraded CDT and frequency optimization (productivity per liter of oil is expected to reach 0.90m^3/L as compared to the 2008-09 level of 0.80m^3/L) to be maintained regarding Output-3

The target of Indicator 4 is partially achieved by the Project.

The target value was set for loaders/flat trucks as representing vehicles. According to the progress report, original value was 0.80m^3/L and it was currently improved by 0.83m^3/L. Effort of improvement will be continued on improvement of productivity per liter after this.

a.6. Indicator 5: Environmentally friendly landfill design advised by JET is incorporated into the new East Landfill to be constructed regarding Output-4

The target of Indicator 5 is achieved. Environmentally friendly landfill technologies advised by Japanese Expert were reflected mainly to 12 items in the design of eastern final disposal site.

5 For measuring the required time for maintenance, same contents of maintenance procedure were set in each fields and the working time was measured for 1) time without procured equipment (as required time before start of the Project) and 2) time with procured equipment (as required time after the Project), and the change rate was calculated. Basically, time was measured once each (some time twice under different conditions). The number of person is depending on the type of works

2.5 Prospect for Achievement of the Overall Goal

a. Overall Goal: Urban solid waste management is properly implemented in Havana City and sanitary environment of the City is improved.

It is expected that the Overall Goal to be achieved within 3-5 years if proper input is made by Cuban side.

Even at the time of terminal evaluation, one indicator out of four is already achieved. Rest of three indicators are also expected to be achieved in the near future if there is a commitment from upper level organization in Cuba for proper resource allocation.

a.1. Indicator 1: Volume of primary materials recovered from waste in Havana City reaches 6,400 tons/year from the current level of 4,000 tons/year.

The quantitative target of Indicator 1 is difficult to be achieved within 3-5 years after the end of the Project if situation seen in 2013 continues.

The amount of primary material recovery measured by UPPH was 5,300 tons/year in 2011 and 6,100 tons/year in 2012, which were encouraging results for achieving the target. However, it was 3,600 tons/year in 2013 and was significantly decreased.

The reason for the decrease in 2013 is most probably caused by a recycling policy change of the Government of Cuba. State-owned recycle enterprise (Matiria Prima) started to buy recyclables directly from general public. As a result, general public or waste pickers tended to sell the recyclables collected from final disposal sites or streets, and the collection amount by UPPH became decreased.

It means the quantitative indicator only measured by UPPH is probably no longer valid under current recycling policy, but from the view point of urban solid waste management mentioned in Overall Goal, present tendency is positively evaluated because the recovery of primarily materials is enhanced when collections both from UPPH and general public are implemented.

a.2. Indicator 2: Over 2 entities in Havana City consider introducing waste reduction model practiced in Pilot Project while there was no entity at the beginning of the Project.

The target of Indicator 2 is expected to be achieved in 3-5 years after the end of the Project.

Currently, one organization (UPPH) is participating in the pilot project for production of compost. During the pilot project, it was found that organic waste like cigarette rubbish, pruning waste and fallen leaves, which does not compete with pig farming companies, could be a source for compost, and there is a possibility to introduce the waste reduction model at new landfill sites in the future.

a.3. Indicator 3: Number of environmentally friendly final disposal landfill sites which are properly maintained is more than 2 at the end of the Project while there was only 1 at the beginning of the Project.

The target of Indicator 3 is expected to be achieved within 3-5 years after the end of the Project.

In July 2014, the final disposal site in which appropriate maintenance is carried out is only Calle100. If construction of new Guanabacoa sanitary landfill is realized as scheduled, the quantitative target of the indicator can be undoubtedly achieved. Construction works for a part of new landfill site has started in June 2014. Quick completion of the construction and starting up the service are anticipated.

a.4. Indicator 4: The level of satisfaction among Havana's citizens in terms of the integrated solid waste management increases. As a representative indicator, the reduction in the number of complaints is used. The number of complaints decreased from 60/year/municipality to 36/year/municipality.

The target of Indicator 4 was achieved.

There were no municipalities in all 15 municipalities of Havana city where number of complaints is counted for more than 36 items per year (from June 2012 to March 2013).

3 Achievement on Capacity Development

3.1 Achievement on Capacity Development for C/P for Output 1

A capacity assessment expert from a third country performed the assessment for capacity development of C/P personnel. Each year the capacity assessment expert was dispatched to Havana and conducted interviews for each C/P member. Based on the interview assessment, the capacity of C/P in output 1 "Comprehensive management capacity on solid waste of DPSC is improved" was assessed as it had been considerably strengthened in the 5 year project period.

As seen in the following figures, the individuals in Output 1 have gradually and steadily developed their capacities on the subject since the commencement of the Project. One can also see that capacity as a group also increased in the same period which can be seen in the annual radar chart that follows.

Due to various reasons, some C/P personnel have left the workforce or changed unit/positions. Therefore, period participated by those successive C/P staffs became relatively short, which in turn made the capacity developed from this Project rather limited.

Under some given circumstances in which the former C/P member who had left the Project return to DPSC/UPPH work unit, it can be anticipated that the capacity as a group will enhanced. On the contrary, some negative impact may be unavoidable if current C/P personnel leaves the unit or changed his/her positions. This will most likely bring narrowing down the group capacity or further weaken some poor field.

Assessment criteria:

<5> It is possible to perform an excellent job without the support by the Japanese expert.

<4> It is possible to perform a job on satisfactory level without the support by the Japanese expert.

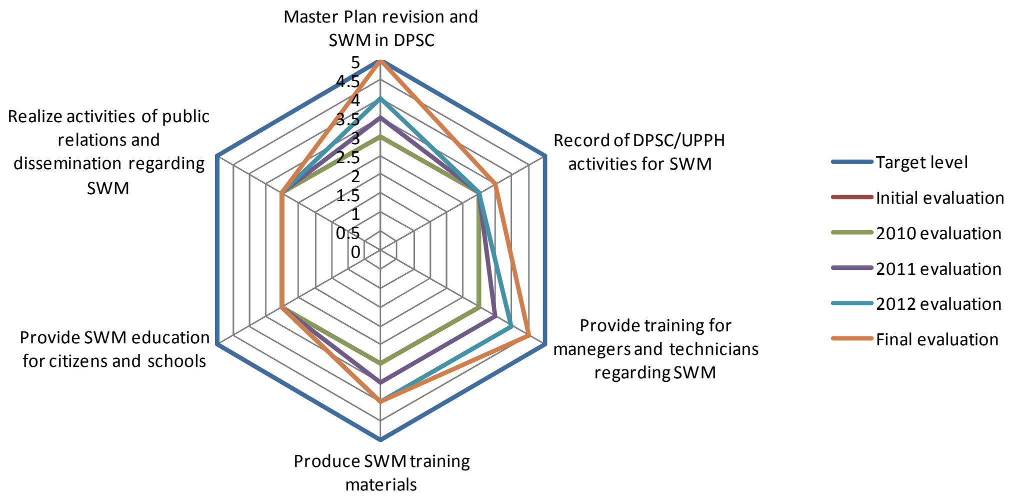
<3> Little assistance by the Japanese expert is required to reach the target level.

<2> A lot of assistance by the Japanese expert is required to reach the target level.

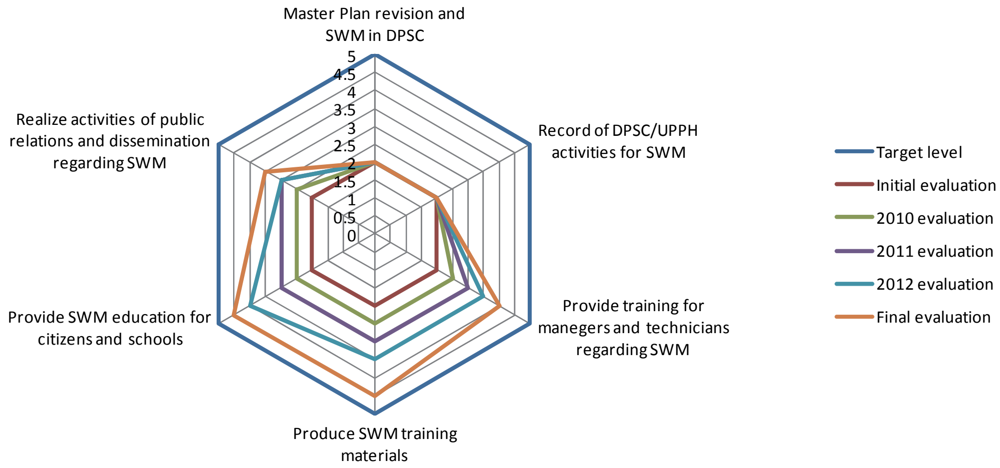
<1> It is impossible to perform the work on satisfactory level even after the capacity development with the Japanese expert.

Assessment for Individual

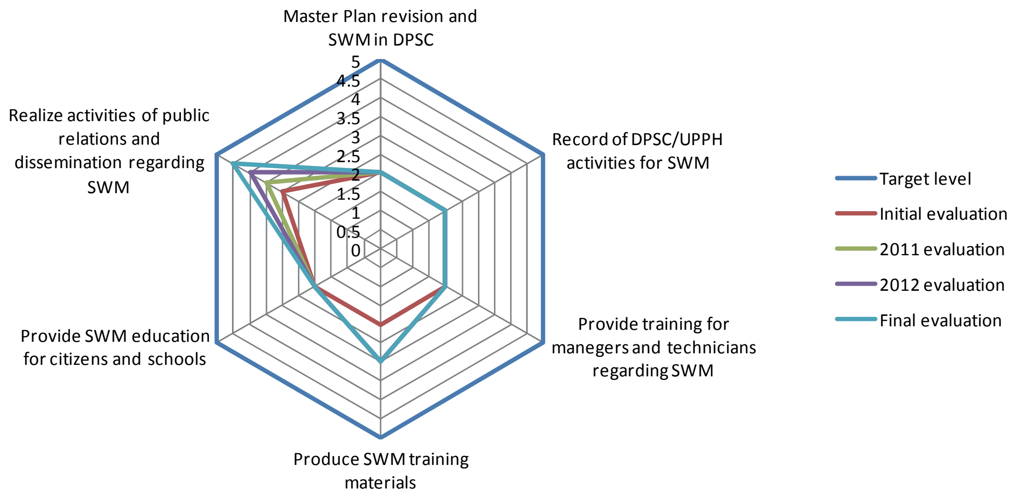
Ms. Odalys García



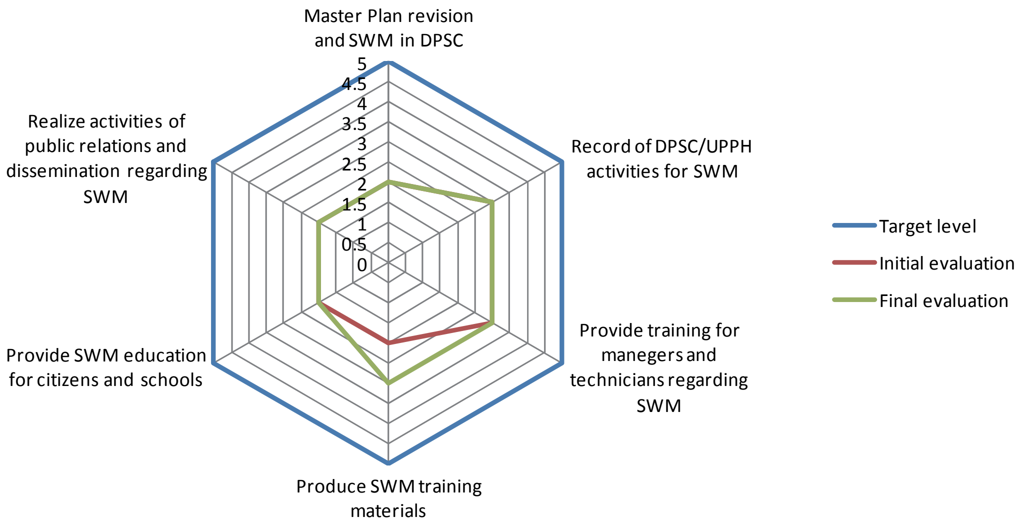
Ms. Jaynet García



Ms. Mariana Echavarría



Mr. Alfredo Rodríguez



Assessment for the Group

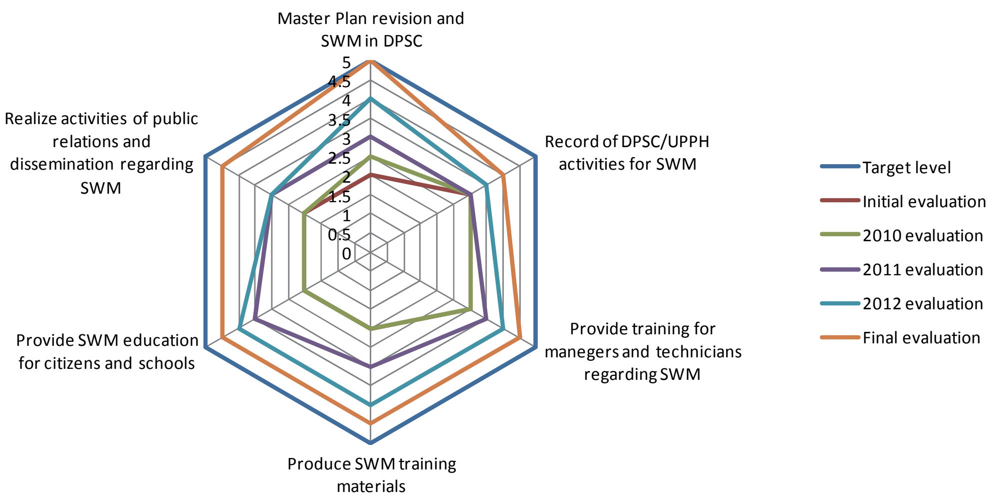


Figure 3-1: Capacity Development for C/P for Output 1

3.2 Achievement on Capacity Development for C/P for Output 2

A capacity assessment expert from a third country performed the assessment for capacity development of C/P personnel. Each year the capacity assessment expert was dispatched to Havana and conducted interviews for each C/P member. Based on the interview assessment, the capacity of C/P in output 2 “Solid waste source separation at Pilot Project site is promoted and capacity of UPPH in organic waste reduction at the source is strengthened” was assessed as it had been considerably strengthened in the 5 year project period.

As seen in the following figures, the individuals in Output 2 have gradually and steadily developed their capacities on the subject since the commencement of the Project. One can also see that capacity as a group also increased in the same period which can be seen in the annual radar chart that follows.

Due to various reasons, some C/P personnel have left the workforce or changed unit/positions. Therefore, period participated by those successive C/P staffs became relatively short, which in turn made the capacity developed from this Project rather limited.

Under some given circumstances in which the former C/P member who had left the Project return to DPSC/UPPH work unit, it can be anticipated that the capacity as a group will enhanced. On the contrary, some negative impact may be unavoidable if current C/P personnel leaves the unit or changed his/her positions. This will most likely bring narrowing down the group capacity or further weaken some poor field. Output 2 has only 3 C/P members therefore negative impact from re-distribution of personnel, if occurs, maybe much more severe. It is highly anticipated that actions be taken by the Cuban side for the continuity of the composting project through retreat the former C/P members and/or recruiting new staffs.

Assessment criteria:

<5> It is possible to perform an excellent job without the support by the Japanese expert.

<4> It is possible to perform a job on satisfactory level without the support by the Japanese expert.

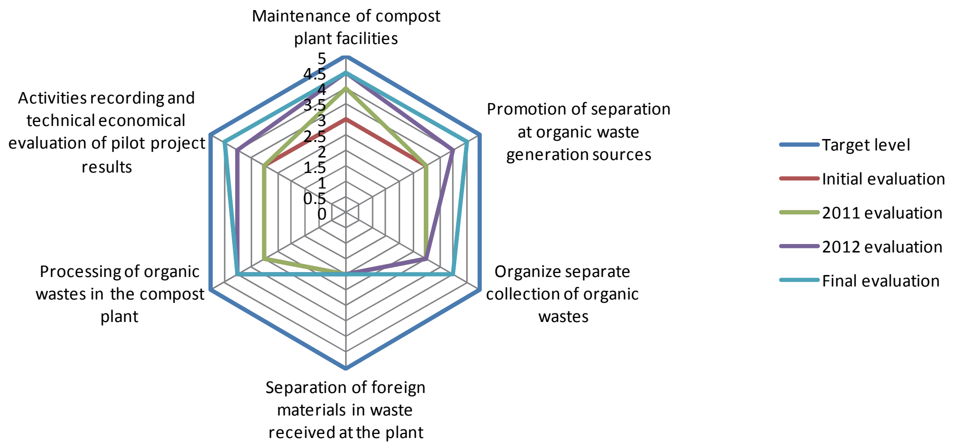
<3> Little assistance by the Japanese expert is required to reach the target level.

<2> A lot of assistance by the Japanese expert is required to reach the target level.

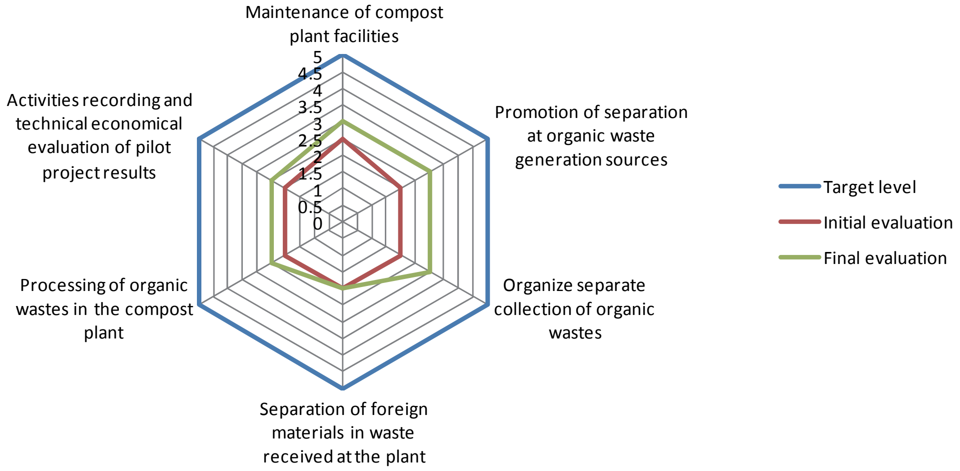
<1> It is impossible to perform the work on satisfactory level even after the capacity development with the Japanese expert.

Assessment for Individual

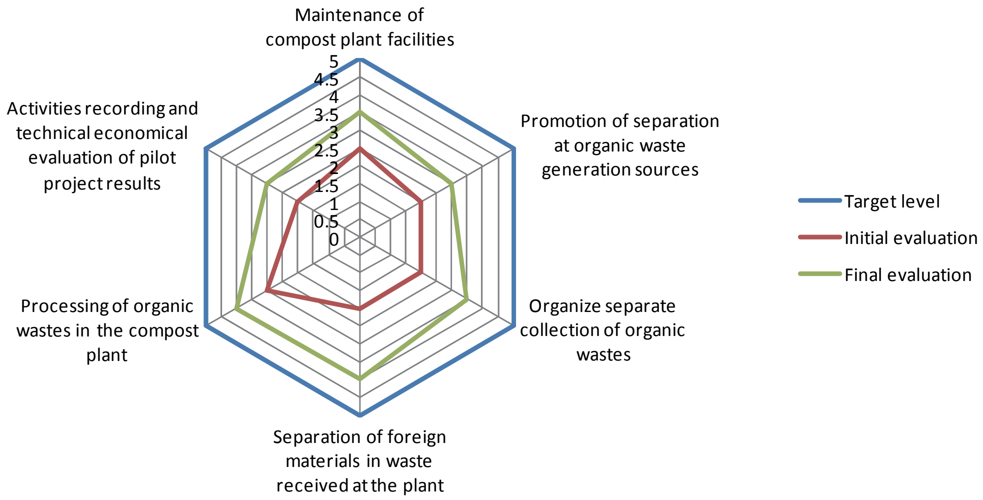
Mr. César de las Pozas



Mr. Apolonio Cerrano Miranda



Mr. David Santana



Assessment for the Group

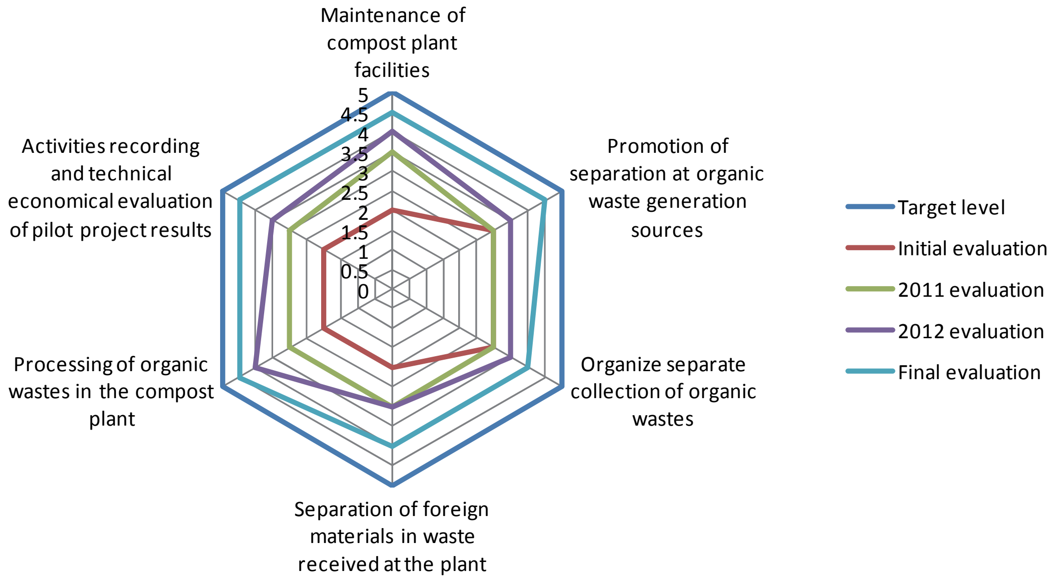


Figure 3-2: Capacity Development for C/P for Output 2

3.3 Achievement on Capacity Development for C/P for Output 3

A capacity assessment expert from a third country performed the assessment for capacity development of C/P personnel. Each year the capacity assessment expert was dispatched to Havana and conducted interviews for each C/P member. Based on the interview assessment, the capacity of C/P in output 3 “Capacity of UPPH in the collection and transportation of solid waste is strengthened” was assessed as it had been considerably strengthened in the 5 year project period.

As seen in the following figures, the individuals in Output 3 have gradually and steadily developed their capacities on the subject since the commencement of the Project. One can also see that capacity as a group also increased in the same period which can be seen in the annual radar chart that follows.

There had no staff relocation or staff who left the workforce for Output 3 C/P personnel in the first half period; therefore, their capacities development have been done smoothly. Unfortunately, however, replacement of UPPH director and consequent change in management styles at the workshop in the final stage of the Project caused some competent C/P members leading the group left the workshop. This has caused not-negligible negative impacts for building and maintaining the capacity of the group. Nonetheless, such impacts were rather limited since a) many C/P members were assigned from the beginning of the Project and b) successive C/P members were assigned immediately, and c) young and highly capable C/P were added in the group.

Assessment criteria:

<5> It is possible to perform an excellent job without the support by the Japanese expert.

<4> It is possible to perform a job on satisfactory level without the support by the Japanese expert.

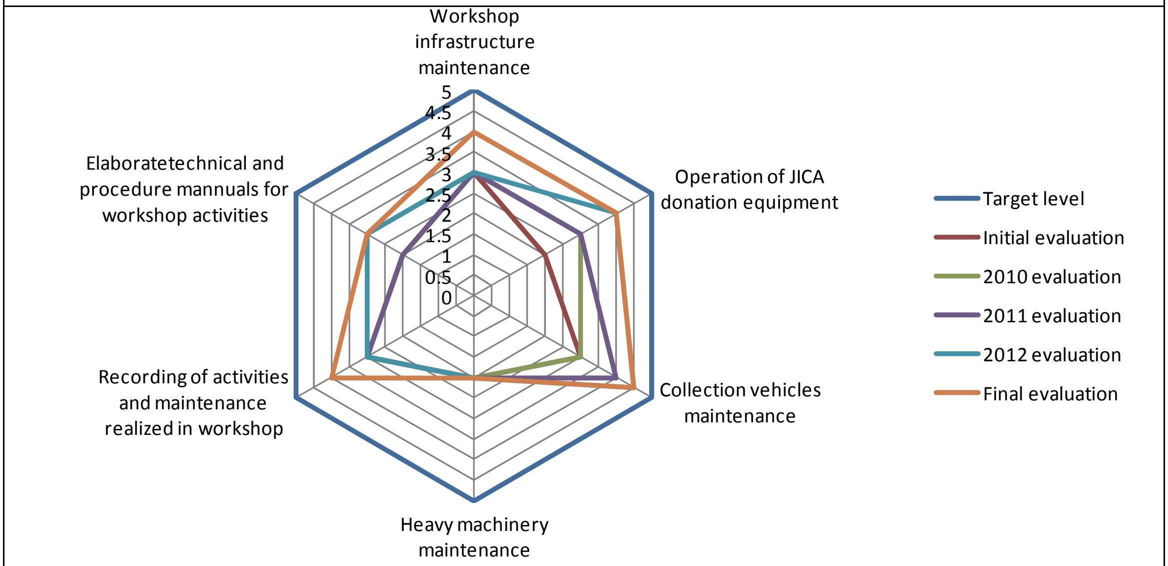
<3> Little assistance by the Japanese expert is required to reach the target level.

<2> A lot of assistance by the Japanese expert is required to reach the target level.

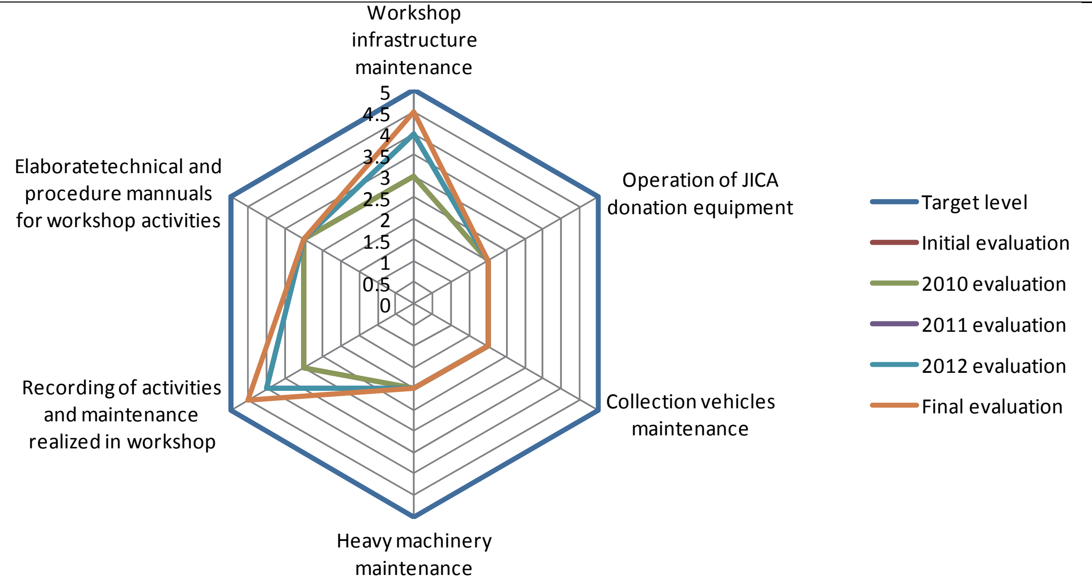
<1> It is impossible to perform the work on satisfactory level even after the capacity development with the Japanese expert.

Assessment for Individual

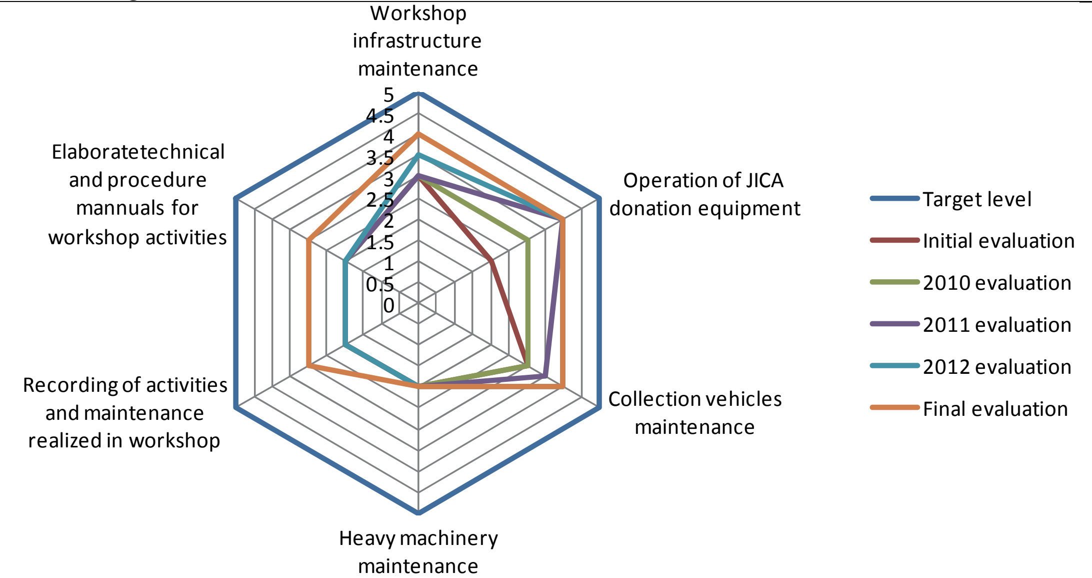
Mr. Félix Arturo Abreu



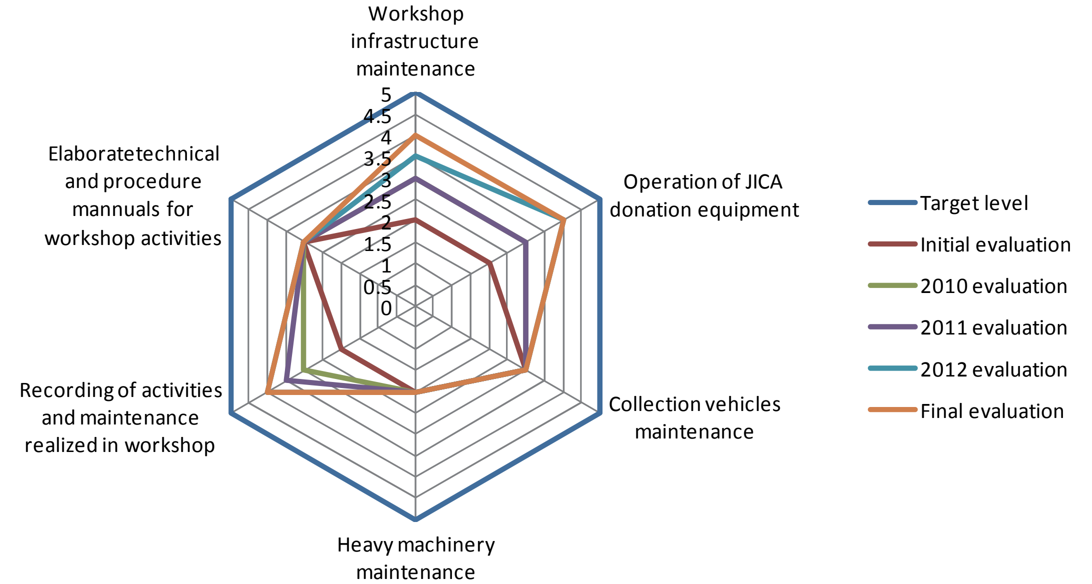
Mr. Fernando González



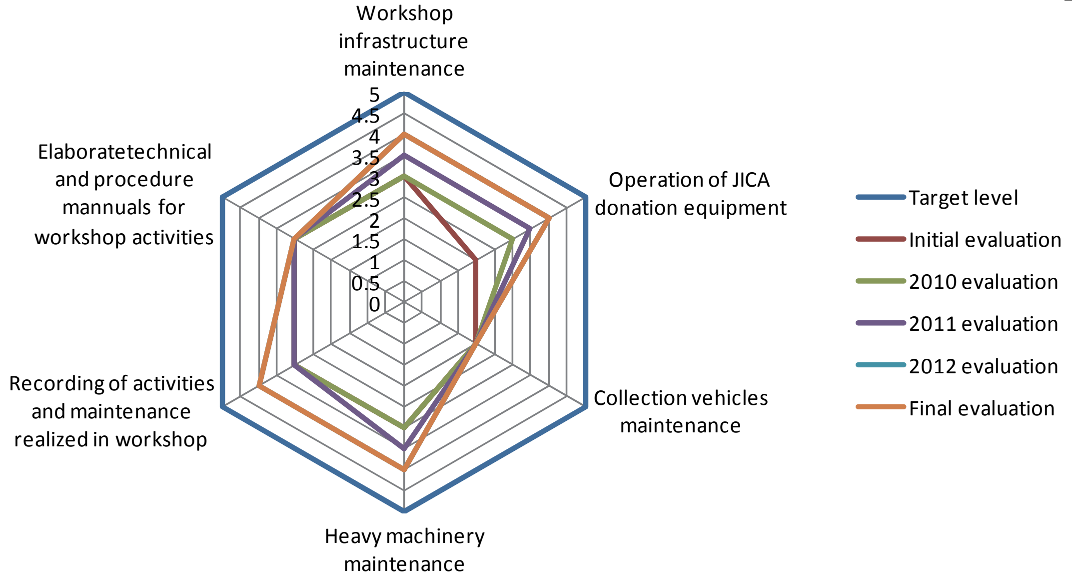
Mr. Diego Guevara



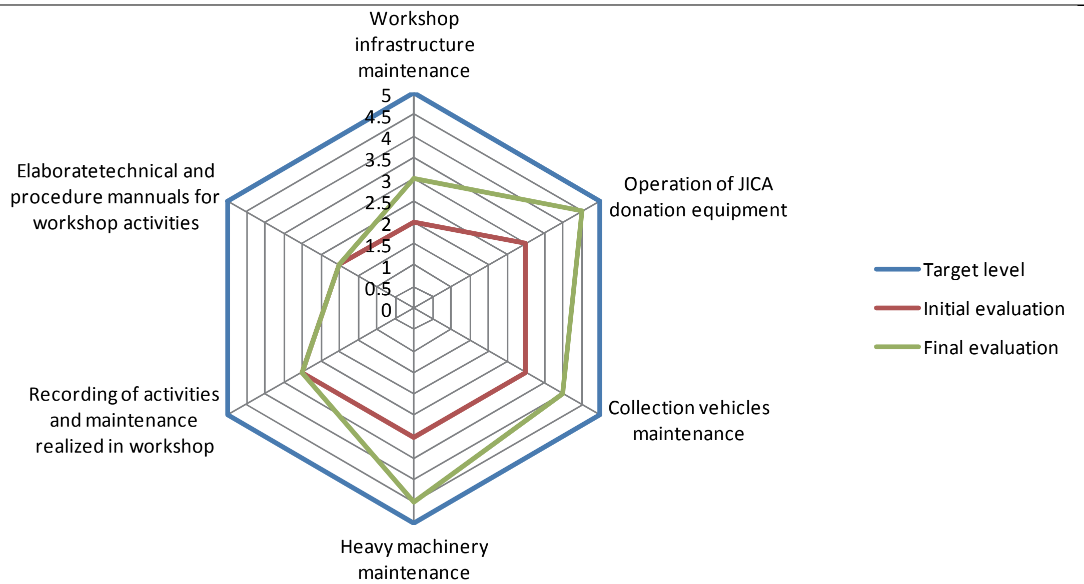
Mr. Enrique García



Mr. Jorge Quintana



Mr. Eduardo Jiménez



Assessment for Group

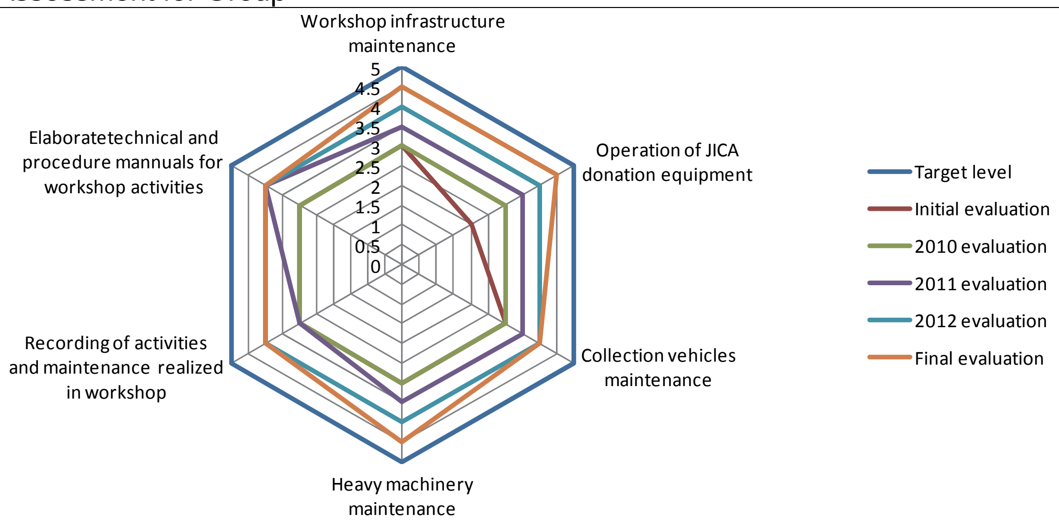


Figure 3-3: Capacity Development for C/P for Output 3

3.4 Achievement on Capacity Development for C/P for Output 4

A capacity assessment expert from a third country performed the assessment for capacity development of C/P personnel. Each year the capacity assessment expert was dispatched to Havana and conducted interviews for each C/P member. Based on the interview assessment, the capacity of C/P in output 4 “Capacity of UPPH on landfill design and operation of final disposal site is strengthened” was assessed as it had been considerably strengthened in the 5 year project period.

As seen in the following figures, the individuals in Output 3 have gradually and steadily developed their capacities on the subject since the commencement of the Project. One can also see that capacity as a group also increased in the same period which can be seen in the annual radar chart that follows.

Due to various reasons, some C/P personnel have left the workforce or changed unit/positions. Therefore, period participated by those successive C/P staffs became relatively short, which in turn made the capacity developed from this Project rather limited.

If current C/P leaves the position, some negative impacts may become evident including narrowing down the radar chart as a group and further weakening poor field. It maybe worth noting that the C/P members from DPSC mainly work on planning field like budgeting, while C/P members from UPPH mainly work on field work like landfill operation and thus designing new landfill site or leachate treatment facility are not particularly in their field of expertise. Therefore, one should pay attention to develop not only the capacities of DPSC/UPPH personnel but also relevant organizations such as DCH and EIPHH in order to develop the capacity of members in Output 4 group be developed in good balance.

Assessment criteria:

<5> It is possible to perform an excellent job without the support by the Japanese expert.

<4> It is possible to perform a job on satisfactory level without the support by the Japanese expert.

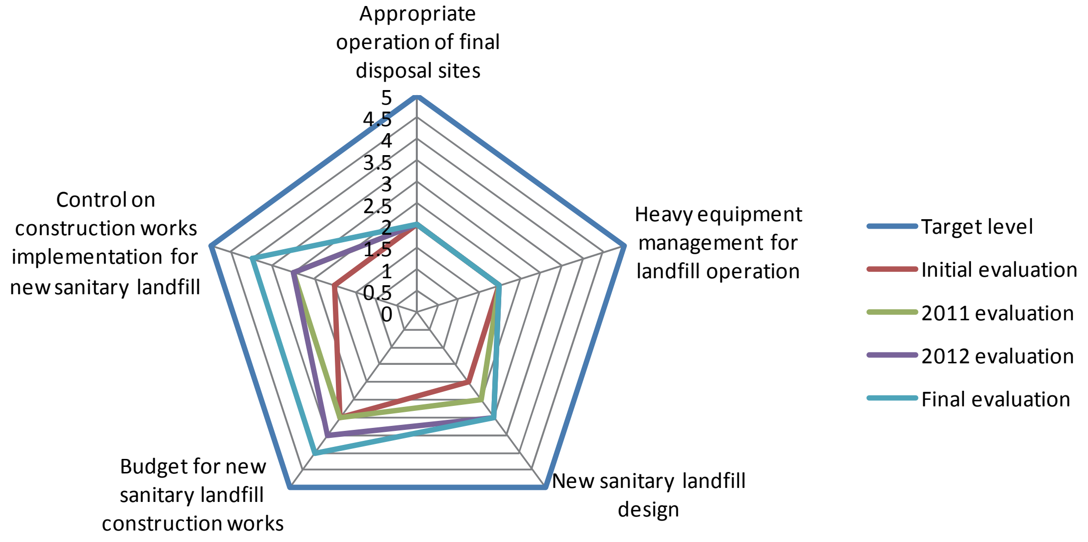
<3> Little assistance by the Japanese expert is required to reach the target level.

<2> A lot of assistance by the Japanese expert is required to reach the target level.

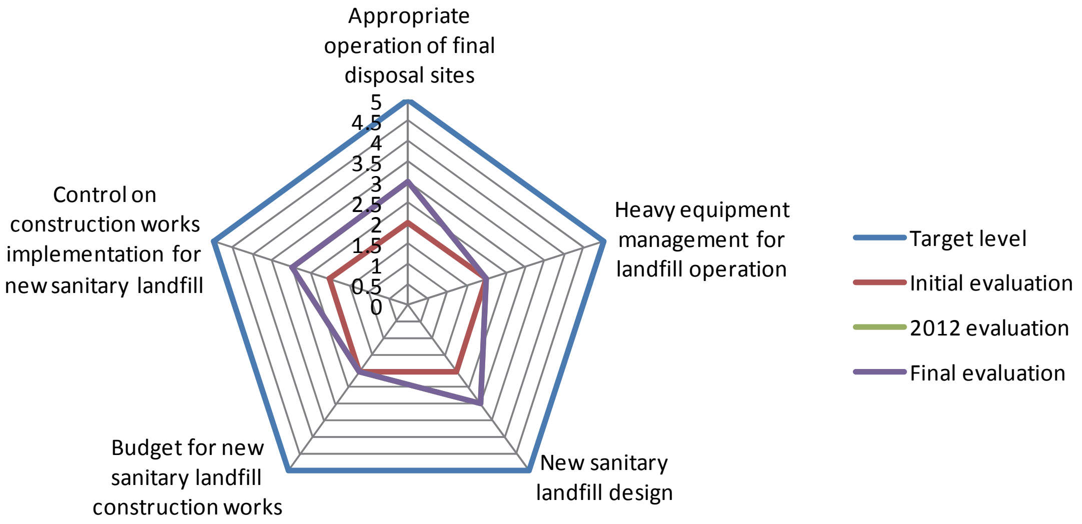
<1> It is impossible to perform the work on satisfactory level even after the capacity development with the Japanese expert.

Assessment for individual

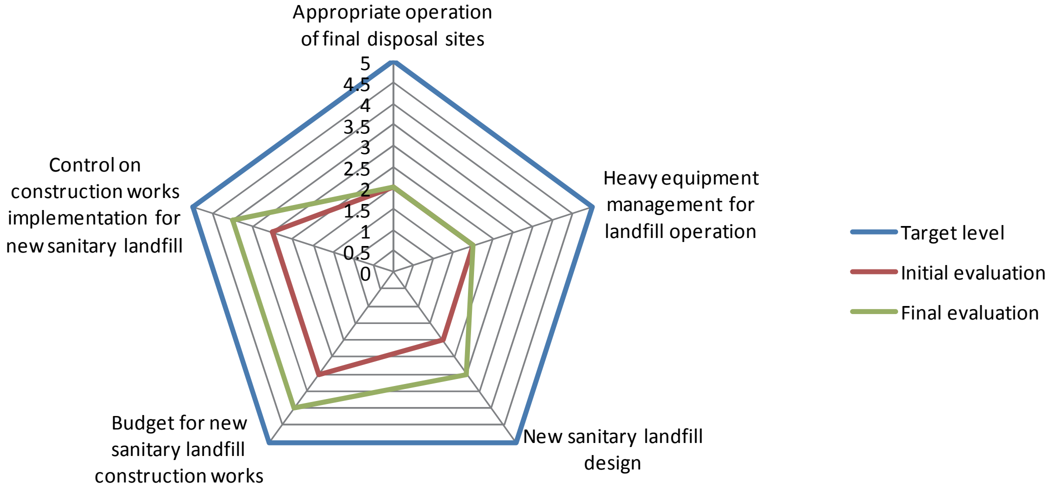
Mr. Ernesto Domínguez



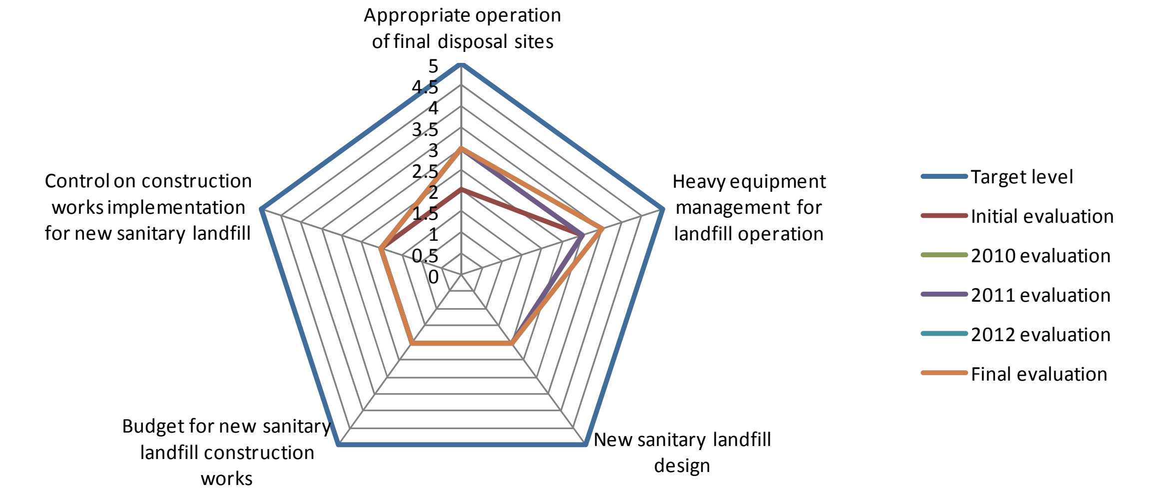
Mr. Lázaro Sotolongo



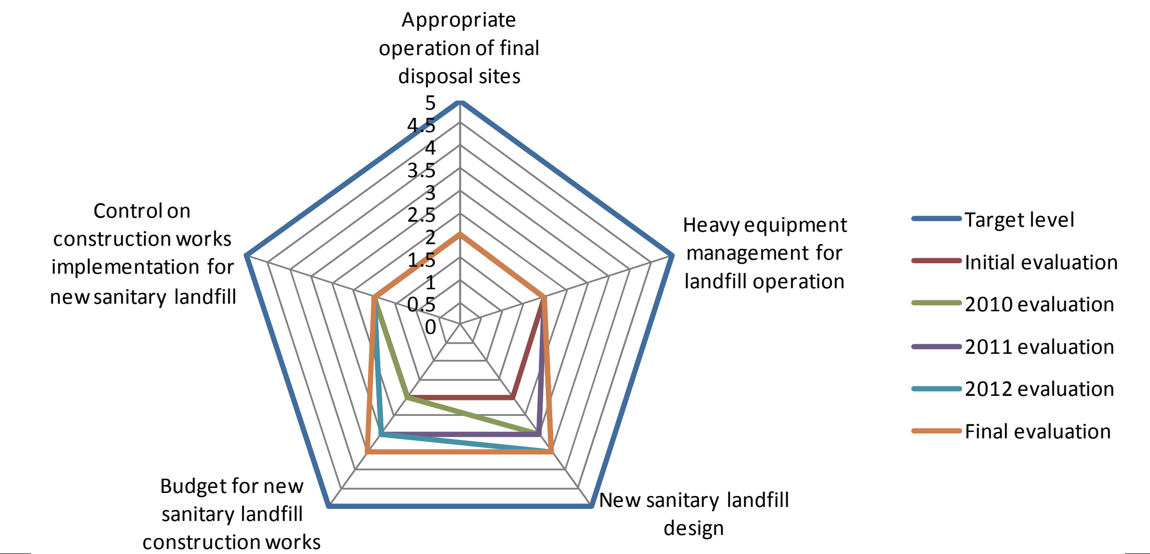
Ms. Harilyn Tamayo



Mr. Camilo Rodríguez



Evaluation for the new landfill design (Other than C/P, Designer of DCH & EIPHH, participants of Training session in Mexico)



Assessment for group

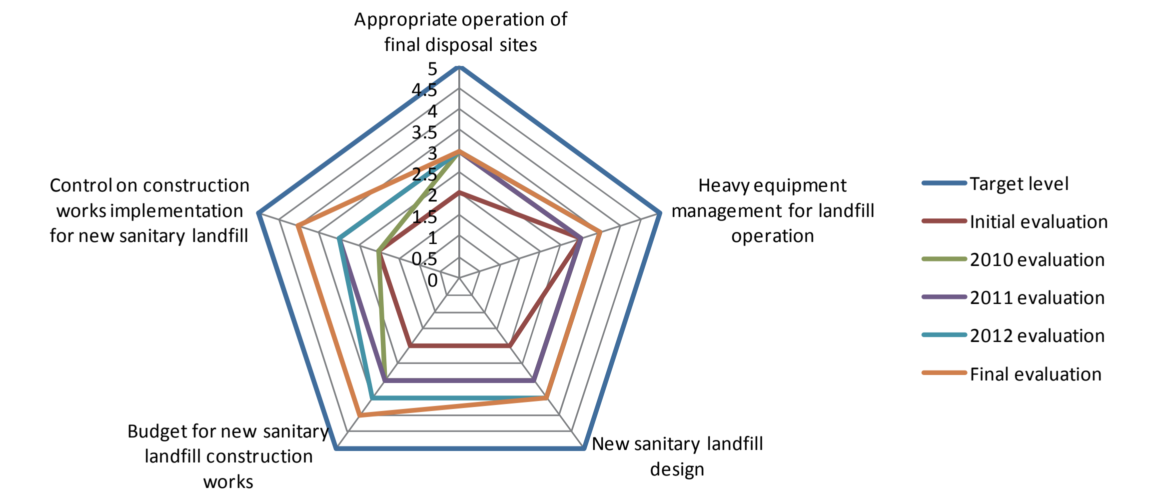


Figure 3-4: Capacity Development for C/P for Output

3.5 Constraining factors of the capacity development for C/P

Major constraining factor of the capacity development for the C/P in this Project is that re-assignment of C/P personnel due either to turnover or transfer have occurred repeatedly. This means that C/P who had shown some progress had to leave the Project and the newly appointed C/P has to build his/her capacity all over again. Although it was an external factor which the Project cannot control, but yet unfortunate circumstances.

Progress of the capacity development for individual C/P in each group and impact of personnel changes are shown in the figure below.

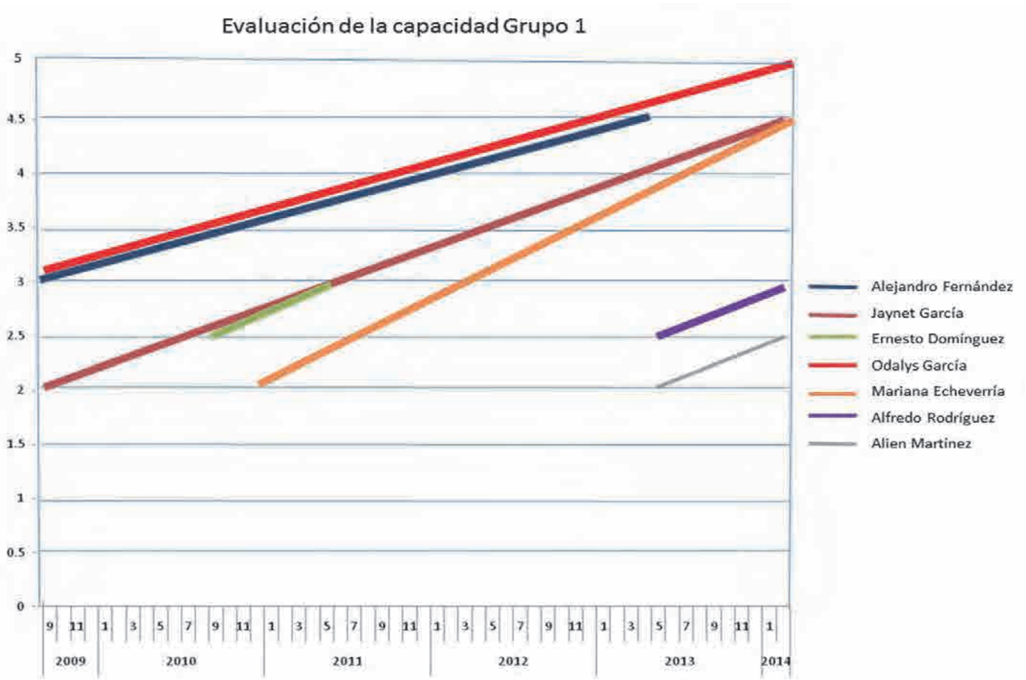


Figure 3-5: Changes in the Capacity of C/P & Impact of C/P Replacement for Output group 1

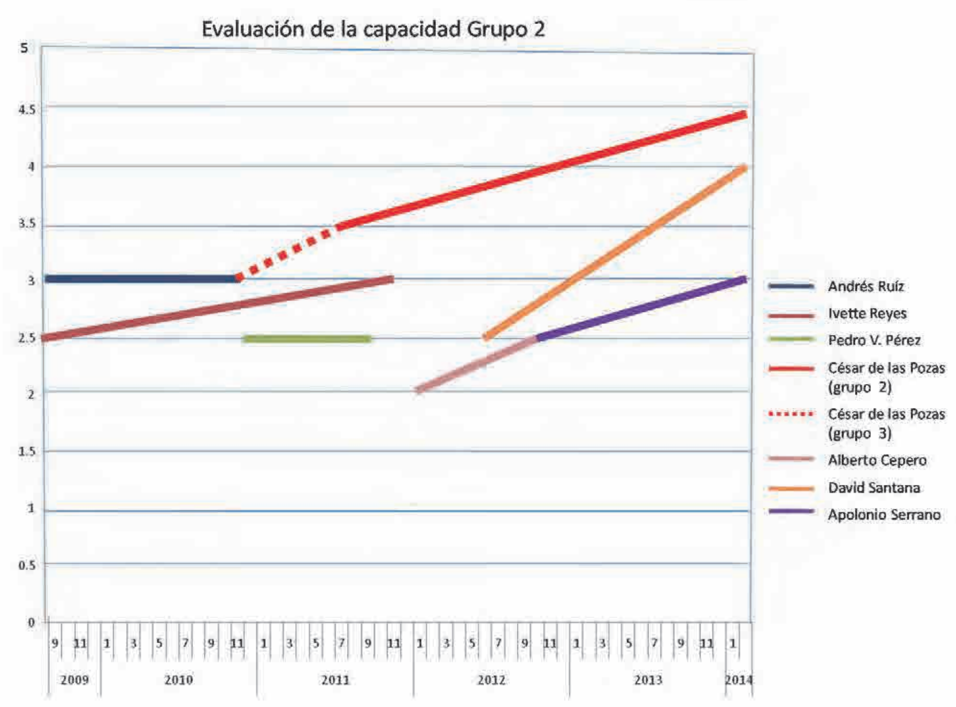


Figure 3-6: Changes in the Capacity of C/P & Impact of C/P Replacement for Output group 2

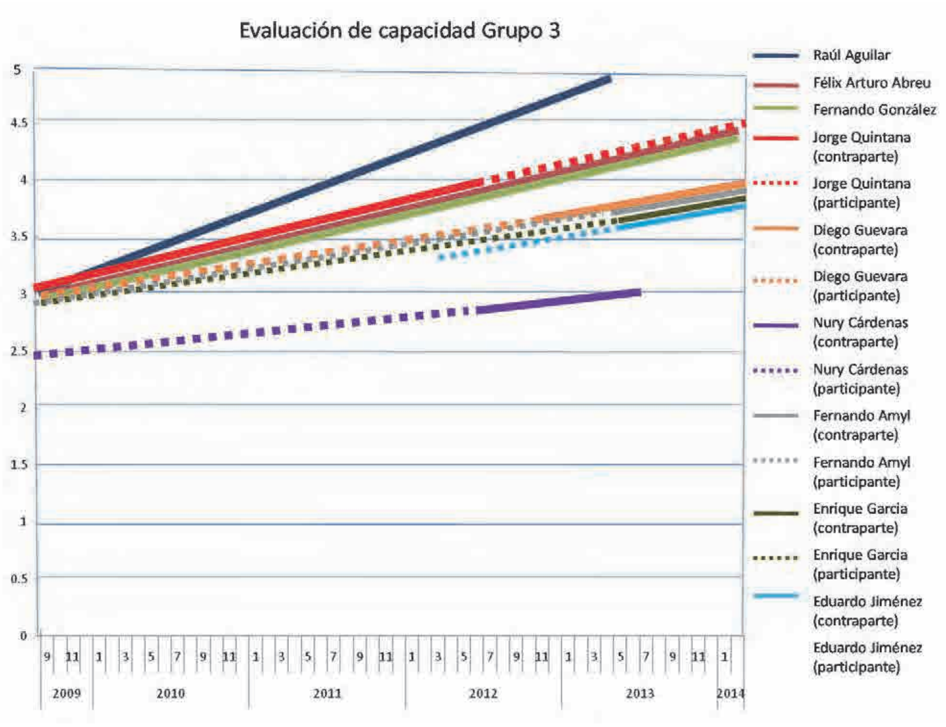


Figure 3-7 : Changes in the Capacity of C/P & Impact of C/P Replacement for Output group 3

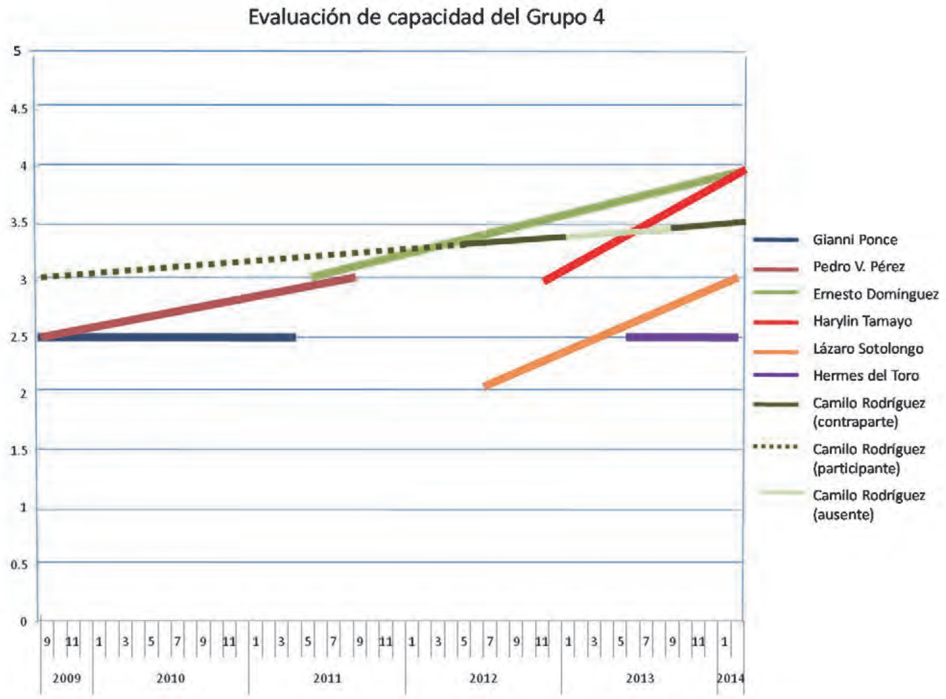


Figure 3-8：Changes in the Capacity of C/P & Impact of C/P Replacement for Output group 4

4 Comparison of Activities Carried out and Plan in Plan of Operation (PO)

Comparison of activities specified in the latest Plan of Operation (PO), updated in January 2012, and activities actually carried out by July 2014 is shown in the Annex.

Following four items are the outputs aimed in this project. Activities for each outputs are explained in detail in separate report.

Outputs

1) Comprehensive management capacity on solid waste of DPSC is improved.
2) Solid waste source separation at Pilot Project Site is promoted and capacity of UPPH in organic waste reduction at the source is strengthened.
3) Capacity of UPPH in the collection and transportation of solid waste is strengthened.
4) Capacity of UPPH on landfill design and operation of final disposal site is strengthened.

5 Inputs

5.1 Japanese Side Input

5.1.1 Dispatch of Japanese Experts

Based on the Record of Discussion (R/D) signed on 18th May 2009, total of 8 Japanese experts were dispatched during the Project period. Total assignment in Cuba was 84.03 man-months. Details of the assignments for each year is shown below.

Table 5-1: Assignment for the Japanese Expert in FY2009

Task	Name	6	7	8	9	10	11	12	Total days
Chief Adviser / Integrated Solid Waste Management (1)	Kihachiro Urushibata					(80)			80
Deputy Adviser / Integrated Solid Waste Management (2) / Segregated Collection of Waste (1) /Waste Management Training	Tadaya Yamamoto				(12)				12
Composting / Segregated Collection of Waste (2)	Ryoichi Ogawa					(60)			60
Vehicle Maintenance (1)	Ryo Hiraga						(30)		30
Vehicle Maintenance (2)	Tadayuki Yamanaka						(40)		40
Machinery (1)	Ryo Hiraga						(10)		10
Machinery (2)	Takeshi Dosho						(34)		34
Project Coordinator	Shin Okamoto				(60)		(20)		(60)

Table 5-2: Assignment for the Japanese Expert in FY2010

Task	Name	2	3	4	5	6	7	8	9	10	11	12	1	2	3	Total
Chief Adviser / Integrated Solid Waste Management (1)	Kihachiro Urushibata	(30)									(66)			(55)		151
Deputy Adviser / Integrated Solid Waste Management (2) / Segregated Collection of Waste (1) /Waste Management Training	Tadaya Yamamoto	(44)		(1)	(32)							(32)				108
Project Coordinator														(12)		(12)
Composting / Segregated Collection of Waste (2)	Ryoichi Ogawa	(30)												(45)		75
Vehicle Maintenance (1)	Ryo Hiraga										(5)					5
Vehicle Maintenance (2)	Tadayuki Yamanaka										(30)					30
Machinery (1)	Ryo Hiraga										(32)					32
Machinery (2)	Takeshi Dosho										(30)					30
Final Disposal Landfill	Toshihiko Chiba	(30)			(50)						(60)					140
Project Coordinator	Shin Okamoto	(16)									(33)					(49)

Table 5-3: Assignment for the Japanese Expert in FY2011

Task	Name	2	3	4	5	6	7	8	9	10	11	12	1	2	3	Total
Chief Adviser / Integrated Solid Waste Management (1)	Kihachiro Urushibata					(38)				(42)				(30)		110
Deputy Adviser / Integrated Solid Waste Management (2) / Segregated Collection of Waste (1) /Waste Management Training	Tadaya Yamamoto									(50)						50
Composting / Segregated Collection of Waste (2)	Ryoichi Ogawa										(60)		(30)			90
Vehicle Maintenance (1)	Ryo Hiraga											(24)				24
Vehicle Maintenance (2)	Tadayuki Yamanaka								(30)			(24)	(30)			84
Machinery (1)	Ryo Hiraga						(45)		(30)				(30)			105
Machinery (2)	Takeshi Dosho						(30)						(30)			60
Final Disposal Landfill	Toshihiko Chiba				(40)					(30)						70
Project Coordinator	Tadaya Yamamoto					(19)						(15)		(22)		(56)

Table 5-4: Assignment for the Japanese Expert in FY2012

Task	Name	2012									2013												2014									Total
		4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	
Chief Adviser / Integrated Solid Waste Management (2) / Segregated Collection of Waste (1) /Waste Management Training	Tadaya Yamamoto								(30)			(30)									(34)				(31) (2)				(24)			151
Integrated Solid Waste Management (1)	Kihachiro Urushibata			(30)					(24)																							54
Composting / Segregated Collection of Waste (2)	Ryoichi Ogawa		(30)					(45)				(20)				(25)			(23)						(22)							165
Vehicle Maintenance (1)	Ryo Hiraga			(30)					(30)						(30)							(30)					(30)					150
Vehicle Maintenance (2)	Tadayuki Yamanaka			(30)					(30)						(30)							(30)										120
Machinery (1)	Ryo Hiraga																															0
Machinery (2)	Takeshi Dosho			(30)																												30
Final Disposal Landfill	Toshihiko Chiba			(30)										(23)							(23)						(44)					120
Mexico training coordinator	Tadaya Yamamoto									(13)															(7)							20
Project Coordinator	Tadaya Yamamoto, Ryo Hiraga, Tadayuki Yamanaka, Shin Okamoto		(15)													(42)											(30)		(21)	(9)		117

5.1.2 Counterpart Trainings (Training in Mexico)

Three training sessions were carried out in Mexico. Trainees for and period of the training are as follows:

Figure 5-1: Counterpart Training in Mexico

Title	Trainees	Period
Training in Mexico: Final Disposal Site	• Mr. Adalberto González Arce • Mr. Lázaro Sotolongo Esquivel • Ms. Odalys García Fonseca • Mr. Bacilio del Vallin Marchego • Mr. José Francisco Santiago Fernández	December 3, 2012 - December 8 (6 days)
Training in Mexico: Solid Waste Management	• Mr. Alejandro Fernández • Ms. Jainet García Portero • Mr. Félix Arturo Abreu Lacalle • Ms. Nury Cárdenas Véliz • Mr. Fernando de Jesús Amil Leal	December 9, 2012 - December 15 (7 days)
Training in Mexico: Training for high ranking officials	• Ms. Mirna Teresa Laffita Cuza • Mr. Ramón Fernández • Ms. Odalys Calidad Goicochea Cardozo • Mr. Juan Nepomuceno Herrera Cruz • Mr. Osmani Castro Cruz	March 23, 2014 – March 29 (7 days)

A report on Mexico training has been prepared by the trainees, which can be seen in a separate document.

5.1.3 Tools / equipment donated by JICA

List of donated equipment / tools is shown in Annex.

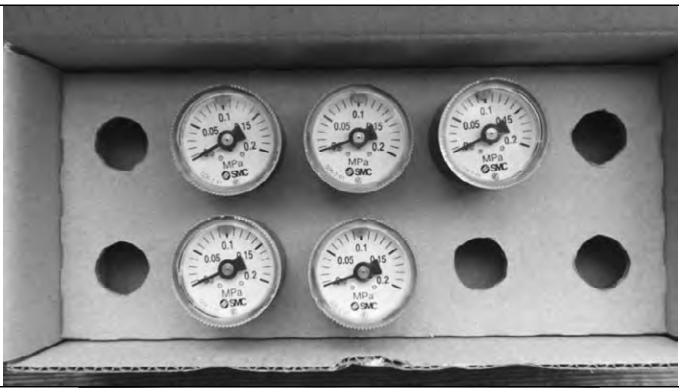
	
Air Compressors	Impact Wrench
	
Greasing system	Tire changer
	
Lathe	Double Head Grinder

5.1.4 Tools / equipments brought by the Expert Team

Tools / equipments brought by the Expert team is shown in Annex.

Power wrench

Air regurator



Air pressure gauges

Gears for lathe

5.1.5 Operation cost

Operation cost incurred by Japanese side for the duration of the project is approximately US$1,500,000.00. （See Table 5-5）

Table 5-5: Operation cost in Cuba

	JFY 2009	JFY 2010	JFY 2011	JFY 2012
General operating expenses	11,027.58	24,525.30	10,756.57	12,078.29
Travel expense (Air fare)	59,479.87	146,222.54	178,740.73	97,822.85
Travel expense (Others)	57,498.04	207,289.20	175,235.03	169,480.49
Fee and honorarium	6,913.58	99,678.18	95,549.01	74,193.21
Meeting expenses	20,562.08	14,216.68	8,760.88	1,689.66
Annual Total (USD)	155,481.15	491,931.90	469,042.23	355,264.51
	1,471,719.8			

5.2 Cuban Side Input

5.2.1 Allocation of Counterparts personnel

Cuba, as indicated in R/D, have allocated the counterpart personnel from the beginning of the Project. There have been cases where C/P personnel turned over or transferred to due to either personal reasons or departmental decisions. Cuban side have –appointed substitute personnel when such issue arises. The changes in C/P members can be seen in the table below.

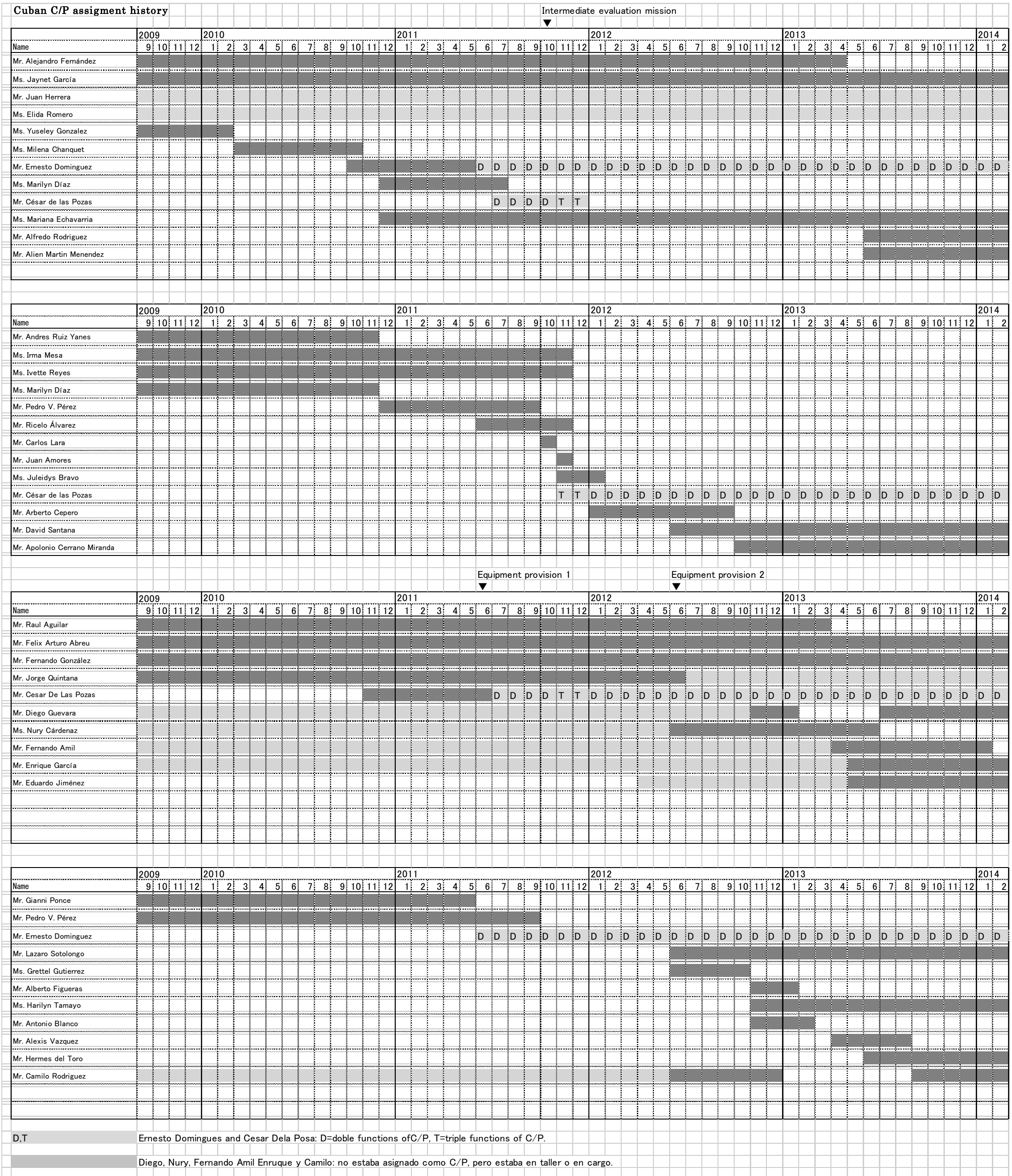


Figure 5-2: Changes of C/P during the Project period

5.2.2 Land, office, and facilities

An office on second floor of DPSC's Calle 30 office was provided by Cuban side to facilitate Japanese Expert. Furniture (tables, chairs, and shelving) was also provided by Cuban side. Due to internal circumstances of DPSC, Calle 30 office was to be used in other unit in early 2012, therefore, the office for Japanese Expert Team was moved to Calle 180 office along with some counterpart office.

Besides the office for Japanese Expert Team, Cuban side provided the followings: construction and operation of compost yard, office in central workshop and heavy machinery workshop, and use of office spaces for trainings/workshops.

5.2.3 Cost of the Project

Cuban side bear cost necessary for implementation of the Project, such as cost for C/P personnel and utilities. In addition, Cuban side borne the cost for renovations of central workshop and heavy machinery workshops for receiving donated tools/equipments as well as construction of composting facility for the composting pilot project for CUC 200,000- and CUP460,000-, respectively.

6 Ingenuity & Lesson Learnt in implementing the Project

During the project start-up in 2009, we faced a special circumstances existed in Cuba that was severe shortage and/or limitation of distribution of goods in domestic market. Commercial goods like copy machines, printers, and personal computers were virtually non-existed. In order to set up the project office, we decided to acquire printer and PC from neighboring country, Mexico. Likewise, some office equipment/supplies had to be procured in next fiscal year. JICA understood and recognized the needs to take appropriate measures; thus, the project was able to start successfully in fairly early stage, under the circumstances.

In addition, there were items we un-doubtfully assumed procurable in Cuban domestic market were non-existed. Such items were gum-boots, rubber gloves, and dolly to be used in the composting pilot project. Again, in early stage we decided to procure them in either from Japan or neighboring countries like Dominican Republic. This shortage of commercial goods also affected vehicle maintenance team. For the vehicle maintenance workshops, small or relatively less complex equipment like air pressure regulator or various gauges were not available in Cuba therefore had to be brought in from Japan.

Furthermore, even though story tells us it differ from agencies or local authorities, basic policy of the authority concerned (Havana municipality) on information control for C/P personnel limits the use of e-mail exchange on domestic intranet[6] only. This cruelly cut communications between JICA Expert Team and C/P when Expert is outside of Cuba, especially for the first 3 years.[7] We therefore made frequent phone calls or send/receive messages via a Japanese assistant who reside in Havana and had an access to e-mails.

In another arena, diplomatic process required us to plan and start processing the visa application more than 45 days[8] prior to travel. This constrain forced us to decide the assignment dates before the Expert can contact and confirm if the C/P had successfully performed the work remained previously. Consequently, the Experts often found the work was actually not conducted therefore had to re-schedule the work-plan after reaching the country.

From these lessons, we had asked JICA aid coordination expert in Cuba to monitor progress of works performed by the C/P side and become a contact person, especially after the visa application process began. This greatly reduced the problems after the expert entered in Cuba.

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6 C/P was able to receive e-mails from overseas could not send outgoing message to foreign e-mail domains.

7 Web-based e-mail became available for C/P in later half of the project period, after repeated requests by the Japanese side that the use of international e-mail communication by the C/P personnel was the conditions agreed between the two countries from the beginning of the project.

8 In later days, visa application process was transferred from embassy of Japan in Cuba to JICA Mexico office. This somewhat recued the time to required apply the visa.

So often Cuban side failed to execute project implementation as Japanese side expected, although such mishaps were usually caused by budgetary or resources distribution delays made from upper authority. To deal this situation, expert assignment period was re-scheduled as flexible as possible.

Furthermore, in order to find the situation/issues, identify the cause, and bring out the commitment from the decision maker, the deputy chief adviser (at the time) – T. Yamamoto who were also assigned in another project in neighboring country Dominican Republic, to visit[9] Havana as a project coordinator. The effort was made to break the stagnation and update the other Expert members with the most accurate and current information from the ground.

Project output included the design and surveillance the sanitary landfill which had never been built in Cuba. To observe and learn sanitary landfills from neighbors who can be better reference since they were close not only to physically but also in situation surrounding waste management. In this view, training programs were planned and carried 3 time in Mexico. During this Mexico training, total of 15 C/P member visited and learned the waste management there which defiantly had great cost-effectiveness.

6.1 Fostering the ownership of the project by C/P

In this project, in the view of the capacity development and sustainability, the project team emphasized to foster the C/P's ownership of the project and assist C/P to bring up the capacity to the targeted level. For example, the progress reports which periodically report the progress of the project were one of outputs the C/P can proactively prepared.[10] Also field activities or presentations at seminars were mainly performed by the C/P.

It required patience for the expert team to wait that the C/P proactively prepared the material/report or perform some activities that had certain deadlines; however, the project team encouraged tenaciously to prepare the outputs by the C/P themselves, for instance to implement the pilot project or developing training manuals.

6.2 Approach to decision makers and upper agency

Key was to ensure the Cuban side input was appropriately / timely done in order to promote project implementation. In order to promote the Cuban side to make the input, it was necessary to gain the approval not only from decision makers of DPSC/UPPH but higher agencies. On the other hand, the decision makers who were not so familiar with waste management had to make decisions. In this case, the decision maker tends to upheld the decision when he had no confident, which in turn inhibited the progress of the project. Therefore, it was vital to provide the practical knowledge on SWM to those already busy decision makers and build good relationship among them.

[9] 6 times, 132 days in total.

[10] Expert team tried to motivate the C/P to prepare the reports by loaning/providing second hand PCs where Cuban side lack resources.

For example, mini-seminar on waste management targeting only Cuban decision makers (such as vice mayor of Havana and directors of DPSC / UPPH) were held in which the lecturers were Mexican expert, Dr. Cuellar, and Chief advisor, Mr. Yamamoto, who can communicate with Cuban side without interpretations. Good relationship were built as any type of questions that the decision makers held from examples from other Latin American countries and SWM related topes were answered instantly and to the point. The decision makers were successfully brought into the project.

Thorough this efforts, certain Cuban side inputs were made in favor of the project like the project manager, Ms. Odalis, stayed in the project throughout the project, even though there were some other external constrains such as changes in DPSC director and vice mayor. Another example of Cuban input in favor of the project through such effort was the commencement of new Guanabacoa landfill site.

7 JCC meetings

Joint Coordinating Committee was established to formulate annual operational work plan, review the progress of the project, examine major issues, and make modification to the activities when necessary. The JCC was composed of the director of DPSC-Havana, who functions as a chairperson, and PD, PM, and other representatives from relevant organizations from Cuba, as well as JICE Expert Team, director of JICA Mexico office, Technical Cooperation Coordinating Expert in Cuba.

JCC was headed by the director of DPSC and composed of the following members, namely for the Cuban side, representative from relevant bodies while for Japanese side, resident representative of JICA Mexico office, JICA expert team, and as observers, embassy of Japan in Cuba and JICA aid coordination expert in Cuba.

- Cuban side
  - Project director
  - Project manager
  - UPPH
  - CAP
  - MEP
  - CITMA-Havana
- Japanese side
  - Resident representative of JICA Mexico Office
  - JICA Expert Team
  - Embassy of Japan in Cuba (observer)
  - JICA aid coordination expert (observer)

During this Project, total of 6 JCC meetings were held, as shown below, to discuss and reach consensus about various issues related to the implementation of the Project. Matters discussed and decided were documented in the minutes of meetings.

- 1st JCC meeting: October 15, 2009
- 2nd JCC meeting: November 9, 2010
- 3rd JCC meeting: July 20, 2011
- 4th JCC meeting: June 21, 2012
- 5th JCC meeting: June 13, 2013
- 6th JCC meeting: July 8, 2014

In addition to the above mentioned 6 annual JCC meetings, additional JCC meetings were held for the mid-term evaluation (October 7, 2011), project extending mission (January 26, 2012), and terminal evaluation (March 20, 2014).

Total of 9 JCC meetings were held during the 61 months project period. Minutes of meeting for each JCC meeting are shown in Annex.

Furthermore, explicit commitments from the Cuban side were attained through Memorandum of Understanding (MOU) in the time of project progress report preparation / submission. The MOU contained various issues and result of discussions at the time and helped to communize among JICA Team and Cuban counterparts.

8 Vicissitude of PDM

Vicissitude of the PDM is as follows:

- PDM0: Attached on R/D signed on May 18, 2009.
- PDM1: Changed some expression of verifiable indicators by the 1st JCC meeting on October 15, 2009.
- PDM2: Changed some expression of verifiable indicators by the 2nd JCC meeting on November 9, 2010.
- PDM3: Proposed to change some expressions of verifiable indicators in the 3rd JCC meeting on July 20, 2011 and agreed by the mid-term evaluation on October 7, 2011.
- PDM4: The project was extended for 19 months with the notice brought by a JICA mission on January 26, 2012. Thus, Project duration on PDF was reflected in 4th JCC meeting on June 21, 2012.

Each version of PDM is shown in Annex.

Project Completion Report

Section 2: Report on Output 1

Chapter 1: Report on Revised Master Plan

Chapter 2: Report on Capacity Assessment

Chapter 3: Report on Training in Mexico

Project Completion Report

Section 2: Report on Output 1

Chapter 1: Report on Revised Master Plan

1 Revised Master Plan

1.1 Summary of Priority in the Revised Master Plan

The Master Plan for Solid Waste Management in Havana City was developed in 2006 JICA development study "the study on integrated management plan of municipal solid waste in Havana city." This M/P was targeted for 2015 and include following components: 1) recycling, 2) community compost, 3) home compost, 4) segregated waste collection, 5) new final disposal site, 6) closure of existing landfill sites, and 7) strengthening maintenance. Based on this M/P, the Havana municipality has introduced waste collection vehicles, closing open-dump type landfill sites, and planning of new landfill site. While much efforts have been made, the target year, 2015, of the original M/P has become just a year away.

In the technical cooperation project, "the project for improvement of capacity on solid waste management in Havana city," this M/P was reviewed and revised. As agreed with the C/P, the Master Plan was revised by analyzing the current situation of waste management and establishing the planning horizon for short-term (target: 2015-2017) and for med-term (target: 2018-2020).

The information included in the revised Master Plan was contributed by the C/P team, whereas the analysis and drafting of the document were jointly carried out by the C/P and JICA's Expert Team. The instructions, alternatives, and activities included in the Revised Master Plan were discussed with authorities from both the Cuban government and Havana City's government.

Following is the summary of a) technical system and b) challenges complementt the technical system are explained.

a. Technical System

Table 1-1: Priority Summary of the Revised Master Plan

	Final Disposal	**Transfer Station (T/S) and Transportation**	**Collection**	**Collection Vehicle Maintenance**	**Storage (Container)**	**3R's (compost)**	**3R's (Recyclables)**
Priority	**High**	Low	**High**	**High**	**High**	Low	Low
Present System (2013-2014)	Critical situation due to the short remaining service life of the FDS in operation.	There are no transfer stations.	Critical situation due to the lack of collection vehicles.	Critical situation due to insufficient supply of spare parts and materials to manufacture parts.	Critical situation due to insufficient containers and increase of small dumping sites.	The pilot project is facing some difficulties with organic waste transportation.	Increase in the number of scavengers at the final disposal sites.
Short Term Target (2015-2017)	**4th priority:** Extend the service life of Calle 100 site and improve the operation of existing FDS. **5th priority:** Build the New Guanabacoa sanitary landfill site and finish the executive project of the New West sanitary landfill site.	**6th priority:** Set up small transfer stations.	**2nd priority:** Acquire vehicles and increase fuel supply. **7th priority:** Set up systems to collect demolition wastes, tree wastes, and wastes from large generators.	**1st priority:** Timely supply of spare parts and materials to manufacture parts. **8th priority:** Proper operation and maintenance of equipment donated by JICA.	**3rd priority:** Acquire containers and/or build a factory to manufacture containers by rotary-casting.	**9th priority:** Keep segregated discharge and collection of organic wastes at hotels and agricultural markets and operate the pilot project compost plant. **10th priority:** Prune waste shredding at high generation sites	**11th priority:** Control scavengers' access to and operation at the FDS. **12th priority** Assess the advisability of installing a recycling plant at the New Guanabacoa sanitary landfill site.
Med-Term Target (2018-2020)	**3rd priority** Build the second stage of the New Guanabacoa sanitary landfill site and build the first stage of the New West sanitary landfill site.	**4th priority** Build a system of transfer stations to transport the wastes to the new sanitary landfill sites.	**1st priority** Have enough vehicles to collect the wastes generated in Havana City.	**2nd priority** Keep the conditions required to carry out timely preventive and corrective maintenance of collection vehicles.	**5th priority** Manufacture or procure enough containers to meet the city's needs.	**6th priority** Extend the operations of the compost plant to receive wastes from other sources, as well as tree waste.	**7th priority:** Propose the recovery and storage of recyclables at schools and community organizations, as well as to be sold to the Enterprise for the Recovery of Raw Materials.

b. Challenges complement the technical system

Following section discusses important aspects in realizing proper waste management in the City of Havana. Although no particular priority is given, there were 5 challenges were highlighted, including waste collection routes and frequencies, outsourcing, vehicle maintenance, institutional management, public participation and waste education on waste management, in which each component indicates activities and the goals in the short-term (2015-2017) and mid-term (2018-2020) target periods in the revised Master Plan.

b.1. Waste Collection Routes and Frequencies

It will be necessary to review and optimize the waste collection route and frequency once existing landfill is closed and/or new landfill and small intermediate transfer stations become operational.

b.2. Outsourcing

Currently waste management is directly administrated by DPSC; however, there may be a room to discuss to allow authorize state-owned enterprises, cooperatives or private individuals to engage in waste collection services, especially for construction waste, green waste, and/or business entities which discharge large amount of waste. It is worth considering to establish ordinance/regulation that permits those large scale waste generators to directly contract waste collectors and not limiting waste management service to be carried out by DPSC or municipalities.

b.3. Institutional Management

In order to properly deal with changes in waste management services in the City of Havana, organization and its various procedures/manuals should be updated and/or modified.

b.4. Public Participation

Quality of waste collection services can be monitored and improved thorugh public perticipation. Records of complains from the public and time required to sovle the issues are some of the examples which can contribute to improv the waste collection service.

b.5. Environmental Education on Waste Management

Promote public participation in solid waste management through environmental education (waste education), including, but not limited to, reusing waste, recovering recyclable materials, and composing organic waste in household in the city’s suburban areas.

1.2 Final Disposal

1.2.1 Current Situation (2013-2014)

The purpose of final disposal of waste is to properly stablize and safely deposit them so that it will not adversely affect the sourrounding environment.

The Master Plan formulated in 2005 includes information about the final disposal sites that had been in operation at that time. Many of those final disposal sites (open dumping) had been opened in 1990 during the so-called Special Period when availability of collection vehicle, fuel supply, and spare parts were very limited. These conditions resulted in introducing horse-driven carts for waste collection service since distance to be covered by municipality owned collection vehicles were reduced.

The final disposal sites being operated in 2004 are listed below:

Table 1-2: Final Disposal Sites Operated in 2004

Disposal Site	Category	Average Waste Volume Received (m^3/day)	Area (ha)	Average Height (m)	Waste Amount Disposed (ton)	Year Operations Began
Calle 100	Provincial	3,857	80.0	20.0	16,000,000	1976
Guanabacoa	Provincial	1,145	28.0	20.0	5,600,000	1976
Ocho Vías	Provincial	1,363	30.0	21.0	6,300,000	1976
Barreras	Provincial (tree waste)	196	10.0	8.0	800,000	1975
Eléctrico	SPLS	25	0.5	7.0	35,000	1990
Fraternidad	SPLS	45	2.0	3.0	60,000	1990
Guásimas	SPLS	21	2.0	1.5	30,000	1990
Lutgardita	SPLS	43	1.5	3.0	45,000	1990
P.Latina	SPLS	91	2.0	7.0	140,000	1990
Rincón	SPLS	49	0.5	10.0	50,000	1990
Las Cañas	SPLS	26	1.0	3.0	30,000	1990
El Vidrio	SPLS	119	2.5	5.0	125,000	1990
Los Perros	SPLS	184	2.0	15.0	300,000	1990
Campo Florido	SPLS	9.1	1.8	0.5	9,000	1990

As shown in Table 1-3, all final disposal sites opened during the so-called Special Period have already been shut down, except for Barreras and Campo Florido final disposal sites.

Table 1-3: Closed Final Disposal Sites

Disposal Site	Area (has)	Average Height (m)	Total Volume (m^3)	Year Operations Began	Year Operations Stopped	Closure Procedure
Guanabacoa	28.0	20.0	5,600,000	1976	2005	Covered with soil
Barreras	10.0	8.0	800,000	1975	2008	Covered with soil
Eléctrico	0.5	7.0	35,000	1990	2008	Covered with soil
Fraternidad	2.0	3.0	60,000	1990	2008	Covered with soil
Guásimas	2.0	1.5	30,000	1990	2009	Covered with soil
Lutgardita	1.5	3.0	45,000	1990	2009	Covered with soil
P.Latina	2.0	7.0	140,000	1990	2009	Covered with soil
Rincón	0.5	10.0	50,000	1990	2009	Covered with soil
Las Cañas	1.0	3.0	30,000	1990	2008	Covered with soil
El Vidrio	2.5	5.0	125,000	1990	2009	Covered with soil and surrounded by fence
Los Perros	2.0	15.0	300,000	1990		Covered with soil

At present, only four final disposal sites are being operated. Basic characteristics of those disposal site are shown in the Table 1-4 below:

Table 1-4: Present Final Disposal Sites

Disposal Site	Average Waste Volume Received (m^3/day)	Average Amount of Wastes Received (tons/day)	Area (has)	Average Height (m)	Total Waste Volume Disposed of (m^3)	Year Operations Began	Estimated Remaining Service Life
Calle 100	9,458	1,583	104	20.0	52,088,785	1976	3-5*
Ocho vías	3,060	510	30	20.0	10,477,455	1976	3
Tarará	1,338	223	10	8.0	1,443,860	1975	1
Campo Florido	117	19.5	5	2.0	38,443.5	1990	4

*Considering the measures proposed in section 1.2.2, regarding the extension of service life of Calle 100 landfill site by increasing waste cell height, by relocating methane gas extraction wells, and by the introduction of a cell filling plan in order to use available space more efficiently, the service life of this site could be further extended depending on the cell height and on the final design to be decided in the corresponding executive project for the site closure to be formulated.

These four sites receive all the wastes generated in Havana City based on the distribution shown in Table 1-5 below:

Table 1-5: Waste Amount in Havana

	Average Waste Volume Disposed of (m^3/day)				
	Calle 100	Ocho Vías	Barreras (Tarará)	Campo Florido	Total
Playa	163				163
Plaza de la Revolución	154				154
Centro Habana	135				135
Habana Vieja	85				85
Regla			38		38
Habana del Este			167	1.5	168.5
Guanabacoa			96		96
San Miguel del Padrón		139			139
10 de Octubre	205				205
Cerro	121				121
Marianao	124				124
La Lisa	115				115
Boyeros	170				170
Arroyo Naranjo	80	100			180
Cotorro		67			67
Industrial waste*	216	108	18	18	360
Hospital wasteU. P. P. Áreas Verdes	15				15
Total	1,583	414	319	19.5	2,335.5

*The 360 tons/day of industrial wastes generated in Havana City are shared by the existing four final disposal sites. On average, 60% is dumped at Calle 100, 30% at Ocho Vías, 5% at Tarará, and 5% at Campo Florido.

The number, condition, and characteristics of the heavy equipment owned by UPPH for disposal site operation are shown in the Table 1-6 below:

Table 1-6: Final Disposal Equipments

Equipments	Plan						In Operation	Downtime Cause
	Number		Brand	Model	Year	Country		
Bulldozers	16	8	TY	220	1989	Chinese	4	Engine
		2	Chantui	SD22R	2008		1	
		5	Fiat	FD-20	1990	Italian	1	
		1	Komatsu	DBE-41	1994	Japanese	-	
Crawler-mounted loaders	3		Changlin	-	2008	Chinese	2	Engine
Wheel-mounted loaders	2	1	Komatsu	-	1994	Japanese	-	Engine
		1	Changlin	-	2008	Chinese	-	Engine
Waste compactors	3		Chantui	SR28MR	2008	Chinese		Differential gear and engine
Backhoe excavator	2		Lishide	FC-220	2008	Chinese	2	-
Dump trucks	12	3	Khamaz	-	1980	Russian	3	-
		2	Maz 700		2000	Russian	1	
		2	Kraz		2000	Russian	8	
Tractor-trailer	1		Synotruck	-	2008	Chinese	1	-

Note: Water tankers are based at the Street Sweeping and Washing Unit, which provides its services to the Final Disposal Unit. Generally, there are 3 water tankers available on a daily basis, 1 for Calle 100 disposal site, 1 for Ocho Vías site, and 1 for Tarará site. .

The characteristics and existing difficulties of each final disposal site currently being operated are shown below:

a. Calle 100 site

Having a total area of 104 ha, Calle 100 site is the largest final disposal site in Havana and receives most of the wastes the city generates, or 1,583 tons per day on average.

Wastes from the following municipalities are disposed at Calle 100 landfill site:

Table 1-7: Final Waste Disposal at Calle 100

Municipality	Amount of Waste Disposed on Average (t/day)
Playa	163
Plaza de la Revolución	154
Centro Habana	135
Habana Vieja	85
10 de octubre	205
Cerro	121
Marianao	124
La Lisa	115
Boyeros	170
Arroyo Naranjo	80
Industrial waste*	216
Hospital wastes	15
Total	1,583

Besides being the most important final disposal site in Havana City, its operation is the most complicated one because of the followings:

- Since 2008 a Clean Development Mechanism (CDM) project to capture and destruct methane gas on Calle 100 landfill site has been implemented. Although the project has gone through a number of difficulties, thousands of methane gas have been successfully treated and carbon credit called Certified Emission Reduction or CERs has been issued. Nonetheless, the methane gas extraction area in which 168 wells were initially installed in its 21 ha area has reduced to 45 wells today. The most likely cause of the cutback is caused by past incidents where much of methane gas was consumed/escaped into the atmosphere. Consequently, the area occupied by the former wells is being excavated to build trenches, and horizontal perforated pipes are being laid to allow gas to move to the main pipes up to the torch. Presently, power generation which has a high priority in Cuban authorities is considerer instead of destruction of methane gas only.

- Provincial Direction of Physical Planning (DPPF) recommends that the height of waste accumulation at Calle 100 disposal site should not exceed 20 meters. This guidance comes from the notion that the landfill a) deteriorates the landscape of area and b) is a major source of pollution so that limiting its service life would ease the pollution level in nearby area and Almendares River which receive leachate from the landfill.
  The possibility of prolonging life time of Calle 100 should be considered as a) there is no other landfill to receive the waste stream the City generates, b) height of the waste can be raised to the point where structural integrity can be maintained, and c) construction of leachate collection / treatment system can reduce the impact on water body nearby. Indeed, last point c) has been emphasized since limiting the service life of the dumpsite does not solve the leachate issue and thus leachate collection, storage, and treatment facility will be necessary in any case.

- Inadequate operation of Calle 100 landfill site, especially in terms of waste compaction and covering, has caused fires to break out. Those fires have resulted in various environmental issues, including quenched, they have originated some environmental problems, have caused some inconvenience in the surrounding area, as in the nearby politechnical institute (ISPJAE), and have damaged some pipes used for methane gas collection. The fires will likely continue to occur, particularly in the dry season, unless the site operation is improved.

- Existing restraints in supply of spare parts and raw materials for heavy equipment, as well as inappropriate equipment operation, have originated some site operation problems, which have been noticed and pointed out by JICA’s Expert Team. Besides the above-mentioned restraints, some of the deficiencies include limited waste compaction and poor waste covering with soil. JICA's donated equipment for the Heavy Equipment Workshop at Calle 100 landfill site helped improve heavy equipment availability. However, as the acquisition of spare parts continues to be limited, heavy equipment availability is still insufficient to operate the site properly. The managers in charge of the site operation are well aware of the site operation difficulties and they are convinced that once existing restraints are overcome, and the site operators are properly trained, the site operation will improve. The alternatives include the site's current equipment and the equipment required for a proper site operation.

- There are references and evidence that the leachate generated at Calle 100 final disposal site is seeping into the subsoil and into the edge of the slopes. Due to the proximity of the Almendares River, this leachate migration may pose a pollution threat for the water table. Therefore, some facilities to collect the leachate draining from the slope base, a storage system, and the equipment to pump it back into the wastes. According to some available information, the executive project for the works corresponding to this treatment alternative has already been prepared.

- In the year 2013, as part of the changes being introduced into the Cuban economic policy, self-employed workers were allowed to recover raw materials and the Enterprise for the Recovery of Raw Materials is currently buying recyclable materials from the general public. This brought about that many people showed up at the final disposal sites, especially at Calle 100 site, in order to recover recyclable materials from the wastes being transported and unloaded by collection vehicles there. The number of people currently carrying out material recovery activities has increased significantly (it is said that they may amount to 500 people), thus affecting the site operation, as they press the site operators not to cover the wastes until they have finished recovering recyclable materials. Moreover, a number of accidents have occurred since they do not pay attention to the operation of the heavy equipment. The collectors' safety and to to check the activities of the people recovering recyclable materials at the final disposal sites is necessary.

- A weighbridge having a capacity of 40 tons was installed at the entrance to Calle 100 site in 2012. It did not become operational until October, 2012, due to electricity supply difficulties and problems with the calculation equipment and the software required for the proper operation of the weighbridge and weighing control. At present, compactor trucks are being weighed, thus enabling to accurately check the amount of wastes received at the final disposal site, reduce fuel supply for collection vehicles and salary costs, and optimize waste collection routes.

- Some works to build a railway line stretching from Mariel Port to Havana City are being carried out. As the line is supposed to go through the outskirts of Calle 100 disposal site, there is a possibility that the site entrance, the weighbridge, and the administrative building will have to be relocated, which will probably bring about some operational problems that need to be anticipated, as this site receives most of the wastes generated in Havana City.

A breakdown of the heavy equipment currently being used for the operation of Calle 100 final disposal site is shown in the tables below.

Table 1-8: Calle 100 Heavy Machinery

Type	Number	Operation
Bulldozers	3	3 bulldozers operate during the day shift, whereas 2 operate during the night shift.
Crawler-mounted loaders	1	
Compactors	1	
Backhoe excavator	1	

Although some new landfill sites are planned to be built and equipped, the present shortage of heavy equipment for the operation of existing sites, particularly at Calle 100 site, should be taken into account. Therefore, the replacement of existing equipment as they are either beyond repair, obsolete, or because their service life has expired, should be anticipated.

The following table shows the estimated heavy equipment replacement to be anticipated for the final disposal sites currently in operation.

Table 1-9: Heavy Equipment Required for the FDS Currently in Operation

Equipment	Short-term			Med-term		
	2015	2016	2017	2018	2019	2020
Bulldozers		2				2
Crawler-type loaders	1			1		
Wheel-type front loaders	2			2		
Backhoe excavators	2			2		
Dump trucks	4	2	2	2	1	1
Tractor trailer			1			

The estimated investment required for heavy equipment replacement at the final disposal sites currently in operation is shown in the following table:

Table 1-10: Estimated Investment Required for Heavy Equipment Replacement at the FDS Currently in Operation

Equipment	Short-term ($USD)			Med-term ($USD)		
	2015	2016	2017	2018	2019	2020
Bulldozers		968,000				
Crawler-type loaders	250,000			250,000		
Wheel-type front loaders	470,000			470,000		

Equipment	Short-term ($USD)			Med-term ($USD)		
	2015	2016	2017	2018	2019	2020
Backhoe excavators	220,000			220,000		
Dump trucks	280,500	140,250	140,250	140,250	70,125	70,125
Tractor trailer			No Data			

b. Ocho Vías Disposal Site

Ocho Vías disposal site has an area of 30 ha. It received an average of 762 m^3/day in the year 2013. This site was originally used to dispose of industrial wastes. However, due to the lack of final disposal sites and the limitations in terms of collection vehicles since 2005, it began to receive general municipal solid wastes, regardless of their type or origin.

Wastes from the following municipalities are disposed of at OchoVías disposal site:

Table 1-11: Final Disposal Amount in Ocho Vias

Municipality	Average waste volume disposed (t/day)
Arroyo Naranjo	100
Cotorro	67
San Miguel del Padrón	139
Industrial Waste	108
Total	414

It is the second most important disposal site in operation in Havana City. Its remaining service life is extremely limited due both to the limitations in the height of the waste cells and to the fact that it is impossible to expand it horizontally, as it borders on places devoted to activities that are not compatible with the proximity of an operating disposal site.

The main characteristics of this final disposal site are the following:

- The access road is usually in poor condition, not only due to a lack of maintenance, but also due to a lack of storm-water drainage. Every time it rains heavily, which happens frequently, the road is covered with puddles. Moreoever, its design is poor and, as it lacks a proper cell construction plan, the wastes are not disposed of in an orderly fashion, thus blocking access to the site. Therefore, the road has to be cleared using heavy machinery to allow access to blocked areas.

- Site operations show some problems due to the same reasons stated for Calle 100 disposal site, originating in the limited availability of heavy equipment and fuel. Waste compaction and covering with soil is also inadequate. Moreover, the material required for waste covering is hard to find near the site, so there is no material available to cover the wastes.

- The remaining service life of this disposal site is short. It is estimated that it will have to be shut down within three years depending on the opening of the New Guanabacoa sanitary landfill site. In fact, the Master Plan of 2005 deemed it necessary to stop operations at the site. However, its service life has been extended as there are no other sites available in the vicinity. The idea is to prevent collection vehicles operating in waste generation areas located near the site from travelling a long distance to Calle 100 disposal site in order to save fuel and use the few existing vehicles as efficiently as possible. In the section devoted to the recommendations for the final disposal of solid wastes in Havana City, the recommendation to shut down this site as soon as possible depending on the construction and start-up of the new final disposal sites is again reiterated.

A breakdown of the heavy equipment currently used for the operation of OchoVías disposal site is shown in the table below.

Table 1-12: Ocho Vias Heavy Equipment

Equipment	Number	Operation
Bulldozers	2	Operating
Crawler-mounted loaders	1	Under repair
Compactors	1	Under repair
Backhoe excavator	1	Operating

c. Tarará Final Disposal Site

Wastes from the following municipalities are disposed of at Tarará disposal site:

Table 1-13: Final Disposal Amount in Tarara

Municipality	Average waste volume disposed (t/day)
Guanabacoa	96
Habana del Este	167
Regla	38
Industrial wastes	18
Total	319

A breakdown of the heavy equipment currently used for the operation of Tarará disposal site is shown below.

Table 1-14: Tarara Heavy Equipment

Equipment	Number	Operation
Bulldozers	1	Operating
Crawler-mounted loaders	1	Under repair

d. Campo Florido Final Disposal Site

The Campo Florido disposal site receives wastes from Campo Florido District within La Habana del Este municipality in Havana City:

Table 1-15: Final Disposal Amount in Campo Florido

District	Average waste volume disposed of (m^3/day)
Campo Florido	1.5
Industrial waste*	18
Total	19.5

*They are mainly generated by the food processing industry.

There is no equipment exclusively utilized for the site. Equipments from other sites are send and used to move and cover the wastes periodically.

e. Overview of Final Waste Disposal in Havana City.

The wastes generated in Havana City are currently disposed of in four sites. However, as can be seen from the table and the pie chart below, most wastes are disposed of at Calle 100 site.

Table 1-16: Distribution of Disposed Amount at Landfills in 2012

Final disposal site	Average waste volume disposed of (m^3/day)	Percentage (%)
Calle 100	1,583	67.77
Ocho vías	414	17.72
Barreras (Tarará)	319	13.66
Campo Florido	19.5	0.83
Total	2,335.5	99.98

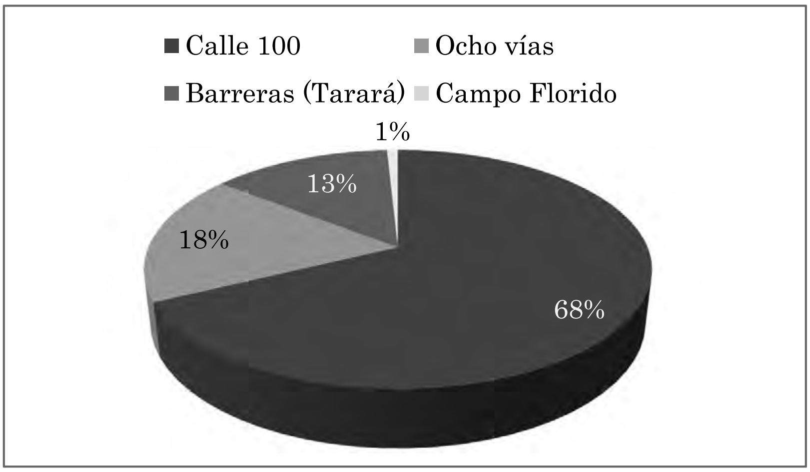


Figure 1-1: Distribution of Disposed Amount at Landfill Sites in 2012

Besides the deficiencies of the infrastructure, the equipment, and the operation of the final disposal sites already referred to above, the existing system for the final disposal of the wastes generated in Havana City show the following short- and medium-term risks that should be pointed out:

- Seventy percent of the wastes generated are disposed of at Calle 100 disposal site. If for some unforeseeable reason access to the site were no longer possible, or simply the wastes could not be disposed of there at the end of its service life, the remaining operating sites would not have the capacity to receive all the wastes generated in the city. Therefore, some alternative disposal sites would have to be improvised, as was the case during the so-called Special Period, thus posing a threat to the aquifer and human health, provoking uncontrolled greenhouse gas emissions, and creating environmental liabilities that would entail more expenses to clean them up in the short and medium terms.

- The operation of OchoVías, Tarará, and Campo Florido disposal sites is extremely inadequate and their service life is practically over. They have extended it by increasing operational deficiencies and pollution risks. Therefore, these sites should be shut down in the short term. If they are closed and no alternative sites such as the new Guanabacoa sanitary landfill site or the new sanitary landfill site planned to be built in the west are made available, the volume of wastes disposed of at Calle 100 site would increase, thus shortening its service life, increasing fuel consumption, and affecting collection vehicles availability, as the distance to be covered by the vehicles currently disposing of the wastes at the sites to be closed would increase.

- Despite several requests, UPPH has not obtained the permit to extract covering materials from a quarry (a site used to extract stone and clayey materials) soil and stones to be used for waste covering at the final disposal sites currently in operation, as only construction companies are authorized to this effect. Therefore, UPPH must procure the covering material from the construction companies. As the sites lack the covering material, demolition wastes dumped at the sites are used instead. Besides the shortage of equipment and fuel, the lack of covering material provokes that the wastes remain uncovered in large areas within the sites, thus increasing fire hazards, and gas emissions. It is estimated that there is an area of approximately 100 ha of uncovered wastes. Using a 0.3 m thick layer, 300,000 m^3 of soil will be needed to cover them, as well as nearly 250 m^3 to be used for daily waste covering.

- Lastly, the most serious risk is that the service life of the sites currently operating, including Calle 100 site, would come to an end and that the new sanitary landfill sites planned to be built, namely, the new Guanabacoa sanitary landfill site and the new sanitary landfill site in the west, are yet not finished. This situation could be avoided if the necessary steps are taken so that the construction of the new sites keeps up with the reduction of the service life of existing operating sites. Otherwise, the only undesirable alternative would be to open makeshift disposal sites in inappropriate locations and without the minimum environmental protection measures required, just as was the case during the so-called Special Period, only that now they would have to be opened not because of international circumstances, but because of a lack of foresight.

The next section will include the recommendations made regarding proper final disposal of solid wastes in Havana City, as well as the situation ahead of the project to build the new Guanabacoa sanitary landfill site.

1.2.2 Short-Term Target (2015-2017)

There are a number of recommended measures and actions that should be implemented as part of this updated Master Plan 2012-2020 for the proper management of solid wastes in Havana City. Such recommendations are shown below:

a) Improve the operation and extend the service life of Calle 100 site as long as possible so that it may receive all the wastes generated in the city when the service life of OchoVías, Tarará, and Campo Florido sites is over, or when they are closed down. Also, the end of the service life of Calle 100 site should be made to coincide with the starting up of the operations of the New Guanabacoa Sanitary Landfill Site and the New West Sanitary Landfill Site.

b) Schedule the construction of the New Guanabacoa Sanitary Landfill Site and the New West Sanitary Landfill Site so that the starting up of their operations coincides with the end of the service life or the closure of Calle 100 site.

A schedule of activities, the details of which should be given by the relevant authorities from Cuba and Havana City, as its implementation depends on many factors, especially budget allocation and the availability of the building contractors that may carry out the works necessary for the construction of the new final disposal sites, is shown below:

Table 1-17: Time Schedule of Actions in Final Disposal

Final disposal site	Average waste volume disposed of (m^3/day)					
	Short term 2015-2017			Medium term 2018-2020		
	2015	2016	2017	2018	2019	2020
Calle 100						
Ocho vías						
Tarará						
Campo Florido						
New Guanabacoa						
New West Sanitary Landfill Site						

The detailed measures and activities to implement this Schedule in the near future (short term) 2015-2017 is shown below.

a. Extension of the service life of Calle 100 disposal site

Based on environmental reasons, it is not right to extend the service life of Calle 100 disposal site. However, in the light of the present lack of alternative final disposal sites being environmentally fit to dispose of the wastes generated in Havana City, this is the most advisable alternative, as it would prevent other places located near the city from being impacted in terms of risks to human health and pollution of the aquifer and water bodies.

The considerations raised to limit the height of Calle 100 disposal site have already been referred to. However, we recommend that they should be revised in the light of the present conditions and the need to prolong the site's service life.

From a technical point of view, the height of a final disposal site essentially depends on the structural safety of the slopes to prevent landslides, on the capacity of the underlying soil to prevent fractures and land subsidence that may pose a threat for the structural integrity of the slopes, and on the slopes being properly built to facilitate the access of collection vehicles to the dumping waste areas at the top of the waste cells.

Although a detailed analysis of these factors and an executive project are required to continue to dump wastes in case the height of the waste cell is eventually raised, it may be said that these three conditions are favorable for Calle 100 disposal site, and that a detailed analysis of them would produce some positive results and would determine the waste volume that could be dumped and the consequent increase in its service life.

It should be noted that the increase in the site's service life depends not only on its structural safety, but also on other elements detailed below:

- We suggest that besides the project prepared to increase waste cell height aiming at expanding the service life of Calle 100 landfill site, a study should be conducted to optimize the areas used for waste dumping, as there are areas that still remain unused. This study should include a cell filling plan enabling not only to increase the amount of wastes to be dumped at the site, but also to plan waste discharge in the remaining areas, to allow dumped wastes to naturally reduce their volume prior to dumping more wastes on top of them, etc. This is intended to increase the service life of this final disposal site.
- We suggest that the possibility and advisability of using the area where the gas extraction facilities stand to dump wastes should be discussed. This does not mean to abandon the biogas collection project, but to make it compatible with the continuity of the site operation by relocating gas extraction areas and gas collection facilities, which may imply higher

costs that may be compensated for in turn with the assurance that the city will operate a proper final disposal site for the wastes generated.

- The planned works to collect along the site perimeter the leachate generated at the site, especially on the slopes bordering on the Almendares River should be carried out. Moreover, the works necessary to store the leachate and to pump it back into the waste cells (re-pumping of the leachate by means of absorption wells located at the top of the site, and not by its evaporation through artificial irrigation).
- Proper waste compaction and timely waste covering with soil should be promoted in order to reduce waste volume and optimize the space available to continue to dispose of the wastes.

b. Improvement of operations and closure of Ocho Vías final disposal site

The 2005 Master Plan recommends that OchoVías disposal site should be closed down. Its service life has been extended ever since as there are no other landfill sites available to dispose of the wastes generated in nearby areas.

Ocho Vías site is saturated and has several operational problems. However, its service life needs to be extended as long as possible, at least until the New Guanabacoa Sanitary Site begins operations, which is not anticipated to take place prior to 2015. Meanwhile, this site will have to continue operating. The following are some of the actions to be carried out to improve the site operation:

- Improve the condition of the access road, including if possible the raising of the road and the construction of drains along its sides to prevent storm water from accumulating on the road and blocking the access of collection vehicles to the dumping areas.
- Prepare a plan to fill the cells or to dump the wastes enabling to optimize the space available and including the rise of the waste height, with the proper slopes to ensure the site’s structural safety and to prevent landslides.
- Improve the site’s operation by strictly fulfilling the plan to fill the waste cells or to dump the wastes to be prepared, by increasing waste compaction to optimize the space available, prevent fire outbreaks, and avoid that wrongly dumped wastes may block the inner access road, and, as far as possible, by timely covering the wastes with soil.

The closure of OchoVías disposal site should be made to coincide with the starting up of the New Guanabacoa sanitary landfill site in order to avoid that the wastes have to be taken to Calle 100 site, as this will bring about an increase in fuel consumption and in the distance to be covered by the collection vehicles currently operating in areas close to OchoVías disposal site.

Moreover, OchoVías disposal site should be closed down properly during this short-term stage (2015-2017) to fulfill the relevant Cuban standard. It means that the corresponding budget allocations will have to be made to at least design the final site geometry by taking into account slope stability, final cover design and construction, site vegetation, storm water drainage design and construction to minimize rainfall seepage and leachate generation, design and construction of the facilities to collect, carry, store temporarily, and re-pump or treat the leachate.

It is not anticipated that a central system to collect, carry, burn, or use the biogas generated at the site will have to be built and operated once it stops operations, as the amount of wastes dumped there is small and, consequently, the amount of gas expected to be generated is also small. Therefore, such an investment project will not be profitable.

c. Clsosure of Barreras (Tarará) and Campo Florido disposal sites

Tarará and Campo Florido sites are a kind of inheritance from the Special Period times. They still receive the wastes generated in nearby areas, thus helping to save fuel and to make the operation of collection vehicles more efficient, as the wastes do not have to be taken to Calle 100 or OchoVías sites.

However, these two sites lack the facilities and the equipment required to operate as final disposal sites posing no threats to the neighboring environment and to the underlying aquifers. Therefore, the Master Plan recommended their closure back in 2005. They have not stopped operations, though, due to the above-mentioned reasons.

These sites will have to continue operating as long as the New Guanabacoa and the New West sanitary landfill sites do not begin operations. However, they have to be improved to prevent fire outbreaks and rainfall seepage into the wastes to reduce leachate generation because, as the cell bottoms lack waterproofing, the leachate seeps into the subsoil, thus posing a threat to the underlying aquifers.

The closure of Campo Florido disposal site should be made to coincide with the starting up og the New Guanabacoa sanitary landfill site so that the wastes generated in the area may be disposed of at the new disposal site, thus preventing collection vehicles from travelling long distances.

The closure of these sites should be carried out properly to comply with the relevant Cuban environmental standard as soon as operations stop under the same conditions and requirements as those pointed out above for Ocho Vías disposal site. They essentially include the design of the final site geometry by taking into account slope stability, final cover design and construction, site vegetation, storm water drainage design and construction to minimize rainfall seepage and leachate generation, design and construction of the facilities to collect, carry, store temporarily, and re-pump or treat the leachate.

As it was pointed out for Ocho Vías site, the installation of a centralized system to collect and convert or to use the biogas generated in these sites after their closure is not recommended as the limited amount of wastes disposed leads us to estimate that biogas generation will be low, thus rendering these facilities unprofitable.

Although not recommended, Campo Florido disposal site could continue operations, as it provides service for a rural area far from the other final disposal sites. However, waste treatment should be minimized, especially in terms of waste covering with soil. Some techniques to use organic wastes, such as composting or tree waste shredding should be introduced. Working conditions should be improved. A hut at the site entrance to control waste reception and an office for the staff should be built.

Table 1-18: Estimated Investment Required for the Closure of Barreras (Tarará) and Campo Florido.

		Barreras (Tarará)		Campo Florido	
Item	Unit Price ($USD)	Quantity	Amount of Money $ USD	Quantity	Amount of Money $ USD
Executive project		One time	ND	One time	ND
Earth moving required for final site shape and slope stability		One time	ND	One time	ND
Final cover layer					
Seal layer	2.30 M^2	300,000 M^2	690,000	100,000 M^2	230,000
Geomembrane	9.27 M^2	300,000 M^2	2,781,000	100,000 M^2	927,000
Base layer	3.94 M^2	300,000 M^2	1,182,000	100,000 M^2	394,000
Vegetation for final cover layer					
Topsoil	8.48 M^2	300,000 M^2	2,535,000	100,000 M^2	848,000
Vegetation	2.06 M^2	300,000 M^2	618,000	100,000 M^2	206,000
Total			7,806,000		2,650,000

d. Construction and operation of the New Guanabacoa sanitary landfill site

The construction of this sanitary landfill site to dispose of the solid wastes generated in the east of Havana City was included in the Master Plan formulated in 2005. According to it, the construction and starting up of the first stage of the site will be in 2011. However, construction has been delayed due to limited resources availability and the failure to timely prepare the construction design and the corresponding executive projects.

In the Project for Capacity Improvement, as a part of which this updating of the Master Plan for the management of solid wastes in Havana City, Republic of Cuba, until the year 2020, was formulated, the advice by JICA's Expert Team in terms of design, executive projects, and construction of this final disposal site (the first of its kind to be built in Cuba to meet the requirements of an environmentally-friendly sanitary landfill site) is pointed out as a prioritized activity.

At present, the site construction design and the corresponding executive projects have already been defined. Some budget allocations have been made to begin the site construction in the first half of 2014. A first stage of the site comprising 2.5 hectares is expected to start operations in 2015.

A summary of the budget for the construction of the first stage of the New Guanabacoa llandfill site and an estimate of the budget for the acquisition of heavy equipment once the site becomes operational is shown in the following tables:

Table 1-19: Investment for the Construction of the First Stage of the New Guanabacoa Sanitary Landfill Site (2014)

Item	Amount (Thousand Cuban pesos)
Earth moving (trench 1)	4,329.2
Leachate network (drainage)	150.4
Wastewater treatment	885.5
Recycling plant	996.0
Administrative building	250.0
Total	6,611.1

Table 1-20: Estimated Investment for Heavy Equipment Acquisition for the Operation of the First Stage of the New Guanabacoa Sanitary Landfill Site (2015)

Item	Amount (Thousand Cuban pesos)
Bulldozer	980.0
Backhoe excavator	110.0
Front loader	235.0
Crawler-type loader	250.0
Water tanker	103.4
Dump truck	280.5
Aerators	50.0
Weighbridge	90.0
Total	2,086.9

The estimated investment to be required in the coming years to build the remaining stages of the New Guanabacoa sanitary landfill site is shown in the table below:

Table 1-21: Estimated Investment for the Construction of the Second and Third Stages of the New Guanabacoa Sanitary Landfill Site

Item		Amount (Thouand Pesos)			
		2015	2016	2017	2018
Second stage	Executive project	42,259.0	0	0	0
	Civil works	0	6,900.0	6,900.0	0
Third stage	Executive project	0	42,259.0	0	0
	Civil works	0	0	0	7,100.0
Total		42,259	49,159	6,900	7,100

e. New West sanitary landfill site

The system planned for the final disposal of solid wastes generated in Havana City should be supplemented with the construction and operation of a sanitary landfill site to the west of Havana to receive the wastes currently being disposed of in Calle 100 disposal site once its service life expires.

The construction of this new final disposal site was also envisaged in the Master Plan of 2005, including some of its characteristics in terms of construction and operation, especially those related to its capacity to receive the wastes currently being taken to Calle 100 site. Three candidate sites were even identified and their potential to build the desired final disposal site was evaluated in terms of environmental suitability and public acceptance.

The first stage of this new final disposal site was scheduled to be built by the year 2013, whereas the second stage was planned for 2015.It is evident that the plan has not been fulfilled. At present, the progress is very limited, mainly focusing on the micro-location of the land eventually selected to build the final disposal site and the permits required to begin the surveys needed prior to the site construction.

The need to build the New West sanitary landfill site stems from the proximity of the end of the operations of Calle 100 site, which is scheduled for the year 2018. Therefore, the activities listed in the table below should be carried out in the near future or short term (2015-2017):

Table 1-22: Time Schedule for the Construction of the New West Sanitary Landfill

Activity	2014	2015	2016	2017
Previous surveys				
Construction design				
Executive project				
Preparation works				
Construction				

As the preliminary surveys have not been conducted yet, it is impossible to estimate the amounts required for the construction of the New West Sanitary Landfill Site. However, the budget for 2014 includes the amount of 92,951 pesos for the site design preparation.

f. Waste Disposal in Case of Natural Disasters

In the light of the present condition of existing final disposal sites in Havana, a city exposed to the occurrence of unforeseen catastrophic meteorological events such as hurricanes, which may generate large amounts of wastes in a short period of time, it is advisable to envisage the availability of alternative emergency disposal sites in case of disasters to prevent presently operating sites from collapsing due to waste saturation and to enable generated wastes to be rapidly disposed of, thus keeping highways clear and allow civil defense authorities to help the population.

Some quarries (mines for construction materials) out of operation have been located in the vicinity of Havana City that could be used to receive wastes in case of natural disasters. The arrangements to be made with CITMA Habana and the Provincial Direction of Physical Planning to obtain the authorization required to this effect should be done as soon as possible.

1.2.3 Med-Term Target (2018-2020)

a. Closure of Calle 100 final disposal site

According to the schedule for the system of final waste disposal, the New West sanitary landfill site is expected to begin operations by the year 2018 to receive the wastes currently being disposed of at Calle 100 site, which is planned to be permanently closed down by then.

Therefore, budget allocations should be anticipated and executive projects for the site closure in the coming years should be prepared in 2018.

The proper site closure should comply with the relevant Cuban standard. Consequently, the closure project to be prepared should at least include the following:

- Design of the final site geometry taking into account slope stability,
- Design and construction of the final cover and site vegetation,
- Design and construction of the storm water drainage to minimize rainfall seepage into the wastes and to reduce leachate generation,
- Design and construction of the facilities to collect, carry, store temporarily, and re-pump or treat the leachate generated,
- Facilities for and operation of a system to collect, carry, burn, or use the biogas generated at the site.

The following table shows the estimated investment required for the closure of Calle 100 landfill site by considering the site surface and its expected service life expiration, and based on the works usually required internationally for the closure of final disposal sites in order to reduce the environmental impact and greenhouse gas emission. For the calculations, international prices were used, which should be timely adjusted to the conditions of the Cuban economy.

Table 1-23: Estimated Investment Required for the Site Closure*

Item	Unit Price ($USD)	Quantity	Amount of Money $ USD
Executive project		One time	ND
Earth moving required for final site shape and slope stability		One time	ND
Final cover layer			
Seal layer	2.30 M^2	1,000,000	2,300,000
Geomembrane	9.27 M^2	1,000,000	9,270,000
Base layer	3.94 M^2	1,000,000	3,940,000
Vegetation for final cover layer			
Topsoil	8.48 M^2	1,000,000	8,480,000
Vegetation	2.06 M^2	1,000,000	2,060,000
Biogas extraction and monitoring			
Well boring and burning heads	2,250.00 well	200	450,000
Total			26,500,000

* The possibility that the closure project may include the extension of the MDL project currently being implemented in a part of the site should be considered. The period to begin the project is yet to be established as it will depend on the time operations end at Calle 100 landfill site.

b. Operation of the New Guanabacoa sanitary landfill site and construction of the second stage

During this medium-term planning stage, the first phase of the New Guanabacoa sanitary landfill site is supposed to be already receiving nearly 400 tons/day of waste generated in the east of the city.

Based on the capacity of the first stage of the site, the construction of the second stage of the sanitary landfill site should be anticipated to prevent both its saturation and the implementation of wrong alternatives to dispose of the wastes generated in areas close to the site, thus avoiding that the wastes have to to be taken to the New West sanitary landfill site, the first stage of which should be operating by then, with the consequent increase in fuel consumption and the reduced efficiency of existing collection systems.

c. Operation of the first stage of the New West sanitary landfill site

As pointed out above, the construction of the first stage of this sanitary landfill site is expected to be completed by 2018. Consequently, it should begin operations in the medium term (2018-2020) by receiving the wastes previously disposed of at Calle 100 site, the operation of which is expected to be stopped by that same year.

Based on the great amount of wastes to be disposed of at this final disposal site on a daily basis, the construction of the second stage of the site is likely to begin during this same period so that the facilities required for the environmentally-friendly disposal of the wastes generated in Havana City may be available by then.

1.3 Transfer Station (T/S) and Transportation

1.3.1 Present System (2013-2014)

A transfer station is a facility used to move the wastes from collection vehicles to larger vehicles to prevent the former from travelling long distances to the final disposal site, thus optimizing waste collection.

Using larger vehicles to carry the wastes to the final disposal site helps reduce the number of vehicles entering the site and improve vehicle check. The circulation of vehicles along the roads leading to the disposal site is also reduced, thus helping to reduce vehicle emissions and traffic jams, which are of the most frequent complaints made by the people living near disposal sites or along the roads leading to the site.

The operation of transfer stations as part of the waste collection and transportation system has a number of advantages. However, some detailed cost-benefit analysis should be carried out to fully justify their installation and operation, as they are not always necessary or advisable.

The following are some decisive factors to be taken into account to justify the installation and operation of a transfer station:

a) Existence of a considerable distance between the waste generation areas and the final waste destination, be it a treatment facility or a final disposal site, or prolonged time taken by the collection vehicles to move from the waste collection area to the final waste destination.

b) Amount of wastes collected that would be transferred to larger vehicles, taking into account the fact that a high-capacity truck may generally carry the wastes transported by 7-8 10 m^3 compactor trucks.

c) Difficult access to dumping areas within the final disposal sites provoked by steep slopes, poor or flooded roads, etc., which might make it difficult or altogether prevent the access of collection vehicles to existing dumping areas, cause vehicle breakdown and deterioration, and dramatically affect the operation of the waste collection system.

d) Complaints by the people living near the final disposal sites or along the access roads leading to them about traffic congestion provoked by the constant circulation of collection vehicles or the long queues at the site entrance.

None of these conditions fully applies to the present waste collection and transport system in Havana City due to the following:

a) The final disposal sites currently being operated are located within the city's urban area, near the waste generation areas.

b) The amount of waste generated in areas relatively far from the final disposal sites is small. Therefore, the installation and operation of a transfer station would not be justified.

c) The access roads to dumping areas within existing final disposal sites are deteriorated and poorly maintained. However, they do not .have steep slopes preventing the access of collection vehicles. The condition of the roads may be improved to prevent vehicle breakdown and deterioration with a relatively small investment.

d) There are no records of complaints filed by the residents about excessive traffic of collection vehicles along the access roads to the final disposal sites that may justify the construction and operation of a transfer station.

Due to the above, there has been no need to build and operate a transfer station as part of the waste collection system in Havana City.

1.3.2 Short-Term Target (2015-2017)

Although the construction and operation of transfer stations has neither been necessary nor advisable so far, it is anticipated that the end of the service life of existing final disposal sites, especially that of Calle 100 site, as well as the construction of new sites, particularly the planned New West Sanitary Landfill Site, will justify or make it necessary to build and operate a system of transfer stations enabling a more efficient operation of the waste collection system under the new circumstances.

In addition, there are some waste generation areas whose population density and importance as tourist districts, like Habana Vieja, for example, may justify the operation of a waste transfer system to move the wastes collected by small collection vehicles into larger vehicles for their transportation to the final disposal site in order to optimize the efficiency of the collection vehicles currently operating in the area.

In the medium term, based on the planning horizon corresponding to 2015-2017 as considered in the present updating of the Master Plan, the following activities and projects responding to the above-mentioned changes in the conditions of the waste collection and disposal system are recommended.

a. Operation of a mini-transfer system in relevant urban areas

During the implementation of the Project for Capacity Improvement, some training courses were held in Mexico for two C/P groups. They could see how waste collection is carried out in Mexico City's Historical Center, where pickup trucks having a capacity of 3.5 tons are used to collect the wastes generated from street sweeping and litter bins, which are later transferred to 10 m^3 compactor trucks for their transportation to the final disposal site.

A similar system is implemented in Santo Domingo City's Historical Center in the Dominican Republic for waste collection and transport to the final disposal site.

The following photographs show the wastes being transferred from the collection vehicles used in these areas to compactor trucks for their transportation to the final disposal sites.

Mexico City's Historical Center

Santo Domingo, Dominican Republic

Photo 1-1: Mini-transfer System in Urban Area

The present updating of the Master Plan recommends that the possibility of implementing a system to collect and transfer the wastes generated in Habana Vieja, including the wastes collected by the street sweepers operating in the area and the wastes collected from existing litter bins, should be analyzed in depth in the year 2015. This system would help increase the sanitation efficiency of the area, which cannot be accessed by 10 m^3 compactor trucks, as it has narrow streets and a number of pedestrian streets. The corresponding system, which, based on the results obtained, could be extended to other prioritized areas in terms of sanitation such as Revolution Square and some other main thoroughfares, should be designed and implemented during the year 2015.

b. Operation of the mini-transfer system in suburban and rural areas

As will be seen in the chapter corresponding to the waste collection system, horse-driven carts are currently used for waste collection in suburban or rural areas near Havana City's center.

It would be desirable to stop using horse-driven carts for waste collection, as they are extremely inefficient, cover long distances from collection areas to disposal sites, have difficulties to get to the dumping area inside the site, and take long to unload the wastes, thus affecting the site operations. However, the few collection vehicles available in some municipalities anticipates that they will continue to be used, at least in the short and medium terms.

A way to reduce the operational problems faced by horse-driven carts is to implement a system of mini-transfer stations to move the wastes to larger vehicles, including 10 m3 compactor trucks or large metal containers (*Ampirol* containers) that may be towed using *roll on roll off* vehicles, as shown in the picture below:

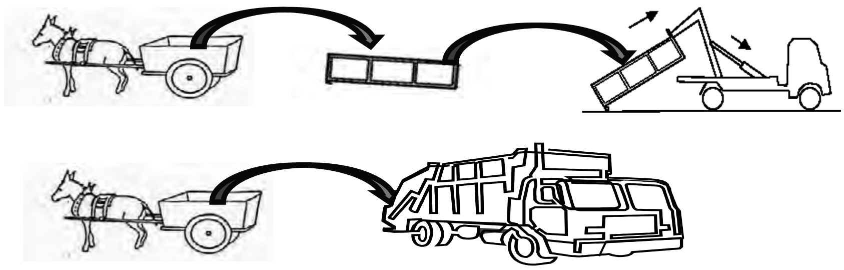


Figure 1-2: Mini-transfer System in Suburban and Rural Areas

The system would consist of places located near the collection areas, preferably somewhere between them and the final disposal sites, to be used to transfer the wastes carried by horse-driven carts. Some hours will be established (by the end of waste collection) for a collection vehicle or a large metal container to be deployed there to receive the wastes transported by the horse-driven carts.

Despite existing limitations in the number of collection vehicles, all the elements required to implement a system of mini-transfer stations in the near future or short term (2015-2017) in those suburban or rural areas currently served by horse-driven carts are available.

c. Preparation and construction of (a) transfer station(s) with the New West Sanitary Landfill Site as the destination of the wastes

With the scheduled end of operations of Calle 100 and Ocho Vías disposal sites and the construction and starting up of the New Guanabacoa Sanitary Landfill Site and the New West Sanitary Landfill Site, the distance between the waste generation and collection areas and the final disposal sites will increase, thus justifying the construction and operation of transfer stations intended to maintain or increase the efficiency of collection vehicles.

We suggest that the preparation works to build one or several transfer stations should coincide with the works to build the new sanitary landfill sites so that they may be built and start operations when needed due to the increase in the distance from the collection areas to the New West sanitary landfill site.

Prior to designing the operation system for the transfer station(s), an engineering survey of the waste collection routes in the areas to be served by the planned transfer station should be carried out in order to determine the most suitable location for the station enabling to reduce the distance to be covered by the vehicles and to optimize the efficiency of the waste collection system.

Under the present circumstances, it is not possible to determine the number of transfer stations that should be advisable to build and operate, nor their capacity and operation system, as this information must be derived from the route engineering survey to be carried out. Nevertheless, there are some points that can be recommended for the surveys of the transfer stations to be built and operated, as follows:

a) The transfer station(s) should be located somewhere between the waste generation and collection areas and the final disposal sites, as close as possible to the waste generation and collection areas in order to reduce the distance to be covered by collection vehicles.

b) Any facility used to manage solid wastes will need consensus building. Consult with the people living near it and select sites (minimal protests). The site must not be near schools, markets, bus stations, or any other place crowded with people, but preferably in industrial or agricultural areas.

c) As the distance existing from waste generation and collection areas to the new sanitary landfill sites planned to be built is not great, the most advisable operation system for the transfer stations would be waste unloading by gravity into transfer containers having a capacity of 60-70 m^3, as shown in the picture included at the end of this section. The use of fixed compaction systems or installed at the transfer containers is not justified.

d) A transfer station operating with tractor-trailers and transfer containers having a capacity of 60-70 m^3 may be designed in a simple way so that the collection vehicles unload the wastes into the transfer container one after the other, as shown in the picture referred to above, or in a way in which several collection vehicles may unload their wastes simultaneously into several transfer containers, as shown in the second picture. However, the design will depend on the amount of wastes to be daily handled at the station and on the discharge frequency and hours of the collection vehicles. These points should be identified prior to the design of the transfer station.

Based on the considerations stated above, we recommend that the surveys prior to the design, the facility design as such, and the executive projects, as well as the construction of the transfer station(s) to be required to maintain or increase the efficiency of the waste collection system in the light of both the closure of Calle 100 disposal site and the construction and operation of the New East sanitary landfill site, should be carried out in 2015-2017.


Mexico's Case 1


Mexico's Case 2

Photo 1-2: Transfer Station, Mexico's Cases

1.3.3 Med-Term Target (2018-2020)

According to the schedule to build and operate the new sanitary landfill sites to ensure the environmentally friendly disposal of the solid wastes generated in Havana City, it is anticipated that the New West sanitary landfill site will begin operations in 2018. Therefore, the starting up of the transfer station(s) to be built should coincide with the beginning of operations at the new disposal site so that the increase in the distance to be covered by collection vehicles from generation areas to the location of the new disposal site does not affect the efficiency of the waste collection system.

1.4 Waste Collection

1.4.1 Present System (2013-2014)

Waste collection in Havana City is carried out in different ways depending on various factors such as the type and source of the wastes, the kind of temporary waste storage, the vehicles used for waste collection, and the organizations rendering the service.

According to the type and source of the wastes, collection may be as follows:

- Wastes generated by small-scale generators collected by public organizations and wastes generated by large-scale generators that may be collected either by state-run organizations, by Aurora enterprises, or be transported to the final disposal sites by the waste generators themselves.

- Wastes from households and entities operating in CUP that are collected by public organizations free of charge and wastes generated by entities operating in foreign currency and private companies, for the collection of which the generators are charged.

According to the type of wastes, collection may be as follows:

- Household or municipal wastes (common garbage) collected by ordinary sanitation, services, bulky tree wastes, which are collected by special collection services, and demolition wastes, which are also collected by special collection services.

According to temporary waste storage, collection may be as follows:

- Wastes dumped in containers deployed along thoroughfares that are collected using compactor trucks (specialized collection), wastes dumped along thoroughfares that are collected using dump trucks and tractor-driven carts (sanitation), and wastes directly collected from the generators using small compactor trucks and horse-driven carts.

According to the organizations involved in waste collection, collection may be as follows:

- Wastes collected by UPPH, wastes collected by Havana City's municipalities, wastes collected by Aurora enterprises, and wastes collected by the municipalities by hiring private operators such as horse-driven carts.

The various waste collection systems and the number of organizations involved make it difficult to monitor it to gather some accurate data about the amount and type of collected wastes.

The following tables show some data about waste collection depending on the various collection modes used:

Table 1-24: Wastes collected from Havana City's municipalities in 2013.

Municipalities	Total (m^3)
Playa	146,500
Plaza de la Revolución	162,200
Centro Habana	75,700
Habana Vieja	63,800
Regla	64,600
Habana del Este	479,200
Guanabacoa	204,500
San Miguel del Padrón	152,400
10 de Octubre	448,900
Cerro	158,600
Marianao	89,600
La Lisa	216,500
Boyeros	548,500
Arroyo Naranjo	252,000
Cotorro	116,700

Municipalities	Total (m^3)
UPPH	3,048,200
Green Areas Division	110,800
Zoo	2,100
Total	6,340,800

Table 1-25: Vehicles in operation used for waste collection in 2013

Type of vehicle	Number
Chinese compactor trucks	65
Compactor trucks (other brands)	
Small Japanese compactor trucks	5
Dump trucks	130
Trucks to handle large metal containers	16
Large metal containers	154
Tractor-driven carts	76
Horse-driven carts	185

Apart from the various waste collection systems and entities involved in waste collection in Havana City, the main problems originate in the shortage of vehicles and equipment, especially containers (an issue to be dealt with in the section devoted to temporary waste storage), and fuel required to carry out waste collection effectively and at the right time.

Havana City's authorities make some efforts to overcome existing financial limitations in order to be able to carry out waste collection more effectively. They have even received some international donations of vehicles and containers. Most important, as part of JICA's Project for Improvement Capacity, a number of tools and equipment was donated for UPPH's Central Workshop.

a. Segregated collection of recyclables is not feasible

In Cuba, raw material recovery is carried out by ERMP. The amount of raw materials found in solid wastes is insignificant and they are highly polluted. Recovery by self-employed workers has increased due to the changes introduced into the country's economic policy. Consequently, the recovery of raw materials should be increased before they get mixed or are dumped together with solid wastes, and not obtained by means of waste segregation at the source and segregated collection.

Wastes are collected unsegregated in Havana City. Although a pilot project was implemented during the Development Study for the formulation of the Master Plan to introduce waste segregation at the source and segregated collection of the waste fractions, its continuity could not be secured due to vehicle limitations, as they lack the trucks required to separately collect each one of the waste fractions that had previously been segregated at the source.

In addition, the city does not have the facilities required to properly use the waste fractions that could eventually be segregated at the source.

Therefore, although the pilot project for waste segregation at the source was supported by the residents, it could not be further implemented and public cooperation was lost.

At present, collection vehicles are short and facilities are lacking to segregate the wastes at the source and to use the segregated wastes. Consequently, waste segregation at the source is neither possible nor advisable in the short and medium terms. All the efforts during this period should focus on properly collecting unsegregated wastes and on promoting the 3R's policy through recycling and composting activities carried out as part of specific projects to be dealt with below.

1.4.2 Short- and med- terms (2015-2020)

a. Applying Same System as current system (large compactor truck)

As pointed out in the previous section, the most serious problems related to solid waste collection originate in the various systems implemented for waste collection and in the many organizations involved in it. However, the main problems affecting waste collection are the limited availability of spare parts, inadequate vehicle maintenance and the ageing of the equipment used for sanitation (over 35 years old)..

It is necessary to comply with the sustainability plan for Havana City, which will enable to replace existing vehicles and will ensure the spare parts and the resources needed to allot them for collection vehicle equipment, especially to acquire compactor trucks and containers having a capacity of 700 l.

A projection of the vehicles to be acquired in the short and medium terms not only to meet the current needs in terms of collection vehicles, but to anticipate the replacement of units that stop operating or that are earmarked to replace others that are not efficient or suitable for waste collection activities, is shown below.

Table 1-26: Planned Vehicle and Equipment Acquisition for Waste Collection

Type of vehicle or equipment	Number					
	2015	2016	2017	2018	2019	2020
Compactor trucks ≥ 10 m^3	10	5	5	5	5	5
Dump trucks	25	10	10	10	10	10
Trucks to operate large metal containers	5	5	5	2	2	2
Large metal containers	40	40	40	40	40	40
Tractors	7	7	7	3	3	3
Carts	7	7	7	3	3	3
Small wheel-type loaders	5	5	5	2	2	2

Table 1-27: Estimated Budget for the Acquisition of Waste Collection Vehicles and Equipment

Type of Vehicle or Equipment	Amount (Thousand Cuban pesos)					
	2015	2016	2017	2018	2019	2020
Compactor trucks ≥ 10 m^3	971,503	485,751	485,751	485,751	485,751	485,751
Dump trucks	196,345	785,298	785,298	785,298	785,298	785,298
Trucks to operate large metal containers	526,231	526,231	526,231	210,492	210,492	210,492
Large metal container operation	427,840	427,840	427,840	427,840	427,840	427,840
Tractors	111,062	111,062	111,062	47,598	47,598	47,598
Carts	88,873	88,873	88,873	38,088	38,088	38,088
Small wheel-type loaders	202,395	202,395	202,395	80,958	80,958	80,958

b. Operation of small transfer stations

In section 1.3.2 a) (Operation of a mini-transfer system in relevant urban areas), a system of small transfer stations is recommended to be implemented for waste collection in densely populated or relevant areas such as Old Havana's tourist section.

The operation of these small transfer stations would modify the current waste collection system in this area, as the containers presently installed along the thoroughfares for the storage of the wastes generated by residents and small business establishments may be replaced by mobile wheelie bins (70-100 l) operated by street sweepers, who will be responsible for the integrated sanitation of the area, including the following:

- Street sweeping and collection of bags or wastes dumped by the residents,
- Emptying the litter bins,
- Direct household collection of the wastes generated by the residents and small business establishments operating during the day, possibly by ringing a bell, or during the sweeping of the stretch assigned.

The wastes collected from street sweeping, litter bin emptying, and generated by the residents will be discharged into 3.5 ton pickup trucks, which would go round the area at predetermined hours to receive the wastes collected by the street sweepers in suitable locations, at the end of the stretch assigned to each one of them.

The wastes loaded onto the pickup trucks will be transferred to compactor trucks at predetermined points and hours for their transportation to the final disposal site.

In the short term (2015), a pilot project of this system of waste collection will be implemented in Old Havana's tourist section to evaluate its cost and efficiency and to design the assignment of the sweeping stretches and the selection of the most suitable mobile containers and the points and hours for the waste transfer.

The wastes from large generators (warehouses, hotels, and institutions) will have to be stored in containers inside those establishments, and the best routes and hours will have to be established for their collection. The most suitable vehicles will also have to be selected taking into account the existence of narrow streets and the fact that some of them are pedestrian streets.

The possibility or advisability that primary collection by street sweepers and secondary collection by 3.5 ton pickup trucks receiving the wastes from the sweepers may be carried out by cooperatives or private operators by signing a contract with UPPH, the terms, costs, and supervision and payment systems of which will be timely designed by the Cuban side based on the outcome of the pilot project, should also be analyzed in the short term.

In conformity with what was pointed out in the section corresponding to small transfer stations, this same primary waste collection system may be applied to the areas currently served by horse-driven carts by establishing small transfer stations where the wastes collected by the carts are loaded into compactor trucks for their transportation to the final disposal sites.

The possibility that some areas served by tractor-driven carts may be assigned to hired cooperatives or self-employed workers will likewise be evaluated. Contract terms, rates, and payment systems will be discussed and decided.

c. Small compactor trucks with bell ringing (no 700L containers)

In some residential areas having a low population density, mainly composed of houses or low buildings, it is advisable to introduce the “door-to-door” collection service using compactor trucks not equipped with container lifting devices, as containers will not be needed. Waste collection could be carried out on alternate days, especially after 6 pm, the time when most residents are home. This system will bring about greater public participation, better environmental protection, as the residents will abstain from dumping the wastes along the streets, and increased collection efficiency.

Likewise, in some densely populated areas, such as some districts in Habana Vieja or Centro Habana municipalities, or in other areas of high population density or bad access, where the containers installed are not enough and the wastes are currently dumped along the roads or in selected places, it is advisable to implement a “door-to-door”, “fixed stops”, or “bell ringing” waste collection system by using small compactor trucks.

This system is the one traditionally implemented in many cities in Latin America where no containers are used for the temporary storage of the wastes prior to their collection. The wastes are stored by the residents and by small business owners inside their households or establishments and are later handed over to the compactor truck staff at some fixed places and hours, or when they hear the ringing of the bell announcing the presence of the collection vehicle.

The best hours and routes for this type of waste collection should be carefully examined, as the route frequency should prevent any inconvenience related to waste storage in the households or business establishments. Waste collection should also be carried out when the residents are home so that they themselves may hand the wastes over to the collection vehicle staff.

The implementation of such a system at some selected areas may relieve the shortage of containers faced by Havana City and prevent traditional waste collection at the dumping area, which entails higher costs, time spent by the collection vehicle as the wastes are collected and the area is cleaned, and, in many cases, the operation of machinery and equipment for waste collection when the amount of wastes accumulated is significant.

d. Weighing collection vehicles at the weighbridge installed at Calle 100 disposal site

The weighbridge installed at the entrance to Calle 100 disposal site became operational in the year 2013. Compactor trucks began to be weighed by the time they enter the site and when they leave it, thus helping to gather accurate and reliable data related to the amount of wastes collected by each truck along its route and, consequently, the total amount of wastes daily collected by compactor trucks as part of the so-called specialized waste collection.

The amount of wastes collected was previously estimated by means of the volume weight and the truck capacity. Therefore, the amount of wastes collected was not known exactly, as neither the volume occupied by the wastes in the truck when unloaded nor the waste compaction was properly checked. Apart from getting to know the amount of wastes collected more accurately, now it was possible to determine the payments due to the collection vehicle crew, which varies depending on the amount of wastes collected.

Waste weighing has certainly had an impact on the waste collection system, as now the vehicle crews, unlike before, care to collect as many wastes as possible in order to increase their salary, thus helping to improve collection efficiency and the handling of containers, which are completely emptied. However, some undesirable phenomena such as the tendency of the crews to prefer those wastes having a high volume weight (for example, demolition waste) to others having a low volume weight, occupying more space, and for collection of which the payment is lower are currently taking place.

In the light of the good results yielded by vehicle weighing, it is planned to be extended to all vehicles, including dump trucks and tractor-driven carts. Weighing will also continue to be used to pay the crews and as a reliable source to determine the amount of wastes collected, both for informational purposes and for the design of waste collection routes and frequency.

e. Demolition waste collection

There has recently been a significant increase in construction works, including both the construction of new buildings and the renovation or the extension of existing buildings, in Havana City as a consequence of the deregulation of some economic activities, thus bringing about a major increase in the generation of demolition wastes, which are currently managed mixed with other wastes. Only in some special cases, demolition wastes are collected separately using dump trucks to be dumped at Calle 100 disposal site.

In a report published in 2012 on sub-direction of UPPH final disposal, the generation of demolition wastes in July, 2012, was estimated to be 3,800 m^3/day, of which only 2,200 m^3 could be collected with the vehicles available. In order to increase demolition waste collection, a number of dump trucks owned by the Sugar Industry were hired.

In a report on sub-direction of UPPH on bulky waste collection updated in November, 2013, the generation of demolition wastes is estimated to be 2,877 m^3, as shown in the table below:

Table 1-28: Estimated Demolition Waste Generation by Municipalities Based on 0.12 kg/inhabitant/day (November, 2013)

Municipality	Demolition waste	Others	Total
Playa	157.6	141.6	299,2274.3
Plaza de la Revolución	234.5	118.3	352.8
Centro Habana	392.7	117.6	510.3
Habana Vieja	250.9	76.9	327.8
Regla	24.0	36.7	60.7
Habana del Este	171.2	160.1	331.3
Guanabacoa.	80.3	178.1	258.4
San Miguel del Padrón	82.6	139.1	221.7
10 de Octubre	327.2	199.6	526.8
Cerro	278.0	101.5	379.5
Marianao.	212.7	103.1	315.8
La Lisa	136.8	184.7	321.5
Boyeros	296.7	159.5	456.2
Arroyo Naranjo	165.8	165.8	331.6
Cotorro	66.5	56.7	123.2
Total	2,877.5	1,939.3	4,816.8

As the generation of demolition wastes is expected to continue to increase during the planning period of the updated Master Plan target year being 2020, it is deemed advisable to implement a home collection service to collect demolition and tree wastes in order to reduce subsidized expenses, improve the residents' environmental awareness raising, as well as to prevent sidewalk and street deterioration by installing 10 m^3 metal containers at construction sites generating such waste volume. Construction companies will be forced to hire this service, paying for container rental, transportation, and disposal at the landfill site.

Some standards regulating demolition waste disposal should be established in the city. The credits granted to residents should include an amount to be used for demolition waste collection. Demolition waste recycling should be promoted as part of the local development of the municipality, which will help create new jobs and reduce the state's budget burden.

This service could be provided by UPPH, or by cooperatives or self-employed workers as part of the changes currently being introduced into Cuba's economic policy.

f. Tree and garden waste collection

There are many green areas in Havana City. Many trees also grow along the sidewalks. Therefore, the generation of tree and garden wastes can be significant, thus making it necessary to implement a specialized collection service, which can be provided by the same organizations currently being involved in tree pruning and gardening activities (for example, the Parks and Gardens. Unit under UPPH or the Zoo).The collection of tree and garden wastes from private entities may also be carried out by cooperatives or self-employed workers, in the same way as was pointed out above for demolition waste collection.

If a service to collect tree and garden wastes separately from other wastes collection servies were to be provided, some facilities for tree waste shredding could even be established in the near future to use the material to improve the soil at the same green areas.

In the medium term, the introduction of segregated tree and garden waste collection could be the basis to eventually carry out composting activities at the same waste generation sites or in special facilities operated by UPPH, municipal governments, the waste generators themselves, or by cooperatives or self-employed workers involved in waste collection.

1.5 Storage (Container)

1.5.1 Current System (2013-2014)

a. Import of Containers (700L)

Most of the wastes generated in Havana City are disposed of by the generators in containers installed along the thoroughfares, or in selected places within the premises of the large generators for their temporary storage prior to their collection by compactor trucks.

Havana City was the first city in Latin America to design and operate in the 80's a system of waste collection using 700 l containers installed along the thoroughfares or in public areas to facilitate waste disposal by the residents prior to collection by the sanitation department, whereas practically all the Latin American cities continued to implement the "door-to-door", "fixed stops", or "bell ringing" system. The Cuban system was then praised as a step in the modernization of waste collection in Latin America.

This system is extremely convenient for the residents as they do not have to store the wastes inside the households, or wait for the collection vehicle to dispose of their wastes, but they can dispose of them any time in the containers installed along the thoroughfares.

It also means a more efficient operation of the waste collection service as it is carried out in a mechanized way, the operators are not in direct contact with the wastes, and a considerable amount of wastes can be collected at a single point because they are stored in containers and not scattered inside each generator's household. Collection routes can also be covered more rapidly, thus reducing costs.

If resources are not limited, as was the case when it was introduced in Havana City, this waste collection system using containers is extremely efficient, the costs are lower, and it is very convenient for the waste generators. However, if the resources to procure equipment are limited, as is the case now, it may pose some serious problems for the waste collection service, as will be explained below.

One of the problems is the need to operate compactor trucks equipped with container lifting devices enabling to empty the container into the truck. Therefore, only compactor trucks can be used for waste collection. Their container lifting devices should operate smoothly so that the compactor truck turns out to be useful. If the lifting device does not operate correctly, then the compactor truck is of no use for waste collection.

This requirement may be critical if vehicles and spare parts for the container lifting devices are limited, as collection frequency may be affected and the wastes may begin to be disposed of outside the container if it is already full, thus bringing about some hygiene-related problems that may provoke complaints by the residents.

Another problem is the fact that containers have a limited service life (approximately three years). The containers in poor condition or rendered useless because of main body or side supports breakdown, missing lids (which provokes that the wastes get soaked during the rainy season), or missing wheels (which provokes that the container has to be dragged to be lifted, thus accelerating its deterioration) need to be constantly replaced.

Apart from the normal deterioration of the containers caused by their installation out in the open, the hot weather conditions in Havana City, and their intensive or inappropriate use for waste storage (for example, they are sometimes used to dispose of demolition wastes), there are other conditions affecting their service life such as container theft and deterioration originated in acts of vandalism. In the second half of the year 2012, 299 containers were stolen, 303 were deprived of their wheels, and 33 were burned down, for a total 635 containers out of work or deteriorated. In 2013, acts of vandalism have continued to take place. However, container thefts have decreased as some measures such as seizing plastic products manufactured using material presumably stolen from containers (green plastic material) and welding container wheels to prevent people from stealing them have been adopted.

It was estimated in 2012 that 21,000 containers would be required to meet the needs of the waste generation in Havana City and for the container-based waste collection system to operate properly. A shortage of about 6,600 containers was then calculated.

In 2013, 4,000 containers were procured. However, this number was only enough to replace damaged containers. Therefore, wastes continued to overflow in the containers installed and the residents continued dumping the wastes on the floor in those places where the missing containers hade not been replaced, which had an impact on the quality of the waste collection service and on the increased number of complaints filed by the residents.

The number of containers installed in 2013 along the thoroughfares, as well as in other several entities signing waste collection contracts with UPPH, the condition of the containers installed, and the estimated container needs, are shown in the following table:

Table 1-29: Condition of Containers Installed and Number of Containers Required to Meet Existing Needs

Municipality	Planned	Actual	In Poor Condition	Shortage
Playa	3,335	2,851	426	910
Plaza de la Rev.	2,272	1,767	328	833
Centro Habana	1,149	831	100	418
Habana Vieja	826	489	221	558
Regla	88	76	12	24
Habana del Este	3,100	2,639	523	984
Guanabacoa	234	199	50	85
San M. del P.	572	542	70	100
10 de Octubre	2,123	1,545	397	975
Cerro	1,176	723	117	570
Marianao	1,417	1,248	165	334
La Lisa	1,071	743	149	477
Boyeros	471	446	251	276
Arroyo Naranjo	522	407	150	265
Cotorro	222	222	0	0
SUBTOTAL	18,578	14,728	2,959	6,809
Hospitals	826	592	81	315
Contracts	253	253	20	20
Agricultural markets	110	58	18	70
Cemetery	100	100	0	0
Zoo	95	95	0	0
SUBTOTAL	1,384	1,098	119	405
Total	19,962	15,826	3,078	7,214

If the average service life of a container is estimated to be three years, besides making up for the existing container shortage, nearly 7,000 containers should be procured and installed yearly. As this has not happened of late, the shortage of containers and the deficiencies in the waste collection system have deepened in recent years.

1.5.2 Short-Term Target (2015-2017)

a. Container (700L) Manufacture

As was stated above, the current shortage of containers in Havana City amounts to 6,600. Some 7,000 containers should be replaced annually for the waste collection system to operate properly.

A projection of the containers required to be procured (or manufactured according to the alternative herein proposed) to close the existing gap and maintain the required number of containers by distributing the containers currently lacking during the short term covered by the updating of the Master Plan is shown in the table below.

Table 1-30: Estimated Container (700L) Acquisition or Manufacture

Year	Number of containers at the beginning of the year	Number of containers put out of work during the year	Number of containers to be acquired to close the gap	Number of containers needed to replace useless containers	Total yearly acquisition	Number of containers at the end of the year
2015	14,400	4,800	2,200	4,800	7,000	16,600
2016	16,600	5,500	2,200	5,500	7,700	18,800
2017	18,800	6,300	2,200	6,300	8,500	21,000
2018	21,000	7,000	0	7,000	7,000	21,000
2019	21,000	7,000	0	7,000	7,000	21,000
2020	21,000	7,000	0	7,000	7,000	21,000

Based on the table above, the budget should include the necessary amounts for the acquisition of the containers required to meet waste storage and collection needs in Havana City efficiently, as shown in the following table:

Table 1-31: Estimated Amounts for the Acquisition of 700L Containers ($ 165.00/container)

Item	2015	2016	2017	2018	2019	2020
Number	7,000	7,700	8,500	7,000	7,000	7,000
Cost (USD)	1,155,400	1,270.50	1,402.50	1,155.00	1,155.00	1,155.00

As containers are not manufactured in Cuba, but have to be imported, a significant yearly financial investment has to be made to procure them. If the unit price of a container were USD 165 USD, 1,155,000USD to 1,402,500USD would be needed annually.

If this amount were not available, waste collection deficiencies would deepen and health hazards and residents' complaints would increase.

Some of the alternatives proposed to tackle this problem are shown below:

a) Install a plant to manufacture containers by rotocasting at DPSC or in another governmental facility in order to reduce the number of containers to be imported. According to an estimate made after the Mexico training in 2012, , the cost to manufacture containers, including the import of raw materials and the recouping of the initial investment, would be less than half the present cost of imported containers. Therefore, the initial investment for the plant would be recouped in two or three years. In addition, one of the plastic recycled from deteriorated containers could also be used as raw material to manufacture the containers. .

b) A second alternative would be to replace the container-based collection system implemented in some areas in Havana City with the direct handing over of the wastes to the collection vehicles by means of the "door-to-door", "fixed stops", or "bell ringing" waste collection system. A convenient replacement of the system would be better than to force waste dumping on the floor in those places where the containers had to be removed due to their deterioration, as it implies higher costs and more equipment to collect the wastes and provokes environmental problems and complaints by the residents. However, it should be taken into account the fact that the direct handing over of the wastes by the generators involves the operation of more collection vehicles, as the routes are longer.

1.6 3R's (compost)

1.6.1 Present System (2013-2014)

In Cuba, as in most Latin American countries, organic waste generation is high, as shown by the waste composition surveys conducted, according to which the organic component is equal to or higher than 50%.

This originates in the fact that people continue to cook at home and consume less processed food than in developed countries. In addition, the cities have large green areas and trees are abundant, thus generating a lot of tree and garden waste.

The solid waste composition surveys conducted during the formulation of the Master Plan in 2005 show that tree and food wastes account for 54% of the total municipal wastes generated, as can be seen in the table below:

Table 1-32: Waste Composition in 2005

Type of Waste	Generation source				Average
	Households	Hotels	Restaurants	Office	
Paper and cardboard	9	22	22	38	23
Aluminum	1	3	4	1	2
Scrap metals	1	1	2	0	1
Plastic	8	9	8	7	8
Glass	11	13	19	3	12
Textile	1	0	0	1	1
Tree waste	9	0	0	0	2
Food waste	60	52	45	51	52
Rubber	0	0	0	0	0
Leather	0	0	0	0	0
Others	0	0	0	0	0
TOTAL	100	100	100	100	100

Under these circumstances, treating organic waste is an alternative to recover resources and reduce the amount of wastes taken to the final disposal sites. Therefore, some efforts have been made to build facilities and implement organic waste treatment operations in Havana City as UPPH's facilities in 2005 when the Master Plan was formulated.

The amount of compost produced as reported by the Master Plan in 2005 is shown in the table below:

Table 1-33: Compost Amount Reported in 2005

Year	Compost (m3)	Earthworm Humus (m^3)
2003	6,534	92
2004	7,019	164

The document pointed out that the product obtained from the treatment of organic wastes was used as cover soil at the final disposal site, or as a soil improvement material for the site reforestation.

However, when this Project for Capacity Improvement began in 2010, compost production had already been stopped and the earthworm humus project no longer existed due to a lack of both vehicles to transport segregated tree wastes to the composting facilities and, especially, the equipment required to turn the waste piles, as the only equipment available then were moved to the landfill site. The trained staff that operated organic waste treatment facilities moved to other places resulting shortfall in human resources.

The Project carried out a pilot project aimed at producing small-scale quality compost from the organic wastes collected at some selected sources such as hotels and agricultural markets.

During the implementation of the pilot project, a number of problems had to be tackled, the most important of which were the following:

- Segregation of the wastes at the generation sources, both in hotels and agricultural markets, and handing over to the composting project, thus preventing them from being used to feed pigs,

- In the light of the lack of equipment to shred tree wastes to be added to the organic material collected to facilitate oxygen penetration into the waste piles, tobacco waste from a cigarette factory began to be used instead.

- Keeping containers used for the temporary storage of segregated organic waste at the generation sources, as the containers installed there were often moved to other places,

- Availability of a vehicle for the collection of the segregated organic wastes at the generation sources, as often there was no vehicle available for collection, thus affecting waste segregation and provoking complaints.

Despite the difficulties, the facilities for a small compost plant were built by the Havana City, and it was proved that a quality composting product that could be used in gardening to improve soil conditions could be produced through the pilot project. Some arrangements were even made to sell the product in agricultural markets.

The sources contributing the organic wastes to be processed at the small compost plant in the Project are shown below:

- Chateau Miramar Hotel,
- Comodoro Hotel,
- Tulipán agricultural market,
- Plaza Cerro agricultural market,
- Milagros agricultural market,,
- Caballo Blanco agricultural market,
- Virgen del Camino agricultural market,
- Santa Catalina agricultural market,
- Wholesale agricultural market (El Trigal cooperative),
- Cigarette factory

Some of these sources left the project for several reasons, particularly due to existing waste collection flaws. The generation sources where the wastes continued to be segregated and collected by late 2013 were the following:

- Chateau Miramar Hotel.
- Comodoro Hotel,
- Caballo Blanco agricultural market,
- Virgen del Camino agricultural market,
- 17 y K agricultural market,

- Tulipán agricultural market,
- Wholesale agricultural market (El Trigal cooperative),
- Cigarette factory

The amount of wastes processed, the amount of foreign materials found in the wastes received, which had to be removed (rejected material), as well as the amount of compost produced during the implementation of the Pilot Project up to February, 2014, are shown in the following table:

Table 1-34: Amount of Compost Produced During the Pilot Project (from November, 2011 to February, 2014

Wastes received at the Compost Plant	Foreign materials removed from the wastes	Processed wastes	Compost produced
3,565 m^3	1,658 m^3	1,949 m^3	1,324 m^3

The data in the table below cover 836 days of operation at the pilot compost plant showing the following percentages:

Table 1-35: Composting Process Indicators at the Pilot Plant

Days of operation	836
Percentage of wastes that could be used out of the total waste received at the plant	55 %
Percentage of foreign materials found in the wastes received at the plant (rejected material)	45 %
Daily processed wastes	2.33 m^3/day

During the implementation of the pilot project, not only records of the amount of material processed and the amount of compost produced were kept, but they were also used to estimate the plant operation cost per each m^3 of wastes processed and compost produced. The calculation data are shown in the table below:

Table 1-36: Operation Cost of the Compost Plant (including waste segregation and transportation)

	Partial Cost in CUC	Partial Cost in CUP	Wastes collected in 658 days (before segregation) : ton
Operation cost	5,889.6	7,863.6	
Equipment	33,351.1	5,056.7	
Total	39,240.7	12,920.2	1,353.0
Cost per ton	29.0	9.5	
Cost per m^3	21.2	7.0	

Table 1-37: Operation Cost of the Compost Plant (including only organic waste treatment)

	Partial Cost in CUC	Partial Cost in CUP	Wastes collected in 658 days (before segregation): ton
Operation cost	1,782.5	70,986.1	
Equipment	6,019.9	5,408.2	
Total	7,802.4	76,394.3	779.9
Cost per ton	10.0	98.0	
Cost per m^3	7.3	71.5	

Table 1-38: Overall Evaluation of the Operation Cost of the Compost Plant

	Partial Cost in CUC	Partial Cost in CUP	Wastes collected in 658 days (before segregation): ton
Operation cost	7,672.1	78,849.7	
Equipment	39,371.0	10,464.9	
Total	47,043.1	89,314.6	779.9
Cost per ton	60.3	114.5	
Cost per m^3	44.0	83.6	

The composting pilot project implemented as part of the Project verified that the organic food wastes collected at hotels and agricultural markets can be used to produce compost. However, it also revealed existing difficulties for organic waste treatment sustainability, which mainly originate in current limitations of resources, containers and vehicles for the storage and transport of organic wastes segregated, which have brought about that the wastes received at the compost plant contain a lot of foreign material that cannot be processed and that need to be manually removed at the final disposal site.

1.6.2 Short- and Med- Term System (2015-2020)

During the short-term planning horizon of the present updating of the Master Plan, the operation of the facility built for the treatment of the organic wastes collected at hotels and agricultural markets results in establishing sustainable composting system if improving the availability of containers and vehicles permanently assigned to the compost plant is kept in order to ensure the continuity of waste segregation at the generation source and their timely transportation to the composting facility.

In addition, the necessary arrangements will be made and the proper permits will be secured to sell the compost at the agricultural markets contributing the organic wastes so that the plant may have a financial source of its own and the market staff may confirm the fruit of their efforts when segregating the wastes.

In Table 1-34 and Table 1-36 of the previous section, the preliminary outcomes of the composting pilot project, including the amount of wastes processed, the amount of compost produced, and the plant operation costs, are shown so that they may serve as the basis for the continuity of the facility, the expansion of its operations, and the establishment of other organic waste treatment facilities in the future, can be seen.

In the medium term, and building on the experience gained during the composting process, the operations of the small compost plant are proposed to be extended to cover other waste generation sources. If equipment and resources availability conditions allow it, a facility to treat tree wastes is also proposed to be set up at New Guanabacoa sanitary landfill site as a way to recover resources, reduce the amount of wastes to be transported to the final disposal sites, and obtain cover material for the site.

Special care should be taken not only with the equipment and the supplies required for the operation of an aerobic bio-digestion plant with waste pile turning, but also with the proper, timely, and balanced supply of the tree wastes to be processed at the plant, which implies the coordination of pruning activities at the city's green areas, the timely collection of the wastes so that they do not accumulate along the thoroughfares and get mixed with other wastes, and their transportation to the plant. The amount of wastes taken to the facility should be consistent with its treatment capacity in order to prevent unprocessed wastes from accumulating, thus posing a fire threat, or to avoid that they may have to be sent to the disposal site without processing.

1.7 3R's (Recyclable Materials)

1.7.1 Present System (2013-2014)

The recovery of recyclable materials from the wastes for their return to the productive cycle has proven to be an important source of resources reducing the impact of productive activities on the environment and the amount of wastes being taken to the final disposal sites, thus reducing their impact on the environment as well.

In Cuba, especially in Havana City, the recovery of recyclable materials has a long tradition. It has been carried out by residents' organizations such as the Committees for the Defense of the Revolution, whereas the Enterprise for the recovery of Raw Materials is responsible for collection and marketing.

Some data about the recovery of recyclable materials in Cuba and in Havana City are included in the Master Plan formulated in 2005 as shown in the table below:

Table 1-39: Recyclables and Price Paid by the Enterprise for the Recovery of Raw Materials in 2005

Item	Price Paid by the Enterprise for the Recovery of Raw Materials
Plastic	700 CUP/ton
Glass	80 CUP/ton
Textile	ND
Paper and cardboard	160 CUP/ton
Wood	ND
Ferrous scrap	35 CUP/ton
Non-ferrous scrap (Aluminum)	600 $USD
Other scrap metals	ND
Bottles	ND

The amount of recyclable materials recovered by UPPH during the years of the project for the formulation of the Master Plan are also reported as shoe in the table below:

Table 1-40: Recyclable Materials Recovered by UPPH

Recyclable Materials	2001 (t/year)	2002 (t/year)	2003 (t/year)
Aluminum	72.0	65.0	84.0
Paper and cardboard	566.0	525.0	369.0
Glass	125.0	404.0	127.8
Plastic	25.0	14.2	119.0
Lead	2.0	34.4	100.0
Ferrous scrap	1,192.0	1,240.0	2,335.0
Wood	No data	No data	No data

The Master Plan does not explain the waste management stage in which UPPH recovered these recyclable materials. However, it mentions the existence of a Recycling Plant near Calle 100 disposal site, which basically prepares the ferrous scrap recovered by UPPH to be handed over to the Enterprise for the Recovery of Raw Materials.

This recycling plant was still operating by the time the Project for Capacity Improvement was being implemented. However, its operation had been reduced to cut the metal scrap for its transportation to the Enterprise for the Recovery of Raw Materials and to a small conveyor belt for the classification of PET wastes.

A UPPH's internal report in November 2015 shows that the amount of raw materials recovered by UPPH in that year amounted to 276.4 tons, most of which come from scrap metal recovered at the Recycling Plant, as the recovery of recyclables at Calle 100 and Ocho Vías landfill sites has reduced dramatically in the year 2013 due to the presence of scavengers who fight over them with UPPH's employees, thus originating conflicts.

Meanwhile, some significant changes related to recyclable material recovery had been brought about by the reforms introduced in the country's economy, which authorized self-employed workers to sell recyclables to the Enterprise for the Recovery of Raw Materials.

This provoked a dramatic increase in the recovery of recyclable materials from the city's containers and especially at the final existing sites, where the presence of "scavengers" was noticeable. There are no data about the number of scavengers operating at Calle 100 disposal site. However, some estimation refers to the presence of nearly 500 people recovering recyclable materials from the wastes, a number increasing during the school break in the summer months as many children join the adults to recover recyclables at the site.

Although the decision to authorize self-employed workers to recover recyclables certainly helped to create jobs and promote material recovery, it has also brought about some operational problems at the disposal site, as the heavy equipment operators are forced to delay waste compaction and covering with soil until the scavengers finish their recovery activities. The number of scavengers who have been injured by heavy equipment or collection vehicles at the site has also increased due to both the scavengers' imprudence when trying to recover as many recyclables as possible, and the carelessness showed by heavy equipment operators and collection vehicle drivers.

Another somehow undesirable consequence of self-employed workers being allowed to recover raw materials is the reduction of the recovery of recyclables as a voluntary activity oriented to protect the environment or show some social solidarity as was carried out before by schools and public organizations.

This was evident during the implementation of the pilot project aiming at promoting environmental protection and the 3R's policy carried out as part of the Project for Capacity Improvement, which, despite the fact that a number of activities were held and some important goals were achieved in terms of recyclable material recovery, both by the residents and by the students in the areas and schools where the pilot project was implemented, had to face the competition by self-employed recyclable collectors who could sell their materials to the Enterprise for the Recovery of Raw Materials, whereas the wastes recovered during the pilot project had to be handed over to UPPH for free.

There are some factors limiting both the variety and the amount of recyclable by-products that can be recovered from the wastes in Cuba, as the capacity of the Enterprise for the Recovery of Raw Materials to buy recyclables is also limited not only by its financial resources at hand, but also by the capacity of the Cuban industry to use recyclables as raw materials for industrial processes, as many of them cannot be used in all its variety or in great amounts, such as paper and plastic, while others can only be exported as they cannot be used in Cuba, as is the case with PET wastes.

1.7.2 Short- and Med- Term System (2015-2020)

As the decision to authorize self-employed workers to carry out raw material recovery activities and to sell their recyclables to the Enterprise for the Recovery of Raw Materials was made very recently, its positive consequences, namely, an increase in the amount of raw materials recovered and the creation of new jobs, as well as its negative ones, namely, an increase in the number of scavengers at the final disposal sites and the lack of incentives to carry out recyclables recovery for social or environmental reasons, will have to be evaluated in the near future.

A number of measures should be adopted in the near future to control scavengers' activities at the final disposal sites, namely:

- Promote the integration of scavengers into cooperatives to control their activities and access to the final disposal sites,
- Take some health-related measures such as the vaccination of the scavengers operating at the final disposal sites and, as far as possible, build some sanitary facilities so that they may clean up once they finish their activities prior to leaving the site,
- Assess the possibility that social organizations and schools may recover recyclable materials and sell them to the Enterprise for the Recovery of Raw Materials, thus obtaining some profits that may be used for the benefit of the community, the acquisition of school materials, or the maintenance of schools.

In the light of the construction of a plant for the recovery of recyclable materials from unsegregated wastes at the planned New Guanabacoa sanitary landfill site, the plant operating conditions, as well as its construction and operation costs, should be carefully evaluated, as under the circumstances described above, both regarding the limited presence of recyclable materials in the city's wastes, and the good chances that existing recyclables may be collected by self-employed workers or by scavengers directly from containers or at the final disposal sites, it is possible that the operation of such a plant is not viable based on the actual waste recovery rate expected and the high energy and maintenance costs involved in a facility of this kind.

1.8 Route and Frequency Management

a. Optimizing routes and frequencies

The planned implementation of various projects, as stated in previous chapters of the present updating of the Master Plan, will force to revise existing waste collection routes and frequencies.

The following are some of the projects planned to be implemented:

- Increase the number of collection vehicles and containers to be used for the temporary storage of solid wastes along thoroughfares and public areas prior to their collection,
- Install small waste transfer stations in densely populated or relevant areas such as in Old Havana and in suburban and rural areas,

- Identify areas where waste collection will be carried out by means of the "door-to-door". "fixed stops", or "bell ringing" system, without using containers along the thoroughfares,
- Revision of the final disposal system as a consequence of both the operation of New Guanabacoa and New West sanitary landfill sites and the closure of Calle 100, Ocho Vías, and Campo Florido final disposal sites.

All these projects or any one of them will bring about the revision of existing waste collection routes and frequencies. Route revision has already been made necessary by the adjustments derived from the operation of the weighbridge at Calle 100 disposal site, which has helped to collect some data about the weight of compactor trucks that will force to redefine existing collection routes and frequencies, as there have been some significant differences between the waste amount as recorded by weighing and the estimated waste volume used before.

It should be noted that a reliable database of the amount of wastes collected by each vehicle along its various routes, including data covering a prolonged period of time enabling to correct any statistic differences, as seasonal variations in waste generation are usually extremely significant, should be available for the revision of waste collection routes and frequencies.

Routes revision should also be carried out in a steady way and not as isolated projects, as the various projects planned to be implemented will modify the waste collection system. These projects may be implemented simultaneously and not in a sequential way. Therefore, their implementation period cannot be accurately predicted, as it depends on resources availability.

Consequently, instead of implementing isolated projects aimed at revising collection routes and frequencies, a department responsible for route and frequency revision should be set up at UPPH to store the data about the amount of wastes collected along each route, based on weight reports, and the time taken to cover the routes in order to be able to optimize the routes and frequencies on a daily basis or to significantly modify them as a consequence of the implementation of one of the projects related to waste transfer or final disposal referred to above.

However, based on the weighbridge data regarding the weight of compactor trucks collecting the wastes disposed of in the containers installed along the thoroughfares, collection routes were adjusted. The results are shown in the table below.

Table 1-41: Specialized Waste Collection Divisions in November, 2013

Municipalities	Routes	
	Before	November 2013
Playa	10	9
Plaza de la Revolución	8	5
Centro Habana	5	3
Habana Vieja	3	2
Regla	1	1
Habana del Este	6	6
Guanabacoa.	1	1
San Miguel del Padrón	3	3
10 de Octubre	10	9
Cerro	5	3
Marianao	6	4
La Lisa	3	3
Boyeros	2	2
Arroyo Naranjo	2	2
Cotorro	1	1
Total	66	54

b. Compliance with routes and frequencies

As could be seen in previous sections, existing conditions do not guarantee compliance with the routes and frequencies planned for waste collection mainly due to the limited number of collection vehicles and containers. However, UPPH and the municipalities try hard to comply with the routes and frequencies to provide a good waste collection service.

When the limitations stated above are essentially overcome based on the plans to improve the number of operating collection vehicles and containers, they will be in a position to properly comply with the routes and frequencies and the service could be improved.

The installation of small transfer stations, as described above, could help improve existing conditions, as they would enable to optimize the limited vehicles currently used for waste collection.

Waste weighing at Calle 100 disposal site could also help improve existing conditions, as the estimations about waste volume weight would improve, and, as pointed out above, it would enable to redesign the routes to adjust them to the loading capacity of the vehicles, preventing routes from exceeding the loading capacity of the vehicles, as well as others in which the loading capacity is not fully used. This could also help improve compliance with scheduled routes and frequencies.

The compliance with scheduled routes and frequencies will enable the wastes to be timely collected, preventing them from being stored in the containers or dumped along the thoroughfares, thus avoiding sanitary risks and nuisances and improving the city’s sanitation, which will definitely help reduce or ultimately eliminate residents’ complaints related to collection service deficiencies.

c. Service supervision

At present, the supervision of waste collection efficiency limits itself to the authorities' tour of the areas reporting waste accumulation or wastes exceeding the capacity of the containers installed due to failure to comply with scheduled routes and frequencies, and to the complaints filed by the residents or by the managers of the entities where the containers had been deployed such as markets, schools, and companies.

Another way to supervise the compliance with scheduled routes and frequencies recently being implemented is the weighing of the collection vehicles entering Calle 100 site, as the weight of the wastes somehow reflects the vehicle's compliance with the assigned route and the collection of the containers installed along it. This way of supervision has a greater impact now that collection vehicle crews are paid based on the amount of wastes collected, and not just depending on the fulfillment of the route assigned.

The progress made regarding the supervision of the compliance with collection routes and frequencies are nonetheless indirect methods just enabling to detect service flaws once they take place.

In the near future or in the medium term, and as the number of collection vehicles and containers increases, these indirect supervision methods may be supplemented with direct supervision by means of the authorities' random, unexpected visits to the routes accompanied by the residents, whose complaints related to waste accumulation or failure to collect containers will be recorded and solved accordingly.

1.9 Outsourcing

The economic changes recently introduced by the Cuban government seem to point to a greater participation of private individuals in productive activities and services, as well as to reduce the direct operation of all productive activities by state enterprises or entities.

At present, all activities related to solid waste management in Havana City are carried out by either DPSC or the municipalities, except for the participation of Aurora enterprises, which are also state enterprises, in waste collection in some areas.

It has been reported that high government authorities have instructed to study the possibility and advisability that some waste management-related activities are carried out by state-owned enterprises other than DPSC and the municipalities, cooperatives, and even private individuals.

It is not possible to anticipate when this may come to happen, or the activities to be included, as it will depend on the studies and evaluations to be carried out by high Cuban government authorities. However, some considerations about it are pointed out below.

1.9.1 Direct Operation by UPPH vs Outsourcing

In other cities in the world and in Latin America, there exist many combinations regarding the management of solid wastes carried out either directly by government entities or by private enterprises. In those cities where the state's participation in the economy is greater, solid waste management is completely carried out by government entities, while in those cities where the economy has been increasingly privatized, it is mostly carried out by enterprises, be it through concessions or contracts, and the government entities limit themselves to manage them and supervise the service rendered.

Between these two extremes, there may be a huge number of intermediate combinations where direct operation by government entities and participation of private enterprises coexist. It cannot be said categorically which model is better or preferable, as both have advantages and disadvantages, and the choice largely depends on the prevailing conditions in each country.

It should be clearly stated that in all cases government entities are responsible for solid waste management. They can provide the service using their own resources or hiring private enterprises through concessions or contracts.

The reasons why private enterprises may be hired are many, ranging from the simple intention to reduce the participation of government entities in direct operations, to save budget resources or to overcome deficiencies, to the lack of resources available to invest in a venture that can be carried out instead by private enterprises, the cost of which can be recouped in the long term through the fees collected for the services rendered or the operations performed.

There are many waste management-related operations that can be carried out by private enterprises, including waste collection, transportation of the wastes unloaded by collection vehicles at the transfer stations, operation of waste treatment plants, and partial or complete operation of final disposal sites.

In the event that some state enterprises other than UPPH or the municipalities, cooperatives, or even private individuals are authorized to participate in some stages of solid waste management in Havana City, DPSC would have to carry out a number of previous activities, as listed below, to ensure that the participation of said entities is successful.

- Clearly identify and specify the activities to be carried out by hired enterprises by preventing to hire only one enterprise or entity to provide the whole service, as in case any deficiencies may arise or the operation is suspended, the service would be neglected. It would be better to divide the hired service among several enterprises or entities so that in case of inefficient service by one of them, the enterprise providing a better service is allowed to increase its operations.

- Fix the proper terms in which the hired service will take place by considering the time required for the hired enterprises to recoup the cost of the investments to be made in terms of buildings, facilities, and equipment necessary to provide the service in order to avoid that the costs may be too high on account of the accelerated recouping or depreciation of the investments,
- Carry out operation cost analysis in order to determine the proper fees to be paid to the hired enterprises for services rendered,
- The contracts signed should clearly specify the activities to be carried out by the hired entities so that they may be duly supervised to determine any responsibility for failure to provide the service or low-quality service,
- The records of the activities to be carried out, including units of measurement and supervision methods, should be clearly kept, preferably in digital form.

The following are some of the activities that could be evaluated to be carried out by hired entities under the circumstances described above:

- Waste collection along selected routes or areas,
- Operation of waste treatment facilities such as compost plants or biodigestion plants,
- Waste transportation from transfer stations to final disposal sites,
- Partial, specific activities at the final disposal sites such as weighbridge operation, heavy equipment operation for waste compaction and covering with soil, operation of leachate treatment facilities, etc.

1.9.2 Providing service for large waste generators (e.g., agricultural markets) and for demolition waste generators

a. Permits/Licences

Another way to promote the participation of third parties in solid waste management would be to authorize self-employed workers, state-owned, or private enterprises to collect the wastes from large generators or from companies operating in foreign currency, as well as to collect special wastes such as demolition or tree wastes.

To this effect, the following conditions would be required:

- The permits allowing self-employed workers, cooperatives, or state enterprises to carry out waste collection activities should be issued.
- The enterprises, entities, or generators obliged to hire waste collection services provided by entities other than DPSC and the municipalities should be clearly determined.
- DPSC and the municipalities should abstain from providing waste collection service to the entities or generators now obliged to hire authorized third parties.

If these entities were authorized to provide the waste collection services mentioned above, existing limitations in terms of resources and collection vehicles faced by UPPH and the municipalities could be reduced, as the amount of waste and the number of collection points would decrease enabling to concentrate the resources on the areas and entities that would continue to be served by UPPH and the municipalities.

As this would be the first experience of this kind not only in Havana City, but in Cuba as a whole, the participation of third parties in waste collection should certainly be preceded by studies and actions to ensure the success of a venture requiring that investments are made under safe conditions.

The following are some of the studies and activities to be carried out prior to the participation of external entities in waste collection:

a) Study the potential for state enterprises, cooperatives, or private individuals to participate in waste collection under the conditions mentioned above.

b) Clearly identify the enterprises and waste generators that would be obliged to hire entities other than UPPH and the municipalities to provide waste collection services.

c) Study and determine the fees to be paid by the entities or generators obliged to hire the services of third parties for waste collection so that the fees are not exclusively determined by supply and demand.

d) Establish the conditions under which state enterprises, cooperatives, or private individuals are to be authorized to provide waste collection services, including the equipment and systems used for waste collection, transportation, and unloading at the final disposal sites or at the transfer stations.

e) Establish ways to control waste collection by third parties by implementing forms recording waste collection source and destination so that the generators may be confident that the wastes collected are really disposed of at authorized landfill sites.

f) Clearly determine the fees, taxes or duties to be paid by the enterprises authorized to provide waste collection services, especially the fee to be paid for unloading the wastes at the transfer stations or final disposal sites.

1.10 Vehicle Maintenance

1.10.1 Present System (2013-2014)

Collection vehicle maintenance is crucial to keep the efficiency of the collection service and to extend the service life of the collection vehicles as long as possible, thus reducing the expenses required for collection vehicle acquisition and the cost of the service rendered. Moreover, proper maintenance reduces vehicle emissions, thus helping to comply with existing environmental standards.

This is particularly important when the limited number of collection vehicles available makes it impossible to assign replacement units to cover the route in case of vehicle breakdown or scheduled preventive maintenance.

The existing limitations in terms of both the number and the type of vehicles available for waste collection in Havana City, as well as the financial restraints to procure the vehicles necessary to provide an efficient service and to replace the units rendered useless due to accidents, prolonged operation, or serious breakdown beyond repair, were tackled in the section corresponding to waste collection.

Therefore, it is extremely important that collection vehicle maintenance is carried out under the best possible conditions to minimize repair time, reduce downtime, and prevent frequent breakdown of the parts already repaired. Proper preventive maintenance should be performed to extend the service life of the vehicles, thus reducing unit replacement.

In many cities in developed countries, and even in Latin America, public organizations providing waste collection services do not have workshops or facilities of their own to carry out repair and maintenance works. A contract is signed with private companies specifying the fees to be paid for repairs and the time required for them. Therefore, the service provider does not carry out repair and maintenance works, but hire an external company for both preventive maintenance and repairs.

As it is well known, despite the recent economic reforms the activities of private enterprises and self-employed workers in the field of vehicle repair is limited. Therefore, the entities providing collection services operate their own repair and maintenance workshops.

This is the case with the Central Workshop managed by UPPH, in which collection vehicles are repaired and maintained so that as many vehicles as possible may operate under the best conditions to provide an efficient service.

Under the present circumstances, the operation of the Central Workshop has a direct impact on the waste collection service, as the number of operating units available for waste collection on a daily basis somehow depends on the repair and maintenance works carried out at this facility.

Consequently, the Project for Capacity Improvement implemented by JICA in Havana City from 2010 to 2014 included as important components the donation of tools and equipment to modernize the workshop operation, the training of the workshop staff to properly carry out preventive and corrective maintenance of collection vehicles, and the improvement of workshop records and activities monitoring.

The Cuban side made great efforts during the implementation of the Project for Capacity Improvement to modernize the workshop infrastructure, to prepare the conditions required for the proper installation and operation of the tools and equipment donated by JICA and for the staff to be trained by JICA's experts, and to improve the monitoring of the workshop operations.

During the Project for Capacity Improvement, the Government of Japan donated the equipment listed below, which were properly installed and put into operation.

Table 1-42: Project Donation Equipment

Equipment	Brand and Model	Number	Function
Forklift truck	KOMATSU	1	Load and carry heavy parts.
Lathe	TAL460-1000	1	Manufacture cylindrical parts.
Milling machine	VHR-A	1	Manufacture parts of various shapes
Drilling machine	SU-1264	2	Open holes.
Hacksaw machine	PSB-210U	1	Cut metal materials
Injection pump test bench	MERLIN	1	Check injection pumps.
Injector tester	AB-0511	1	Check injectors
Crimping machine	EH-0717	1	Manufacture and crimp hoses.
Hydraulic press	AHP-35	2	Press and pull bushings, bearings, etc.
Chain block	NT-0314G	2	Hoist heavy parts.
Electric welding machine	RJ-0115	2	Electric welding.
TIG welding machine	YC-300WX4TOO	1	Argon welding.
Grinding machine	LP-1407, LP-1409	4	Grind
Tire changer	CG-5424	3	Change tires
Tire vulcanizer	CG-7001	1	Vulcanize tires.
Compressors	XO-0147, XO-0145, 0205	5	Compressed air systems.
Air tank	XO-0727H	1	Store air.
Washer	CWH-R16V-60	2	Wash vehicles using hot and cold water.
Fixed lubrication equipment	PM-0301	1	Grease vehicles.
Oil supply system		1	Supply 5 different kinds of oil.
Mobile greasing equipment	PM-0902	2	Grease parts.
Mobile oil supply equipment	PM-0904	2	Supply oil for gearboxes and differential gears.

Besides the equipment donated, the workshop was provided with 3 batches of tools, some specifications and functions of which are highlighted below:

- Air tools and accessories (impact wrenches, grinders, drills, polisher, etc.)
- Garage equipment (20 ton jacks, battery charger, hydraulic press, stands, etc.)
- All-purpose hand tools (reinforced and standard socket sets, combination wrench sets, pipe wrench sets, monkey wrench sets, pliers, screwdrivers, etc.)
- Electrician's tool sets.
- Cutting tools(cutters, bits, drills, etc)
- Die and socket set
- Punch set
- Technical diagnosis tools (compression meter, pressure gauge, etc)
- Measurement equipment (micrometers, caliper, thickness gauge, dial indicator, etc.)
- Grinding wheels
- Others (torque wrench, vises, etc)

The following training courses were held to improve the workshop staff's capacity:

Table 1-43: Training Courses and Workshops

Course	Participants	Lecturer:
Vehicle maintenance management and preventive maintenance	10	Ryo Hiraga, Yamanaca
Air and electric systems of compactor trucks	12	Ryo Hiraga, Yamanaca
Training on compactor trucks donated by Japan	11	Yamanaca
Maintenance of compactor trucks (operation and management) / Machine tool operation (selection, acquisition, and distribution design)	10	Ryo HIRAGA
Maintenance of compactor trucks (diagnosis, maintenance, and repair)	10	Tadayuki YAMANAKA
Machine tool operation (heavy equipment maintenance improvement)	6	Takeshi Dosho
TIG welding machine	7	Yoshikazu KANAZAWA
Milling machine and lathe	5	Takamitsu NAGASHIMA
Directions for the installation of additional equipment (Injection pump test bench, service tool sets, crimping machine)	2	Saburo TANIMURA
How to use the regulator and maintenance of large tires	15	Yamanaka, Hiraga, Hasegawa (translator)
Practical seminar on tire maintenance	17	Yamanaka, Hiraga, Hasegawa (translator)
Brakes maintenance 1 and 2	12	Yamanaka, Hiraga, Hasegawa (translator)
Practical training on tire operation	2	Yamanaka, Hiraga, Hasegawa (translator)
Practical training on the proper operation of the compressor, the regulator, and the impact wrenches.	5	Yamanaka, Hiraga, Hasegawa (translator)
Cylinder repair (hydraulic system)	7	Juan Rodríguez
Clutch repair, assembly and disassembly	8	Alfredo Valdés
Differential gear operation and repair	8	Geroncio Hernández
Engine lubrication system operation	9	Alfredo Valdés
Lathe operation and maintenance	5	Nelson Sánchez
Engine cooling system operation	11	Bienvenido Pombet
Engine maintenance	6	Frank Zorrilla
Labor Safety and Hygiene	11	Eduardo Jiménez

These theoretical and practical seminars were aimed at training the workshop staff and ensuring quality repair and maintenance works. They will also be used to evaluate the knowledge acquired by the staff during the implementation of the Project

Another remarkable achievement of the Project for the Improvement of Capacity is the quality training of the workshop technicians and mechanics as shown by the results of the tests jointly prepared by JICA's Expert Team and the C/P taken by 51 employees. The initial goal of training 20 people was exceeded. Test results are shown in the table below:

Table 1-44: Results of Theoretical Tests Taken by Technicians and Mechanics from the Central Workshop in 2013

Area	Number of people taking the tests	Number of people passing the tests
Maintenance	14	14
Electric system	5	5
Hydraulic system	8	8
Welding	4	4
Tyres	7	7
Machine tools	6	6
Fuel injection pumps	2	2
Greasing	4	4
TOTAL	50	50

The following manuals were either prepared or translated to assist the proper operation of donated equipment and complex repair of compactor trucks:

Table 1-45: Manuals Elaborated

Manual	Goal
1. Hydraulic system maintenance manual	In general, the preparation of these manuals is aimed at providing workers and technicians with the knowledge required to properly operate donated equipment and to carry out proper repair and maintenance works enabling to extend the service life of the compactor trucks. These manuals will also be useful for future consultation.
2. Clutch maintenance manual	
3. Electric system maintenance manual	
4. Electric welding manual	
5. Autogenous welding manual	
6. Air tool maintenance manuals	
7. Tire maintenance manual	
8. Tire changer operation manual	
9. Differential gear manual	
10. Machine tool maintenance manual	
11. Cooling system maintenance manual	
12. Lubrication system maintenance manual	
13. TIG welding manual	
14. Manual de mantenimiento del sistema de alimentación	
15. Air intake and exhaust system maintenance manual	
16. Labor safety and hygiene management manual	
17. Injection pump test bench operation manual	
18. Engine maintenance manual	
19. Greasing equipment operation manual	
20. Air-operated brake manual	
21. Steering maintenance manual	
22. Transmission maintenance manual	

The following forms were also prepared to ensure proper monitoring and recording of workshop activities:

Table 1-46: Format and Instructions Established

Form	Function
Donated equipment maintenance manual	Establish operations and maintenance cycles for donated equipment
Tire pressure table	Supply the recommended air pressure
Table of torque values for each type of bolt	Tighten bolts according to existing standards
Tool records to be used at the tool room	Ensure proper control over existing tools to prevent tool loss and deterioration

The Cuban side also carried out some works to renovate the workshop infrastructure and buildings so that the facilities were safe and appropriate to perform vehicle maintenance. The works carried out at the Central Workshop are shown in the table below, whereas some photos of the works are included in Appendix-1.

Table 1-47: Works Carried Out to Improve Workshop Facilities

Area	Works
Workshop 1	Roof repair, repair and paint of structures, general repair of the electric system, air system piping, repair and installation of donated welding equipment, etc.
Workshop 2	Roof repair, repair and paint of structures, general repair of the electric system, air system piping, expansion and redesigning of the tool room, etc.
Machine tool room	Roof replacement, repair and paint of the structure, general repair of the electric system, air system piping, preparation and installation of the donated machine tools, etc.
Injection pump lab	Roof replacement, repair and paint of the structure, general repair of the electric system, air and water piping, preparation and installation of the injection pump test bench and the injector tester, etc.,
Greasing plant	Roof replacement, repair and paint of the structure, general repair of the electric system, air and water piping, installation of the greasing and lubrication pumps, etc.
Washing facility	Repair and paint of the structure, general repair of the electric system, water system piping, installation of the washing pump, improvement of the drainage system, etc.
Warehouse	Roof replacement, repair and paint of the structure, general repair of the electric system, lighting, etc.

Therefore, as a result of the Project for Capacity Improvement and the participation of the Cuban side, the following goals related to the operation of the workshop managed by UPPH for the repair and maintenance of collection vehicles were achieved:

- Parts and spare parts that are difficult to acquire could be manufactured using the lathe, the milling machine, and other donated equipment.
- Injectors and injection pumps, except the pumps used by Chinese compaction trucks, for the repair of which a special tool is needed, could be diagnosed and repaired.
- Tire repair time was reduced by using the equipment installed at the tire repair shop.
- Air-operated equipment helped reduce repair time and hard physical work.
- Electric and hydraulic systems could be diagnosed and repaired.

- Preventive maintenance was scheduled and executed.
- There are some facilities for vehicle washing and greasing that have not operated on a regular basis due to existing drainage problems.
- Proper tools are now available for their simultaneous use by mechanics.
- Manuals for proper operation of donated equipment were prepared.
- Forms and records to monitor workshop operations were also prepared.
- Labor safety and environmental protection measures improved at the workshop.

However, the most significant goal achieved by the workshop improvement and modernization was the reduction of the time needed to carry out the most frequent repair works, as shown by the table below:

Table 1-48: Repair Time Reduction

Repair	Average time needed before the Project for Capacity Improvement (hours)	Average time needed after the Project for Capacity Improvement (hours)	Reduction rate (%)
Container lifting device welding	3.00	1.05	64
Clutch repair	3.45	2.10	42
Tire repair	1.20	0.30	63
General greasing	1.10	0.25	64

NOTE: It should be noted that due to the fact that air piping was only recently completed, the time needed for maintenance of other systems using donated air-operated tools has not been measured. However, we are positive that the time will be reduced significantly.

Another significant effect of the workshop operation improvement was the considerable reduction of the workshop times and the increase in the technical availability coefficient, which increased dramatically during and after the implementation of the Project, as shown in the following table:

Table 1-49: Project Indicators Measurement

Indicator	December 2010 Before the Project	March 2012	October 2012	October 2013
CDT-1(including vehicles proposed to be no longer operated)	50.7%	82.8%	81.5%	64.9*
CDT-2 (excluding the vehicles proposed to be no longer operated)	58.6%	85.7%	85.13%	78.7*
TT (Total time at the workshop)	16:20hr	8:10hr	7:57hr	7.57
TR (Breakdown time)	10:40hr	6:30hr	6:23hr	6.23
TE (Stay over time)	6:22hr	1:40hr	1:34hr	1.34

*The reduced technical availability coefficient in 2013 as compared to 2012 originates in existing spare parts supply limitations.

These indicators should be further improved with the completion of air piping in Buildings 1 and 2, which was in fact finished in 2013, as it helps improve working conditions and mechanics' efficiency dramatically. The CDT is expected to be calculated not taking into account the delays provoked by spare part supply in order to properly evaluate workshop operation. See Photos in Appendix-1.

Despite the remarkable progress made in terms of workshop operation, some deficiencies have remained during and after the implementation of the Project for Capacity Improvement mainly related to the insufficient supply of materials and spare parts originated in the existing financial restrains and the limited availability at the market, as most spare parts required for vehicle repair are imported and cannot be procured at the local market. Therefore, when a part is needed, location and acquisition take a long time.

Moreover, there have been some delays to build the area earmarked for the air-operated oil supply system, as the lubricant tanks have not been installed yet for lack of a compressor, steel materials, and concrete.

1.10.2 Short and Med-Term target (2015-2020)

Under the conditions described above, it is anticipated that during the short and mid- term period of the Master Plan the following activities will be carried out to ensure the proper operation of the Central Workshop:

- Finish the construction works at the area earmarked for the air-operated oil supply system, which are still pending for lack of some material resources.
- Finish the pending works at the workshop facilities to ensure a proper operation of donated equipment.
- Provide a small room with the necessary specialized staff to ensure the proper repair and maintenance of donated garage equipment and machine tools.
- Properly use the manuals for the operation of donated equipment and carry out proper scheduled maintenance to ensure their efficient operation and extend their service life.
- Properly use the manuals and the knowledge acquired to repair complex systems such as the electronic, electric, and air systems.
- The Cuban side should continue to train newly appointed staff to operate donated equipment and carry out maintenance of compactor trucks.
- Continue to carry out scheduled preventive maintenance of compactor trucks and keep materials and parts required in stock to ensure maintenance quality.
- Timely procure and keep a stock of steel and other metals required for parts manufacture.

- Anticipate the acquisition of the spare parts required to repair the most frequent breakdowns and keep enough spare parts in stock to carry out repairs efficiently, thus reducing vehicle repair time and increasing the technical availability coefficient.

- Properly implement existing forms, manuals, and records used to monitor workshop operations.

Before	After
	
	
	
	

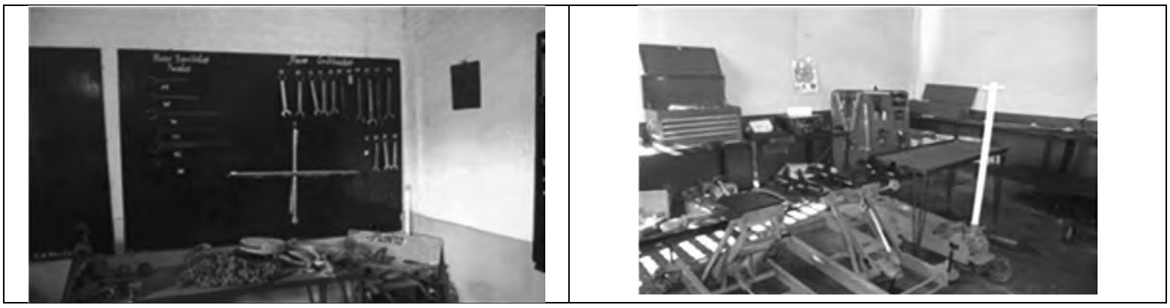


Photo 3: Renovation Works at the Central Workshop

Photo 4: Improvement made in the Project

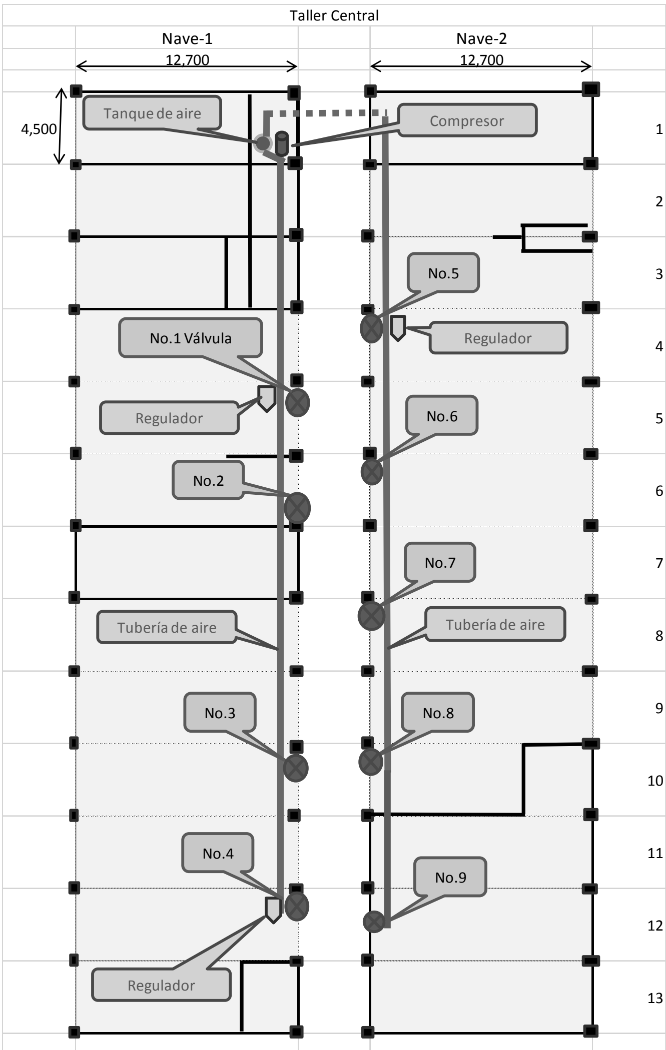


Figure 1-3: Air Piping at Building 1 and 2

1.11 Institutional Management

1.11.1 Structure for Proper Solid Waste Management

Since the formulation of the Master Plan in 2005, a number of changes in the organization and distribution of the activities and responsibilities of the institutions involved in solid waste management in Havana City, as well as frequent changes in the technical staff and the managers responsible for collection, treatment, and final disposal of solid wastes, have taken place.

Restructuring and staff changes are due to the need to cope with the huge tasks meant by the management of the city's wastes with extremely limited resources, so these changes have been aimed at using available resources more efficiently.

However, restructuring has often been insufficiently documented and the responsibilities have not been clearly identified or documented in the organization and procedures manuals, which should be revised in the coming years, within the near future or short term period of the planning horizon of the present updating of the Master Plan.

Moreover, this lack of documentation has made it difficult to train newly appointed staff replacing employees who had worked for many years as technicians and officials in the various institutions involved in waste management and to deal with some activities not directly related to waste collection and final disposal, but playing a very important role in the activities carried out during waste collection and disposal, such as labor safety and occupational health, and environmental protection.

All these issues should be tackled during the planning horizon of this revised Master Plan, be it in the near future or in the medium term.

The following specific activities should be carried out:

- Update the organization and procedures manuals of the institutions involved in waste management. The responsibilities of the various institutions and the resources allocated for the activities should be clearly specified.
- Redefine the salary plan for the staff involved in solid waste management aiming at selecting the most suitable to improve performance and to become an economic incentive for qualified, efficient workers to remain in their jobs.
- Prepare and use labor safety and occupational health manuals in all the activities related to solid waste management by following the example of the manuals prepared by JICA's Expert Team for the Central Workshop as part of the Project for Capacity Improvement.

- Recover some of the working conditions lost in the last years that allowed or facilitated the staff to carry out their work efficiently, such as lunch, transport, etc.

Overcoming existing economic limitations and implementing some of the measures mentioned above will enable to assess the number of staff required to carry out the works related to solid waste management in the various institutions concerned, as well as to strictly implement working shifts and attendance checks.

Moreover, overcoming resource limitations will help pay more attention in the near future to some issues related to environmental protection, such as monitoring wastewater discharge into the drainage system, emission control, energy saving, etc.

1.12 Customer Service

The Master Plan formulated in 2005 points out that there was not a provincial government agency specifically in charge of receiving and dealing with the residents' complaints regarding solid waste management, and that a Provincial Strategy for Environmental Education had been formulated to cover this area. However, it stated that coordination with UPPH and the organizations responsible for solid waste management was insufficient.

It also points out that there are certain problems related to solid waste management that could provoke complaints by the residents, as they involved hazards and nuisance for the people concerned, as follows:

- Waste scattering anywhere in Havana City due to the limited number of containers available for waste disposal, and illegal waste dumping.
- Container capacity saturation due to irregular waste collection.
- Environmental problems occurring in the vicinity of final disposal sites caused by waste scattering, unpleasant odors, insect breeding, biogas combustion, and surface and ground water quality deterioration.
- Environmental pollution due to exhaust fumes generated by the old vehicles used for waste collection.
- Potential hazards for the residents and especially for solid waste collection and disposal staff due to the discharge of industrial and hospital wastes mixed with municipal solid wastes.

a. Complaints Received and Dealt with

After the formulation of the Master Plan, an Office for Complaints Reception was set up at DPSC and at the municipalities to receive and deal with the complaints filed by the residents regarding the services provided by these government agencies, including complaints related to solid waste management.

In addition, there is another way to receive residents' complaints about communal service operation, including solid waste management. The so-called delegates (local government representatives) collect and channel the complaints, which may be "statements" if they are really proposals or requests, or "complaints" if they certainly refer to the demand to solve existing problems originated in poor service.

Once the complaint has been received and recorded, a period of time has been established for the Office for Complaints Reception or the local government representatives to convey to the resident who filed the complaint an alternative solution for the problem and to do what it takes to solve it. All complaints should be received and the problems raised should be solved. The time stipulated to solve the problems depends on resource availability.

The complaints received by the Offices for Complaints Reception and the local government authorities regarding solid waste management from 2010 to 2013 refer to the following:

- Existence of small dumping sites provoked by uncollected wastes and demolition or tree waste accumulation.
- Lack or shortage of containers provoking solid waste accumulation.

As can be seen, most of the complaints originate in the limited resources to ensure proper waste collection. However, some of them have to do with inappropriate solid waste management.

All the complaints are assumed to have been satisfactorily dealt with, as there exists a system to monitor the solution of the complaints within a previously established period of time.

It should be noted that despite existing difficulties and limitations for proper waste collection, the number of complaints received is small, which can be explained by the fact that either the residents are not aware of the existence of the Offices for Complaints Reception at DPSC, UPPH, and the municipalities, or that they accept the fact that present resource limitations faced by Communal Services hinder efficient solid waste collection.

b. Impact of complaints on solid waste management

Although there is a system to ensure that the complaints filed by the residents are dealt with, a system enabling complaints to be used as feedback to assess solid waste management, especially waste collection, efficiency or quality, is currently lacking.

As long as the present resource limitations remain, it is not advisable to encourage the submission of complaints, as they could not be dealt with satisfactorily. However, when the limitations are overcome, at least partially, the existing system to submit the complaints should be promoted among the residents, as it is a good way to supervise service quality, especially regarding waste collection, as well as to identify existing problems that should be tackled to improve service quality.

In addition, when the scenario mentioned above is achieved, it would be advisable to carry out surveys or polls to know and record residents’ opinions in terms of waste collection service quality so that the organizations involved in waste management may pinpoint the areas to be improved.

1.13 Environmental Education on Solid Waste Management

It is known worldwide that Cuban citizens are highly educated and well aware of the need to protect the environment by minimizing the impact of productive activities on environmental pollution and ecosystem deterioration.

However, with regard to municipal solid wastes, this environmental concern is not expressed in concrete actions by the individuals to improve solid waste management or to carry it out minimizing the impact on the environment.

Before the so-called Special Period, there was a public interest to participate in solid waste management by segregating recyclable materials from the wastes in order to cooperate with raw materials recovery, thus helping to reduce the impact of productive activities on the environment.

Nevertheless, this interest increasingly faded due to the limitations faced by the organizations responsible to collect recyclable materials segregated by the residents. Consequently, recyclable material segregation meant to pile up the wastes that had to be later disposed of mixed with the common garbage for lack of segregated collection.

At present, waste segregation by the residents for the sake of recycling is extremely limited. It is mainly carried out by authorized self-employed workers.

During the Project for Capacity Improvement, a pilot project on environmental education for solid waste management was implemented in primary and secondary schools. It was possible to confirm not only that this subject was not included in the syllabus, but that the activities scheduled on this subject as part of the pilot project could only be carried out as extra-curricular activities in the so-called Vocational Clubs with the cooperation of teachers, to whom these activities were added to their regular school work.

The environmental education for solid waste management focused on waste description, existing waste collection, treatment, and disposal methods and systems, and especially on waste segregation for recycling and composting.

The environmental education project could not progress in the area of organic waste segregation to produce compost, as educational and sanitary authorities did not allow the installation and operation of containers for composting at schools.

Therefore, the project had to focus on recyclable material recovery, especially aluminum cans and PET bottles, the only wastes municipal authorities and UPPH showed any interest to collect and carry to the storage facility as part of their plan to recover raw materials.

Enquiries were made about the possibility that schools or students’ organizations could carry out recyclable material recovery for their sale to the Enterprise for the Recovery of Raw Materials. However, no progress could be made in this area as schools are not authorized to undertake this activity.

Therefore, the project was implemented under some difficult conditions as it was made evident for the students that they were supposed to hand the recovered materials over to the municipalities or UPPH for free, whereas self-employed workers were paid for the same materials by the Enterprise for the Recovery of Raw Materials.

The project could nonetheless be successfully implemented and the students could increase their knowledge on environmentally friendly waste management and on the importance of material recovery from the wastes by means of recycling and composting.

In addition, some activities to recover materials for recycling were carried out in six primary and two secondary schools, in which aluminum cans and PET bottles were recovered and handed over to Playa Municipality, where the schools involved were located. Playa Municipality authorities were in charge of installing the containers for waste storage and transporting the recyclable materials recovered.

Despite the difficulties encountered during the implementation of the Pilot Project, it was possible to prove the existence of great chances for extending waste management-related environmental education both for the residents and school students, and that the latter could carry out recyclable material recovery activities if the schools were authorized to recover and sell them to the Enterprise for the Recovery of Raw Materials to use their profits to procure some school materials or to improve school conditions.

Project Completion Report

Section 2: Report on Output 1

Chapter 2: Report on Capacity Assessment

1 Final Capacity Assessment of DPSC's C/P Team (Organization - Institution and Individual Assessment)

1.1 Final Capacity Assessment of DPSC's C/P Team (Organization-Institution and Individual Assessment)

1.1.1 Interview assessment

While emphasizing on the achievements made and how work environment has changed during the project, the capacity assessment was carried out through interview with C/P members in order to assess how each C/P members has raised their capacities. Activities discussed in this chapter was solely performed by the Mexican expert, Dr. Cuellar.

The following C/P members were interviewed:

Table 1-1: C/Ps Interviewed for Capacity Assessment

Name	Position
1. Solid waste management:	
Mrs. Odalys García	Vice-director of Development and Investment
Mr. Alfredo Rodríguez	Sanitation technician, UPPH
Mrs. Jaynet García	Solid waste specialist, DPSC
Mr. Ernesto Domínguez	Solid waste specialist, DPSC
Mr. Alien Martín Menendez	Electric engineer, DPSC
Mrs. Mariana Echavarría	Responsible for Difusion, , DPSC
2. Waste reduction and composting	
Mr. César de las Pozas	Mechanical engineer, DPSC
Mr. David Santana*	In charge of composting
Mr. Apolonio Serrano*	Biogas and compost plant manager
3. Vehicle maintenance and workshop management	
Mr. Fernando Amil	Vice-director of Mechanization, UPPH
Mr. Félix Arturo Abreu	Central Workshop administrator, UPPH
Mr. Fernando González	Vice-director of Purchasing, UPPH
Mr. César de las Pozas	Mechanical engineer, DPSC
Mr. Diego Guevara*	Workshop chief, UPPH
Mr. Enrique García	Repair and maintenance specialist, UPPH
Mr. Eduardo Jiménez	Repair and maintenance specialist, UPPH
4. Landfill design and final disposal site operation	
Mr. Lázaro Sotolongo*	Candidate for Guanabacoa landfill site supervisor
Mr. Ernesto Domínguez	Solid waste specialist, DPSC
Mr. Hermes del Toro	Civil engineer, UPPH
Mr. Camilo Rodríguez*	Landfill site unit head, UPPH
Ms. Harylin Tamayo*	Investment specialist, UPPH

* New C/P members for whom initial capacity assessment was carried out.

Capacity assessment was carried out by means of interviews. Explanation made during site visits, reaction of and questions made by the C/P members during Dr. Cuellar's lectures were also used as a reference to evaluate their capacity. The indicators used for the initial or the intermediate capacity assessments were the following:

Level 5. It is possible to perform an excellent job without the support by the Japanese expert.
Level 4. It is possible to perform a job on satisfactory level without the support by the Japanese expert.
Level 3. Little assistance by the Japanese expert is required to reach the target level.
Level 2. A lot of assistance by the Japanese expert is required to reach the target level.
Level 1. It is impossible to perform the work on satisfactory level even after the capacity development with the Japanese expert.

1.1.2 Background

Following points which significantly affect project implementation have been taken into account in the intermediate capacity assessments conducted since 2011.

- Although there are still some difficulties regarding resource allocation and investments, the budget for 2013 includes supplies for the Central Workshop and resources for some works at Calle 100 landfill site, as well as to begin the construction of the New Guanabacoa sanitary landfill site.

- Resource allocation for spare parts supply at the Central Workshop has not completely resolved as difficulties for parts acquisition and delays for delivery still persist. Many collection vehicles remained at the workshop due to lack of tires or batteries or as a consequence of minor breakdowns in the clutch or brakes.

- In the case of the resources allocated for the construction of the first stage of the New East sanitary landfill site in Guanabacoa, the works have not yet begun as the contractor was changed and the new construction company had not started to work fully. With regards of the resources to build the trenches at Calle 100 landfill site, the works are significantly delayed due to deficiencies on the part of the contractor. Leachate recirculation at the disposal site have not begun because the construction system is yet to be defined.

- The work pace of some personnel sectors are still extremely low due to the lack of or reduced resources to carry out the work, transportation, working hours, performance incentives, etc.

- Transfer of the technical and management staff continues, that disrupts the project implementation as the C/P's capacity building becomes fruitless when a trained C/P member leaves the project and a new member has to be trained. Waste management staff mobility has also increased as a result of the new national policy allowing self-employed workers and authorizing Cuban citizens to travel abroad.

Besides the above-mentioned situation, there are other circumstances that have impacts on the project implementation, namely:

- Despite the resource scarcity in Cuba, a budget indicating strong commitment of C/P personnel for the project has passed. This budget include infrastructure works at the vehicle repair workshop, the heavy equipment workshop, and the composting project facilities.
- In 2013, changes in the C/P personnel continues to take place. Even for the group 3 (vehicle maintenance workshop) which had been the most stable group in the preceding years had personnel changes during that year. In 2013, personnel changes occurred in group 1 (waste management), group 3, and group 4 (final disposal). Only group 2 (waste reduction and composting) was untouched. Such frequent personnel changes means project delays and the loss of the trained members since the new C/P members have to train themselves or to obtain some hasty training.
- Although some progress has been seen in inter-ministerial coordination for waste management planning activities, there are still some coordination problems persist. For instance, the construction of new access road to Calle 100 landfill site, that had been planned to respond to the railway line construction, was delayed due to coordination problems. It is particularly important to improved coordination with authorities among the Ministry of Education, City Planning, the Enterprise for the Recovery of Raw Materials, the Ministry of Public Health, and the Ministry of the Environment.
- The legalization for the “raw material collector” has helped increase the recovery of recyclable materials from the containers deployed on streets and business establishments. Volume of recyclable recovery was also increased at the final disposal sites, despite the fact that raw material collection by self-employed collectors at the landfill sites is forbidden.

1.1.3 Qualitative Assessment of the Capacity

In the Inception Report of the Project for Improvement of Capacity on Municipal Solid Waste Management in Havana City, Republic of Cuba, the following Outcomes are mentioned:

1. DPSC’s capacity for integrated solid waste management is strengthened.
2. The segregation of solid waste at the source in the Pilot Project area is promoted, and UPPH’s capacity for organic waste reduction at the source is strengthened.
3. UPPH’s capacity for solid waste collection and transport is strengthened.
4. UPPH’s capacity for sanitary landfill design and for final disposal site operation is strengthened.

The results of the final capacity assessment for the fulfillment of the goals identified in the Inception Report and in the modified Outcomes pointed out in the Progress Reports are shown below.

1.1.4 Results of Capacity Assessment for Output 1 Team

a. Output 1. DPSC's capacity for integrated solid waste management is strengthened.

The activities carried out in the latter half of the project to achieve Outcome 1 are included in "C.4 Develop and implement the Plan of Action for DPSC's management capacity building" and "C.6 Prepare an educational program on SWM for sanitation workers and the residents" contained in the Inception Report, as well as in the activities "1.2 Plan of Action to improve DPSC's capacity for project planning, monitoring, and evaluating" and "1.4 Preparation of an environmental education program on SWM for Communal Services staff, local residents, schools, etc.", contained in the Plan of Operations.

a.1. Capacity of the Organization / Institution

Changes in the C/P members for Group 1 have inevitably had adverse effects on the project. Mrs. Odalys García, Mrs. Jaynet García, and Mr. Ernesto Domínguez are still part of the group; however, Mr. Alejandro Fernández, who had been a member since the beginning of the project, left the C/P team and was replaced by Mr. Alfredo Rodríguez. Mr. Martín Menéndez also joined the Group 1 during the project implementation. Other members such as Mr. Juan Herrera and Mrs. Elida Romero, from CITMA Habana, and Mrs. Mariana Echavarría, from other DPSC departments, have remained in the C/P team; nonetheless, their involvements in the project have been very limited.

The followings can be high lightened in the capacity assessment of the organization and the institution three years after the commencement of the project regarding Outcome 1:

- There are still some deficiencies in terms of the supply of spare parts and materials, as well as some difficulties to make supply arrangements. However, several government agencies are willing to support the project implementation by means of investments and by facilitating procedures. This situation was taken into consideration in the revision of the Master Plan.

- The railway is going to be built near Calle 100 landfill site, forcing some landfill facilities to be relocated. Access road is one of the facilities which will be affected. Vehicles entering the landfill site are considered to be controlled by crossing gate which will be installed after the height of the railway and access road is leveled.

- While the construction of Guanabacoa landfill site has delayed, the surveys to close Ocho Vías landfill site, which has already reached its capacity, began. Meanwhile, surveys are expected to be carried out in Calle 100 landfill site in order to extend its service life, as recommended by JICA Expert Team.

- The C/P team members are well qualified, nonetheless, have some difficulties to put their specific work in the context of solid waste management, or to relate them to environmental issues. The residents are also neither sufficiently aware nor willing enough to get involved in activities aimed at improving solid waste management. Consequently, some efforts in terms of education and training will have to be made in order to get their involvement in certain areas envisaged in the Master Plan. This was taken into account in the review of the Master Plan.

- C/P Group 1 drafted a revised master plan with the advice of JICA Expert Team. The revised Master Plan was drafted in the Progress Report 7 and finalized by the end of the Project.

With regard to the fulfillment of the goals related to capacity development of communal services personnel and to public awareness raising aimed at improving solid waste management, following assessments were made:

- The seminars and training courses for the Communal Services personal were held, whereas the materials for the training courses were prepared and already in use in the first half of the year 2013.
- The activities related to public awareness raising carried out in schools targeting children and teenagers in the first half of the year 2013 are also outlined in Progress Report 7. Awareness raising activities have still been carried out in six primary schools and two secondary schools focusing on solid waste management and environmental education. Activities related to the recovery of wastes for recycling at schools have not been yet begun as the containers required for the storage of recyclable materials recovered have not been procured.
- The mass media campaign about proper waste management has already begun. Several radio programs were produced and broadcasted. A promotional video was also produced and to be shown soon on Havana's official TV channel.
- No specific resources are available to carry out activities focusing on public awareness raising and training, nor there is an officially approved program to this effect. However, higher authorities have shown their understanding and given their support to carry out these activities.
- Environmental education activities carried out at schools have been fruitful. However, environmental education and waste management are not included in the school program. Therefore, those activities have to be taught by voluntarily bases only.

a.2. Individual Capacity

Due to the changes undergone by C/P Group 1, the final capacity assessment was carried out for Mrs. Odalys García and Mrs. Jaynet García, whereas the initial evaluation was conducted for Mr. Alfredo Rodríguez and Mr. Alien Martín Menéndez.

a.2.1 Mrs. Jaynet García, solid waste specialist, DPSC

Mrs. Jaynet García is knowledgeable and experienced in environmental matters. She has also shown some progress in her knowledge of solid waste management as she has been able to prepare public awareness raising and training materials as part of the project in schools, as well as to provide related information to the teachers responsible for the group activities.

The materials prepared by Mrs. Jaynet García for public awareness raising in schools show significant progress in terms of the understanding of integrated solid waste management. In addition, her persistence to organize environmental education activities at schools and to ensure the voluntary cooperation of students and teachers to carry out these activities, despite the limited support and the material difficulties encountered throughout the project, has been remarkable.

The final capacity assessment corresponding to Mrs. Jaynet García is the following:

Level 3.5 Between "Little assistance by the Japanese expert is required to achieve the target level or the results expected" and "It is possible to carry out a satisfactory a work and to achieve the results expected without the Japanese expert's support".

a.2.2 Mr. Ernesto Domínguez, solid waste specialist, DPSC

Mr. Ernesto Domínguez is experienced in project formulation and in making arrangements to ensure construction works and the supply of the materials necessary to improve DPSC's capacity for solid waste management in Havana City. His presence in the C/P team helps increase the chances of the project to succeed.

Mr. Ernesto Domínguez has increased his capacity both for solid waste management by attending seminars and other training activities, and for landfill site construction and management through his work contacts with Mr. Toshihiko Chiba, JICA expert.

The final assessment in terms of individual capacity indicators corresponding to Mr. Ernesto Domínguez is the following:

Level 4 "It is possible to carry out a satisfactory work and achieve the results expected without the Japanese expert's support".

a.2.3 Mrs. Odalys García, Vice-director of Investment and Development, DPSC

Mrs. Odalys García has a wide experience in solid waste management. She has been trained on this subject in Japan and participated in the project previously carried out by JICA to formulate the Master Plan for Havana City. She has played the role of project manager and the person in charge of the investments and construction works carried out to implement this JICA project.

Her training in Mexico City had a great impact on her increased capacity to achieve a comprehensive approach to solid waste management. Her capacity in the field of investments for DPSC is unquestionable.

Based on the comments made above, the final assessment of Mrs. Odalys García's capacity is the following:

Level 4. "It is possible to carry out a satisfactory work and to achieve the results expected without the Japanese expert's support".

a.2.4 Mr. Alfredo Rodríguez, Vice-director of Hygiene, UPPH

Mr. Alfredo Rodríguez has recently taken over the position of Vice-director of Hygiene at UPPH to replace Mr. Alejandro Fernández. Therefore, his initial capacity assessment was carried out this time.

From the beginning of the Project for Improvement of Capacity on Municipal Solid Waste Management in Havana City to his recent promotion, Mr. Alfredo Rodríguez was the second person in charge at the Vice-director of Hygiene's office. He participated in project activities, especially training-related activities, and provided statistical information regarding solid waste management in the city. In other words, he had involved in the project prior to this promotion.

In particular, he contributed in areas such as planning and statistical information required for the updating of the Master Plan, which is the main activity of C/P Group 1.

Based on the above-mentioned reasons, Mr. Alfredo Rodríguez's initial evaluation is the following:

Level 3. "Little assistance is required by the Japanese expert to achieve the target level or the results expected".

a.2.5 Mr. Alien Martín Menéndez, Solid waste specialist, DPSC

He joined DPSC's Investment and Development Division in early 2013 and was officially became a member of C/P Team 1 at the Joint Coordination Committee in June 2013. Therefore, this is his initial assessment.

Mr. Alien Martín Menéndez is an electrical engineer with experience in alternative energies and logistics. He neither has experience nor has received any training in the field of solid waste management; however, he has shown his interest to participate in the projects to treat organic wastes involving energy generation being discussed at DPSC.

Although he has no experience in the field of solid waste management, his interest to learn and his expertise in energy generation and power plant installation are very useful in the medium term for solid waste management in Havana City.

Based on the above, the initial evaluation of Mr. Alien Martín Menéndez is the following:

Level 3. "A lot of assistance is required by the Japanese expert to achieve the target level or the results expected".

a.2.6 Mrs. Mariana Echavarría, DPSC's Public Relations and Publicity

Mrs. Mariana Echavarría is in charge of promoting DPSC's activities and implementing public education-oriented activities. As part of the project, she has promoted several publicity campaigns focusing on proper solid waste management and the 3R's policy.

She has a clear idea about public participation in solid waste management related to both proper waste disposal in the containers installed along the thoroughfares and the city's sanitation, as well as regarding the need to promote the 3R's policy by means of recycling and household composting.

She has carried out some significant publicity activities taking into account the limited resources available and the fact that she has not always been supported by higher authorities. Nevertheless, she has managed to prepare several radio and TV spots.

Although she has been a member of C/P Team 1 for some time, her capacity assessment had not been carried out until now because she works primarily for DPSC and her project-related activities have mainly been performed in the course of the last year.

The initial capacity assessment for the activities related to promotion and public education is the following:

Level 3. "Little assistance by the Japanese expert is required to achieve the target level or the results expected".

1.1.5 Results of Capacity Assessment for Output 2 Team

a. Output 2. Waste segregation at the source is promoted within the Pilot Project area, and UPPH's capacity for organic waste reduction at the source is strengthened.

The activities carried out during the last half of the project period are included in "C.8 Implementation of the Pilot Project (organic waste collection)" and "C.9 Implementation of the Pilot Project (composting)" of the Inception Report, as well as in activities 2.2 "Implement the activities of the pilot project on segregated waste collection from large generators" and 2.3 "Implement the activities of the pilot project to produce compost at the compost yard" of Progress Report 5, which were confirmed in Progress Report 7.

The results of the capacity assessment of the organization and the institution three years after the commencement of the project regarding Outcome 2 about segregated collection and the implementation of the pilot project on composting are the following:

a.1. Capacity of the Organization / Institution

C/P Team 2 had no staff change or transfer in the last half of the project period, except for Mrs. Ivette Reyes who had not actively participated in the project in 2012 due to her work responsibilities elsewhere.

The followings can be high lightened in the capacity assessment of the organization and the institution for Outcome 2:

- In 2013 segregated organic waste collection continued at Ciudad Deportiva Cerro and Tulipán agricultural markets, at Chateau and Comodoro hotels, whereas cigar waste continued to be collected at the cigarette factory. Despite the efforts made, the number of segregated organic waste collection points has not been increased because of lack of containers, arm-roll containers, and collection vehicles.

- Segregated organic waste collection has consolidated at the agricultural markets by installing small metal containers at the stands, in which the market employees disposed the segregated organic wastes which are later disposed into larger metal containers or into arm-roll containers earmarked for organic wastes.

- The truck donated by JICA for the pilot project that was fully repaired now and is currently operational. Presently the truck is used to collect segregated organic waste collection from the hotels contributing to the pilot project.

- Organic wastes received at the compost plant from the agricultural markets are still mixed with other type of waste, which has to be manually removed by the plant workers. This situation is most likely originating from the insufficient number of metal containers installed at the markets and in the inappropriate collection of other type of waste. As the vehicle collecting segregated organic wastes from the agricultural markets also collects other type of waste en route to the compost plant, foreign matters entered into the metal containers and thus contaminate segregated organic wastes. This occurs because there is a limitation in number of vehicles used for waste collection as a whole, and also because the implementation of a payment system is in place whereby vehicle crews has incentives to receive more payment for more waste they collects. That is why they not only collect the wastes segregated at the markets, but also some mixed wastes at other locations to increase their salaries.

- Other reasons why mixed wastes are brought to the compost plant are not only cause by the insufficient number of containers installed at the agricultural markets but with the fact that the containers used to dispose of other type of waste at the markets are not timely collected/emptied, thus provoking that other waste stream is discharged. Since the market employees have volunteered to segregate organic waste, no- or less-contaminated organic waste should arrive at the composting plant if the number of metal containers assigned to the agricultural markets is increased and waste collection for other waste stream is performed regularly. That would reduce the needs for waste segregation at the composing plant. There were times when approximately 70% of organic waste received at the compost plant was actually contaminants.

- The system to collect segregated organic wastes to feed both biogas and compost plants is continue to be used. This has not caused any difficulties for operation of the compost plant as the biogas plant consumes only a limited amount of organic waste. Biogas plant indeed uses the organic waste intermittently.

- The shredder machine is not yet operational; therefore, cigarette waste is still being used as covering material and to reduce humidity at the beginning of the composting process. Using this kind of waste is perfectly justified as it would otherwise be dumped at the landfill site. Its use for composting not only helps reduce waste amount disposed at the landfill site but also suitable for the composting process.

- The final report on the compost pilot project shows that the compost produced has not been tested because there is no certified laboratory in Cuba. Consequently, other satisfactory seed germination tests using compost have been conducted.

- By the end of the project, there has not been granted to sell the produced compost in the market. Therefore, the product is still being donated to the Zoo and the nursery run by DPSC's Green Areas Unit.

- According to the compost plant personnel that the collection of segregated organic wastes had not become stable, which delays the composting process. The problems related to organic waste collection may be solved when a vehicle collecting only the segregated wastes to be taken to the compost plant becomes available.

a.2. Individual Capacity

a.2.1 Mr. César de las Pozas, Mechanical engineer, DPSC

Mr. César de Las Pozas shows a great capacity to manage and supervise the works and facilities required for the composting project.

Mr. César de Las Pozas was in charge of construction works and has also become responsible for the composting process supervision when JICA Experts are not based in Cuba, thus significantly contributing to the project progress.

The result of the final assessment regarding the personal capacity indicators corresponding to Mr. César de las Pozas is the following:

Level 4. "It is possible to carry out a satisfactory work and to achieve the results expected without the support by the Japanese expert".

a.2.2 Mr. Apolonio Serrano

Mr. Apolonio Serrano continues to be the manager of the compost and biogas plants. Despite the fact that he has more information about the organic waste treatment process, he is not fully aware of the need to comply with the technical requirements necessary for segregated organic waste collection and composting.

Apparently, he is experienced in management activities for the Mayor's Office in Havana. However, he is more focused on achieving goals and managing resources than on the technical quality of the process.

Due to the above, the final individual assessment for Mr. Apolonio Serrano is the following:

Level 2. "A lot of assistance by the Japanese expert is required to achieve the target level or the results expected".

a.2.3 Mr. David Santana

Mr. David Santana has been in charge of the composting process ever since organic wastes began to be treated at the plant in 2011, although he joined the C/P team in mid- 2012. He has practical experience in compost making as he used to work at the former compost yard located within Calle 100 landfill site.

He is still responsible for the plant operations and the person in charge of measuring various parameters and deciding whether to increase humidity or turn the compost piles. He also manages the plant staff.

Although he is in charge of the compost plant operations, his knowledge on composting process is not deep enough. Therefore, his assessment result is the following:

Level 3. "Little assistance by the Japanese expert is required to achieve the target level or the results expected".

1.1.6 Results of Capacity Assessment for Output 3 Team

a. Output 3. UPPH's capacity for solid waste collection and transport is strengthened.

The activities planned to achieve Outcome 3 are detailed in activities "C.10 Review and implementation of the waste collection/transport plan", "C.11 Improvements in the vehicle maintenance workshop", "C.12 Improvements in the operations of containers and collection vehicles", and "C.13 Capacity building on waste collection and transport" in the

Inception Report, as well as in activities “3.2 Provision of tools and equipment for the collection vehicle maintenance workshop”, “3.3. Implement the relevant activities to improve the operation of collection vehicles and containers”, and “3.4 Conduct training for UPPH’s staff” in the Plan of Operations, Project Design Matrix, and in Progress Reports.

a.1. Capacity of the Organization or Institution

The C/P team member for Group 3 had remained unchanged since the beginning of the project. However, many staff changes occurred in 2013 as Mr. Raúl Aguilar, UPPH’s Vice-director of Mechanization, left his position to be replaced by Mr. Fernando Amir, who used to be the Vice-director’s office. Accordingly, initial assessment for Mr. Fernando Amir was conducted. Mrs. Nury Cárdenas, Head of the Central Workshop, has also left the position.

The people who remained in C/P team 3 are Mr. Félix Arturo Abreu, now as the Central Workshop administrator, Mr. Jorge Quintana, Heavy Equipment Workshop manager, Mr. Fernando González, UPPH’s Vice-director of Purchasing, Mr. Diego Guevara, repair and maintenance specialist, and Mr. César de las Pozas, a mechanical engineer for DPSC, who is a consultant in the field of facility and equipment supervision for UPPH’s Central Workshop. Mr. Enrique García and Mr. Eduardo Jiménez, both repair and maintenance specialists, joined the team as new members.

The infrastructure works required for the installation and operation of the equipment donated by JICA have been completed. Air pressure pipes at the greasing facility and the repair shop are already operational, so donated air tools are being used.

After the installation of donated equipment at the Central Workshop and the Heavy Machinery Workshop, the work of the Expert Team has focused on preparation of manuals in Spanish which is to be used for the maintenance of engines, electronics and hydraulic systems, as well as for workshop staff training to facilitate proper use of the tools and equipment donated by Japan. The work for the Experts also emphasized in the installation of the air pipes and the proper operation of the air tools donated by JICA.

Followings can be pointed out in the institutional capacity for Outcome 3:

- Besides the installation works at the Workshop for the equipment donated by JICA, some other improvements in the facilities have continued to be implemented, including installation of air piping for the operation of the air tools at the tire repair shop and the greasing lines for greasing facility, a fence to enclose the facilities, and a vehicle control gate.
- The manuals prepared and the training courses held at the Central Workshop in 2013 by both JICA experts and the technical workshop staff are described in final report.

- Existing monitoring activities and the indicators used to measure the improved efficiency of workshop operations continue to be implemented. In addition, staff training activities and the preparation of manuals for collection vehicle maintenance were intensified. It should be noted that workshop mechanics took some tests intended to evaluate the training. The results were excellent. The number of mechanics expected to be trained during the implementation of the capacity improvement project was exceeded.

- It should be noted that despite management staff changes at the workshop and existing limitations related to material and spare part supply, preventive maintenance for collection vehicles continues to be implemented as frequently as recommended by JICA Expert Team. The operation of the equipment donated by JICA for both the Central Workshop and the Heavy Equipment Workshop has also continued without interruption. Moreover, training provided by JICA experts has been put into practice during vehicle repair and it has also been extended to almost all the workshop mechanics. As these achievements are outstanding, it can be said that the goals of the capacity improvement project have been fully achieved in terms of the increased capacity for collection vehicle and heavy equipment maintenance.

a.2. Individual Capacity

a.2.1 Mr. Fernando Amil, Vice-director of Mechanization, UPPH

Mr. Fernando Amil has worked at the Central Workshop for many years. Prior to his promotion as Vice-director of Mechanization, he used to be the second person in charge at the Vice-director’s office. Therefore, he has a wide experience in the field of workshop management and has responsibly taken over his new position.

Despite the fact that there were some concerns that Mr. Raúl Aguilar’s departure might bring drawbacks for the workshop operation, and that it might affect the Project for Capacity Improvement, none of this has actually happened and the difficulties inherent to a change in a management position are being overcome.

Mr. Amil participated in the training on solid waste management held in Mexico City in December, 2012, which had a positive impact on his new job as it helped him better understand the importance of waste collection and the role played by the repair workshop to increase collection vehicle availability.

Based on the above, the result of Mr. Fernando Amil’s initial assessment is the following:

Level 3. “Little assistance by the Japanese expert is required to achieve the target level or the results expected”.

a.2.2 Mr. Félix Arturo Abreu, Central Workshop manager, UPPH

Mr. Félix Abreu was not promoted to UPPH's Vice-director General and continued as the Central Workshop administrator. Therefore, he continued to be a C/P team 3 member. Mr. Félix Abreu also took part in the training on solid waste management held in Mexico in December, 2012, which helped increase his understanding of the various stages involved in waste management, thus enabling him to better understand the role played by the repair workshop to increase vehicle availability for waste collection.

The result of the final assessment regarding Mr. Félix Arturo Abreu's personal capacity indicators is the following:

Level 4. "It is possible to carry out a satisfactory work and achieve the results expected without the Japanese expert's support".

a.2.3 Mr. Fernando González, Vice-director of Purchasing, UPPH

The role of Mr. Fernando González in the Central Workshop is to ensure the supply of spare parts and other materials required for collection vehicle repair and maintenance.

His section has to overcome existing difficulties derived from the shortage of spare parts in the local market, budget limitations, and cumbersome formalities necessary to obtain authorization for parts acquisition. Despite this situation, the assessment of his capacity as stated in the previous intermediate assessment in the sense that he shows great capabilities to perform his duties, as well as a total commitment to his work, is reiterated here.

The result of the final assessment regarding Mr. Fernando González' personal capacity indicators is the following:

Level 4. "It is possible to carry out a satisfactory work and achieve the results expected without the Japanese expert's support".

a.2.4 Mr. Jorge Quintana, Heavy Equipment Workshop manager, UPPH

Mr. Jorge Quintana has a lot of experience in heavy equipment repair works, as well as wide workshop management capabilities. Therefore, he is deemed to be capable of ensuring the proper operation, handling, and maintenance of donated equipment.

He has been trained by JICA Expert Team in terms of both the proper operation and maintenance of the tools and equipment donated by JICA, and the repair of some of the breakdowns of the heavy equipment used for the operation of Calle 100 landfill site.

The result of the final assessment regarding Mr. Jorge Quintana's personal capacity indicators is the following:

Level 4. "It's possible to carry out a satisfactory work and achieve the results expected without the support by the Japanese expert".

a.2.5 Mr. César de las Pozas, Mechanical engineer, DPSC

Mr. César de las Pozas played a decisive role in the design, planning, and execution of the works required for the installation of JICA's donated equipment at the Central Workshop and the Heavy Equipment Workshop. He continues to provide technical support at the workshops. However, his work is basically focused on the implementation of the composting project as a member of C/P Group 2.

The assessment of Mr. César de las Pozas is included in the section corresponding to C/P Group 2 members.

a.2.6 Mr. Diego Guevara, Central Workshop head, UPPH.

Mr. Diego Guevara has worked at the repair shop for over 30 years. He began as an assistant mechanic and continued his training until becoming the manager of UPPH's Central Workshop recently. He has both experience and technical capacity. The training carried out by JICA has helped him enhance his capacities.

He had left his position though. There were some concerns that his resignation might affect the progress made at the Central Workshop during the implementation of the Project for Capacity Improvement. However, he accepted to return as the workshop manager, thus ensuring the continuity of the improvements at the workshop and generating more confidence among JICA Expert Team members. The result of the fourth intermediate capacity assessment of Mr. Diego Guevara is the following:

Level 3. "Little assistance by the Japanese expert is required to achieve the target level or the results expected".

a.2.7 Mr. Eduardo Jiménez, repair and maintenance specialist, UPPH

Mr. Eduardo Jiménez is a young man who has recently graduated from a technical school as an engine repair expert. He has worked at the Central Workshop for only two years. Despite his youth and relatively short experience, he has shown he is capable and has a desire to learn, thus being promoted to assistant workshop manager on his own merits. Therefore, he has been made a member of C/P Group 3.

Mr. Eduardo Jiménez has made the most of the training implemented by JICA Expert Team and his dedication and desire to learn have been recognized by the team members.

Based on his recent integration into the C/P team, his initial capacity assessment was carried out with the following results:

Level 2. “A lot of assistance by the Japanee expert is required to achieve the target level or the results expected”.

a.2.8 Mr. Enrique García, repair and maintenance specialist, UPPH

Mr. Enrique García has worked at the Central Workshop for a long time. Some responsibilities were recently assigned to him at the Vice-director’s office. Therefore, he was made a C/P team member and his initial evaluation was conducted.

His recent promotion was based on his long experience in workshop operations. He has also been trained by JICA Expert Team. However, his waste management background is not significant.

Level 2. “A lot of assistance by the Japanese expert is required to achieve the target level or the results expected”.

1.1.7 Results of Capacity Assessment for Output 4 Team

a. Output 4. UPPH’s capacity for landfill site design and final disposal site operation is strengthened.

The activities scheduled to achieve Outcome 4 are shown in detail in activities “C.14 Prepare a plan to check collection vehicle access to the sanitary landfill site”, “C.15 Check collection vehicle entrance to the sanitary landfill site”, “C.16 Improvement of heavy equipment maintenance at the existing final disposal site”, “C.17 Give advice as to the plan to build the new final disposal site”, “C.18 Prepare a plan for the final disposal site management and operation”, “C.19 Revise and prepare training materials for the operation/management of the final disposal site”, and “C.20 Carry out training activities related to the operation and maintenance of the final disposal site” in the Inception Report, as well as in activities “4.1 Coordination of collection vehicle access to existing final disposal sites”, “Implementation of the relevant activities to improve heavy equipment maintenance at existing final disposal sites”, 4.3 Give advice as to the design and construction of the new east landfill site”, and “4.4 Training for the operation and management of the final disposal site”, in the Plan of Operations, Project Design Matrix, Activities 2 and 5.

a.1. Capacity of the Organization or Institution

The final assessment of C/P Group 4 shows again the existing institutional weakness as the team composition has changed once more. Mr. Ernesto Domínguez, Mr. Lázaro Sotolongo, and Mrs. Harylin Tamayo continue as team members, whereas Mr. Alejandro Figueras left the team and Mr. Hermes del Toro, a civil engineer working for DPSC, joined it.

Mr. Antonio Blanco, who by the time of the third intermediate assessment was the Head of the Landfill Unit and as such was a member of team 4, left his job recently to be replaced by Mr. Camilo, who had held this position before, and so has been reinstated as a team member.

The remarks made during the third intermediate capacity assessment in the sense that there are still some concerns regarding the operation of final disposal sites in Havana, especially Calle 100 landfill site, and the beginning of the construction of the new Guanabacoa landfill site are reiterated here as follows:

- Calle 100 landfill site is practically the only site available for solid waste disposal in Havana at present as 8 Vías landfill site is saturated and its service life is about to be exhausted. However, wastes continue to be dumped at the site and the site operation has become increasingly difficult, especially during the rainy season, as the wastes are scattered along the site entrance, thus aggravating operation- and public image-related problems.

- With regard to the operation of Calle 100 landfill site, trenches are still built to continue waste disposal and extend the service life of the site. JICA Expert Team, however, has repeatedly pointed out that this system implies a high cost and that the best way to proceed would be to implement a project to extend the life service of the site as much as possible by increasing the waste pile height in an area other than the one currently used for landfill gas collection.

- Limited coordination among the various agencies involved in the design of the new Guanabacoa landfill site had been included in the previous intermediate assessment. This situation was resolved by holding more coordination meetings attended by the various agencies involved in the project, both from DPSC and the designers, which resulted in the completion of the executive project for the New Guanabacoa landfill site. The process to select the contractor is currently ongoing so that construction works began in early 2014.

- The visit to several sanitary landfill sites by both the designers of the new Guanabacoa site and DPSC's staff during the training in Mexico City was useful in developping capacities regarding sanitary landfill site design, construction, and operation. It also served to improve the executive project already prepared for the final disposal site.

The most outstanding issues identified during the final assessment regarding the capacity of the organization or institution in terms of Outcome 4 are the following:

- In the final assessment no improvements in the site infrastructure or in the operation of Calle 100 landfill site were identified, except for the increased availability of heavy machineries as a result of the improved operation of the heavy equipment workshop thanks to the equipment donated by JICA.

- The weighbridge installed at Calle 100 landfill site finally became operational. It is being operated by a state-run enterprise other than UPPH. It was known that the weighbridge operation has been stable with only short periods when it did not operate. However, weighbridge calibration and weighing accuracy reliability are questionable.

- It was reported that the number of scavengers at the final disposal site has increased and that there are practically no hired workers involved in recyclable waste recycling. It was also informed that police raids have stopped as scavengers set the site on fire in retaliation. The number of attacks on site workers has also increased as reported. In the light of this situation, scavengers are allowed to operate to avoid conflicts.

- In 2013 no progress was made regarding the construction of the new Guanabacoa landfill site. However, the executive projects for the first trench and the oxidation pond were authorized and completed. Construction is scheduled to begin soon. The pipe to collect and carry the leachate and the weighbridge to be installed at the site were already procured.

- Mr. Toshihiko Chiba, JICA final disposal expert, worked in Cuba and his detailed activities is included in final report. However, his contribution to the revision of the executive projects and his advice on the leachate recirculation system for Calle 100 landfill site should be highlighted.

a.2. Individual Capacity

a.2.1 Mr. Ernesto Domínguez, Solid waste specialist, DPSC

Mr. Ernesto Domínguez is responsible for having the studies and projects required for the construction of the new Guanabacoa landfill site made, and he plays the role of coordinator for C/P Group 4. Despite the fact that he has no experience in landfill site design and operation, he shows great management and work supervision capabilities, thus becoming a valuable asset for C/P Group 4.

Mr. Ernesto Domínguez was already evaluated as a member of C/P Group 1.

a.2.2 Mr Lázaro Sotolongo, Manager-to-be of the new Guanabacoa landfill site.

Mr. Lázaro Sotolongo joined C/P Group 4 in late 2011 as manager-to-be responsible for the operation of Guanabacoa sanitary landfill site. His knowledge of sanitary landfill sites and solid waste disposal was extremely limited. However, he has been trained and read many materials on the subject. His training in Mexico City in late 2012 was particularly important to increase his capacity as there he could experience the construction and operation of several landfill sites, thus enabling him to compare theory and practice.

Based on the above, Mr. Lázaro Sotolongo's capacity assessment remains as follows:

Level 3. "Little assistance by the Japanese expert is required to achieve the target level or the results expected".

a.2.3 Mrs. Harylin Tamayo, Investment specialist, UPPH.

Mrs. Harilyn Tamayo is the person currently responsible for investments at UPPH and will be the person directly responsible for the supervision of the construction works at the new Guanabacoa landfill site, so she was made a member of C/P Group 4 as of the year 2012.

Mrs. Harylin Tamayo has experience in investment supervision and construction works. She had neither knowledge nor experience in the field of sanitary landfill sites. However, she attended a training course in Japan in 2013, where she could visit several sanitary landfill sites and other facilities used for waste management, thus expanding her capacity for waste management. This experience will be extremely useful for her work during the construction of the New Guanabacoa sanitary landfill site.

Based on the above, Mrs. Harylin Tamayo's intermediate evaluation is the following:

Level 3. "Little assistance by the Japanese expert is required to achieve the target level or the results expected".

a.2.4 Mr. Camilo Rodríguez, Landfill Site Unit, UPPH

Mr. Camilo Rodríguez has worked for UPPH, especially at the landfill sites, for many years. He had already been the Head of the Landfill Unit at the beginning of the Project. However, he later left his position to be recently reinstated. His capacity assessment had not been conducted before as he was either on vacation or had been relieved of his duties by the time of yearly assignment period in Cuba. Therefore, his initial capacity assessment is conducted this time.

Mr. Rodríguez thoroughly knows the operation and present condition of Calle 100 final disposal site and the rest of the sites currently used for dumping the wastes generated in Havana City. He is also acquainted with the proper operation techniques to be implemented for final disposal. However, these are not fully put into practice for the operation of Calle 100 landfill site seemingly due to material, staff, equipment, and fuel constraints.

JICA Expert Team has repeatedly offered some recommendations regarding the need to cover solid wastes and compact them, as well as about the proper way to move and compact the wastes using heavy equipment. However, the site operation is very inadequate, not only in terms of waste compaction, but also with regard to waste covering with soil, road maintenance, presence of scavengers, etc.

Based on the above, the initial evaluation of Mr. Camilo Rodríguez is the following:

Level 3. "Little assistance by the Japanese expert is required to achieve the target level or the results expected".

a.2.5 Mr. Hermes del Toro, civil engineer, DPSC

Mr. Hermes del Toro joined DPSC and C/P Group 4 nearly a month ago. Therefore, his initial evaluation is conducted now.

He does not have any experience in the field of landfill site construction and operation. However, as a civil engineer he has a long fieldwork experience, including earth moving, construction, and equipment installation.

His fieldwork experience enables him to warn about the difficulties that projects may encounter during their implementation by judging from the condition of existing machineries and the equipment owned by the building companies in Cuba. His expertise may mean a significant capacity contribution to C/P Group 4 for the design and construction of the New Guanabacoa sanitary landfill site, the project for the New West landfill site, and for the works to be carried out at Calle 100 site.

Fortunately, his integration into team 4 coincided with Mr. Chiba's assignment in Cuba. He could therefore be informed of the current waste disposal projects and began his formal training in the subject. However, Mr. Del Toro needs to make the most of the expertise of JICA Expert Team during the time left for the Project for the Improvement of Capacity on Municipal Solid Waste Management in Havana City, Republic of Cuba.

Based on the above, Mr. Hermes del Toro's initial evaluation is the following:

Level 2-3. Between "A lot of assistance by the Japanese expert is required to achieve the target level or the results expected" and "Little assistance by the Japanese expert is required to achieve the target level or the results expected".

1.2 Capacity development attained by the C/P members through the Project

1.2.1 Achievement on Capacity Development for C/P for Output 1

A capacity assessment expert from a third country performed the assessment for capacity development of C/P personnel. Each year the capacity assessment expert was dispatched to Havana and conducted interviews for each C/P member. Based on the interview assessment, the capacity of C/P in output 1 “Comprehensive management capacity on solid waste of DPSC is improved” was assessed as it had been considerably strengthened in the 5 year project period.

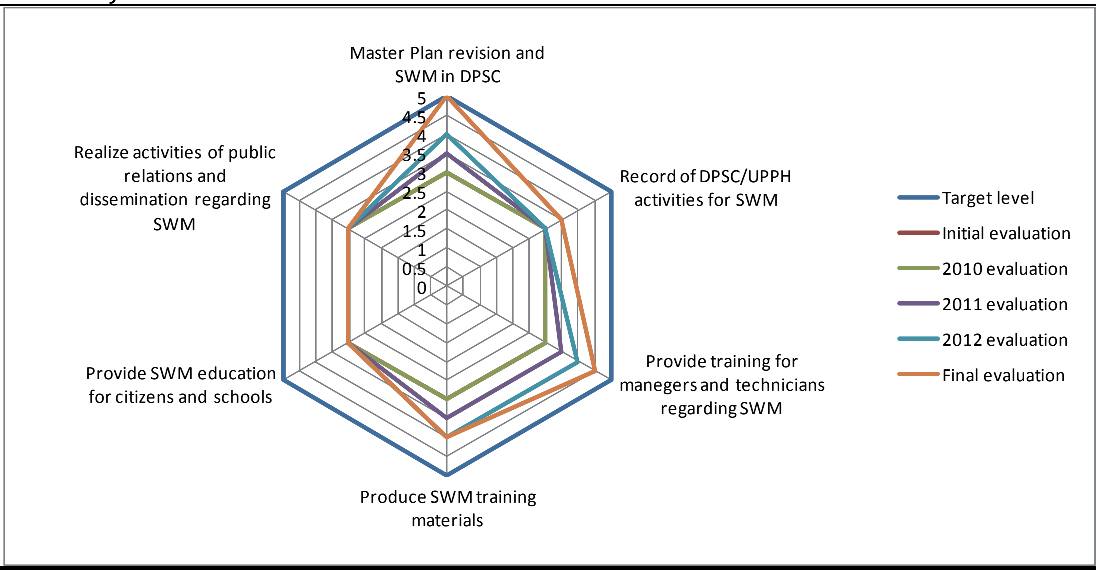
As seen in the following figures, the individuals in Output 1 have gradually and steadily developed their capacities on the subject since the commencement of the Project. One can also see that capacity as a group also increased in the same period which can be seen in the annual radar chart that follows.

Due to various reasons, some C/P personnel have left the workforce or changed unit/positions. Therefore, period participated by those successive C/P staffs became relatively short, which in turn made the capacity developed from this Project rather limited.

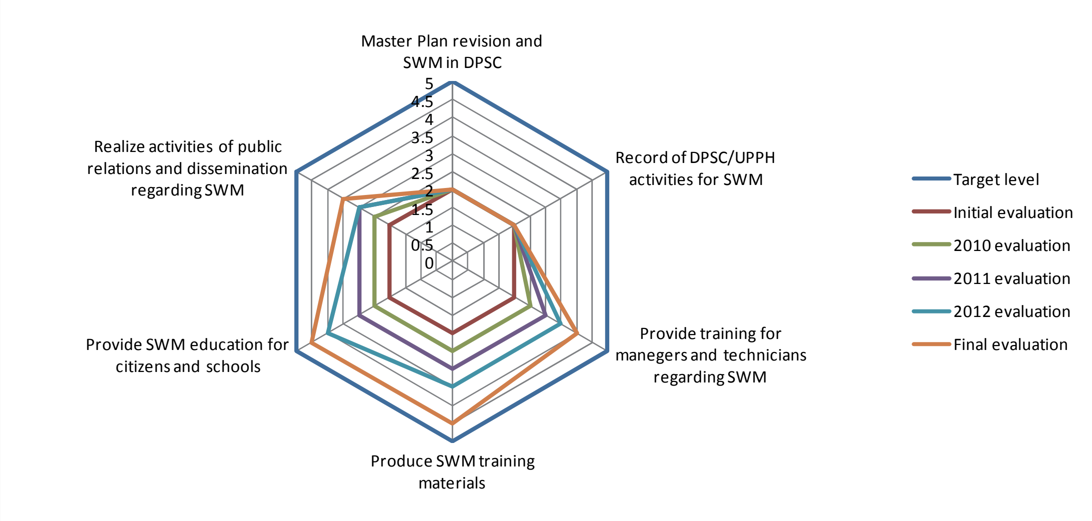
Under some given circumstances in which the former C/P member who had left the Project return to DPSC/UPPH work unit, it can be anticipated that the capacity as a group will enhanced. On the contrary, some negative impact may be unavoidable if current C/P personnel leaves the unit or changed his/her positions. This will most likely bring narrowing down the group capacity or further weaken some poorly evaluated field.

Assessment for Individual

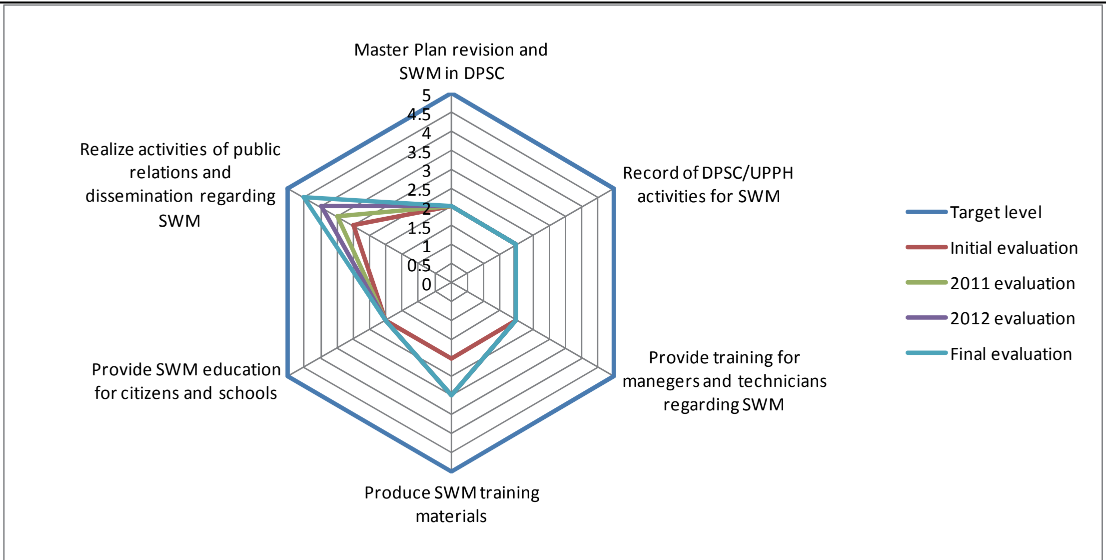
Ms. Odalys García



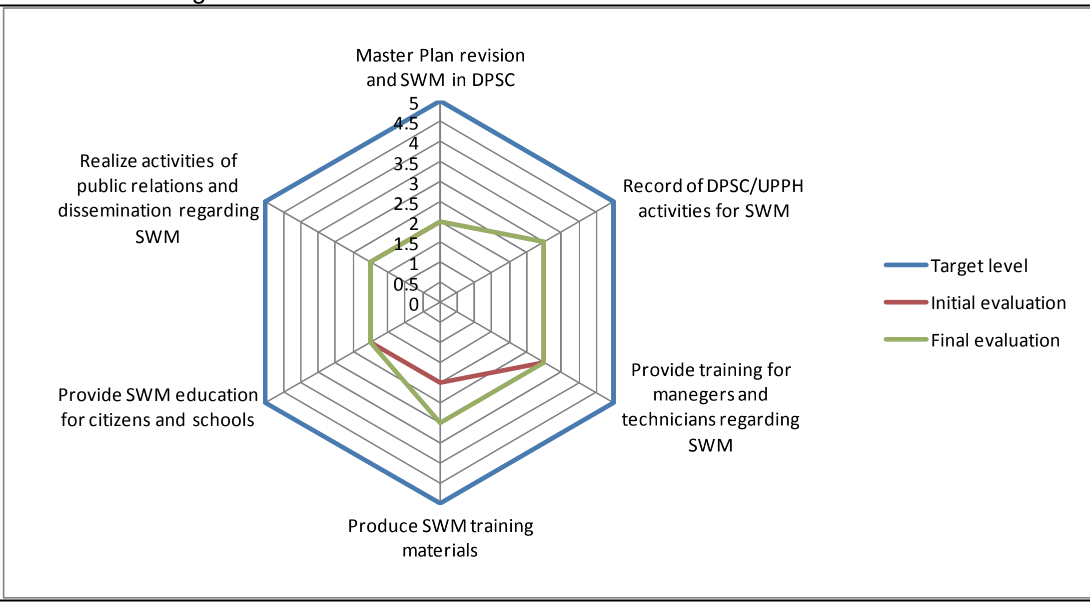
Ms. Jaynet García



Ms. Mariana Echavarría



Mr. Alfredo Rodríguez



Assessment for the Group

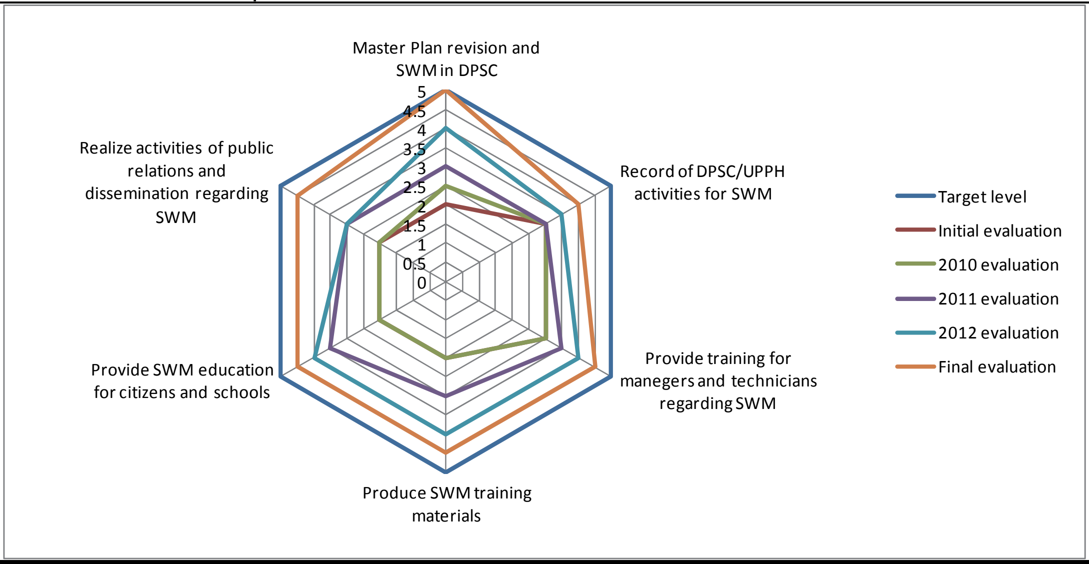


Figure 1-1: Capacity Development for C/P Output 1

1.2.2 Achievement on Capacity Development for C/P for Output 2

A capacity assessment expert from a third country performed the assessment for capacity development of C/P personnel. Each year the capacity assessment expert was dispatched to Havana and conducted interviews for each C/P member. Based on the interview assessment, the capacity of C/P in output 2 "Solid waste source separation at Pilot Project site is promoted and capacity of UPPH in organic waste reduction at the source is strengthened" was assessed as it had been considerably strengthened in the 5 year project period.

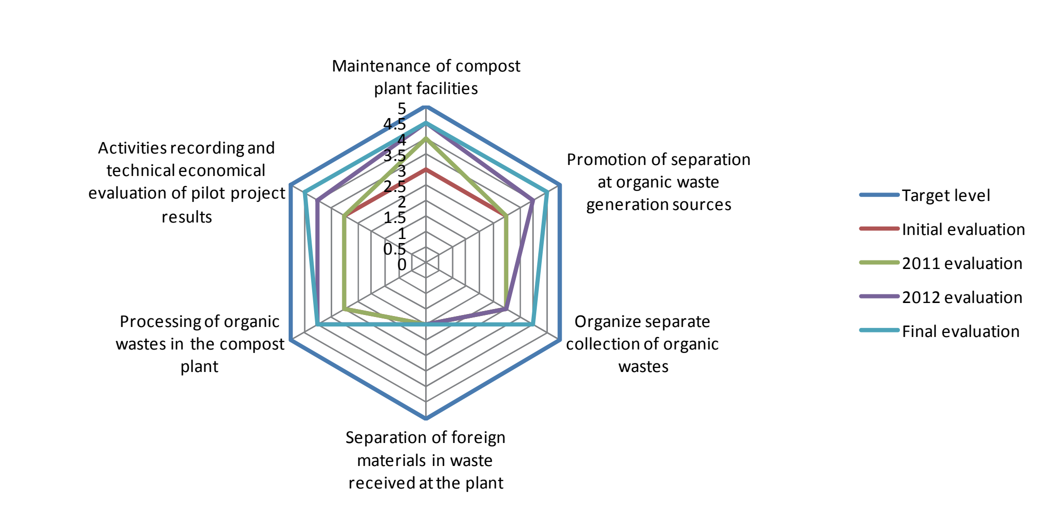
As seen in the following figures, the individuals in Output 2 have gradually and steadily developed their capacities on the subject since the commencement of the Project. One can also see that capacity as a group also increased in the same period which can be seen in the annual radar chart that follows.

Due to various reasons, some C/P personnel have left the workforce or changed unit/positions. Therefore, period participated by those successive C/P staffs became relatively short, which in turn made the capacity developed from this Project rather limited.

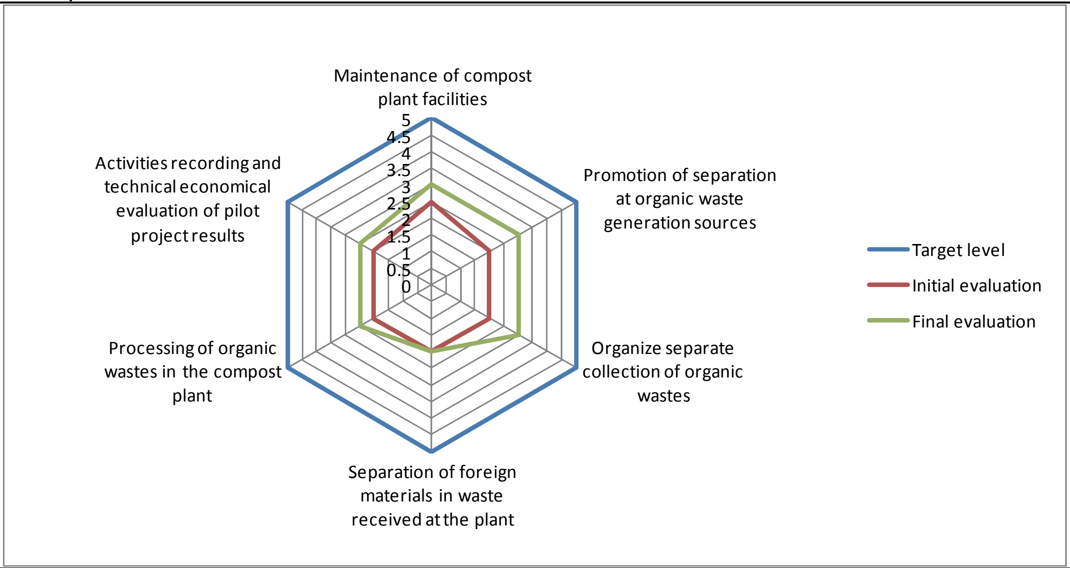
Under some given circumstances in which the former C/P member who had left the Project return to DPSC/UPPH work unit, it can be anticipated that the capacity as a group will enhanced. On the contrary, some negative impact may be unavoidable if current C/P personnel leaves the unit or changed his/her positions. This will most likely bring narrowing down the group capacity or further weaken some poor field. Output 2 has only 3 C/P members therefore negative impact from re-distribution of personnel, if occurs, maybe much more severe. It is highly anticipated that actions be taken by the Cuban side for the continuity of the composting project through retreat the former C/P members and/or recruiting new staffs.

Assessment for Individual

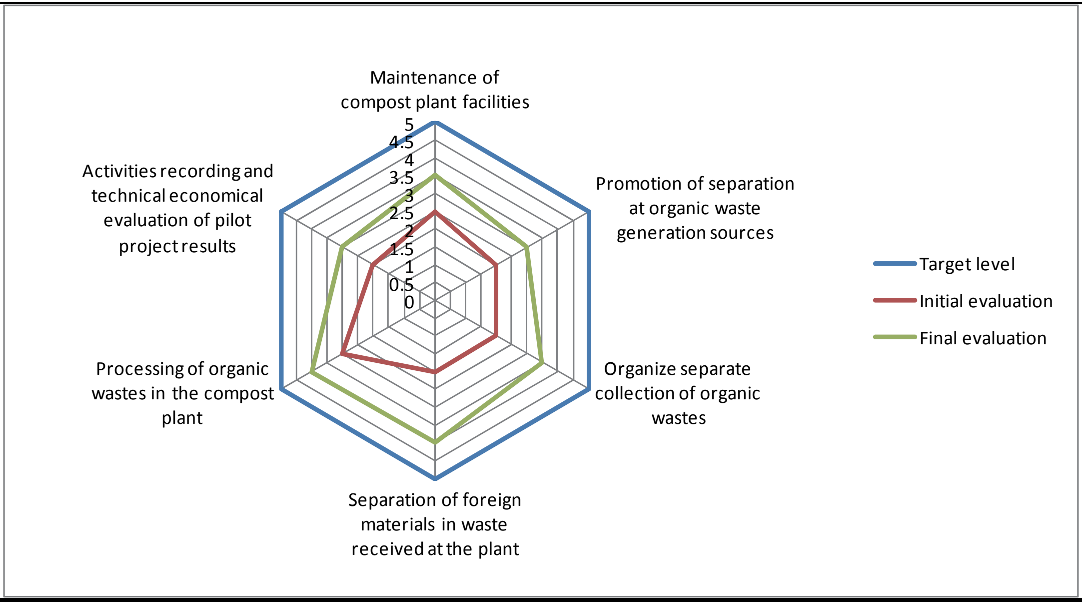
Mr. César de las Pozas



Mr. Apolonio Cerrano Miranda



Mr. David Santana



Assessment for the Group

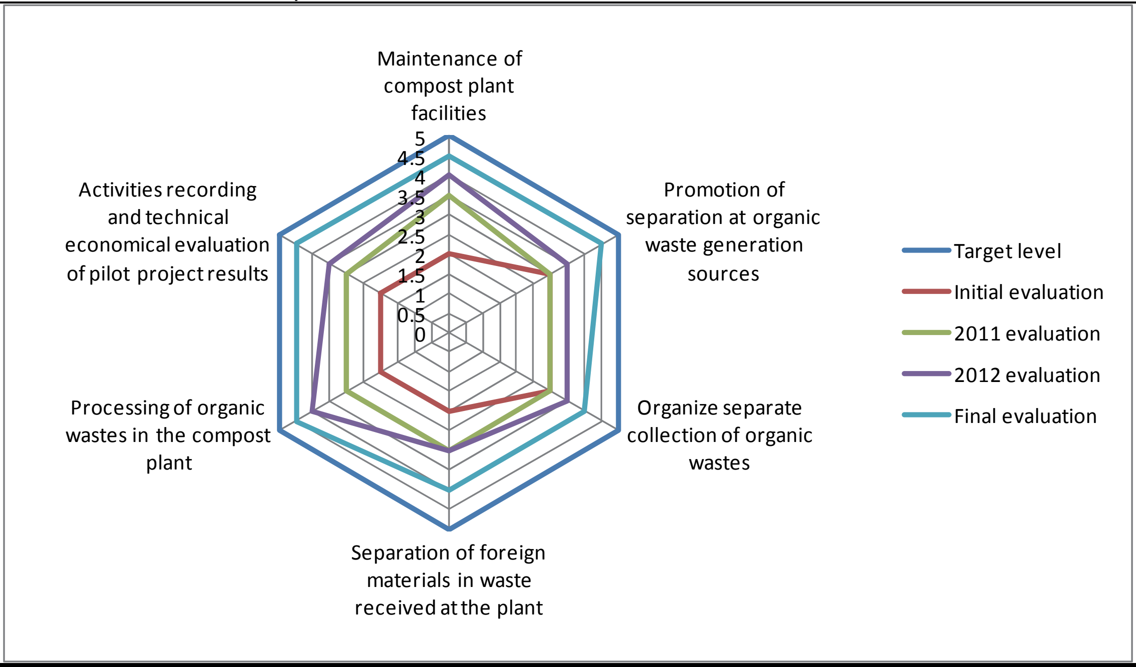


Figure 1-2: Capacity Development for C/P for Output 2

1.2.3 Achievement on Capacity Development for C/P for Output 3

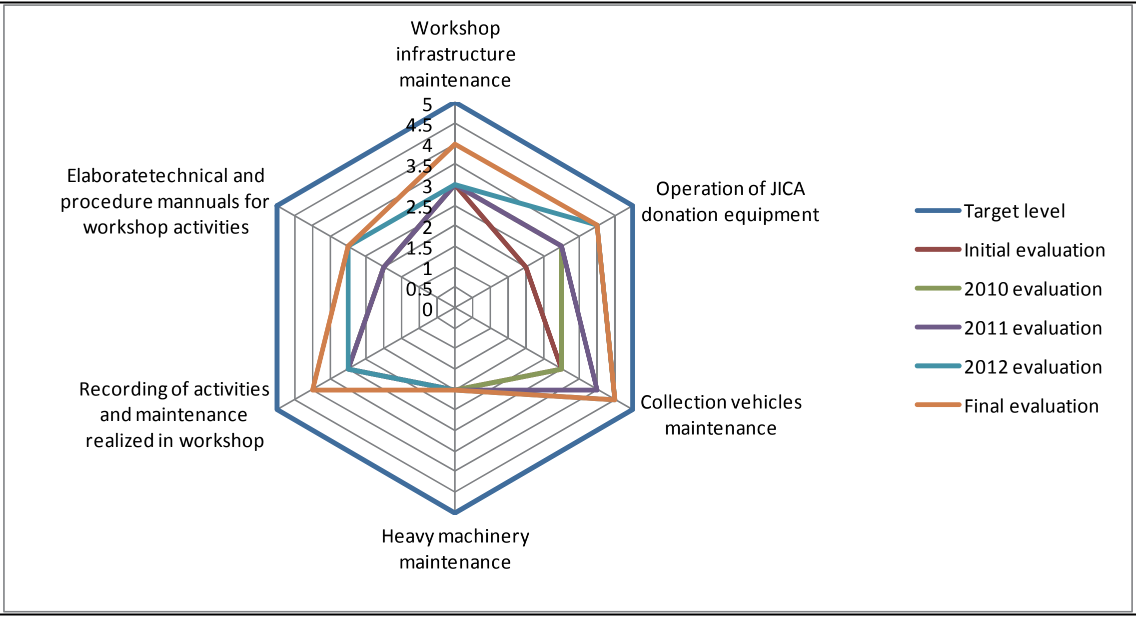
A capacity assessment expert from a third country performed the assessment for capacity development of C/P personnel. Each year the capacity assessment expert was dispatched to Havana and conducted interviews for each C/P member. Based on the interview assessment, the capacity of C/P in output 3 "Capacity of UPPH in the collection and transportation of solid waste is strengthened" was assessed as it had been considerably strengthened in the 5 year project period.

As seen in the following figures, the individuals in Output 3 have gradually and steadily developed their capacities on the subject since the commencement of the Project. One can also see that capacity as a group also increased in the same period which can be seen in the annual radar chart that follows.

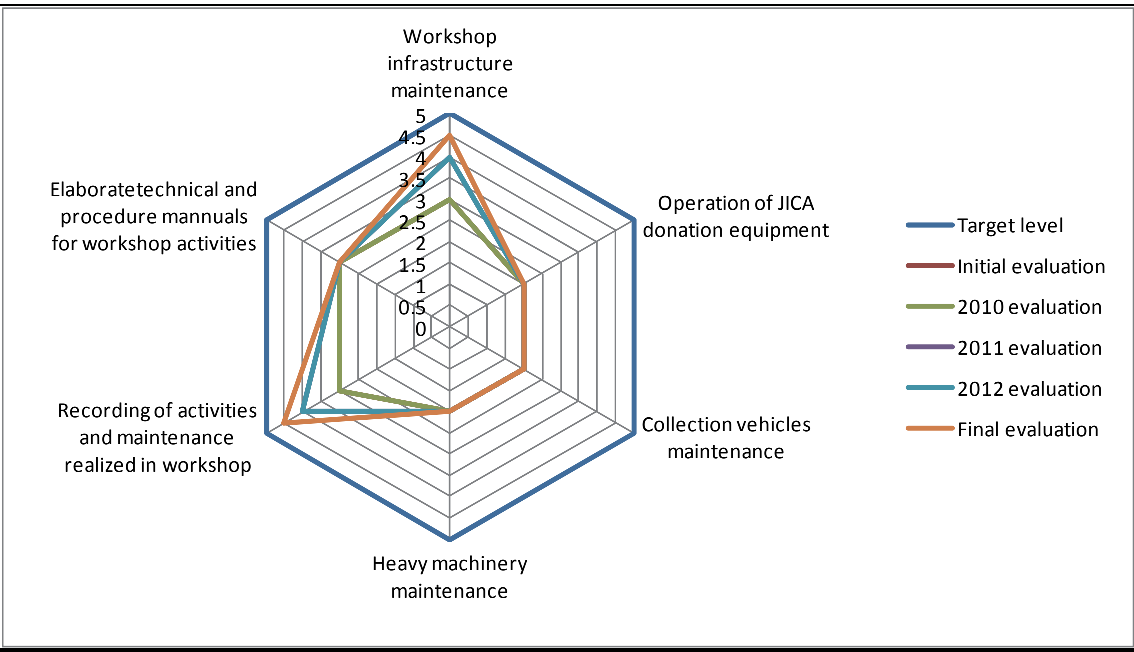
There had no staff relocation or staff who left the workforce for Output 3 C/P personnel in the first half period; therefore, their capacities development have been done smoothly. Unfortunately, however, replacement of UPPH director and consequent change in management styles at the workshop in the final stage of the Project caused some competent C/P members leading the group left the workshop. This has caused not-negligible negative impacts for building and maintaining the capacity of the group. Nonetheless, such impacts were rather limited since a) many C/P members were assigned from the beginning of the Project and b) successive C/P members were assigned immediately, and c) young and highly capable C/P were added in the group.

Assessment for Individual

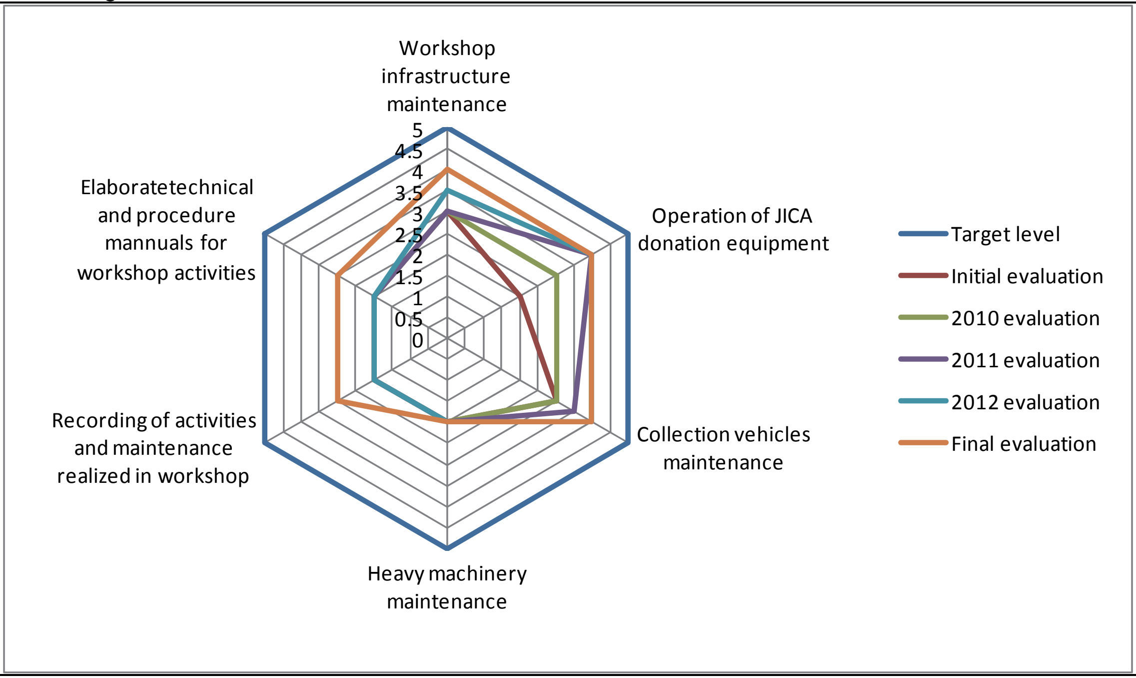
Mr. Félix Arturo Abreu



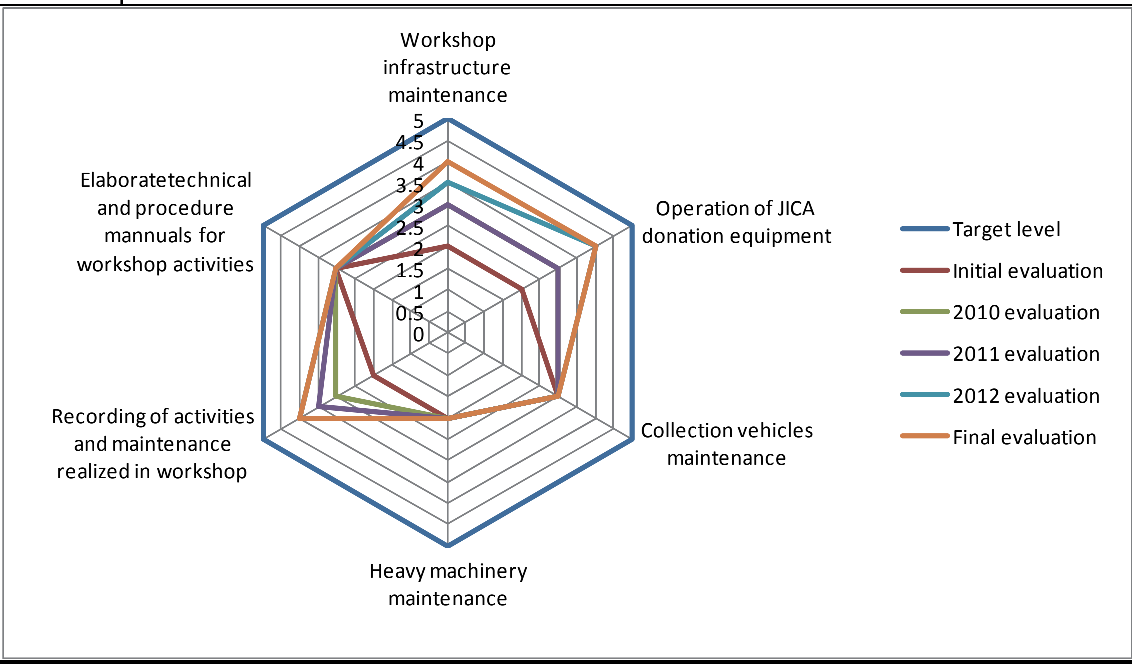
Mr. Fernando González



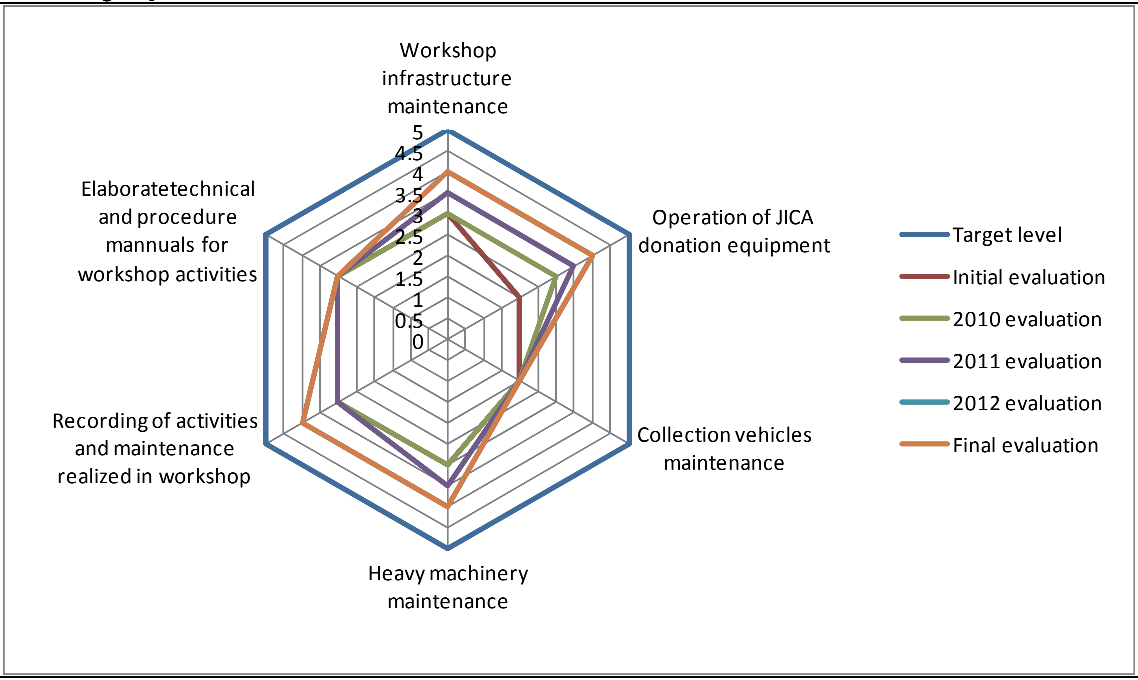
Mr. Diego Guevara



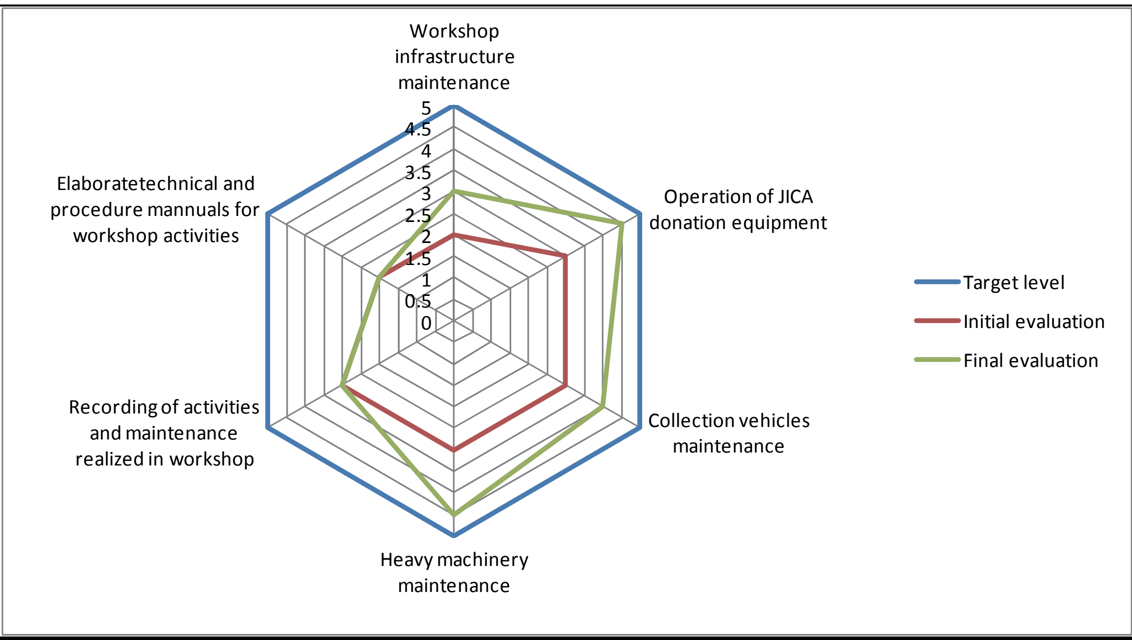
Mr. Enrique García



Mr. Jorge Quintana



Mr. Eduardo Jiménez



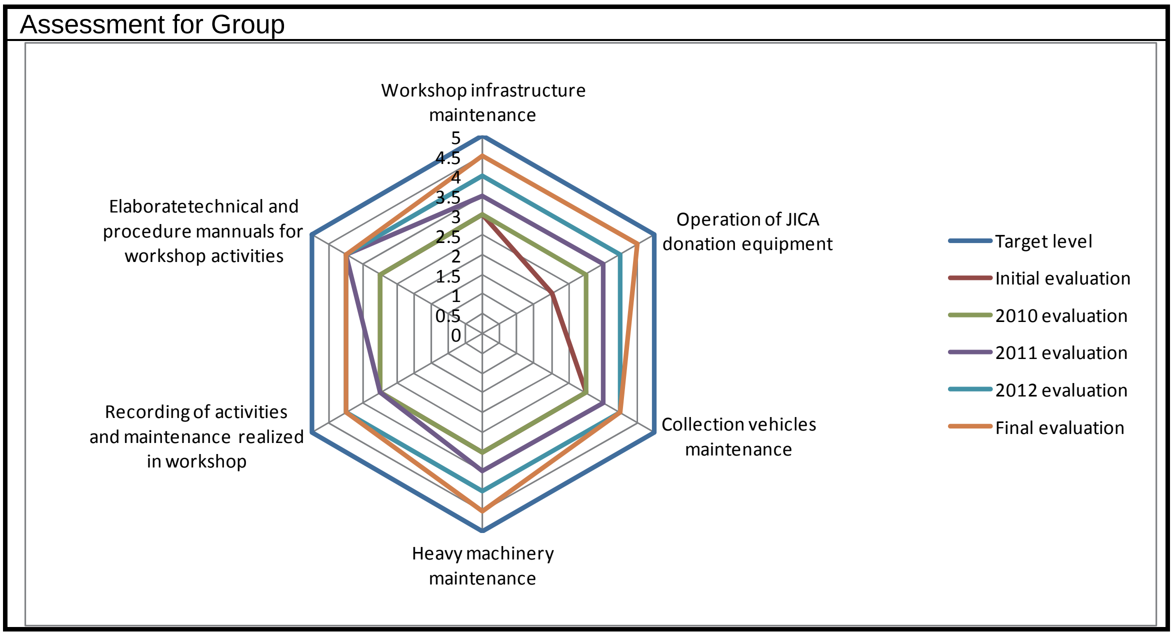


Figure 1-3: Capacity Development for C/P for Output 3

1.2.4 Achievement on Capacity Development for C/P for Output 4

A capacity assessment expert from a third country performed the assessment for capacity development of C/P personnel. Each year the capacity assessment expert was dispatched to Havana and conducted interviews for each C/P member. Based on the interview assessment, the capacity of C/P in output 4 “Capacity of UPPH on landfill design and operation of final disposal site is strengthened” was assessed as it had been considerably strengthened in the 5 year project period.

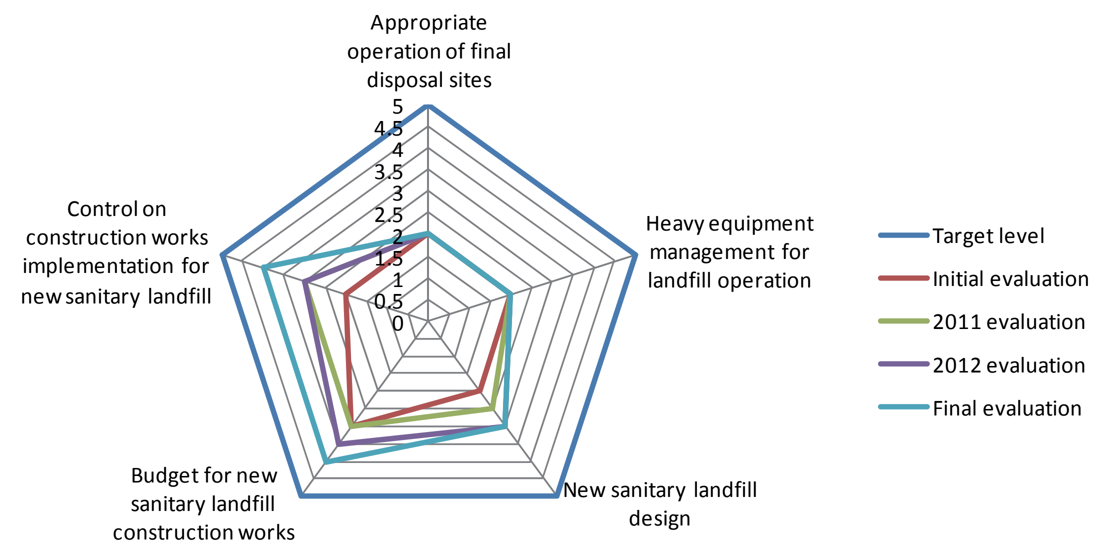
As seen in the following figures, the individuals in Output 3 have gradually and steadily developed their capacities on the subject since the commencement of the Project. One can also see that capacity as a group also increased in the same period which can be seen in the annual radar chart that follows.

Due to various reasons, some C/P personnel have left the workforce or changed unit/positions. Therefore, period participated by those successive C/P staffs became relatively short, which in turn made the capacity developed from this Project rather limited.

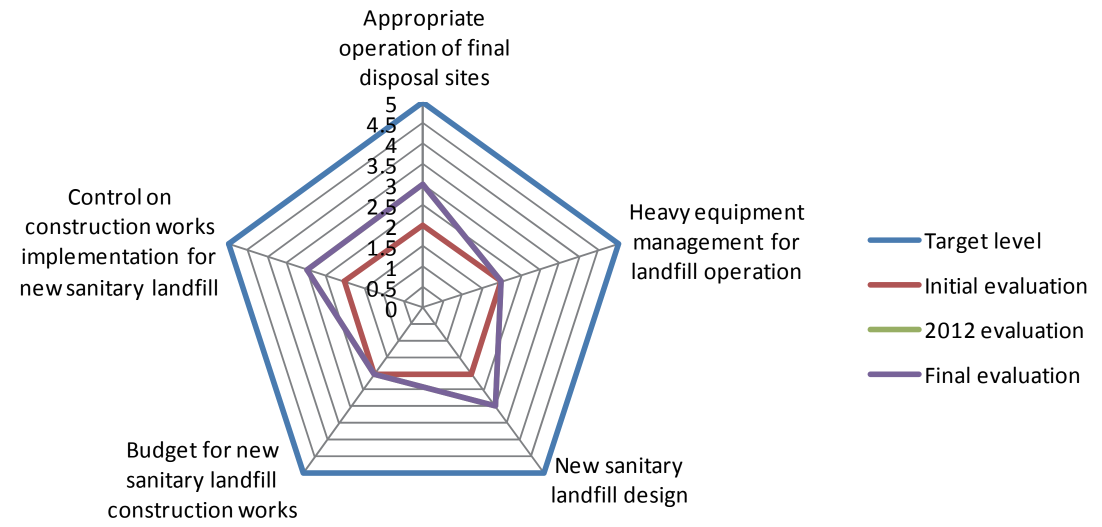
If current C/P leaves the position, some negative impacts may become evident including narrowing down the radar chart as a group and further weakening poor field. It maybe worth noting that the C/P members from DPSC mainly work on planning field like budgeting, while C/P members from UPPH mainly work on field work like landfill operation and thus designing new landfill site or leachate treatment facility are not particularly in their field of expertise. Therefore, one should pay attention to develop not only the capacities of DPSC/UPPH personnel but also relevant organizations such as DCH and EIPHH in order to develop the capacity of members in Output 4 group be developed in good balance.

Assessment for individual

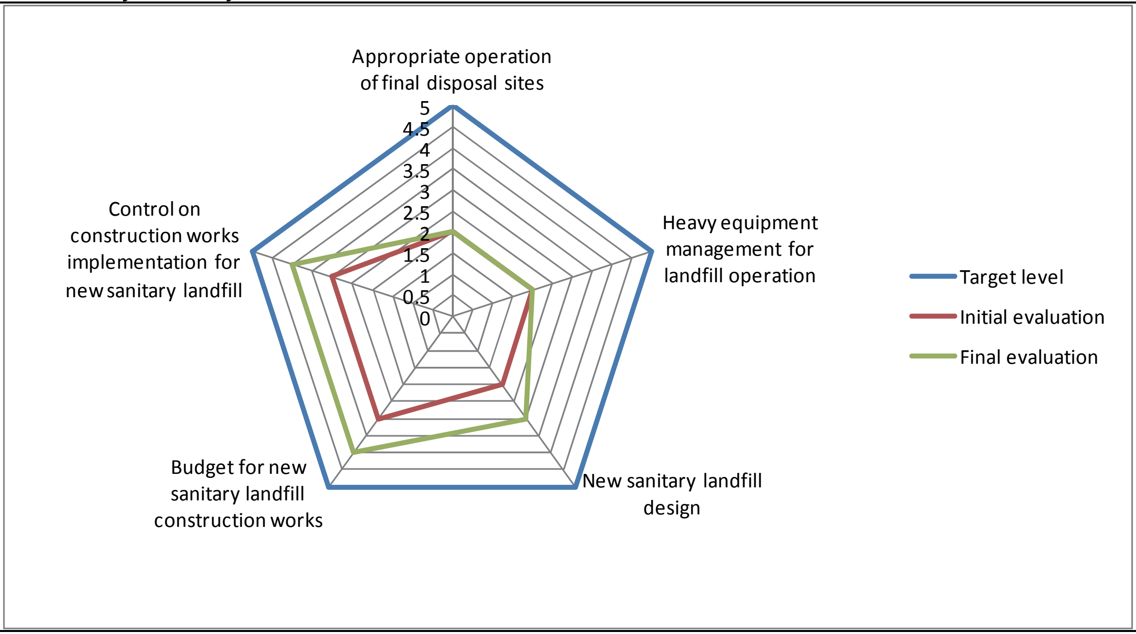
Mr. Ernesto Domínguez



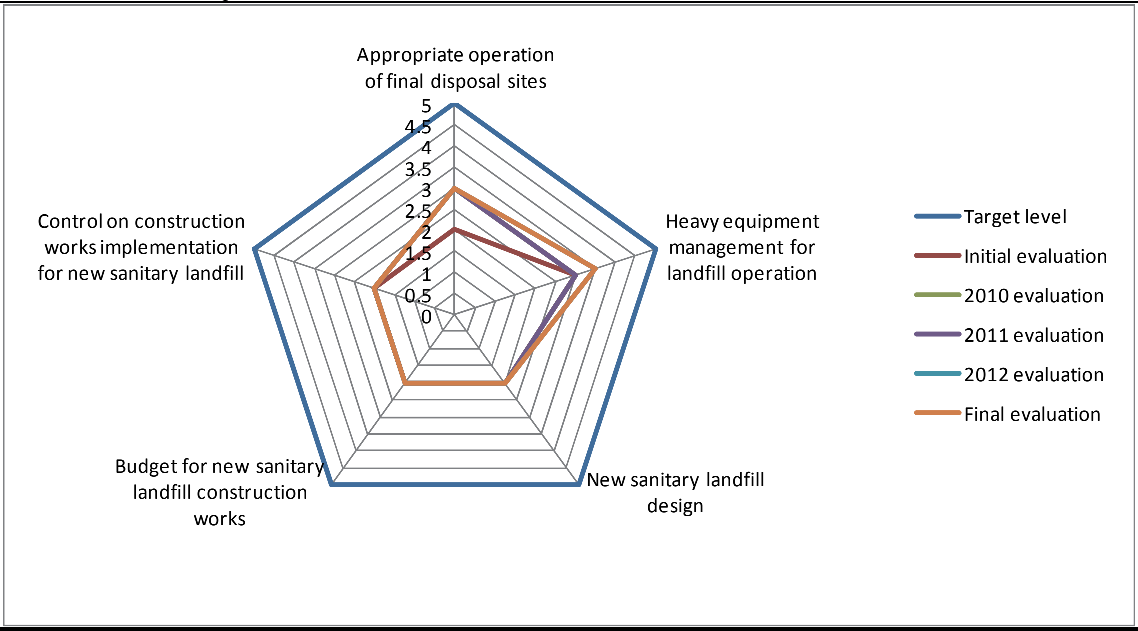
Mr. Lázaro Sotolongo



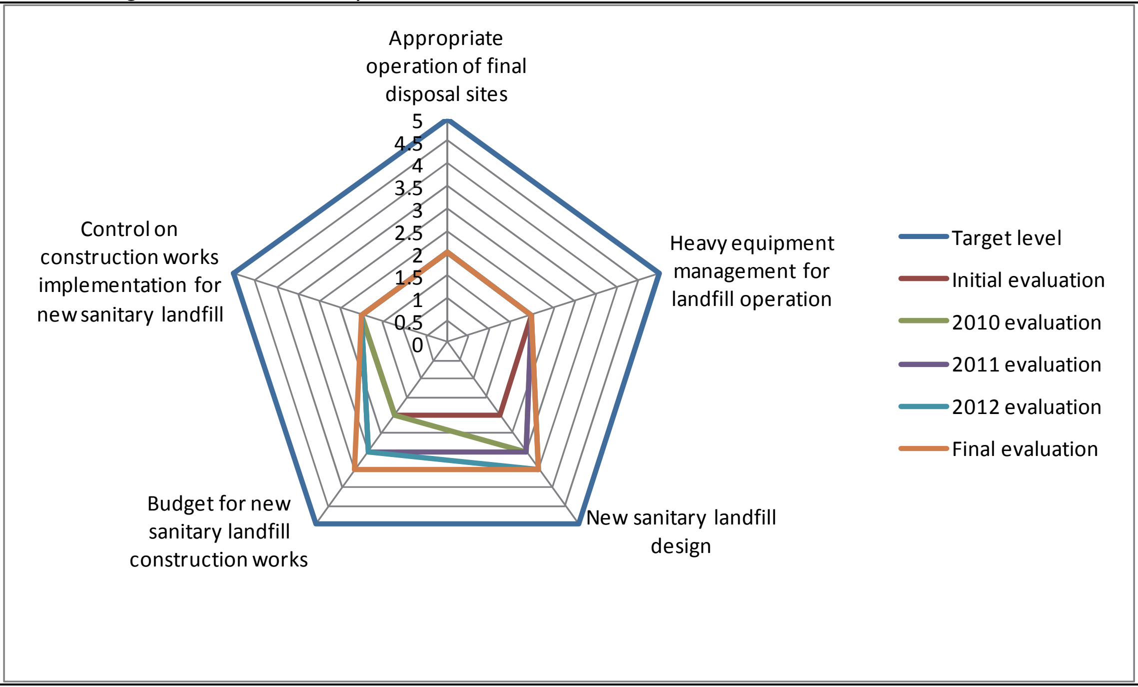
Ms. Harilyn Tamayo



Mr. Camilo Rodríguez



Evaluation for the new landfill design (Other than C/P, Designer of DCH & EIPHH, participants of Training session in Mexico)



Assessment for group

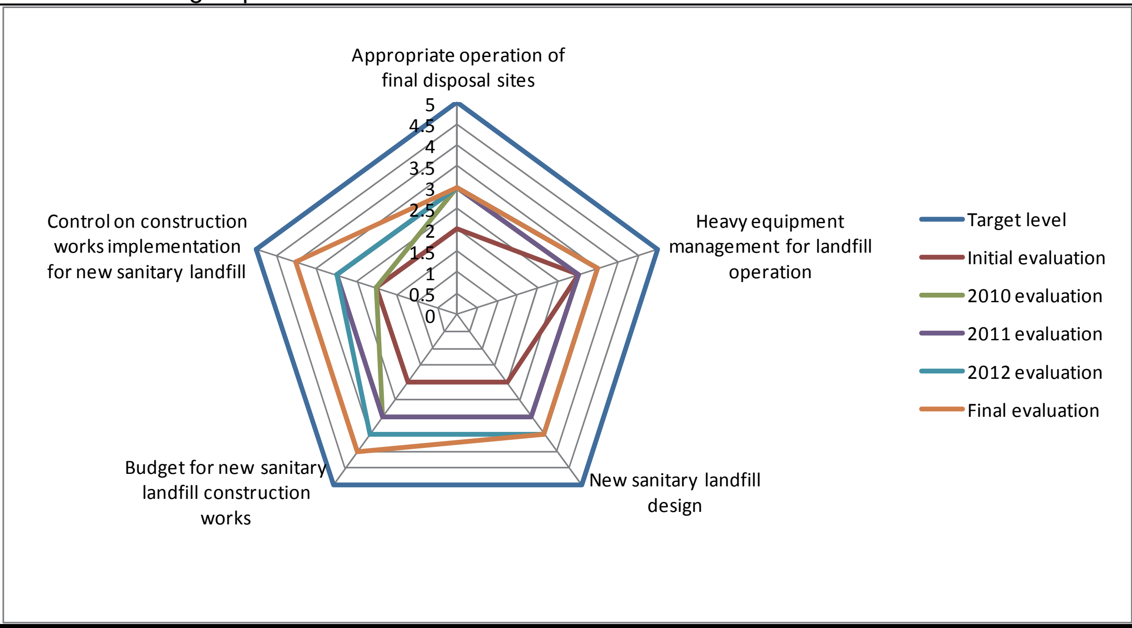


Figure 1-4: Capacity Development for C/P for Output 4

1.2.5 Constraining factors of the capacity development for C/P

Major constraining factor of the capacity development for the C/P in this Project is that re-assignment of C/P personnel due either to turnover or transfer have occurred repeatedly. This means that C/P who had shown some progress had to leave the Project and the newly appointed C/P has to build his/her capacity all over again. Although it was a external factor which the Project cannot control, but yet unfortunate circumstances.

Progress of the capacity development for individual C/P in each group and impact of personnel changes are shown in the figure below.

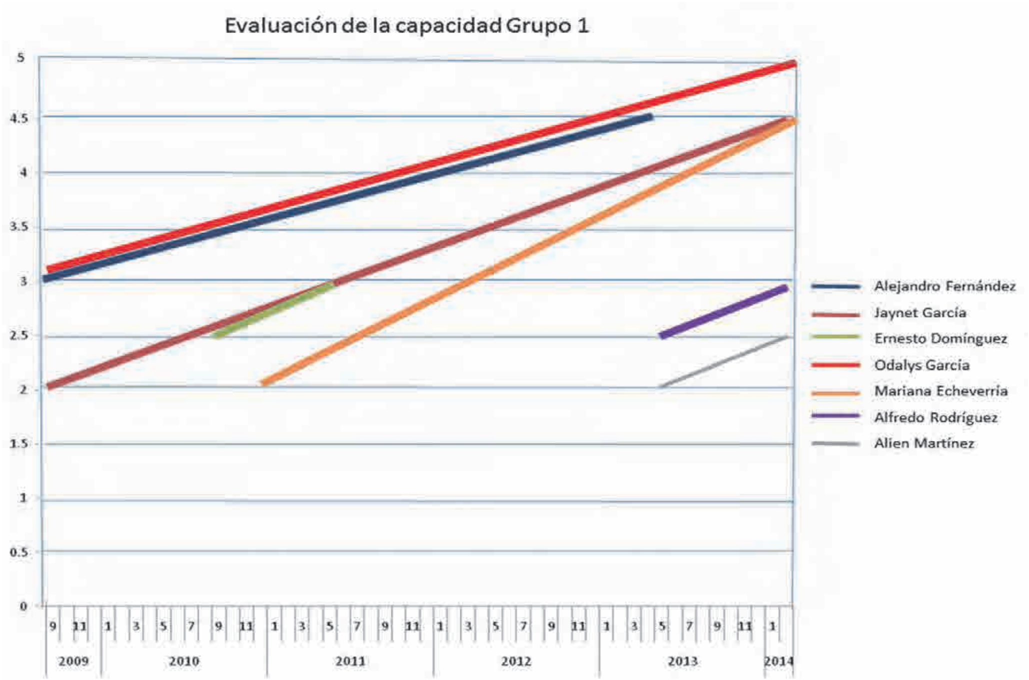


Figure 1-5: Changes in the Capacity of C/P & Impact of C/P Replacement for Output group 1

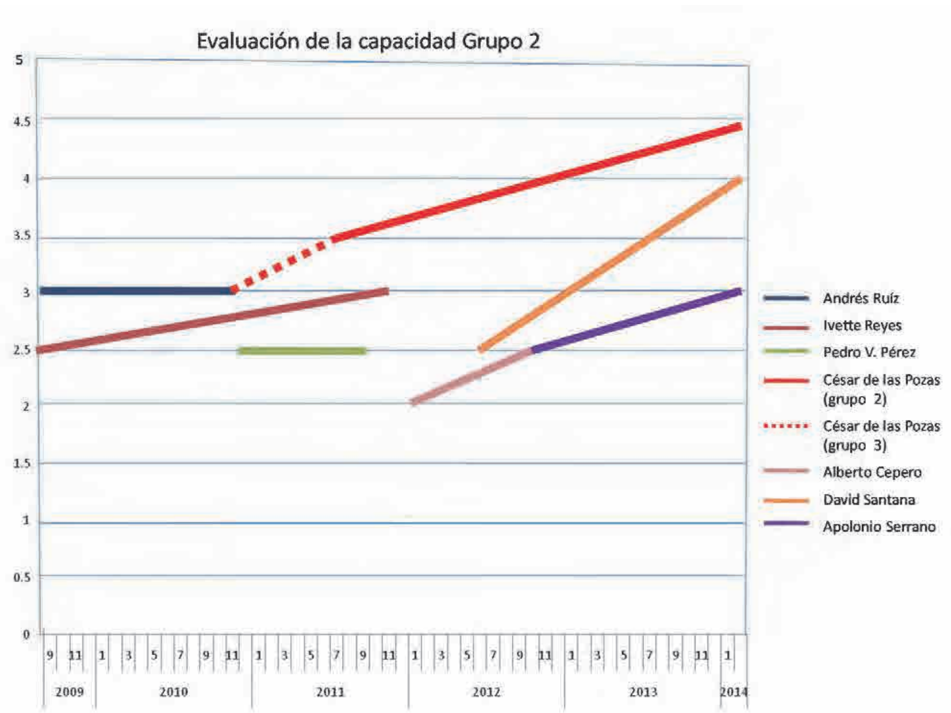


Figure 1-6: Changes in the Capacity of C/P & Impact of C/P Replacement for Output group 2

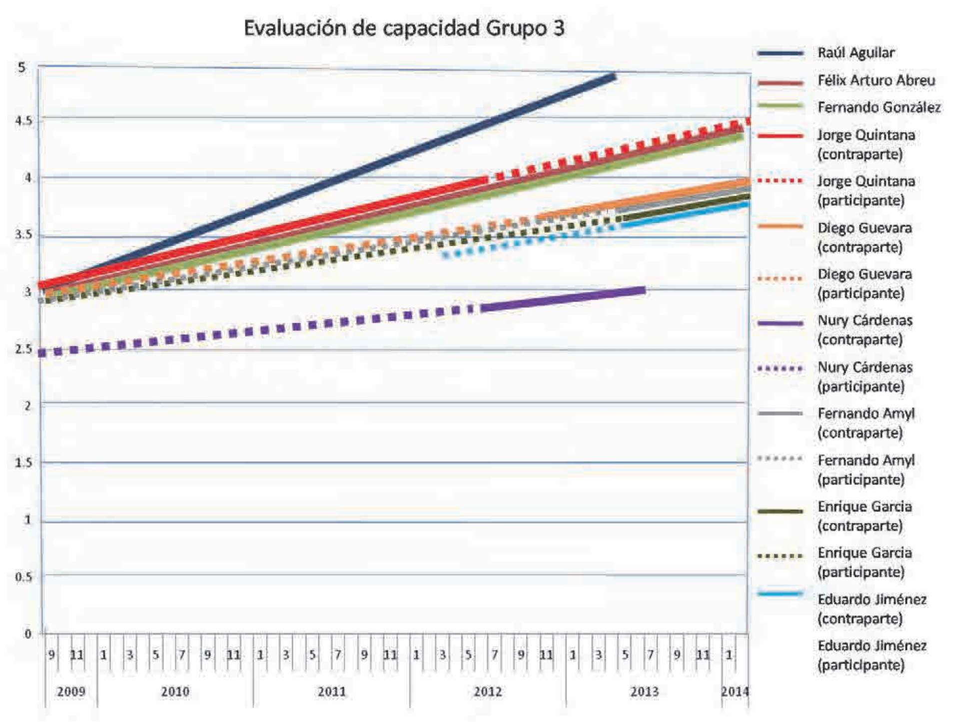


Figure 1-7: Changes in the Capacity of C/P & Impact of C/P Replacement for Output group 3

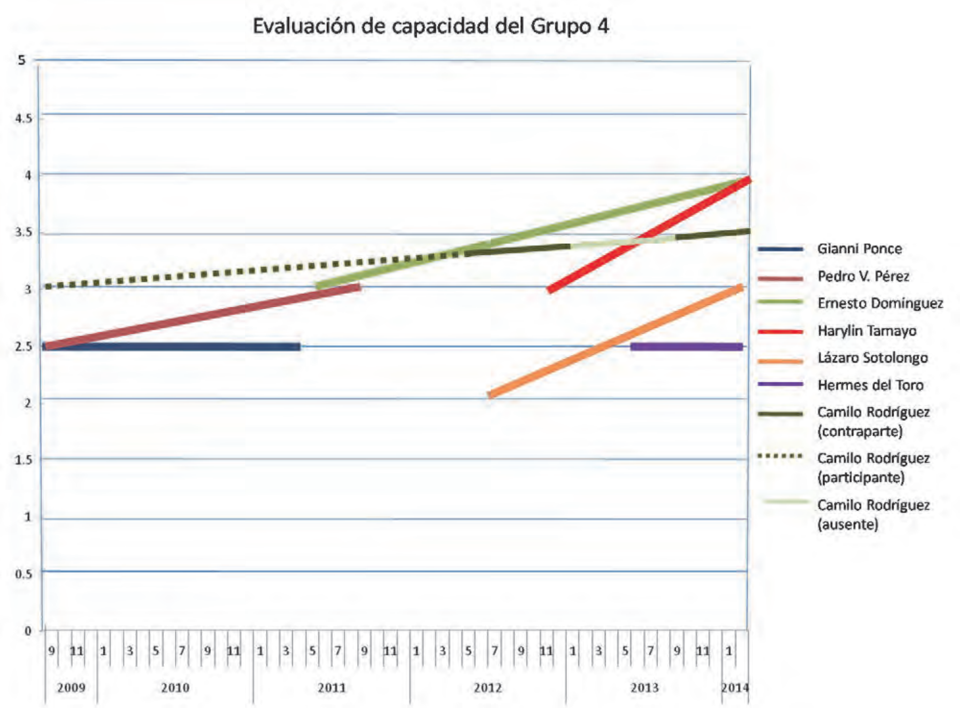


Figure 1-8: Changes in the Capacity of C/P & Impact of C/P Replacement for Output group 4

1.3 Final Capacity Assessment of Organization and Institution

Following 4 goals are set as project outputs.

1. Comprehensive management capacity on solid waste of DPSC is improved.
2. Solid waste source separation at Pilot Project site is promoted and capacity of UPPH in organic waste reduction at the source is strengthened.
3. Capacity of UPPH in the collection and transportation of solid waste is strengthened.
4. Capacity of UPPH and DPSC on landfill design and operation of final disposal site is strengthened.

In order to conduct the second intermediate analysis of the organization/institution, it was again deemed convenient to perform a qualitative analysis of the strengths, weaknesses, and opportunities to achieve the goals of the Project for Capacity Improvement on Municipal Solid Waste Management in Havana City, Republic of Cuba, taking into consideration the relevant categories included in Table 3.1 "Contents of Capacity Assessment (draft)" of the Inception Report of the Project for Capacity Improvement on Municipal Solid Waste Management.

In this final assessment, many of the remarks made in the previous intermediate evaluations about the capacity of the organization/institution remain unaltered as no significant changes in solid waste management in Havana City have been introduced.

Table 1-1: Strengths, Weaknesses, and Opportunities in DPSC Organization / Institution

Category/ Sub-category	Organization			Institution/social systems		
	Strengths	Weaknesses	Opportunities	Strengths	Weaknesses	Opportunities
<u>National policy</u> Solid waste policy	JICA's Project has helped some of DPSC's managers become aware of the need to define an environmentally-friendly waste management policy.	Some management staff have recently been changed and the newly appointed officials do not know the technical side of solid waste management in depth, or the measures to increase its use.	The Project for the Improvement of Capacity includes a training program for managers, which may be used to stress the need to define a proper environmentally-friendly waste management policy.	The need to allocate resources to improve solid waste management has been stressed.	There still exist many limitations in terms of infrastructure and equipment necessary for solid waste management.	Authorized investments should be used to improve solid waste management.
Relevant laws / regulations	There is a legal framework related to the management of both municipal and hazardous solid wastes.	The legal framework is inadequate and not thoroughly known by managers.	The existing training program may be used to increase the knowledge of DPSC's managers and staff regarding relevant laws and regulations.	Some measures have been adopted in order to improve waste collection and fuel consumption efficiency.	The results of the measures adopted to improve fuel consumption efficiency, as well as the new salary policy for collection vehicle drivers, are not clear.	The proper adoption of the new measures and the regular operation of the weighbridge may help increase waste collection efficiency.
<u>National policy</u> Environmental evaluation	There is a standard for the setting up of sanitary landfill sites.	The C/P staff and the designers are not well aware of the standard and have no experience in sanitary landfill site design.	The participation of JICA's experts has facilitated the training of the C/P staff in terms of the environmental assessment of facilities used for waste management.	Some people at CITMA Habana have experience in environmental assessment.	CITMA Habana's participation in waste management is very limited.	The participation of CITMA Havana's staff in some project activities may facilitate the coordination with DPSC regarding solid waste management.
<u>Basic information on Havana City</u> City planning	DPSC may have access to the city's development plans.	There is no close coordination between DPSC and the Physical Planning Authority.	The contacts between DPSC and the physical Planning Authority as a result of the plans to build a railway line may facilitate coordination between the two organizations.	They contacts have taken place in coordination meetings between DPSC and the Physical Planning Authority.	There is no permanent contact between DPSC and the Physical Planning Authority.	The contacts between DPSC and the physical Planning Authority as a result of the plans to build a railway line may facilitate coordination between the two organizations.

Category/ Sub-category	Organization			Institution/social systems		
	Strengths	Weaknesses	Opportunities	Strengths	Weaknesses	Opportunities
Legal framework By-laws and regulations	Some of DPSC's management staff is aware of the by-laws and regulations related to solid waste management.	Due to the frequent changes in DPSC's management staff, the newly-appointed people are not aware of existing by-laws and regulations related to solid waste management.	JICA's Project may help the newly-appointed management staff to be trained in this subject.	There is a suitable, though insufficient, legal framework for solid waste management.	No by-laws have been passed about waste discharge in containers or demolition waste management	Some progress can be made in terms of understanding the proper management of solid wastes with the review and updating of the Master Plan and regulating waste demolition generation and management..
Institutions Missions, purposes, and implementation	DPSC's purposes and goals are clearly stated.	They are neither stated as DPSC's mission or purpose, nor are they clearly documented.	Changes in management staff may be used to define the mission and the purposes of the institution.	A significant number of DPSC's management staff clearly knows DPSC's mission and purpose.	The newly-appointed officials do not know the mission or the purpose of the institution in depth..	The training and publicity programs may help the residents to get to know DPSC's mission and purpose.
Institutions Separation of responsibilities	The responsibilities of the various DPSC's departments are clearly defined.	The separation of duties brings about thatmanagers fail to see the organization as a whole.	The implementation of JICA's project may help achieve an overall view of the organization.	The structure of the institution is strengthened.	There are frequent changes in the management staff and in the organization of the institution.	The newly-appointed managers may have innovative ideas about solid waste management.
Institutions Communication/ Sharing information	Statistical records related to solid waste management are kept.	Statistical records refer to the fulfillment of goals rather than to the environmental issues involved in waste management.	JICA's development project may have a positive impact on the number of records to be kept related to the environmental issues involved in waste management.	Statistical records related to waste management activities are kept.	Statistical control parameters for the information refer almost exclusively to performance evaluation.	JICA's development project may have a positive impact on the number of records to be kept related to the environmental issues involved in waste management.
Institutions Staff management	Some of the staff is exclusively devoted to waste management.	The frequent changes in DPSC's management staff and in the C/P members have hindered the implementation of JICA's project.	The newly appointed management staff needs more training in solid waste management..	A new system to provide incentives for the workers is being introduced.	There is not a clear policy to provide incentives for managers.	The new policy of incentives may have a positive impact on workers' performance.

Category/ Sub-category	Organization			Institution/social systems		
	Strengths	Weaknesses	Opportunities	Strengths	Weaknesses	Opportunities
<u>*Community participation*</u> Complaints	DPSC keeps a record of residents' complaints.	Apparently the number of complaints is only used as an indicator.	The evaluation of residents' complaints may be used to improve the service.	DPSC keeps a record of residents' complaints.	DPSC's Complaints Department handles complaints about any service offered by the organization, not only those related to waste management.	UPPH handles the complaints to solve existing problems. They are used as a feedback to improve the service.
<u>*Community participation*</u> Participation	DPSC is willing to help improve community participation in waste management.	Few people at DPSC and UPPH are in charge of keeping in contact with the community.	JICA's project may stress the need to improve the communication with the community.	The solid residents' organization may be used as a way to increase community participation in solid waste management.	Community participation in solid waste management has been lost. It would be difficult to revive it.	The Pilot Project may contribute some interesting experiences for community participation in the present circumstances.
<u>*Waste collection and transport*</u> Collection plan	The improved condition at the workshops has helped increase the technical availability coefficient of collection vehicles.	The number and condition of collection vehicles is still inadequate.	Waste collection is expected to improve when more vehicles are available.	T weighbridge at Calle 100 landfill site became operational.	The impact of the payment system using waste weighing records on collection improvement is not known.	The start-up of the weighbridge may help improve collection efficiency check.
<u>*Waste collection and transport*</u> Publicity	DPSC has stressed the need to establish some regulations for waste discharge by the generators.	The initiative to establish regulations for waste discharge by the generators has not been approved yet.	JICA's project may help approve the project to establish regulations for waste discharge by the generators.	Waste discharge is planned to be established to take place between 6 and 8 pm.	The regulations for waste discharge by the residents have neither been established nor advertised.	The approval of the regulations for waste discharge and the subsequent information to the residents may help improve waste collection.
<u>*Waste collection and transport*</u> Waste collection management	JICA's project helped establish some new performance indicators for collection vehicle crews.	Although the weighbridge became operational, its operation has not been stable.	The regular operation of the weighbridge will help improve performance indicator estimation.	The new performance indicators may provide an incentive for collection workers.	The weighbridge should operate regularly so that performance indicators may be used to provide an incentive for collection workers.	The start-up of the weighbridges will help improve performance indicator estimation.

Category/ Sub-category	Organization			Institution/social systems		
	Strengths	Weaknesses	Opportunities	Strengths	Weaknesses	Opportunities
Waste collection and transport Collection vehicle management	UPPH's workshop has a qualified staff and it has been equipped by JICA's donations.	The supply of spare parts and materials for the workshop is still limited.	JICA's donations have helped improve the workshop's capacity for vehicle repair and maintenance. However, the progress made need to be strengthened.	The works required to improve the condition of the workshop and to install JICA's donated equipment were carried out.	The workshop equipment has improved. However, the supply of spare parts and materials is still limited.	JICA's donations have helped increase the capacity of the institution to improve collection vehicle maintenance.
Waste treatment Waste collection data management	There are records related to the reception of wastes at Calle 100 landfill site.	The records are not accurate because they show waste volume when the weighbridge is not operating or in the case of open vehicles.	The operation of the weighbridges will help improve the accuracy of the records related to waste reception at the landfill site.	T weighbridge installed at Calle 100.	The operation of the weighbridge installed at Calle 100.	JICA's project has helped approve some investments to improve the landfill site equipment.
Waste treatment Waste treatment plan/operations	The proper procedures for sanitary landfill site operation are known.	The procedures are not properly carried out due to lack of equipment, fuel, or workers' discipline.	The support by JICA's Expert Team may help improve the capacity building of the workers at the landfill site.	The Heavy Equipment Workshop at Calle 100 landfill site has been equipped by JICA's donations.	Equipment maintenance is still deficient due to the lack of supplies at the Heavy Machinery Workshop.	JICA's donation for the Heavy Equipment Workshop and training may help improve the landfill site operation as more heavy equipment will be available.
Waste treatment Hazardous waste	Not applicable. DPSC has no jurisdiction over hazardous wastes.	Not applicable. DPSC has no jurisdiction over hazardous wastes.	Not applicable. DPSC has no jurisdiction over hazardous wastes.	Not applicable. DPSC has no jurisdiction over hazardous wastes.	Not applicable. DPSC has no jurisdiction over hazardous wastes.	Not applicable. DPSC has no jurisdiction over hazardous wastes.
Recycling Recycling activities	The capacity to recover recyclables may increase with the authorization of the activity of self-employed workers as raw material collectors.	The new regulations may help increase the number of scavengers at Calle 100 landfill site.	The new regulations may help reduce the amount of waste to be disposed of. However, they have provoked some operational problems at Calle 100 landfill site.			The operations of the scavengers at Calle 100 landfill site will have to be regulated by checking their number and by establishing minimum hygiene and protection measures.

1.4 Final Evaluation of the Sustainability of the Activities Related to the Project for Improvement of Capacity on Solid Waste Management (February, 2014)

The evaluation of the sustainability of the activities implemented during the Project for Improvement of Capacity on Solid Waste Management in Havana City, Republic of Cuba, is conducted using the “strength, weakness, and opportunity” criteria. It is based on the activities carried out to achieve the Project’s expected outcomes as pointed out in Progress Report 1.

The Project’s expected outcomes are included in the categories, whereas the activities carried out in order to achieve the expected outcomes are included under the sub-categories.

Table 1-2 shows the result of final evaluation on sustainability of the project activities.

Table 1-2: Final Evaluation on Sustainability of the Activities by Category

Category	Sub-category	Strength	Weakness	Opportunities	Risks	Remarks by DPSC
Grouo 1 Solid waste management	Master Plan Revision/updating	The C/P staff, with the advice of JICA’s Expert Team, revised the Master Plan formulated in 2006 by updating the available information on the present solid waste management and by planning prioritized activities for the short term (2015-2017) and the medium term (2018-2020).	Manager’s participation in the revision/updating of the Master Plan was extremely limited. The activities for solid waste management in Havana City planned for the short and medium terms are accepted by DPSC and UPPH’s managers. However, they need to better understand the financial and organizational implications of the activities proposed in the revision of the Master Plan. The changes in technical and managerial staff may provoke that when those involved in the Master Plan revision leave DPSC/UPPH, the newly appointed personnel may not know the updated Master Plan and so fail to put it into practice.	The updated Master Plan is instrumental in planning solid waste management in Havana City for the next years. The updated Master Plan examines the flaws of the present system for the management of solid wastes in Havana City and it proposes several alternative solutions. It also warns about the risks of the existing waste management system and proposes the activities to be carried out to prevent them.	The Master Plan has been updated. The main risk lies in the failure to disseminate it, that DPCS/UPPH’s managers or the city’s senior officials fail to understand it deeply and it ends up being another document in their files. In order to prevent such a risk, seminars are recommended to be held to discuss the updated Master Plan attended by the technical and managerial staff who was not actively involved in its formulation. This seminar should also be held for the technicians and managers who join DPSC/UPPH in the future.	In order to prevent the updated Master Plan from eventually turning out to be just another document, we suggest that it should be channeled to UPPH, DPSC, and CAP’s top authorities for its approval so that it may become a guide for the activities related to the city’s sanitation.
	Community education/participation	The results of the pilot project on proper solid waste management implemented in some districts showed that the residents are willing to cooperate with the projects	The lack of collection equipment makes it impossible for community participation-based projects for solid waste management to ensure its continuity because the collection of wastes or recyclable materials initially promised is not	A proper assessment of the results of the pilot projects focusing on raising environmental education for solid waste management implemented at some schools, which proved that the students and residents are willing to get involved in waste	The greater risk is the failure to continue this activity for lack of resources or because it is not a priority for DPSC/UPPH’s authorities.	Although environmental education is taught at schools in Cuba, the issues directly related to solid waste management should be dealt with more deeply. Therefore, both DPSC and UPPH’s development plans should include the implementation

Category	Sub-category	Strength	Weakness	Opportunities	Risks	Remarks by DPSC
		executed to improve waste management, including those related to waste segregation at the source. Moreover, the projects carried out in schools proved the students' willingness to learn about waste management and to cooperate with the activities related to the 3 Rs.	carried out on a regular basis. The pilot project focusing on environmental education for solid waste management at schools had to be implemented in an extra-curricular way as this subject is not included in the syllabus. No budget has been allocated for activities related to environmental education or dissemination at DPSC/UPPH.	management and 3R's-related activities, may favor the allocation of financial, material, and human resources, although limited, for these activities enabling to continue or replicate the pilot projects implemented during the Project for Improvement of Capacity on Solid Waste Management.		of projects and initiatives fostering community work aimed at raising people's awareness in sanitation-related matters.
Group 2 Waste reduction and composting	Pilot composting project and plant	During the pilot project for composting, a small plant was built and operated for the treatment of organic wastes segregated at the source and collected at hotels and agricultural markets. The technical and financial feasibility of the composting process for this kind of wastes was also proven. The product obtained at the compost plant has been successfully used	The first weakness is waste segregation at the source, as organic wastes were mixed with a lot of foreign materials, which had to be removed at the compost plant. The second weakness is the inadequate collection of organic wastes segregated at the source, which originates some resistance from the residents to cooperate as the segregated wastes are not timely collected, thus causing a great deal of inconvenience.	Facilities, equipment, and trained staff are available to process previously segregated organic wastes at the Pilot Composting Plant installed during the Project implementation. The technical and financial feasibility of organic waste processing, as well as the suitability of using the finished product to improve the soil at the city's green areas, was proven.	The first risk is that the waste generation sources stop segregating organic wastes because they are not timely collected or because they would rather use them for other purposes, e.g. for pig feeding. The second risk is the lack of the equipment and the vehicles required for the temporary storage of the segregated organic wastes and their timely collection. The third risk is that the arrangements necessary to authorize compost sale at the agricultural markets supplying the wastes are not made.	The implementation of this project and other projects before it has helped UPPH increase their expertise in terms of the production of quality compost. Therefore, UPPH is currently qualified to achieve more ambitious goals. Segregated waste collection at the generation source should be increased as there are enough large metal containers and 770ls containers installed to collect the organic wastes generated by the markets enabling to produce large amounts of quality compost.

Category	Sub-category	Strength	Weakness	Opportunities	Risks	Remarks by DPSC
		in some of the city's green areas and it is expected to be sold at the same agricultural markets generating the wastes processed.				
Group 3 Vehicle maintenance and workshop management	Equipment donated by JICA	The equipment donated by JICA to the collection vehicle maintenance workshop has already been installed and are currently being operated, thus increasing dramatically the workshop's repair capabilities, reducing repair time, and improving the vehicle availability rate. The repair workshop staff was trained to properly operate the tools and equipment donated by JICA, as well as to carry out the most frequent repair works.	The supply of spare parts for vehicle repair is deficient due to resource limitations, inadequate availability of parts in the local market, and prolonged procedures to be followed for parts acquisition. The stay of vehicles in the workshop is increased due to the lack of spare parts and consumable materials such as tires, which reduces vehicle availability for waste collection. The workshop lacks a department responsible for machinery and equipment maintenance, especially those donated by JICA.	There are tools and equipment available for proper workshop operation, as well as trained staff to operate the equipment and perform the most frequent repair.	Staff changes may provoke that the newly-appointed people replacing those trained during the implementation of the Project for Improvement of Capacity to operate the equipment and to perform the most frequent repairs lack the qualification required to operate the donated equipment, which may bring about breakdowns. The lack of a department responsible for equipment maintenance and the limited availability of spare parts at the local market, especially for the equipment donated by JICA manufactured in Japan, jeopardize not only the proper operation of the equipment, but also the continuity of the operations. This may originate that some minor breakdowns, which could be repaired at a low cost, may interrupt	The donation of equipment for the workshop is one of the greatest contributions of this project enabling to revitalize an ill-equipped facility. Staff training has been excellent with 20 manuals produced. Working conditions have improved dramatically at the workshop. At present parts and accessories can also be manufactured, thus facilitating increasingly timely vehicle repair. This component should be further implemented in the future for the sake of the project's sustainability. To this effect, we have requested its continuity by way of the implementation of a new project. In addition, we believe it extremely necessary to set up a maintenance group at the workshop as soon as possible.

Category	Sub-category	Strength	Weakness	Opportunities	Risks	Remarks by DPSC
					the operation of some expensive pieces of equipment necessary for the workshop activities.	
	Workshop management	Several technical and organizational manuals were prepared during the implementation of the Project for Improvement of Capacity. Records of preventive and corrective maintenance of collection vehicles were also formulated. Preventive maintenance of vehicles was likewise introduced, thus helping increase their service life and keep a record of the vehicle maintenance, which will help anticipate the most frequent breakdowns and ensure a stock of spare parts, thus facilitating repair works and reducing downtime of vehicles.	Although preventive maintenance of collection vehicles has already been established, it is difficult to comply with planned maintenance works due to lack of lubricants and consumable materials. Staff changes make it difficult to keep a record of the repair works performed for each collection vehicle. Computers are also lacking at the workshop, thus making it impossible to keep a digital record of workshop operations and vehicle repair.	The installation and operation of the tools and equipment donated by JICA entail some minor investments so that the workshop may properly operate and the operation of the equipment donated by Japan may be guaranteed.	Staff changes may provoke that the newly appointed personnel replacing those who were trained to manage the equipment and prepare the records lack the training required for proper workshop management, thus affecting the continuity of record keeping.	Workshop staff changes should not affect work continuity as working procedures will continue to be the same, both for old and new employees. We count on JICA to continue its support in this field.

Category	Sub-category	Strength	Weakness	Opportunities	Risks	Remarks by DPSC
Group 4 Sanitary landfill site design and operation	Sanitary landfill site design	The Project for Improvement of Capacity offered some advice to the C/P staff regarding the design of the new Guanabacoa sanitary landfill site and the executive project for the first stage, thus providing the necessary elements to begin the site construction. Training in Mexico City made it possible for the C/P staff to correct some mistakes in the design of the new Guanabacoa sanitary landfill site. Training received by the C/P staff related to the design of sanitary landfill sites made it possible to have some qualified personnel on the subject in Cuba and to have the capability for the design of other sanitary landfill sites, especially	Existing financial limitations made it impossible to begin the construction of the new Guanabacoa sanitary landfill site four years ago as planned, practically at the beginning of the Project for Improvement of Capacity. These same limitations have delayed the commencement of the design works for the new West sanitary landfill site.	The design and the executive project for the first stage of the new Guanabacoa sanitary landfill site are ready. Therefore, the site construction may start any time. The micro location survey for the new West sanitary landfill site. Therefore, the design and the executive project for the first stage may be undertaken.	The risk lies in the failure to execute the works corresponding to the design and the executive project already prepared, thus further delaying the beginning of the site construction, which may provoke that the sites currently being operated no longer can receive wastes and that some new makeshift sites, as was the case during the so called Special Period, may have to be used for waste disposal. Moreover, if earth moving works begin at the new Guanabacoa landfill site and are then interrupted, there is a chance of losing the investments made due to the exposure to the elements.	The formulation of the executive project for the new East Sanitary Landfill Site is considered to be a major achievement as this is the first site of its kind to be built in Cuba. Although delayed, the site construction will be eventually realized because the funding and the contractor are both currently available. Our intention to make the most of the final disposal expert's knowledge during the site construction and operation could not be materialized. Therefore, we will have to deal with it by ourselves in the future. We will certainly make the most of the transferred knowledge to design the new landfill sites.

Category	Sub-category	Strength	Weakness	Opportunities	Risks	Remarks by DPSC
		the planned new West site.				
	Sanitary landfill site operation	Some guidance on proper waste dumping, compaction, and covering at the sites currently being operated was provided during the implementation of the Project for Improvement of Capacity. Therefore, the employees and managers trained are aware of the operations required for the proper management of final disposal sites. In addition, some equipment were donated for the Heavy Machinery Workshop in Calle 100 landfill site and the staff was trained to repair some heavy equipment then out of service, thus increasing their availability for landfill site operations.	Recommendations about appropriate waste discharge, compaction, and covering at the landfill sites are not properly followed due to the limited number of heavy equipment and vehicles. Cover materials are also limited as the authorization to procure them directly from a quarry is yet to be obtained.	There are available manuals about proper discharge, compaction, and covering of the wastes at the landfill sites. Training conducted in Mexico City in 2013, as well as the training activities planned for the year 2014, include visits to landfill sites to see their operations and receive the corresponding technical explanations, thus helping to qualify the personnel for the proper operation of existing final disposal sites and the sanitary landfill sites to be built in the future.	The greatest risk lies in the fact that the flaws in the operation of existing final disposal sites may provoke fires like the ones that broke out recently. These flaws may reduce the service life of the currently operated sites due to inadequate waste discharge and compaction. Another risk is the uncontrolled operation of scavengers at the sites, which may originate accidents, delayed operations, and even the spread of diseases.	Proper site operation is duly regulated in UPPH's manuals. The staff to operate the landfill sites will continue to be trained in the future either with JICA's assistance or by our own experts.

1.5 Capacity Development attained through the Project evaluated during the Final Capacity Assessment of DPSC-UPPH

The capacity assessment of the C/P team was conducted through taking into consideration the applicable aspects of the “Table 3.1 Contents of Capacity Assessment” of the Inception Report of this Project and by means of assigning a numeric evaluation, utilizing the following criteria.

<5> It is possible to perform an excellent job without the support by the Japanese expert.

<4> It is possible to perform a job on satisfactory level without the support by the Japanese expert.

<3> Little assistance by the Japanese expert is required to reach the target level.

<2> A lot of assistance by the Japanese expert is required to reach the target level.

<1> It is impossible to perform the work on satisfactory level even after the capacity development with the Japanese expert.

At the same time, the initial evaluation and the intermediate evaluations were compared to the final capacity evaluation of the project implementation.

Table 1-3 shows the result of the capacity assessment.

Table 1-3: Result of Capacity Assessment for DPSC – C/P

Category	Sub-category	Contents	Self-evaluation by DPSC 2009	External Evaluation 2009	External Evaluation 2010	External Evaluation 2011	External Evaluation 2012	External Evaluation 2013	Final Self-evaluation by DPSC	Final External Evaluation
National Policy	Waste management policy	Are waste management policy and its contents understood?	Waste management policy is still incipient. A lot of awareness raising activities targeting our staff need to be carried out so that they grow aware of the significance of their work.	Level 2-3 Policy on awareness promotion seems still necessary many things to do for DPSC workers to understand it deeper and wider.	Level 3 Preparation of a survey to measure awareness, as well as training materials for technical and operational staff, experienced some progress. Training materials for the residents are currently been prepared.	Level 3 The level is the same as that achieved in the first intermediate evaluation as, notwithstanding the fact that some training courses for managers have been held, there is still a long way to go so that all DPSC's managers and technicians may fully be aware of the environmentally friendly waste management policy.	Level 3 The level is the same as in the second intermediate evaluation as no progress either in terms of an improved definition of a national waste management policy, or a better understanding of it by management staff, is noticeable.	Level 3 The level is the same as in the third intermediate evaluation as no progress either n terms of an improved definition of a national waste management policy, or a better understanding of it by management staff, is noticeable.	Awareness raising activities focusing on the existing national policy for solid waste management should be strengthened among DPSC's managers, technicians, and workers in order to improve their performance.	Level 3 Understanding of the national policy is limited among DPSC's managers, technicians, and workers. This limitation is aggravated by frequent staff changes originating that the new employees lack any previous experience in waste management and that they do not get to fully understand the policy related to this field as their stay with DPSC is brief.
	Relevant laws / regulations	Are laws and regulations on hazardous waste such as industrial waste and	Our staff needs to be trained in these issues as they do not really perceive the risks posed by hazardous wastes.	Level 3 Systematic education on this matter seems necessary to the staff engaged in waste	Level 3 Perception survey only refers hazardous wastes (biological, infectious) topics by an indirect manner. And the results are	Level 3 The level is the same as that achieved in the first intermediate evaluation as no progress was identified in this area.	Level 3 The level is the same as in the second intermediate evaluation as no progress in	Level 3 The level is the same as in the third intermediate evaluation as no progress in this field	Laws and regulations related to solid waste management have not been sufficiently disseminated among DPSC's staff. Information on this subject	Level 3 The staff lacks information about the laws and regulations related to waste management. Frequent staff changes aggravate this

Category	Sub-category	Contents	Self-evaluation by DPSC 2009	External Evaluation 2009	External Evaluation 2010	External Evaluation 2011	External Evaluation 2012	External Evaluation 2013	Final Self-evaluation by DPSC	Final External Evaluation
		medical waste well understood?		management.	reflected that further training on the topic is required.		this field could be identified.	could be identified.	should be increased.	problem.
	Environmental assessment	Are environmental assessment processes necessary to develop waste management facilities well understood?	The EIA process largely depends on staff training. They do not fully understand it due to insufficient information on solid waste management.	Level 3 The staff involved in the process of Environmental Impact Assessment should be duly experienced and capable of responding the request from CITMA Havana as the process of EIA.	Level 3-4 With JICA support, the staff involved in the design of the new landfill site enhanced their understanding of the environmental impact assessment for this type of facilities. CITMA Habana is responsible for all EIA's conducted for the facilities related to the project, as well as for facility construction. However, no evaluation of their performance is known to be carried out.	Level 2-3 Training suffered some setbacks as the staff being trained in this area no longer works for DPSC and the newly appointed staff needs to be further trained in the design of the new final disposal site.	Level 2-3 The level is the same as in the second intermediate evaluation as there was no progress during 2012 in terms of the construction of the new Guanabacoa landfill site and the understanding of the environmental evaluation of the new final disposal site.	Level 3 The level is higher than the one achieved in the third intermediate evaluation as the executive project for the New Guanabacoa landfill site, which includes an environmentally-friendly design with a facility for leachate treatment, was completed.	Staff training on the environmental requirements to of the facilities and operations used for solid waste management should be increased.	Level 3 There is no qualified personnel at DPSC to conduct the environmental evaluation of the facilities and operations used for solid waste management. Environmental requirements are established by CITMA Habana. However, as CITMA has nothing to do with waste management activities, these requirements are often established without taking into account whether or not they can be fulfilled.
Basic information on Havana	Urban planning	Are any of the following known? Urban planning, such as re-	The city's Territorial Organization Plan is known as DPSC actively cooperates	Level 2-3 Staff for planning should have a viewpoint that utilizes urban infrastructure	Level 3 Some progress has been made. However, more coordination among the section	Level 3 The impact of the new railway line construction on Calle 100 landfill site facilities is	Level 3 The level is the same as in the second intermediate evaluation	Level 3 The level is the same as in the second intermediate evaluation	The city's territorial arrangement plan is known and coordination with the Provincial Authority of Physical Planning	Level 3 DPSC and DPPF are still in touch about the city's development plans and the location of the

Category	Sub-category	Contents	Self-evaluation by DPSC 2009	External Evaluation 2009	External Evaluation 2010	External Evaluation 2011	External Evaluation 2012	External Evaluation 2013	Final Self-evaluation by DPSC	Final External Evaluation
		development plan, housing development, or traffic control plan that may affect waste management.	with the Provincial Direction of Physical Planning in its preparation.	at full extent for solid waste management. At the same time the staff should have an idea to improve the plan on urban structure if it is deemed necessary.	managing solid waste, DPSC-UPPH, and the sections related to urban planning, is required. This stands out when the news of an existing plan to build a railroad running near Calle 100 landfill site, where recently some building works have been carried out, was disclosed.	already known. However, nothing has been done so far in this respect. It seems coordination among city planning authorities and DPSC's staff in charge of solid waste management is still poor.	as no works have been executed to prevent the impact that the construction of the new railway line in the vicinity of Calle 100 landfill site may cause.	as no works have been executed to prevent the impact that the construction of the new railway line in the vicinity of Calle 100 landfill site may cause. Only a level crossing at the entrance to the site is expected to be built.	(DPPF in Spanish) is ongoing.	facilities to be used for solid waste management such as the new landfill sites planned to be built.
Legal framework of Havana	Ordinances, regulations	Are the content of the basic policy, ordinances and regulations on SWM in Havana City well understood? How the M/P utilized?	Decree-Law 272 regulates basic policy, including ordinances regarding the city's hygiene. It is applied on our daily activities and enforced in case of infringement. The Master Plan was applied taking into account	Level 3 Staff for waste collection and street sweeping are to be given opportunities of learning the essential clauses of ordinances and regulations that refer to the responsibility of both sides,	Level 3 Additional efforts should be made for solid waste collection and street sweeping staff to know the content of Law 271. No progress was made during this time. Efforts are currently been made to implement the Master Plan.	Level 2-3 The level is lower than the one achieved in the first intermediate evaluation as the composition of both DPSC's management staff and the C/P team staff has changed. The new staff members need to be briefed about existing	Nivel 3 Despite the changes in the C/P staff, the new C/P members have experience in UPPH or in Communal Services. Therefore, they have some knowledge about the	Level 3 The level is the same as in the third intermediate evaluation as no progress has been made in terms of the knowledge of existing regulations related to solid waste management	Some efforts have been made to fulfill the MP's forecast. However, existing limitations have made it impossible to carry out some activities as planned then, especially those related to waste segregation and the recommended recycling and composting operations. The planned closure of the so-	Level 3 There are some regulations for solid waste management, waste collection, and the operation of final disposal sites. However, both the population and DPSC/UPPH's operational staff know little of them. Therefore, training in this area should be increased. The MP

Category	Sub-category	Contents	Self-evaluation by DPSC 2009	External Evaluation 2009	External Evaluation 2010	External Evaluation 2011	External Evaluation 2012	External Evaluation 2013	Final Self-evaluation by DPSC	Final External Evaluation
			our needs and aspirations. We have been implementing its directions in as many fields as possible.	namely citizens as beneficiary and DPSC as service supplier. The Master Plan has been referred to as the guiding principle in planning of facility and equipment for better quality of operation in solid waste management.	However, material limitations have hindered such implementation. Some decisions have recently been made in terms of solid waste collection such as the introduction of nighttime collection, changes in the raw materials recovery policy, and the construction of a new landfill site, which should be reflected in the review of the Master Plan.	regulations in terms of solid waste management in Havana City, as well as about the content of the Master Plan.	basic policy related to solid waste and about the relevant by-laws and regulations.	shown by the newly-appointed staff in DPSC and UPPH.	called Special Period final disposal sites was carried out as planned. However, the construction of new landfill sites has been delayed due to financial limitations.	formulated in 2006 is not well known by DPSC's authorities and technical staff as there have been many staff changes and the newly appointed managers and technicians barely know it. Despite the efforts made, the majority of the measures and advice included in the M/P (particularly regarding waste segregation at the source, recycling, composting, and new landfill sites) have practically not been implemented largely due to existing material and financial limitations.
Institutions	Missions, purposes, & their executions	Are mission and purposes of the institution clear? All	The institution has its mission and purposes, which are discussed by the employees early each year and approved	Level 3 Staff for waste handling front is mainly assigned to DMSC. Staff for logistics is	Level 3-4 JICA's Expert Team has enhanced their understanding of the role of each of the organizations	Level 3 The level is lower than the one achieved in the first intermediate evaluation as the composition	Level 3 The level is the same as in the second intermediate evaluation as there was	Level 2-3 The level is lower than the one achieved in the third intermediate evaluation	Work structure for solid waste management-related activities is divided into DPSC, a provincial organization including UPPH,	Level 3 DPSC's mission and goals are clearly defined and they are revised periodically. Even though

Category	Sub-category	Contents	Self-evaluation by DPSC 2009	External Evaluation 2009	External Evaluation 2010	External Evaluation 2011	External Evaluation 2012	External Evaluation 2013	Final Self-evaluation by DPSC	Final External Evaluation
		personnel understood them? How are the organizations structured? How is the personnel distributed (budgeting)?	after reaching a consensus. Its structure is the following: DPSC at the top with a provincial jurisdiction, and under it UPPH also having a provincial scope, then the various DMSC's and Communal Zones, which are municipal in nature. The staff is divided into management, technicians, which can be planners and administrators, and workers. An annual budget is allocated by the government.	divided to DPSC and DMSC by function and the staff for planning/ managing is mostly assigned to DPSC including UPPH.	involved in solid waste management. The understanding of the technical staff involved has also improved. New appointments for certain positions have also occurred. The organization is kept unchanged. Some changes in staff allocation have taken place as a result of the introduction of nighttime collection.	of both DPSC' management staff and the C/P team staff has changed. The new staff members need to be trained in terms of the mission and purpose of the organization. The training in this area also needs to be extended to be able to cover the technical staff and the workers.	no progress in terms of the understanding of the mission and purposes of the institution, and because there still remains a partial view of the various departments comprising DPSC.	as there was no progress in terms of the understanding of the mission and purposes of the institution, and also because the newly-appointed managers are not well aware of its mission and purpose. They limit their work to merely operational matters intended to fulfill a goal.	both of which are responsible for solid waste management in Havana City, and DMSC's and Communal Zones, which are in charge of waste collection and sanitation at a municipal level. The staff is divided into management and technicians, who can be planners and managers, suppliers, and workers. The government allocates a yearly budget to carry out waste management operations.	management, technicians, and workers do not take them into account, they fully understand their commitment to the city's sanitation and waste collection. Activities related to waste collection and final disposal are divided and coordinated between the provincial and municipal levels. However, there are frequent coordination-related difficulties to carry out waste collection and sanitation activities, as well as regarding equipment operation and repair.
	Segregation of duties	Are duties for each division/department clear?	The duties of each section are clear. In case any difficulty arises,	Level 3 Guidelines define the duties of each section and	Level 3-4 The work to be performed by each section and each	Level 3 The level is lower than the one achieved in the first	Nivel 3 The level is the same as in the second	Level 3 The level is the same as in the second	There is a clearly defined organization at DPSC and UPPH. Duties, which are	Level 3 The duties of each section and employee are clearly defined

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		Are duties for each personnel clear? Are they duly executed?	it should be conveyed to headquarters. The duties of each employee are also clear. Employees are paid according to their performance. All duties are appropriately fulfilled. In case they were not, they should be discussed at the corresponding section.	individual personnel for those engaged in waste handling, however, for the other sections of planning/ managing, the situation is not clear. As for the execution of duties, the section engaged in waste handling and logistics are apparently executing its duties. Meanwhile, this situation is not clear for other sections.	employee involved in waste management is clearly specified. However, coordination among them during daily activities is lacking. Insistence by JICA's Expert Team on the need to implement a comprehensive approach to solid waste management has brought about attempts to try to solve the existing lack of coordination by holding frequent meetings attended by representatives of the various sections. Some clues point at the existence of a too rigid share of responsibilities.	intermediate evaluation as the composition of both DPSC's technical and management staff and the C/P team staff has recently changed. Therefore, the new members are currently improving their knowledge in terms of their role within the organization and the duties inherent to their positions.	intermediate evaluation as, despite the fact that the duties of the staff and the various departments are clearly defined, there has been no progress in terms of the understanding of specific duties in waste management or in UPPH's or DPSC's mission as a whole.	intermediate evaluation as, despite the fact that the duties of the staff and the various departments are clearly defined, there has been no progress in terms of the understanding of specific duties in waste management or in UPPH's or DPSC's mission as a whole.	subject to strict monitoring, are properly established. The organization of Communal Services in the city is currently being evaluated in order to improve its efficiency, which will probably bring about some changes in the present work structure and staff organization.	and they are properly fulfilled. However, there are some organizational problems, namely: the separation of duties among sections and employees is rigid, each one doing his duties without considering his role in the activities as a whole; when something out of the ordinary occurs, nobody acts unless given a direct order. This rigid structure causes the whole process to stop when somebody fails to do his duty. As the fulfillment of responsibilities is strict, nobody is willing to take any chances by carrying out activities exceeding his obligations. Control over resources and fulfillment of duties

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					Therefore, every section or employee tends to fulfill the role assigned disregarding the overall result.					is strict, thus originating laborious monitoring and record keeping, as well as time-consuming procedures to obtain the authorizations required.
	Communication/ information sharing	Is information to be shared among divisions/ department clear? Is information shared as expected? How is coordination made? What is the decision making mechanism?	There are forms where waste volume hauled to and treated at the landfill sites, and the staff involved, are recorded on a daily basis. A nationwide competition involves every worker. Workshop employees should repair broken vehicles as soon as possible. Otherwise truck drivers are not paid. Only operating vehicles are	Level 3 Information on managerial aspects is periodically shared among concerned sections. For example, daily input of workforce to collection is recorded by DMSC, waste volume brought to landfill is recorded daily by UPPH at dumping site, and fuel consumption is recorded by mechanic section respectively	Level 3-4 Communication between sections or employees is extremely limited, Every one of them plays a role assigned without frequently getting involved in what the others do or much regard for sharing information. Statistical information management is extremely well organized. However, information is only shared	Level 3 The level is lower than the one achieved in the first intermediate evaluation as the conditions then identified remaining unaltered. The changes in DPSC's technical and management staff and the C/P team personnel have hindered coordination among related organizations under DPSC.	Level 3 The level is the same as in the second intermediate evaluation as no progress was noticeable in this field.	Level 3 The level is the same as in the second intermediate evaluation as no progress was noticeable in this field.	Records of the wastes collected, transported, and treated at the final disposal sites, and of the staff involved in the operations, as well as records of other sanitation-related activities such as fuel consumed, vehicle repairs, complaints filed, number of operating vehicles and equipment, use of resources, etc., are kept. All this information is processed by the DPSC/UPPH's accounting and statistics departments. The data collected are also used for	Level 3 There are detailed records of DPSC/UPPH's activities. However, they are aimed at goal achievement rather than at decision making or at the environmentally-friendly improvement of solid waste management. Information flows from lower to higher levels. However, there is not an efficient information flow within the sections to improve the service or to make decisions. This lack of a

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			supplied with fuel. All this information is channeled through UPPH Accounting and Statistics departments. Early each morning a meeting is held attended by the Heads of Departments to organize daily activities. As solid wastes are being collected at night, collection is coordinated at that meeting.	and shared all the record among concerned sections and processed into statistics of daily operation at hygiene section. It is not yet learned who holds the initiative among the intersectional activity.	among sections during coordination meetings, or it is used to make decisions. It is never used to evaluate the process, or to modify the existing organizational structure.				the nationwide competition checking goal achievement and involving all employees at the provincial and national levels. A daily meeting is held at UPPH headquarters attended by Heads of Sections to organize the operations, whereas a weekly meeting is held at DPSC to check goal achievement, progress of construction works, and existing problems related to services rendered.	continuous information flow is replaced by a number of coordination meetings. Existing chains of command and the structure for decision-making are clear. However, important decisions are made at the higher levels, and the criteria used are not clear or they are not shared with the lower levels, thus making the impression that decisions are made without taking into account the sustainability of services, the protection of the environment, the recovery of recyclable materials, etc., but only bearing in mind the solution of short-term problems.

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	Personnel management	Not over- (or under-) staffed? Are all attendance record correctly kept? Is health check done?	There is a shortage of staff. Payrolls are being readjusted to reduce existing shortage. However, implementation of night collection should require more workers to cover the double shift and more money for wages. Attendance is recorded daily and used for monthly payments, which are audited through internal and external inspections. Workers get periodical medical checkups, including vaccination to prevent diseases.	Level 3 Whereas collected waste volume has increased from 17,600 m3 of year 2004 to 20,000 m3 in 2009, the number of staff engaged in solid waste management has decreased from about 8,000 in 2003 to 6,600 in 2009. It is feared that the steep staff reduction would lead to a deficit of capacity for waste management. Workers attendance is recorded at each occasion of work everyday and collected to hygiene section of	Level 3 The staff has been reduced as of late, and further reduction is expected with the increased number of self-employed workers. The existing work attendance record is efficient as it is used for staff payment. Payment is also made according to work performance. If performance is not satisfactory, some penalties are imposed. Employees should produce a medical certificate when hired. However, no periodical checkups are enforced. Employees are only encouraged to get vaccine shots to prevent	Level 3 The level is the same as that achieved in the first intermediate evaluation as the conditions then identified remain unaltered. It has not yet been possible to assess the impact of either the new policy aiming to boost self-employed work or the new measures implemented to measure the efficiency of waste collection activities.	Level 3 The level is the same as in the second intermediate evaluation as the impact of the new salary policy on staff attendance cannot be yet assessed, and no progress in this sense could be identified.	Level 3 There is no information enabling to evaluate the results of the new salary policy for collection vehicle crews.	The staff has been adjusted in accordance with the new payment system introduced for street sweepers and waste collection crews. New payment systems are planned to be implemented in order to improve efficiency. The new payment systems and improved attendance control are expected to be instrumental in completing the staff and improving the services. Workers' attendance is recorded on a daily basis and work fulfillment is checked. The staff also has regular check-ups and medical care provided by the government.	Level 3 There is no information about any increase in the number of workers involved in solid waste management in the city. Therefore, the conditions are assumed to be the same than at the beginning of the Project. The staff is enough for the existing equipment and for the resources available for waste collection and final disposal. However, if the number of equipment was increased, the services rendered were improved throughout all the stages of waste management (from collection to final disposal), and environmental issues such as timely collection, increased recycling , final

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				UPPH every 15 days. The record forms the basis of payment to workers so that the reliability is regularly verified by workers themselves. There is no information available on whether workers are provided with periodical health check.	cholera and *leptospirosis*.					waste usage, and, especially, waste disposal in environmentally-friendly sanitary landfill sites were properly addressed, then the present staff would not be enough. An attendance record is kept and the staff involved in waste management has regular check-ups.
Community participation	Complaints	Are complains and satisfaction for collection service recorded? Are those complaints appropriately responded and used for feedback?	DPSC has a section in charge of collecting and processing complaints addressed by the residents regarding services rendered by the institution. The institution should reply to those complaints as soon as	Level 3 A section engaged in public relations is said to be set up in DPSC, however, the outline and activity of the section has not yet presented in this project. It will be identified through the	Level 3 There is a section under DPSC handling complaints. However, it covers all DPSC activities. It is not clear whether the idea is to have a section handling sanitation-related complaints, or whether it will otherwise be	Level 3 The level is the same as that achieved in the first intermediate evaluation as the conditions then identified remain unaltered. No major modifications have been introduced in this area.	Nivel 3-4 The evaluation is improved because complaints records are kept and improvement is shown that it decreases complaints from community regarding waste collection	Level 3 The level is lower than the one achieved in the fourth intermediate evaluation as the number of complaints related to waste collection and cleaning is known to have	Both at DPSC and at the various DMSC's there is a Customer Service Department in charge of filing residents' complaints related to services rendered. The entities involved should provide the service requested or explain why it cannot be rendered timely and properly within	Level 3 Complaints are filed through existing customer service departments at provincial and municipal levels. Complaints can also be filed by the residents at electoral districts. The problems should be solved as soon as possible. However, complaint records

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			possible by either rendering the service requested or by explaining why it cannot be rendered timely and appropriately.	joint execution of the survey on the citizens' awareness at the beginning of the project.	used it to evaluate services rendered and as feedback. There exists an evaluation system for communal services nationwide. However, evaluation parameters used are not clear. They are seemingly based upon goal achievement.		services as shown in Progress Report 5.	increased, which resulted in management staff changes at DPSC.	a reasonable length of time. The complaints generally have to do with missing containers or in poor condition, and to unauthorized waste dumping due to failure to timely collect the wastes.	are not sufficiently used to improve waste collection, but only to solve existing problems. The system to file complaints has not been properly disseminated among the residents, thus originating that most of the complaints are filed at the districts where they are not recorded.
	Community participations	How are the awareness rising, public relations and promotions, activities of neighborhood community, waste collection by the community, and	At present, environmental awareness has improved in the city as educational messages on environmental issues are often shown on TV. However, public awareness on solid waste management should be reinforced. Residents	Level 2 Community participation in solid waste management is still inactive in general. Even a nationwide Anti-vector Campaign in 2009 was carried out under the initiative of government and with the participation	Level 3 Community participation in solid waste segregation is extremely limited. Apparently prior to the Special Period, CDR's members and school pupils used to volunteer to collect raw materials. However, raw materials	Level 3 The level is the same as that of the first intermediate evaluation as community participation in waste management remains unchanged. An evaluation of the impact of the new policy authorizing raw materials recovery by self-	Level 3-4 The level of satisfaction of the residents regarding the waste collection service has been evaluated and apparently there has been some improvement in public perception	Level 3-4 The level is the same as the one achieved in the third intermediate evaluation as no changes are noticeable during 2013.	Radio and TV spots have been produced by DPSC about residents' participation in proper waste management, which are shown repeatedly. In addition, some educational programs about solid waste management in other countries are shown on TV to increase residents' awareness in this	Level 3-4 It is known that the residents were actively involved in solid waste management years ago, not only in terms of the city's sanitation, but also in the recovery of raw materials for recycling and community composting. However, it was dramatically reduced during the so-called Special

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		satisfaction of the residents?	should be taught how to collect wastes separately, as well as the positive environmental impact derived from such a good practice. Therefore, the section dealing with complaints should be staffed with people trained in public relations. Community participation will be significant if people's involvement is secured through appropriate awareness raising.	of local government staff only.	collection was discontinued due to transportation problems. At present, along with the implementation of the new raw material recovery, community participation in recyclables segregation, especially those generated in industries, commercial establishments, hotels, offices, etc., as they will be forced to segregate and deliver them to Communal Services so that they can be handed over in turn to the raw materials recovery enterprise. Likewise, solid waste segregation is expected to	employed workers has not yet been produced.	judging from the reduction in the number of complaints filed. With regard to environment al awareness, there has been no progress in this field, so it is still a pending matter.		field. JICA's Project for Improvement of Capacity included some environmental education-related activities focusing on solid waste management in the form of a pilot project implemented at the community level and at schools. The outcomes were excellent, thus showing the residents' willingness to participate in and cooperate with this project.	Period due to the limited availability of resources required for efficient waste collection and the slim chances to use recyclable materials. At present, residents' participation in solid waste management is reduced to file complaints for inadequate service. Some campaigns on solid waste management have been produced for the mass media. However, a proper system to facilitate residents' participation has yet to be set up. Environmental education on solid waste management is no longer included in the school syllabus.

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					increase now that people involved in raw materials recovery are legally authorized to collect recyclables.					
Waste collection and hauling	Collection plan	Are collection area, frequency of collection, collection time, and rules for waste discharge clearly established, and executed as established? Is collection works done by communities or other bodies, if so, how are their performanc	Waste collection and transport activities are clearly identified. They are carried out regularly and appropriately, especially at night when over 60% of solid wastes are collected. Vehicles broken during operations are either repaired or replaced. There is a governmental regulation stipulating that entities should dispose of their nonhazardous wastes in our landfill sites.	Level 3 Collection plan is mostly executed as is planned. Exceptional cases happen in the case of failure of vehicle or container or irregular discharge of waste by citizens Workers at the front of cleaning are quite earnest in performing their duty Community contributes by far less than expected to reduce the burden of cleaning	Level 3-4 There are no regulations for waste disposal into containers. A regulation for waste generators to dispose of their waste only from 18:00 to 22:00 hours is seemingly being considered to facilitate nighttime collection and to allow for containers to remain clean during the daytime. Collection routes are clearly identified and they are properly operated.	Level 3-4 The level is the same as the one achieved in the first intermediate evaluation as the conditions then identified remain unaltered. No major modifications have been introduced in these areas.	Level 3-4 The level is the same as in the second intermediate evaluation as the condition of waste collection remains unaltered, including the shortage of containers. Despite the fact that the maintenance of collection vehicles has improved, the number of collection vehicles is not enough to collect all the wastes	Level 3 The level is lower than the one achieved in the third intermediate evaluation as waste collection deficiencies have increased as a result of the decreased number of collection vehicles provoked by the limited supply of spare parts.	Waste collection-related activities are carried out efficiently. However, they vary depending on the availability of vehicles and containers. Existing financial limitations have hindered spare parts acquisition, thus extending vehicle downtime. Residents cooperate with waste collection activities by refraining from dumping the wastes outside the containers or from dumping demolition wastes in the containers. The complaints filed when an authorized	Level 3 The areas for specialized waste collection using containers and the areas where the wastes are collected directly from the floor are clearly identified. There are also areas located in the outskirts of the city where wastes are collected by tractor- or horse-driven carts or by implementing door-to-door collection. There are not enough vehicles for waste collection and the country's existing financial limitations have a negative impact on the number of

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		es?	However, disposal frequency depends on waste generation, a process in which we do not participate directly. Residents do not play an active role in waste collection. Sometimes they do not even contribute to keep their communities clean.	workers.	However, due to lack of equipment, collection is not implemented as frequently as required. Participation of the community and other organizations in solid waste collection is practically nonexistent.		generated in Havana, especially demolition wastes, the amount of which has increased this year.		dumping site emerges or when containers are lacking also help improve waste collection. Some efforts have been made in order to solve container shortage and to prevent acts of vandalism damaging containers.	spare parts and consumable materials, especially tires, available for repair and maintenance, thus reducing the number of vehicles required for waste collection.
	Publicity	Is above information known to households? Are households discharged their waste according to the set rules?	Residents get some information in electoral district meetings held periodically, where they can complain about the quality of services rendered and should be given a plausible explanation,	Level 2 It is uncertain whether C/P personnel has contact with a section in charge of public relations in DPSC or other bodies which has the task to raise awareness of citizens with respect to the	Level 2-3 No awareness raising activities for the residents focusing on ways to improve solid waste management or waste disposal regulations are known to have been implemented so far. A general campaign on	Level 2-3 The level is the same as that achieved in the first intermediate evaluation as the conditions regarding public information on solid waste disposal regulations remain unaltered despite the fact that the pilot	Level 2-3 The level is the same as in the second intermediate evaluation as there has been no progress in informing the residents about the regulations for waste discharge	Level 2-3 The level is the same as in the third intermediate evaluation as no progress was identified in this regard.	Community meetings attended by local residents and presided over by the District Representative serve to file complaints and to advice people about the hours and the way to discharge the waste into the containers. However, wastes continue to be discharged	Level 3 Hours for waste discharge into installed containers have been established, However, the residents generally dispose of their wastes continuously, thus provoking that there are regularly uncollected wastes in the containers. The shortage of

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			and also through the mass media (radio and TV). Residents normally dispose of their wastes in containers deployed along the streets, or using plastic bags to be left in previously identified areas. However, both residents and institutions often dispose of their wastes in unauthorized places, thus bringing about waste accumulation in various parts of the city.	manner of waste discharge.	proper management of solid waste, and a more intense campaign focusing on the Pilot Project area are being planned. The campaigns have not been yet finalized as resources required have not been ensured. No regulations on waste disposal, or knowledge of them by the residents, are known to exist.	awareness raising project in schools has already begun. However, the ongoing pilot project needs to be strengthened and assessed.	into containers.		inappropriately and even demolition wastes are disposed of in existing containers, thus affecting waste collection operations.	containers have originated that in some places the residents dispose of their wastes right on the floor using plastic bags, thus bringing about unauthorized dumping sites, the wastes of which have to be occasionally collected using heavy equipment. Construction works have recently increased, thus helping to increase the amount of demolition wastes currently being disposed of. As there is not a specialized demolition waste collection system, they are generally disposed of together with solid wastes in the containers or right next to them, which originates container damage

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										or breakdown of the container lifting device of the compactor trucks.
	Waste collection task manage ment	Are procedures for waste collection work documente d and executed? Are performanc e index established and is the methodolo gy to acquire such index established ? Are methods to analyze index, how to feedback to actual work developed, and executed? Zonal inspectors perform	Waste collection workers have a daily route to follow and collection should be carried out at a specified time. Collection rates were established and are used for payment based on achievement. Waste collection figures are periodically analyzed to estimate achievement rate, fuel consumption, and personnel expenses, especially in terms of wages. These figures are used for the competition at	Level 3 Zonal inspectors work closely coordinating with DMSC head section and UPPH. Their performance forms an indispensable part of daily collection and their contribution is therefore grasped easily by respective administrative staff of DMSC.	Level 3-4 Solid waste collection procedures are well documented and properly followed. No procedures for random supervision aimed at checking condition of containers are known to exist. Performance rates for compactor truck crews were modified. The truck driver and the operators were separately paid a fee per route before, while now only one fee per route will be paid so that it is shared by the crew (driver and operators). This	Level 3-4 The level is the same as that achieved in the first intermediate evaluation as the conditions related to waste collection recording procedures remain unaltered. Likewise, the impact of the new policy aiming to measure waste collection efficiency indicators is yet to be known as Calle 100 landfill site weighbridge is not yet operational.	Level 3-4 The level is the same as in the second intermediate evaluation as no significant progress related to waste collection could be identified.	Level 3 The level is lower than the one achieved in the third intermediate evaluation as waste collection deficiencies have increased mainly due to the limited number of vehicles and spare parts.	Routes and areas for specialized waste collection using containers and compactor trucks have been established. Collection is carried out at night. There are some parameters for the amount of waste that should be collected by the compactor truck along each route, which are used for the payment of the collection crews, thus being an incentive to carry out collection operations properly and to save fuel. Inspectors supervise that wastes are disposed of correctly and deal with any complaints filed.	Level 3 Waste collection operations are well documented and clearly identified. However, existing vehicle and equipment limitations make it difficult to fulfill them, thus leaving some margin for uncollected wastes. The collection vehicle availability rate and the fuel consumption rate per amount of collected waste are estimated. These rates are used to improve service efficiency and optimize available resources. However, they are barely used as feedback to improve the service efficiency. Inspectors

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		their expected tasks?	the various levels, from municipal to provincial to national levels. Inspectors help DPSC reduce both social and administrative indiscipline by imposing penalties on those who infringe existing regulations for waste discharge in public spaces.		modification is expected to reduce the number of crew members, as they will try to keep the number at a minimum to maximize their payment. The weighbridges are expected to help verify that vehicles comply with their loading capacity before heading for the landfill site.					supervise waste collection operations, but they only cover some prioritized areas such as governmental or tourist sectors.
	Vehicle management	Is number and capacity of vehicles enough, and are they properly distributed according to collection areas? What is the maintenance capacity	UPPH vehicles are extremely varied and old. As of late, however, the government have purchased a number of Chinese compactor trucks, which are insufficient to meet the city's waste collection	Level 3 The skill of maintenance staff is outstanding but vehicles are too much deteriorated to repair the vehicles. To compensate for poorly equipped workshop, some parts of repair works	Level 3-4 Compactor trucks used for solid waste collection are insufficient and old. Recently a number of Japanese compactor trucks were donated to a municipality in Havana City. Distribution of compactor	Level 3-4 The level is the same as that achieved in the first intermediate evaluation as the conditions related to the inadequate number of waste collection vehicles remain unaltered, despite the fact that some new compactor	Level 3-4 The level is the same as in the second intermediate evaluation as there is still a shortage of collection vehicles, despite the reduction in repair time as a result of	Level 3-4 The level is the same as the one achieved in the third intermediate evaluation because, despite the acquisition of 40 new collection vehicles, they have suffered	Operations at UPPH's Central Workshop were dramatically improved due to JICA's donation of tools and equipment as part of the Project for Improvement of Capacity to be completed in 2014. Time required for repairs could be reduced and the technical	Level 3-4 The number of collection vehicles is limited despite the fact that some compactor trucks manufactured in China have been recently procured. However, the number of operational vehicles is not enough as there are some obsolete trucks already out of service due to

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		and the maintenance done adequately? Troubleshooting capacity adequate? Management capacity for spare parts and their procurement. Is there knowledge of necessity of procurement plan for the future?	needs. Most major repairs are carried out at the Central Workshop, whereas minor repairs are performed in municipal workshops. Tools are scarce in both provincial and municipal workshops. However, the staff is qualified and willing to solve any problem that may arise and find local solutions so that waste collection is not interrupted. Older spare parts are lacking and their acquisition is exhausting as they are not always found in the market, thus delaying	are contracted out to the other government workshops though it costs much. Procurement of spare parts is usually takes years of time due to scarcity of old model products and lack of fund. Absence of parts book for old equipment also causes a difficulty to identify the exact parts to be procured. The staff is enough knowledgeable to prepare any type of procurement plan such as package of large number of new vehicles, containers, heavy	trucks is appropriate along collection routes, and nighttime collection has helped increase truck efficiency as traffic is not so heavy then and truck engines are less prone to overheat. Mechanics are exceptionally qualified. However, equipment and spare parts are lacking. Present evaluation of compactor truck maintenance personnel capacity and workshop conditions is similar to that of 2009.	trucks have been purchased and that downtime for repairs has certainly been reduced due to the improvement in workshop conditions brought about by JICA's equipment donation.	the improvements at the collection vehicle workshop, and the fact that 40 new vehicles were bought, though not delivered yet.	constant breakdowns that have hindered their regular operation. Also, spare parts acquisition is still limited, thus bringing about reduced vehicle availability.	availability coefficient of collection vehicles could be increased. There is still a shortage of spare parts and consumable materials required to improve vehicle availability for operations. However, some efforts are made to improve existing conditions. A plan is formulated every year to procure spare parts and materials for collection vehicles. To this effect, some financial resources are allocated under the difficult economic circumstances.	the lack of spare parts needed to repair them. Repair capabilities at UPPH's Central Workshop increased dramatically due to the tools and equipment donated as part of JICA's Project for Improvement of Capacity. Supply of spare parts and consumable materials is still limited due to existing financial limitations, little availability of parts to repair old trucks, and delayed procedures to import and make them available. A plan for the acquisition of spare parts and consumable materials is formulated each year. However, the country's financial limitations have

Category	Sub-category	Contents	Self-evaluation by DPSC 2009	External Evaluation 2009	External Evaluation 2010	External Evaluation 2011	External Evaluation 2012	External Evaluation 2013	Final Self-evaluation by DPSC	Final External Evaluation
			repairs. The workshop staff knows the parts needed as acquisition is timely planned. However, due to limited funding or parts availability, purchasing is sometimes delayed.	machinery, entire workshop equipment and partial supply of parts for repair, which are executed in a few years.						made it difficult to fulfill the plan timely and properly.
Waste treatment	Waste haulage data manage ment	Are volume and hauler identified? Are truck scale trustable and its data recorded?	Wastes are identified when they reach their final destination, including where they were generated, waste amount and type, and hauler. Collected information is processed and submitted to DPSC, which in turn conveys it to MEP, where it is recorded and used for the	Level 3 Not only waste volume and hauler but also other information such as origin of loaded waste, signature of landfill manager etc. is identified for each collection vehicle for each trip to dumping. Accumulated information is processed into various	Level 3-4 The amount of waste transported to the landfill sites is recorded, but only the volume is known as no weighbridge is operational to know the weight. The bases to install the weighbridges at Calle 100 and 8 Vías landfill sites have already been built. Weighbridges and monitoring houses are	Level 3-4 The level is the same as the one achieved in the first intermediate evaluation because the conditions related to the use of volume to estimate the amount of solid waste being transported to the final disposal sites remain unaltered as Calle 100 weighbridge is not yet operational.	Level 3-4 The level is the same as in the second intermediate evaluation as the weighbridge installed at Calle 100 landfill site has not become operational yet.	Level 3-4	A record of the wastes received at the landfill site is kept and their origin is identified. The wastes collected using compactor trucks are weighed at the weighbridge installed at Calle 100 landfill site, whereas the waste volume carried by other types of vehicles is only estimated. Records and statistics are reported to DMSC and MEP to be used as indicators for the plan	Level 3-4 Wastes are transported to the final disposal sites by the same vehicles used for waste collection. A record of the origin, volume or weight of the wastes received, as well as other relevant data, is kept to be used to pay the crews. Records about waste reception are used as data for solid waste management and to pay collection workers. There is a

Category	Sub-category	Contents	Self-evaluation by DPSC 2009	External Evaluation 2009	External Evaluation 2010	External Evaluation 2011	External Evaluation 2012	External Evaluation 2013	Final Self-evaluation by DPSC	Final External Evaluation
			nationwide competition. Efficiency rates and expenses disbursed are scrutinized.	aspects of statistics and utilized for collection planning, however, the way of usage is not opened to all the concerned persons.	expected to be installed soon.				fulfillment and for the competition in terms of waste collection efficiency to be compared to other provinces.	weighbridge installed at the entrance to Calle 100 landfill site where compactor trucks are weighed. Neither open trucks nor carts are weighed.
	Waste treatment plan / work	Is landfill procedure documented and executed? Are models, types, number and operation rate of heavy machineries appropriate? Are workers appropriately allocated? Are environmental conditions	There is an operation manual in every landfill site. Wastes should be treated and covered with soil on a daily basis. There are also maintenance and consumption coefficients for landfill equipment. Staff increase has to do with acquisition of heavy equipment for landfill operations. The waste lab monitors	Level 2 180 workers are assigned to landfill operation at present. The figure of workers has been raised by 27 % from 2003 while waste volume has increased by 13.4 % from 2004. in addition the procedure of landfill has got complicated by adopting daily surface cover, which pushes the demand on workforce bigger.	Level 2-3 Heavy machinery operation at the landfill sites is well documented. However, there is no evidence that such documentation is related to waste compaction rates or daily soil covering, but rather to fuel consumption rates. There is no evidence that wastes are properly compacted at the landfill site. There seems to	Level 2-3 The level is the same as the one achieved in the first intermediate evaluation as the following conditions remain unaltered: a) There is no evidence that the suggestions made by JICA's Expert Team in terms of proper waste compaction at the landfill sites have been taken into consideration. b) No	Level 2-3 The level is the same as in the second intermediate evaluation as the operation of Calle 100 landfill site remain unchanged, and 8 Vías and Tarará final disposal sites have exhausted their service life.	Level 2-3 The level is the same as in the third intermediate evaluation as Calle 100 landfill site operation conditions remain unchanged and Ocho Vías and Tarará sites are saturated.	Landfill site operations are standardized in the operation manuals and in the national regulations for final disposal sites. There are some deficiencies regarding landfill site operations and daily covering of wastes with soil due to the limited number of equipment available. However, some efforts are being made to improve present operations. The impact of pollutants on the conditions of the landfill sites was	Level 2-3 There are four landfill sites in operations in Havana City. Calle 100 landfill site receives most of the wastes generated. These landfill sites do not comply with the requirements of a sanitary landfill site. Operations are deficient as the wastes are not covered with soil on a daily basis, leachate and biogas generation is not monitored, and the number of scavengers has increased as of late. The tools and

Category	Sub-category	Contents	Self-evaluation by DPSC 2009	External Evaluation 2009	External Evaluation 2010	External Evaluation 2011	External Evaluation 2012	External Evaluation 2013	Final Self-evaluation by DPSC	Final External Evaluation
		of the landfill site monitored? Waste pickers?	environmental conditions at the landfill sites. There are a few scavengers, but their number tends to decrease with reinforced landfill security.		be some contradiction between guidance provided by JICA's Expert Team on the appropriate way to compact solid waste and the indications provided by the enterprise managing biogas abstraction regarding the way to arrange and compact the wastes. Environmental conditions at the landfill sites are monitored. However, there is no evidence that groundwater samples are taken. Unauthorized scavengers tend to be eliminated. They will be replaced with authorized employees who	procedures exist for the environmental impact assessment of the landfill sites. c) At Calle 100 landfill site, both self-employed workers and DPSC's employees collect recyclable materials simultaneousl y, thus bringing about some conflicts.			no longer measured after the shutdown of the Waste Lab. The number of scavengers operating at the landfill sites has increased recently after self-employed people were authorized to recover recyclable materials.	equipment donated by JICA to the Heavy Equipment Workshop located near the site made it possible to repair some heavy machineries out of service, thus improving equipment availability for site operations. However, there continue to be a shortage of heavy equipment for landfill site operations, thus originating fires that have been put out though. The impact of pollutants on the site conditions is not being measured at present. Apparently, leachate has polluted the underlying aquifer.

Category	Sub-category	Contents	Self-evaluation by DPSC 2009	External Evaluation 2009	External Evaluation 2010	External Evaluation 2011	External Evaluation 2012	External Evaluation 2013	Final Self-evaluation by DPSC	Final External Evaluation
					will recover recyclables at the landfill site.					
	Hazardous waste	Is hazardous waste, like medical waste, not mixed with municipal waste? Any accident occurred?	Hazardous wastes are not mixed with municipal solid wastes. Hospital wastes are collected and disposed of separately. No accident has occurred so far.	Level 3 Responsibility for hazardous medical waste is clearly regulated separate from ordinary nonhazardous waste at source. DPSC is just responsible for treatment of nonhazardous medical waste only.	Level 3-4 There is a special trench where wastes generated by health institutions are dumped and covered daily. However, it does not differ from the other areas of the landfill site. Health institutions should comply with certain regulations.	Level 3-4 The level is the same as the one achieved in the first intermediate evaluation as the conditions related to management and final disposal of hospital wastes remain unaltered.	Level 3-4 The level is the same as in the second intermediate evaluation as no changes in hospital waste management were identified.	Level 3-4 The level is the same as the one achieved in the third intermediate evaluation as no changes in hospital waste management were identified.	Hazardous hospital wastes are segregated at the source and they are dumped at Calle 100 landfill site in a special protected cell. No incidents have been reported.	Level 3-4 Hospital wastes are segregated at the source and safely transported to Calle 100 landfill site to be disposed of in a special cell lined at the bottom.
Recycling	Recycling activities	Operating organizations, main items, trading volume, price trend for recycling	Some recycling activities are being carried out, but they are still incipient. Recycling can be possibly strengthened in the near future as there is a system allowing income generation	Level 2-3 Though UPPH has a recycle section and earns an income by selling recycle material through ERMP, the activity is not included in the scope of the project. Therefore the	Level 3-4 Some raw materials recovery goals were set up in Progress Report 2. Such goals were established based on the availability of raw materials in every municipality. However, the mechanisms necessary to achieve the goals were not clearly identified.	Level 3-4 The level is the same as the one achieved in the first intermediate evaluation due to the following conditions related to recycling activities brought about by the new policy authorizing recyclable materials recovery by self-employed	Nivel 3-4 The level is the same as in the second intermediate evaluation as the conditions for the recovery of recyclable materials remain unchanged,	Level 3-4 The level is the same as the one achieved in the second intermediate evaluation as the conditions regarding recyclable material recovery have not	Recycling activities have increased after self-employed people were authorized to sell recyclable materials to the Enterprise for the Recovery of Raw Materials.	Level 3-4 Some recyclable materials are being recovered at a recycling plant located in the vicinity of Calle 100 landfill site. However, only ferrous scrap is recovered. Recovery of recyclable materials by the general population and by the

Category	Sub-category	Contents	Self-evaluation by DPSC 2009	External Evaluation 2009	External Evaluation 2010	External Evaluation 2011	External Evaluation 2012	External Evaluation 2013	Final Self-evaluation by DPSC	Final External Evaluation
			through the Enterprises for the Recycling of Raw Materials (ERMP).	aspect of recycle is not evaluated in this table.	The relationship between DPSC and recyclables generators is not clear. It seems that generators will hand over recyclables to either UPPH or DMSC's, which in turn will sell them to the enterprise for the recovery of raw materials. The proceeds from the sales will be used to purchase protection gear for the workers. The way households will take part in raw materials recovery is not clear either. They will certainly convey recyclables to communal services facilities deployed in every district, and then either UPPH or DMSC's will collect and transport them to the enterprise for raw materials recovery to be sold. Likewise, participation of recently	workers: a) The policy has helped increase raw materials recovery. However, it has also fostered recovery of recyclable materials directly obtained from containers and the piling up of solid wastes in the city, thus making it difficult to collect wastes as they are more scattered. b) Self-employed workers have been authorized to collect recyclable materials at the landfill sites alongside with DPSC's employees, thus bringing about a conflict of interest among them as the former can sell recyclables to the	except for the increase in the number of scavengers at Calle 100 landfill site due to the permission granted for people to recover raw materials as self-employed workers, and the fact that the Enterprise for the Recovery of Raw Materials has planned to establish a point of purchase for recyclable materials in the vicinity of this final disposal site, which will probably have an impact on the number	changed, except that the number of scavengers at Calle 100 landfill site has increased.		scavengers operating at the landfill sites has recently increased after self-employed people were authorized to sell recyclable materials to the Enterprise for the Recovery of Raw Materials.

Category	Sub-category	Contents	Self-evaluation by DPSC 2009	External Evaluation 2009	External Evaluation 2010	External Evaluation 2011	External Evaluation 2012	External Evaluation 2013	Final Self-evaluation by DPSC	Final External Evaluation
					authorized self-employed recyclables collectors in raw materials recovery is not clear either. It is not known whether they will collect recyclables directly from waste containers, or whether they will buy recyclables from households instead. Neither is known for sure whether this practice will contradict recovery-related activities carried out by DPSC or DMSC's.	Enterprise for Raw Material Recovery for cash while the latter are only paid a meager salary for their work. c) Seemingly, raw materials recovery has increased. However, the fact that the Enterprise for Raw Material Recovery is the sole buyer of recyclables, and that it fixes the prices and the volume of recyclables to be accepted depending on their capability to reuse them or to export them, still poses a problem. d) The policy for raw materials recovery will need to be assessed in the short or medium terms.	of scavengers, thus bringing about some operational problems at the site.			

Project Completion Report

Section 2: Report on Output 1

Chapter 3: Report on Training in Mexico

1 Report on Training Held in Mexico

This report contains results of training held in Mexico, F.D., for the Cuban Counterpart Team from December 3 to 8, 2012 (first C/P group), from December 9 to 15, 2012 (second C/P group), and from March 24 to 28, 2014 (third C/P group).

Those three training courses were carried out with the support of the National Center for Environmental Research of the National Institute of Ecology and Climate Change (INE) under the Ministry of the Environment and Natural Resources (SEMARNAT) of the Mexico Federal Government and by Mr. Tadaya Yamamoto, JICA's Team Leader of the Project for Capacity Improvement on Municipal Solid Waste Management in Havana, Republic of Cuba, and with the participation of Mr. Raúl Sergio Cuellar, an SWM expert participating in the said Project.

1.1 Report on Training Held for the First C/P Group

The SWM training for the first C/P group was carried out from December 3 to 8, 2012, focusing on the construction and operation of sanitary landfill sites for the appropriate disposal of municipal solid wastes.

The training was requested by the Cuban Counterpart Team in order to increase their capacity on final disposal of solid wastes as a) a new sanitary landfill site is planned to be built in Guanabacoa municipality to cover eastern Havana, and b) there is no previous experience in Cuba that a final disposal site complying with the international standards and technical guidelines of sanitary landfill site is to be built and operated.

The first C/P group was composed of the following members:

- Mr. Adalberto González Arce:
  Provincial Director of Waste Collection and Final Disposal, and
  a counterpart member responsible for general issues pertaining to the Project.
- Mr. Lázaro Sotolongo Esquivel:
  Manager of the new sanitary landfill site to be built in Guanabacoa, and
  a counterpart member responsible for final disposal of wastes in the Project.
- Ms. Odalys García Fonseca:
  DPSC's Assistant Director of Investments and Development, and the manager of the Project.
- Mr. Bacilio del Vallin Marchego:
  Designer of the new Guanabacoa sanitary landfill site, and a specialist at DCH.
- Mr. José Francisco Santiago Fernández:
  Designer of the leachate pond with biological treatment system at the new Guanabacoa sanitary landfill site, and an expert for the Water Resources Project Enterprise.

The training schedule is shown below:

Table 1-1: Program of the First Group

December 4, 2012
Reception at CENICA
Tour of CENICA's facilities
Technical visit: Transfer station at the "Central de Abastos" (large wholesale market) run by the government of the Federal District
Technical visit: "Bordo Poniente" waste segregation plant run by the government of the Federal District
December 5, 2012
Technical visit: Sanitary landfill site and leachate treatment plant at Tlalnepantla de Báez, State of Mexico
Technical visit: Biological treatment plant at Villa Nicolás Romero, State of Mexico
December 6, 2012
Technical visit: Sanitary landfill site and waste segregation plant in the city of Puebla
Technical visit: Sanitary landfill site at Huejotzingo, Puebla
December 7, 2012
Technical visit: Transfer station in the city of Querétaro
Technical visit: Sanitary landfill site and waste segregation plant in the city of Querétaro

Since people responsible for the designing and operating the new East sanitary landfill site located in Guanabacoa municipality were part of this group, the training was focused on the design and operation of sanitary landfill sites.

Consequently, four operational sanitary landfill sites having different sizes and designs, and various operational and environmental impact monitoring systems were visited.

The training also included the segregation and use of recyclable wastes. To this effect, three recyclable waste segregation plants, two of which were operational, were visited. The design and operation of each one of them was thoroughly explained to the trainees.

The main training issues regarding final disposal sites were the following:

a) Size and design of the waste cells, including the gradient of slopes and plans to link closed and operational cells,
b) Waterproofing system using a HDPE liner at the base of the waste cells,
c) Location of the leachate collection system at the base of the waste cells,
d) Characteristics of the landfill gas collection wells and vents at the sanitary landfill site,
e) Construction and operation of the systems to store leachate (leachate collection and evaporation ponds),
f) Size of and waste dumping system at the working area of the sanitary landfill site,
g) Machinery used to dump, spread, and compact the wastes at the sanitary landfill site, including the performance of the machinery used,
h) Leachate recirculation systems used at the sanitary landfill site,
i) Staff involved in the operation of the sanitary landfill site, and
j) Automated operation of the weighbridge to monitor the weight of the wastes received at the final disposal sites.

As a result of the training, some expertise that will initially be used for the design and construction of the new Guanabacoa sanitary landfill site, and later for other sanitary sites that may be built in Cuba, was passed on to the trainees, as follows:

a) Evaluation of the geometry of the waste cells to build the new sanitary landfill site in Guanabacoa, including the calculation of the gradient of slopes and the height of the waste cells,
b) Re-designing of the treatment system planned for the leachate at the new Guanabacoa sanitary landfill site, including the option to recirculate the leachate in the waste cells,
c) Reconsideration of the waste dumping system at the new disposal site by evaluating the planned size of the working face, as well as the machinery required for the efficient operation of the site,
d) Evaluation of the staff, machinery, and equipment required for the proper operation of the new final disposal site,
e) Supply requirements for the daily covering of wastes at the final disposal site, including the option to use the cover material generated during the excavation works carried out for the construction of the waste cells, and
f) Reconsideration of the construction schedule for the new final disposal site by reviewing the minimum requirements for the proper site operation and the successive building of the planned waste cells as required.

The transfer station at the Central de Abastos was also visited. The trainees were shown the vehicles used for waste transport and the facilities used to dump the wastes by gravity from the collection vehicles into larger units.
The following issues were derived from the visit to the transfer station at the Central de Abastos:

a) The existence of differentiated discharge hoppers used for the reception of both organic and inorganic wastes, and the inspection of organic wastes to check they do not contain any inorganic wastes by the time they are transported to the compost plant for treatment,
b) The loading capacity of the transfer vehicles and the possibility of carrying the wastes from up to 6 collection vehicles,
c) The weighing of transfer vehicles in order to keep a record of the wastes being handled at the transfer station and the wastes being carried to each destination, and
d) The operation and control of the transfer station, as well as the cleaning of both the facilities and the transfer vehicles.

The lessons derived from the visit to the transfer station at the Central de Abastos could be used in future transfer station projects in Havana City. Specific studies justifying the construction of such facilities should be conducted at which following elements should be carefully looked; the distance between the collection area and the final disposal sites, the amount of wastes that can be handled in such a facility, the requirements of space and equipments for the proper installation and operation of a transfer station, and the needs in terms of staff and the operation costs.

Establishing the transfer stations should be based on the impact on the waste collection system whether it brings some operational advantages in household waste collection system by reducing the routes of collection vehicles.

With regard to the treatment and recovery of recyclable materials from solid wastes, the following lessons were derived:

a) The design of existing recyclable material selection plants having various sizes and capacity, as well as the characteristics of the motors and the materials used in the conveyor belts, the elevating platform, and the stands,
b) Several operation systems implemented at existing recyclable material selection plants for the discharge and loading of the wastes onto the conveyor belts, the position of the workers selecting the wastes alongside the belts, the storage of the recyclable materials recovered, etc.,
c) Some information about the characteristics of the materials recovered for recycling, the operation costs, and the estimated output per ton of wastes processed, and
d) Some information about the machinery and the vehicles used for the operation of the selection plants, as well as about the transport of both the recyclable materials recovered and the wastes not suited for recycling (the remaining non-recyclable wastes accounting for up to 90 to 95% of the wastes received).

The training helped the participants to acquire certain knowledge that can be utilized in evaluating the advisability of building the recyclable material selection facility planned to be built within the new sanitary landfill site in Guanabacoa by taking into account the construction and operation costs involved, the amount of recyclable materials expected to be recovered depending on the composition of the wastes generated in Havana City, and the existing difficulties to market or use the recyclable materials.

If the decision to build the plant to segregate recyclable materials at the new final disposal site stands, it can be said that the trainees acquired valuable knowledge about the design and operation of a plant having the size and capacity necessary to handle the amount of wastes planned to be received at the new Guanabacoa sanitary landfill site.

Based on this, it was possible to get a clear idea about the area required to build the waste selection plant, its location within the planned sanitary landfill site, as well as the engineering works, the machinery, and the equipment to be needed for its operation. Therefore, it can be anticipated that a proper executive project for the plant construction and operation will be successfully finalized.

1.2 Report on the Training Held for the Second C/P Group

Based on the duties performed in Havana City by the people composing C/P group 2, the training focused on solid waste collection, transfer, and treatment systems, as well as on environmental awareness raising activities related to the proper management of solid wastes to be held for both schools and residents.

To this effect, several facilities involved in waste management such as the sanitation system for Mexico City's Historical Center, a transfer station, a recyclable material segregation plant, a compost plant handling tree waste, two plants using recycled materials, and a factory manufacturing containers were visited.

In addition, three agencies responsible for environmental education and capacity building in Mexico, especially environmental education related to proper solid waste management, were visited.

The second C/P group was composed of the following members:

- Mr. Alejandro Fernández:
  Assistant Director of Sanitation, and a counterpart member for waste management in the Project,
- Ms. Jainet García Portero:
  Waste Specialist, Division of Investments and Development, and a counterpart member for waste management in the Project,
- Mr. Félix Arturo Abreu Lacalle:
  Assistant Director General, Provincial Sanitation Unit (UPPH), and a counterpart member for waste collection and transport in the Project,
- Ms. Nury Cárdenas Véliz:
  Specialist, UPPH's Division of Mechanization, and a counterpart member for waste collection and transport in the Project, and
- Mr. Fernando de Jesús Amil Leal:
  Mechanization Specialist, UPPH's Division of Mechanization, and a counterpart member for waste collection and transport in the Project.

The training schedule for C/P group 2 is shown below:

Table 1-2: Program of the Second Group

December 10, 2012
Visit to watch the street sweeping and waste collection system in Mexico City's Historical Center
Reception and tour of CENICA's facilities
December 11, 2012
Technical visit: Transfer station at the Central de Abastos in the Federal District
Technical visit: San José paper mill in order to watch the process to recycle laminated cardboard
December 12, 2012
Technical visit: Bordo Poniente waste segregation plant in the Federal District
Visit to DGSU's Technical Division to learn their activities related to the clean school program and the crafts workshop using recycled materials
December 13, 2012
Technical visit: UNAM's compost plant
Visit to the Training Center for Sustainable Development to know their work on environmental education and waste management
Technical visit: "PETSTAR" PET bottles recycling plant in Toluca, State of Mexico
December 14, 2012
Technical visit: Sanitary landfill site at Tlalnepantla de Báez
Visit to the Division of Infrastructure Programs under the Ministry of Social Development to know their experiences regarding technical training for waste management
Technical visit: Win Tech container factory

The following information was derived from the visit to watch street sweeping and waste collection activities in Mexico City's Historical Center:

a) The works performed and the equipment used by the street sweepers at the Historical Center, as well as the length of the sweeping stretches and the duties to be done,
b) The litter bins have been replaced by mobile containers having a capacity of 70 liters to be used to collect the garbage dumped by passers-by,
c) The wastes collected by street sweepers are dumped into light vehicles (3.5 ton vans) and from then into 15 m^3 compactor trucks,
d) Some other problems related to sanitation in Mexico City's Historical Canter were noticeable such as the inappropriate cleaning of sidewalks and pedestrians' roads, and the dumping of chewing gums and cigarette butts. Some measures such as posting "No Litter" signs and fines for offenders have been implemented to improve such issues.

As a result of these learning experiences, some alternatives that could be implemented to improve street cleaning and waste collection in Habana Vieja (based on its similarity to Mexico City's Historical Center) such as the replacement of litter bins and 70 liter containers, the sweeping of streets by stretches, and the collection of wastes using small vehicles and then transferring them to compactor trucks, were recommended.

During the visit to the transfer station at the Central de Abastos, the trainees could see the existing facilities used to dump the wastes by gravity from collection vehicles into larger units, as well as the vehicles used to transport these wastes.

At Bordo Poniente recyclable material segregation plant, they could tour the facilities and see how they operate. They were also informed about the amount of recyclable materials recovered, the conditioning process, and the destination of these materials.

They also visited the Tlalnepantla de Baéz sanitary landfill site in the State of Mexico, where they could see the design of the waste cells, the facilities for leachate control, and the machinery used at the site. Likewise, the group was informed about the site operation system, the amount of wastes received daily, and the existing leachate and landfill gas treatment systems.

With regard to the visits to the transfer station at the Central de Abastos, the Bordo Poniente segregation plant, and the Tlalnepantla sanitary landfill site, the lessons learned by Group 2 are practically the same as those of Group 1 and they have already been described above.

Additionally, Group 2 members visited the compost plant at UNAM's University City, where tree and garden wastes generated at the University City are processed.

They could watch the shredding and composting process implemented for tree and garden wastes and were informed about the system to collect such wastes, as well as about the composting process using dynamic piles.

Some lessons were learned that could be possibly implemented to compost tree waste in Havana City.

The Win-Tech container factory was also visited. There they could see the equipment used to manufacture 700 liter plastic containers, the molds and a finished container together with all its accessories (lid, wheels, etc.).

The visitors were informed about the process to manufacture the containers and the molds, as well as about the estimated investment cost to build a similar plant in Cuba having the capability to manufacture the containers required to replace those that are damaged in a year or to cover the present shortage of containers.

They were also informed about the estimated operation costs of the factory, the unit costs of the raw materials, and power required to manufacture the containers fitting for Cuba.

The visit served to rule out the possibility of using the casting equipment currently in operation in Cuba to manufacture water tanks, as it is deemed inappropriate for such purposes.

The information conveyed during the visit can be used to evaluate the advisability of installing a similar plant in Cuba aiming at reducing the expenses incurred to annually acquire the nearly 4,000 containers currently required to replace the damaged ones.

The C/P members who visited the container factory pointed out that based on their preliminary estimations at the site, the investment cost necessary to install such a plant in Cuba could be recouped in one or two years, thus helping to cut yearly expenses.

The C/P members involved in environmental education-related activities targeting solid waste management in Cuba visited several agencies performing the same work both in Mexico City and throughout the country. They exchanged experiences and collected information about the priorities in terms of environmental capacity building for waste management and the resources used to implement training.

Three such agencies were visited, namely, the General Authority of Municipal Services under the Government of the Federal District, the Training Center for Sustainable Development under the Ministry of the Environment and Natural Resources, and the Authority of Infrastructure Programs under the Ministry of Social Development. The latter two being agencies pertaining to Mexico’s Federal Government.

The trainees were informed about the environmental education programs related to waste management training currently implemented, especially in schools, as well as about the educational methods and procedures used for capacity building. They were also provided with some training materials, both hard and digital copies.

The training content received in terms of environmental education for waste management can be used for the programs currently being implemented in the pilot project for environmental education targeting solid waste management in the schools selected in Havana City.

The materials provided by these agencies will certainly help improve environmental education activities targeting solid waste management in Cuba.

1.3 Report on the Training Held for the Third C/P Group

The training program implemented for the third C/P group was designed based on a) the activities carried out by the participants as part of their daily work for the Government of Havana, b) issues related to environmentally sound waste management, and c) the investments required to improve waste management in the city in accordance with the Master Plan updated during the Project.

The participants visited some of the facilities included in the previous training courses, stressing this time environmental protection, investments, and the operation cost of the facilities.

Trainees could see how the sanitation system works at Mexico City’s Historical Center, and also visited a transfer station, 2 recyclable material segregation plants which had closed down shortly before, a sanitary landfill site, a compost plant processing tree waste, 2 plants for the reuse of recycled materials, and a factory manufacturing containers by ‘rotomoldeo.’

The people who attended the training activities were the following:

- Mrs. Mirna Teresa Laffita Cuza:
  Vice-director General of Economy and Planning, Havana City's Administration Council,
- Mr. Ramón Fernández:
  Assistant Director of Investment, Development, and Cooperation, Havana City's Provincial Authority of Communal Services,
- Mrs. Odalys Caridad Goicochea Cardozo:
  Director of Environment, Ministry of Science, Technology, and the Environment, Republic of Cuba,
- Mr. Juan Nepomuceno Herrera Cruz:
  Expert in Science, Technology, and the Environment, Havana City's Branch, Ministry of Science, Technology, and the Environment, Republic of Cuba, and
- Mr. Osmani Castro Cruz. Expert:
  Office of International Relations and Cooperation, Havana City's Government.

The training program for the third C/P group is shown below:

Table 1-3: Program of the Third Group

March 24, 2014
Reception at INECC and discussion on solid waste management a. Waste management in Mexico based on the 3 R's approach b. Waste management in Cuba c. Outcomes of Research on Life Cycle Assessment of PET in Mexico
Technical Tour: San José Paper Factory to see the recycling process of laminated cardboard.
March 25, 2014
Waste sweeping, collection, and transfer at Mexico City's Historical Center
Technical Tour: "Recycling Technology" Enterprise. PET recycling process
March 26, 2014
Tour of the Transfer Station at the Central de Abastos to see the facility design and operation
Tour of the Waste Segregation Plant at Bordo Poniente (out of operation) to see the facility design
March 27, 2014
Tour of the Sanitary Landfill Site in Querétaro to see the site construction process, waste compaction operations, and leachate management
Tour of the Win Tech container factory to see the equipment used to manufacture containers
March 28, 2014
Tour of the closed landfill site of Neza I, upon which some sports facilities were built (Jardín Bicentenario City)
Technical tour: UNAM's compost plant to see the facility equipment and tree waste processing

After seeing the system implemented for street sweeping and waste collection at Mexico City's Historical Center, the trainees pointed out that a similar scheme could be implemented in Old Havana and other tourist areas in Havana City. Therefore, they will present the Mexican experience to the consideration of the city's authorities.

During the tour of the facilities of the “Recycling Technologies” Enterprise, they could see how PET bottles are recycled after washing and shredding process to later use them to produce fibers and textiles. It was pointed out that there are not enough PET bottles in Cuba for a similar facility to be feasible.

At the Transfer Station of the Central de Abastos the trainees could see the facility design and operation. They pointed out that by the time the new East landfill site begins operations, it would be advisable to evaluate the need to install a smaller transfer station to transport the wastes generated in those areas far from the planned site.

The tour of Bordo Poniente Waste Segregation Plant served to realize the need to thoroughly evaluate the advisability of installing a waste recycling plant at the new Guanabacoa sanitary landfill site, as these are expensive facilities that need to process wastes rich in recyclable materials, and which are hardly profitable or not profitable at all. Consequently, the trainees pointed out that it would better to assess the alternative of organizing and monitoring the activities of waste-pickers at the landfill sites so that they may be carried out under proper hygienic and safe conditions.

The tour of the sanitary landfill site in Querétaro enabled the trainees to see the facilities and the way the wastes are discharged and covered and how leachate is managed. These experiences may be applied to both the operation of existing landfill sites and to those sites planned to be built in the city.

The trainees observed the equipment and the manufacturing process used at the Win Tech container factory. They could also collect some data about the cost of the equipment and the raw materials, the facility operation, etc., which may be used to carry out a cost-benefit analysis to determine the advisability of installing such a plant to manufacture the containers currently being imported.

At the closed Neza landfill site, they could see the facilities that can be built after the site is properly closed. They certainly realized that a proper site closure involves surveys and complex engineering designs, and the cost is high. All this is extremely relevant judging from the relatively short remaining service life of some of the landfill sites currently being operated in Havana City.

Finally, the visit to the UNAM’s Compost Plant, which processes prune waste, enabled the participants to see the facilities and the equipment used for compost production. This experience could be taken into account to evaluate the advisability of installing a similar plant to process prune waste generated in Havana City’s green areas. In addition, the tour served to thoroughly assess the advisability of procuring tree waste shredders to be used where the waste is generated, as a lot of dust and noise would be produced, thus certainly causing a great deal of inconvenience for the residents.

All the people who participated in the training activities pointed out that the experience was very useful to be implemented to improve solid waste management in Havana City and to adopt the recommendations included in the Revised Master Plan formulated during the JICA Project. In addition, the trainees assured they would give a detailed presentation of the lessons learned for the city’s top authorities so that the training can be properly disseminated.

1.4 Additional Report on Final Disposal Sites Visits (4-7December 2012)

December 4:

1.4.1 Visit to CENICA: National Center for Environmental Research and Training (CENICA) under the National Institute of Ecology (INE)

We were informed about the Center's research programs regarding the various technologies currently being implemented in Mexico for solid waste management.

The Center has surveyed existing technologies and has formulated a methodology to evaluate them. The Center also has an information system on solid waste management and published a magazine on SWM.

They survey the impact of the current technologies on the environment. The Center has a lab equipped with state-of-the-art technology enabling them to monitor the various components of the environment, as well as to evaluate water, air and soil pollution resulting from the dumping or inappropriate treatment of solid wastes. We toured its facilities and the staff explained to us the functioning of the equipment and the research currently being carried out.

There is some collaborative work among CENICA, INE, and SERMAT to support the implementation of public policies for solid waste management promoting their reduction, recycling, and reuse.

a. Lessons

- ✓ The technologies devised to manage municipal solid waste should be supported by monitoring systems enabling sample taking and by systematic lab testing in order to evaluate pollution levels. Arrangements should be made with those Cuban institutions owning labs such as Havana University, CITMA, INRH, etc. to outsource them during the construction and operation of the landfill sites.
- ✓ Cuban standards for the design and operation of landfill sites, as well as for other technologies that may be used, should be formulated.

1.4.2 Visit to the Federal District's transfer station capable of handling 1,200 tons of solid waste per day

The station operates for 10 hours a day from 8 am to 8 pm. It receives approximately 1,200 tons of solid wastes daily.

a. Technology and Process

After checking and weighing the wastes at the station entrance, collection vehicles move to the upper floor to dump the waste. There are two hoppers located at the entrance, into which the wastes are directly dumped to fill the open trucks deployed at the lower floor. These trucks carry the solid wastes to their final destination. 230 trucks with a loading capacity of 70 m^3 (30 tons) operate at the transfer stations.

There is a segregation of organic and inorganic wastes at the upper floor. Organic wastes are mainly composed of tree waste, which is later used to produce compost.

1.4.3 Visit to Bordo Poniente Segregation Plant, Compost Plant, and Sanitary Landfill Site

a. Technology and Process.

The segregation plant staff explained the operation of the facility. After the vehicles are weighed, the wastes are dumped in front of the plant. A small loader is used to move the wastes closer to the plant. Four mini-loaders pick up the wastes there and discharge them into an elevating platform, which carries them to the conveyor belts extending approximately 2.50 meters from the floor, where the selection process begins. The conveyor belts are powered by 15 HP motors, which make them move at a speed of 1 m/second. The belts are nearly 0.40 m high from the metal platform on which the workers stand. The plant has 4 lines (4 conveyor belts placed parallel to one another). Fifty workers and 15 assistants work alongside each belt sorting out the materials into glass, paper, plastic, cardboard, PET, etc., and throwing them into various containers placed next to them. The wastes that cannot be recovered go to a rejection area (reversible belt), from where they are loaded into the trucks to be taken to the landfill site. There is a leachate treatment system beyond the rejection area. We were told that as it rains little in Mexico, several alternatives can be used to treat the leachate.

- ✓ According to the operators, only 5-10% of the solid wastes are recovered. 90-95% of the wastes are taken to the landfill site. Even though the waste recovery rate is small and the plant is not as efficient as desired, it ensures employment for its workers, who are also unionized. One of the issues to be evaluated in implementing segregated collection in countries like ours is the fact that it may bring about unemployment, thus provoking some social problems.
- ✓ It was explained that recycling begins at the waste generation source. The wastes are handled first by scavengers and collection crews before they get to the recycling plant, thus dramatically reducing the waste recovery rate.
- ✓ The factors having an impact on the actual recovery rate of the materials to be recovered at the plant, which depends on the components selected to be recovered, have been identified. The process efficiency depends in turn on the participation of the residents, the efficiency of waste collection, and other factors such as waste composition, the possibility of marketing recovered materials, the existence of a legislation, the cost associated to the materials to be recycled, etc.
- ✓ Recycling should not be considered as environmentally beneficial if it involves more resources and energy than what it claims to save.


Photo 1-1: Visit to Selection Plant

December 5:

1.4.4 Visit to the private sanitary landfill site at TLANEPANTLA de BAEZ

150 to 275 tons of solid wastes are daily received at the landfill site. It has a surface area of 16 ha and it is made up of 4 cells or trenches, which can reach a height of up to 85 m during operations.

It is equipped with leachate drainage and biogas venting facilities and it receives some payment for helping reduce pollution (carbon credits). It has a 1.5 megawatt gas burner.

Leachate drainage:

It is composed of holed HDPE pipes with a gradient of 0.2% draining by gravity into an evaporation pond, which is used to treat the leachate.

For the design and selection of the drainage pipes, the load to which they will be submitted should be taken into consideration. The pipe thickness should be calculated to prevent pipe deformation or collapse during operations due to the loads exerted by the compacted material on top of them, which can reduce the maximum height that a cell should reach. Slotted pipes 8 inches in inner diameter (160 mm) were used in this landfill site as side pipes, whereas 200 mm pipes were used as main pipes.

The slot thickness, length, and distribution, as well as its placing in the site enabling a proper drainage, should also be taken into account for the calculations.

When asked about the use of the HDPE liners to waterproof the cell base, we were told that the overlaps are firstly sewn and then glued by thermofusion. They are tested to check they are watertight as the works progress.

A layer of round river stones 25-30 cm thick is used as filter at the cell base. To protect the geomembrane, a geotextile liner is used on top of it.

Old tires are used to wedge and protect the geomembrane. The wastes should get in touch with it. Firstly, a 3m thick layer of un-compacted wastes is placed to protect the geomembrane. Then, if the wastes begin to be compacted, the density of compacted wastes can reach up to 850 Kg/m^3 depending on the compacting machinery used.

Concrete or asbestos-cement holed pipes 150 mm thick inside a filter in a wire mesh are used for the landfill gas venting wells. A gas burner is placed at the tip of each pipe. There are 70 wells deployed 30-60 m apart from one another. Up to 4 layers of wastes are dumped.

- ✓ The cell slopes are 1V:2.5H. They do not compact the cover material to reach high densities. They just wet and compact it to cover the wastes. They use 30 cm thick layers of clayey material containing little slime to prevent mud. In order to wet the cover material, leachate from the pond is used.
- ✓ The berms are 4 m wide and 4 m high. The storm water drainage is composed of ditches covered by HDPE liners to prevent surface water from getting in contact with the wastes and to reduce leachate generation.
- ✓ The inner roads do have a proper compaction and they are maintained throughout the operations. Differential settlements occur during operations and they have to be stabilized.

- ✓ They own 2 dump trucks and 1 compactor. They work until 10 pm using portable lighting towers equipped with 4 lamps. They can generate up to 3 megawatts using landfill gas.
- ✓ The leachate generated amounts to 0.4 L/sec in the dry season and 1.1 L/sec in the rainy season.
- ✓ This landfill site proves that landfill gas can be produced 1 year after the beginning of operations, when the gas begins to be burned. The equipment used for landfill operations is replaced every 10 years. Site improvements are ongoing. A pilot plant using a physical and chemical process was unsuccessfully used for leachate treatment. The site staff is composed of 25 workers, including management and operators.

Photo 1-2: TLANEPANTLA de BAEZ sanitary landfill

a. Lessons for Guanabacoa Landfill Site.

- ✓ The project for the surface drainage of the trenches should be modified by using HDPE liners instead of the proposed prefabricated concrete slabs due to the settlements that may occur.
- ✓ The possibility of re-circulating the leachate back to the landfill site by infiltrating it into the landfill gas wells should be evaluated.
- ✓ The increase of the service life of Calle 100 landfill site should be evaluated. The maximum height should be coordinated with and approved by the Physical Planning Authority and CITMA (Ministry of Science and the Environment). It can be increased if a proper study is conducted.
- ✓ If sprinklers are used to irrigate the leachate, the resulting aerosols may have an impact on the environment. Water tankers or pipes are recommended instead for leachate recirculation as they are less harmful.
- ✓ The roads used during the site operations should be included in the initial design.
- ✓ The way the geomembrane is installed inside the slope should be evaluated. The liner anchoring plan should be checked. A viable solution was proposed in the project, which may be modified.


Photo 1-3: Surface drainage and Impermeable Liner

1.4.5 Visit to the Nicolás Romelo Integrated Solid Waste Treatment Plant (a private facility)

Our guides explained that one of the main goals of the facility was to produce a top quality compost. They use a Colombian patent, the initial research principle of which was to expose the bacteria degrading and decomposing the wastes to high temperatures and to check their behavior under these conditions. As it turned out to be satisfactory, the required technological adjustments were then made to produce compost using this technique. At present the facility implements this patent by using a dynamic bio-pile.

The government pays them 150 pesos per ton of municipal solid waste received at the facility. They are paid USD 270 per ton of compost produced. Approximately 270 tons of wastes are received. 300 people work daily in 3 shifts at the plant.

The facility has confining cells to bury the wastes. It was noticed that only 30% of the wastes are in the cells, and that large piles are all around the place. The bulldozer used to move the wastes was broken.

We asked about the possibility of generating power using the landfill gas from the organic waste received. They said the energy-producing balance was not very satisfactory.

When asked about leachate generation and the possible soil pollution, they pointed out that the wastes in the site practically do not generate any leachate, only some in the rainy season, so they do not have a leachate treatment system.

They have a German-made plasma machine to generate electricity that is not currently operational.

a. Lessons

- ✓ A large amount of waste could be seen outside the confining cells, which are prepared with waterproofing and drainage systems at the cell base to store the wastes after their selection at the plant. The soil may then be getting polluted during the rainy season.
- ✓ The purchase of a state-of-the-art plasma machine to generate electricity meant a huge investment, and it is not currently operational. Incineration has been bitterly criticized due to the increase of pollution associated with gas emission. Any technology to be introduced in our country should be economically justified and sustainable over time. The Mexican experiences should be apprehended and a

methodology to evaluate the technologies to be introduced in Cuba in the future should be formulated. The adoption of imported technologies that have proved to be efficient in the country of origin does not necessarily mean they are to be effective in our country as the conditions are absolutely different.

- ✓ At the facilities where compost was being produced, very few bags were noticeable, so apparently the end product is not enough to meet a part of the market needs. When asked about this matter, they said that most of the compost produced is used in agriculture, especially for avocado growing. Therefore, we concluded, and were later told, that their main source of income is the payment made by the government for the reception of solid wastes at the site.
- ✓ The production of a profitable quality compost that can be sold should be guaranteed. A system certifying compost quality should be implemented if a large-scale distribution of the product is desired.
- ✓ The possibility of producing a quality compost using municipal solid wastes and tree and garden wastes devoid of either inert materials or heavy metals in financially efficient plants should be evaluated.

Photo 1-4: Visit to the Nicolás Romelo Site and Plant

December 6:

1.4.6 Visit to the Sanitary Landfill Site in the City of Puebla

- ✓ The surface area of the landfill site is 40 ha. It has been operational for 18 years and so far 8.5 million tons of solid wastes have been dumped. One of its cells has been closed. Another cell is currently being prepared to begin operations. 1,000-1,500 tons of solid wastes are brought daily to the site in 200 truck trips. Mondays and Tuesdays are the busiest days. The city of Puebla has a surface area of 30 km^2 and a population of 1.8 million.
- ✓ The site began operations in 1995. The geomembranes were installed at the base of the cell to ensure waterproofing, and a layer of sand 30 cm thick was placed on top to protect them and to facilitate leachate drainage.
- ✓ Municipal solid waste generation depends on the social and economic level of the residents. In Mexico, an average 800 g/day/person of solid wastes are generated.
- ✓ The height of the site cells ranges from 21 to 25 meters, and they are formed by compacted waste layers 4 m high and a layer of cover material 30 cm thick.
- ✓ Leachate is collected using HDPE pipes having a RDE 21, an inner diameter of 200 mm for main pipes and 150 mm for side pipes. It is pumped from the cell base to the existing system of oxidation ponds used to treat it.
- ✓ The 3 ponds has a storage capacity of 15,000, 20,000, and 35,000 m^3 respectively. Leachate is recirculated to the landfill. Sprinklers are used for leachate irrigation. Recirculation is carried out 12 hours a day. The pH of the leachate is higher than 8. Portable pumps are used to pump it from the sumps at the cell base to the ponds. Leachate is pumped from the pond having a larger storage capacity. Untreated leachate dumping into rivers is forbidden by Mexican standards.
- ✓ The site has 2 sheep-foot compactors, 4 Caterpillar bulldozers, and 60 trucks. Each truck has 1 driver and 3 operators. The site staff is composed of 80 workers.

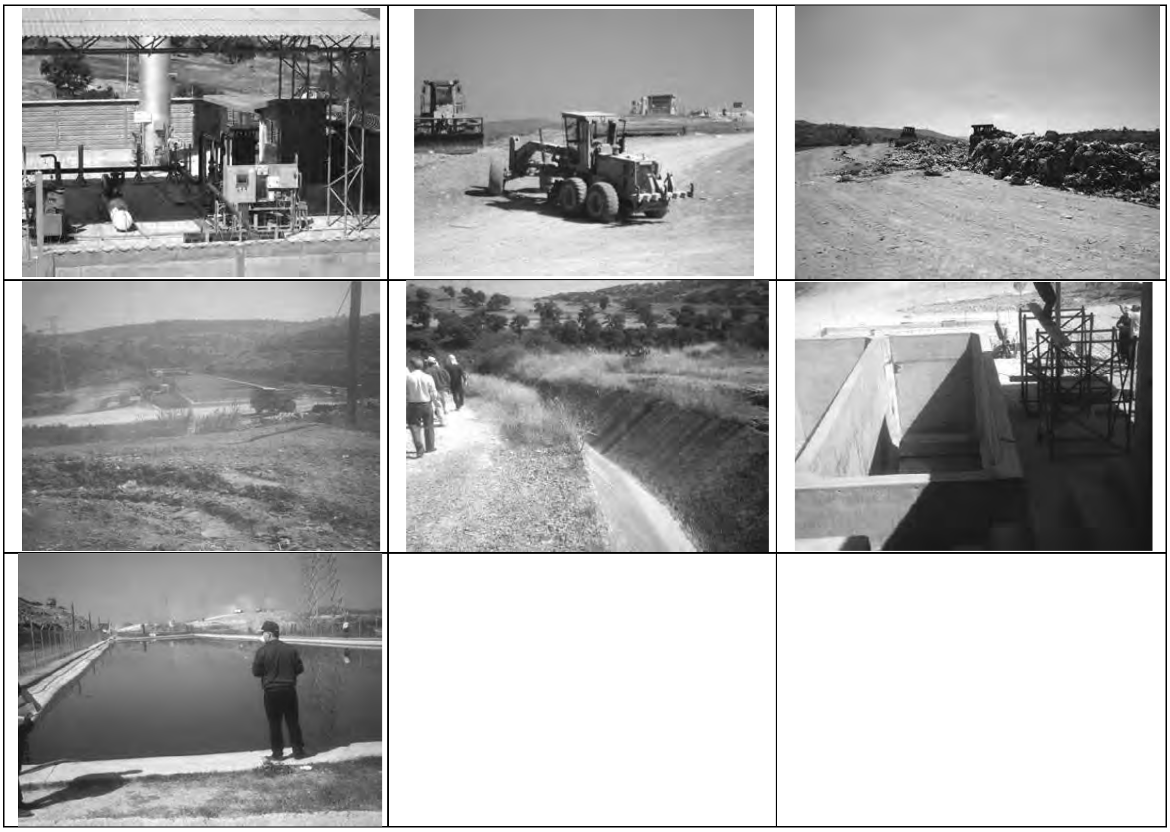


Photo 1-5: Puebla Sanitary Landfill Site

a. Lessons

- ✓ Order and discipline were noticeable during operations and the construction of the new cell.
- ✓ The current use of sprinklers for leachate recirculation, which may generate aerosols and affect the environment, should be evaluated.

Photo 1-6: Facilities at Puebla Sanitary Landfill Site

1.4.7 Visit to ATLIXCO Landfill Site

a. Remarks:

- ✓ A digital AUTOCAD copy of the site project was handed over to us.
- ✓ The wastes should be continually covered within 24 hours after being dumped in order to avoid the spreading of wastes, the breeding of harmful animals, and rain infiltration.
- ✓ Municipal solid wastes are not segregated at the source. They are segregated at the landfill site.
- ✓ 10 waste collectors with their corresponding permits are authorized to enter the landfill site. They work from 8 am to 6 pm. They earn an average 1,000 Mexican pesos a week depending on the amount of materials they are able to recycle.
- ✓ The equipments are the property of a private company. There are 3 dump trucks, 1 backhoe excavator, and 1 small Gonder tractor used to shape the slopes.
- ✓ The irrigation of the leachate over the cover material helps compaction and slope preservation.
- ✓ The site has an evaporation pond to treat the leachate generated.
- ✓ If any problem arises regarding leachate extraction, a temporary well is dug in the slope to recirculate the leachate.
- ✓ Leachate treatment components: A waterproofing system using a geomembrane, a protective geotextile liner, perforated drainage pipes surrounded by granular material, and sumps equipped with submersible pumps for deep wells used to extract the leachate and pump it to the gas wells.
- ✓ Maintenance is carried out by the site staff.
- ✓ The sanitary landfill site is managed by decentralized public agencies. Elections for the municipal mayor’s office take place every three years, which brings about changes of already qualified personnel. The new staff needs to be qualified.
- ✓ The slope was initially designed with a gradient of 28 degrees and was later increased to 31 degrees. The sanitary landfill site is 30 m high. Slope stability studies using parameters defined by soil mechanics were carried out to design the slopes.

<u>December 7:</u>

1.4.8 Visit to the city of Querétaro

Photo 1-7: Visit to Queretaro Site

2 Summary of the Training in Mexico – applying the knowledge and know-hows in Havana

2.1 Summary of the training for the group 1

For group 1 training, emphasis was placed on proper construction and management of sanitary landfill. Participants were able to gain certain level of knowledge to evaluate the adequacy of resource segregation facility which is planned to be built within new Guanabacoa sanitary landfill site. Evaluation includes various components like estimated volume of resources recovered from the waste stream considering the waste quality of Havana, construction and operation cost, marketability of recyclable materials or difficulty in utilizing the recyclable materials.

If the plan to construct resource recovery plant within the new Guanabacoa sanitary landfill site retained, it can be said that the trainees have gained knowledge and know-hows necessary to design and operate the facility which is capable of handling the waste volume planned. In other words, trainees got clear idea on necessary constituents such as area required to build resource recovery facility, location to be build within the new sanitary landfill site, civil engineering works or machinery/facility necessary to operate the landfill site. This will leads to realization of proper implementation plan for construction and operation of sanitary landfill site in Havana.

2.2 Summary of the training for the group 2

The training for group 2 was emphasizing on waste collection, transportation, and treatment, as well as environmental awareness raising activity on proper waste management targeting schools or residents. They also attained the knowledge on composting for green waste which can be applied in Havana.

It was also valuable to learn about garbage containers which in Cuba is necessary to be replaced every year from brake down. Trainees learned container production/ process, investment amount required to build container plant which has capability of producing replacement containers. Of course, approximate estimation on plant operation, unit cost of raw materials necessary to produce containers which meet Cuban requirements, and power necessary to run the plant were all part of what they have learnt regarding container production.

The visit to container producing plant made trainees realize the casting equipment in Cuba currently used to produce water tank was actually not suitable for waste dumping containers. The information can also be used when considering the feasibility of building container plant to reduce the cost of foreign currency required to replace 4,000 containers/year.

Environmental education materials provided by Mexican bodies are very helpful in promoting environmental education for waste management in Cuba. What they have learnt in environmental education focusing on waste management can be applied to pilot project program being implemented in some of schools in Havana City.

2.3 Summary of the training for the group 3

This training focus environmental control, facility operation cost and investment cost. It has become evident that proper closure of landfill site needs complex engineering design and study, as well as high cost is involved. This visit was vital to Havana considering the fact that there are landfills currently operation but are closed down in relatively near future.

The trainees also visited compost plant run by Universidad Nacional Autonoma de Mexico. This experience was particularly important when considering similar plant to be built in Havana in order to treat green waste. It was also helpful to realize the crashing machine produce considerable amount of noise and dust which requires consideration for nearby residents. This is valuable knowledge on evaluating the feasibility of crushing machine procurement.

All trainees argues this training program and facilities visited were extremely beneficial in improving waste management in Havana and realization of revised M/P. They also assured the details of lessons learnt through the Mexico training will be explained to higher officers to properly share and spread the accomplishment.

Project Completion Report

Section 3: Report on Output 2

～Report on Compost Pilot Project～

1 Compost Pilot Project

1.1 Existing Situation on Organic Waste and Former Activities

1.1.1 Existing Situation

The master plan study conducted from 2004 to 2007, found that 60% of wastes were organic, which contaminates recyclable materials and decomposes generating foul odors, leachate, gas, and proliferating vectors such as mice and cockroaches.

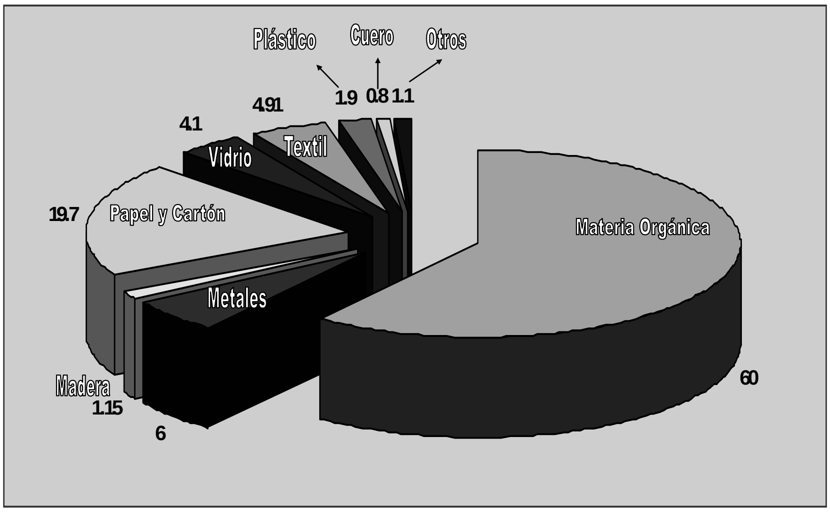


Figure 1-1: Composition of waste in Havana City

Thus, reduction of organic waste is one of the main pillars of the 2007 M/P strategy on municipal solid waste management, including the following:

- Recycling of recyclable materials and composting of organic wastes
- Introduction of home composting
- Introduction of 3 kinds of segregation, which are recyclables (cans, bottles etc.), organic wastes and others

In order to examine the above activities, the study implemented the pilot projects in some areas, which are waste segregation at source and collection, home composting or community composting with segregated organic wastes and increase awareness on waste reduction. The quality of produced compost was not so favorable because waste segregation was not enough and hurricanes damaged the facility constructed by the pilot project. Regarding home composting, the households did not use donated containers properly as they do not have enough space and were concerned with foul odors from composting. However, it was confirmed that workshops for waste reduction increased public awareness. Thus, the study concluded that public awareness is a major component of the strategy for waste reduction.

1.1.2 The UNIDO project

UNIDO implemented "Transfer of Environmental Sound Technology for Cleaner Management of Municipal Solid Waste in Havana City" Pilot Project from March 2005 to June 2009. UNIDO has formulated 4 project components, having the M/P as a reference, which are training for waste management employees, capacity strengthening in a laboratory, introduction of segregation for waste reduction and recycling of organic waste by composting and bio-gas generation. Then, about 2,000 employees attended courses and the project made it possible for the laboratory to analyze quality of leachate. In addition, a manual was made for composting, a sieve system and an engine shredder have been installed for garden waste, and a bio-gas plant has been constructed, which generates power using organic waste from agricultural markets and tobacco factories.

1.1.3 JICA detailed planning survey

In January 2009, a survey was conducted for identifying a detailed plan for this project. The aims of the survey were to confirm progress of activities and projects recommended by M/P and to examine the appropriateness of this project proposed by Cuban side. In their proposal, the project focused on improving collection, transportation and recycling; however, the survey confirmed that increased waste amount brings about more workload for the maintenance workshops. It was also confirmed that planning and construction of the new final disposal site was one of the issues. Therefore, the survey concluded that waste reduction should be one of the main issues for implementation of the project. Thus, the survey proposed a pilot project for producing good quality compost should be implemented by utilizing segregated organic waste from large-scale generators in Miramar area in the Playa municipality.

1.1.4 Lessons learned from past projects

As mentioned, there have been some previous composting experiences. As part of the Master Plan, a pilot project on segregation of municipal solid waste at the source and compost production was carried out, while segregated waste collection together with domestic composting were implemented under a UNIDO Project. The following are the lessons learned from past projects, i.e., the Master Plan study and the UNIDO project

- Carry out environmental awareness raising activities for organic waste generators focusing on the appropriate segregation of organic wastes in order to produce quality compost.

- Comply with the organic waste collection schedule agreed by both generators and collectors.
- Acquire the equipment necessary for compost production

1.1.5 Conclusion

By processing organic waste the wastes amount hauled to the landfill sites is reduced, and compost, an effective biofertilizer, can be produced. Therefore the counterpart tried to treat and/or reduce organic waste after the M/P study.

On the other hand, recycling activities in Cuba have been conducted since 1961 involving the companies and communities and have been implemented by ERMP and UERMP. It can be said, therefore, that Cuba has potentials for recycling. The compost pilot project, although the recycled material is different, can be implemented with those entities such as large organic waste generators.

1.2 Pilot Project

The pilot project consists following 4 steps; 1. plan formulation, 2. preparations (equipment procurement, construction of the compost yard and awareness rising among cooperating organizations), 3. Implementation and 4. evaluation. These are described along time series.

1.3 Formulation of Pilot Project Plan（September 2009 to March 2010)

1.3.1 Pilot Project Framework

The frame of the pilot project was formulated based on lessons learned from past projects and the results of the detailed planning survey, which are:

- Goal of the Pilot Project
  Collect organic waste from large generators, produce compost whose quality to be confirmed, and reduce waste volume.
- Activities
  - ✧ Identify the places where organic waste will be collected by the pilot project
  - ✧ Implement waste segregation at the source in the places selected.
  - ✧ Organic Waste Collection Schedule
  - ✧ Improvement of compost quality
  - ✧ Evaluate the method implemented

1.3.2 Waste generation and segregation

a. Identification of large waste generators

First, we visited several large organic waste generators that could be persuaded to cooperate with the project.

- Copacabana Hotel
  - Hotel closed on account of the low occupancy rate
- Chateau Miramar Hotel
  - 50 rooms
  - 1 restaurant
  - 1 lobby Bar
  - 1 snack Bar
- Panorama Hotel
  - Organic waste is collected by another company to feed pigs
- Neptuno-Tritón Hotel
  - Organic waste is collected by another company to feed pigs
- Comodoro Hotel
  - 3 restaurants
  - 1 lobby Bar
  - 5 light meal shops
  - 1 central kitchen
- Dos Gardenias Complex
  - 3 restaurants
  - 2 coffee shops
- "El Algibe" restaurant
  - Organic waste is collected by another company to feed pigs
- Agricultural market located on 42nd st. and 19th Ave.

The following places were chosen taking into account the fact that their wastes are not collected by pig farm enterprises, that they are willing to cooperate with our Project, and finally that the waste volume generated meets our needs.

Table 1-1: Large-scale generators at the pilot project

	Comodoro Hotel	Agricultural market 42y19	Chateau Miramar Hotel	Total
Waste Generation (L/day)	2,800	2,940	1,400	7,140
Ratio of Organic waste (see note 1 and 2)	0.52	0.9	0.52	
Organic Waste generation (L/day)	1,456	2,646	728	4,830
Bulk density	0.4	0.4	0.4	
Organic Waste generation (kg/day)	582	1,058	291	1,932

Note 1: Organic waste proportion to total waste generated in hotels is referred to the M/P study report.

Note 2: Organic waste proportion to total waste generated in agricultural market is estimated by visual observation.

b. Awareness raising activities for waste segregation at the source

Effective environmental education for people involved in organic waste selection will be required.

A number of lectures and practical activities to raise environmental awareness, promote the project, and explain how to segregate organic waste and how to store it will be conducted. It is also planned to make a technical manual including environmental education activities, segregated collection and biofertilizer production.

1.3.3 Collection and transportation

A schedule to collect and transport organic waste and to determine the amount of containers to be used in each place, as well as waste collection time and frequency, will be established.

1.3.4 Composting methods

a. Discussion on composting methods in Group 2

Annual average rainfall in Havana City is about 1,100 mm, and rainfall differs widely between dry and rainy seasons. Therefore, JICA experts mentioned that the composting facility must have a roof to prevent negative influences from strong rainfalls and/or drying by sunshine in order to improve quality of compost. However, the C/Ps did not have any experience on composting under a roof and insisted that low-quality compost is mainly due to a lot of foreign objects mixed in the waste collected. On the other hand, the soil research institute under the Ministry of Agriculture recommends composting by utilizing earthworms and C/Ps have had experience in this field and are interested in this method using segregated organic wastes. Thus, we concluded that the following three methods are examined as shown in the table below, namely, composting under a roof, composting in the open air, and earthworm composting. We may find the best method to evaluate advantages/disadvantages of each method through the pilot project.

Table 1-2: Methods and amount of organic wastes used for each

Method	Amount of organic waste (approximately)
Method 1: Composting under a roof	800kg/day
Method 2: Composting in the open air	800kg/day
Method 3: Earthworm composting	400kg/day

In terms of the composting facility for Method 1, the expert team proposed utilization of the existing empty facility at the recycling plant, but the counterpart team has declined because the facility has already assigned for another scheme and the counterpart team insists to layout all composting facilities together in the composting yard. Cuban side offered to construct roofed-compost yard as its undertaking due to the availability of necessary materials for construction in Cuba, expecting larger undertaking by the Japanese side for procurement of necessary equipment to be imported.

The following shows the details for each method.

a.1. Composting under a roof

In order to control moisture contents in material properly, the compost is produced in the roofed facility. The detailed methods are as follows;

Table 1-3: Design parameters of row materials

	Moisture content (%)	Weight of materials (kg)	Weight of Materials at dry condition (kg)	Water content (kg)	Carbon Content (%)	Nitrogen content (%)	C/N ratio
Organic waste	80	800	160	640	38.5	3.5	11.1
Sub-material for mixing with organic waste (shredded garden waste)	40	480	288	192	50.7	0.9	59.0
Total	65	1,280	448	832	43.0	2.5	17.3

A place for organic waste reception and mixing with the sub-material will be set up within the composting facility. The mix will then be transferred to the waste stacks accordingly.

Garden waste, a suitable material that can be supplied in a stable way, will be generally used as sub-material. If available, bagasse can also be used.

Table 1-4: Design parameters for Operation

Operation	Composting Period	60 days
	height of compost in chamber	2 m
	frequency of mixture	2 times/month (2 times /week at beginning)

Table 1-5: Design parameters for Material Balance calculation

Degradation Ratio of raw material in dried condition	Organic waste	30 %
	Sub-material	9 %
Total calorific value of dried materials in organic waste	organic waste	4,500 kcal/kg
	Sub-material	3,000 kcal/kg
Required calorific value for evaporation per 1 kg of water		900 kcal/kg

Table 1-6: Material Balance in 60 days in the compost facility

		Water content (%)	Treatment amount (kg)	Dried material (kg)	Water content (kg)
Raw Material at 1st day	Organic waste	80%	800	160	640
	Sub-material	40%	480	288	192
	Total	65%	1,280	448	832
	Bulk density (kg/m^3)	790	-	-	-
Reduction in the Process	Reduced amount: Organic waste	-	-	48	-
	Reduced amount: sub-material	-	-	26	-
	Total of reduced amount		400	74	326
	Compost	57%	880	374	506
	Bulk Density (kg/m^3)	610	-	-	-
Compost Product at 60th day	per day	57%	880	374	506
	per year		321,000		
	Compost/Raw material		69%	84%	61%

Table 1-7: Required Area of the Compost facility

Parameter for treatment	Raw material	1,280kg/day
	Composting period	60 days
	Bulk density	790kg/m^3
	Height of compost in chamber	2m
Design of the facility	Required Capacity (m^3)	97
	Required area(m^2)	53
	Size of chamber (4mx5m: Effective area 4mx4m)	4

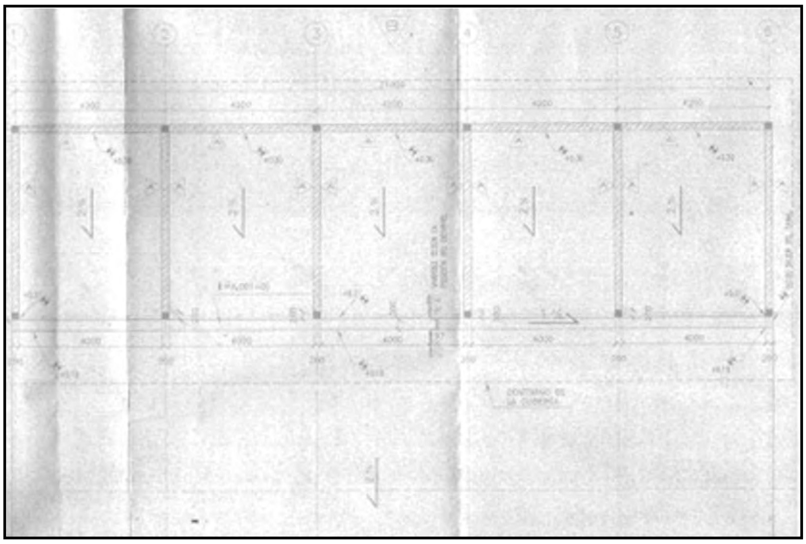


Figure 1-2: Layout of the compost facility

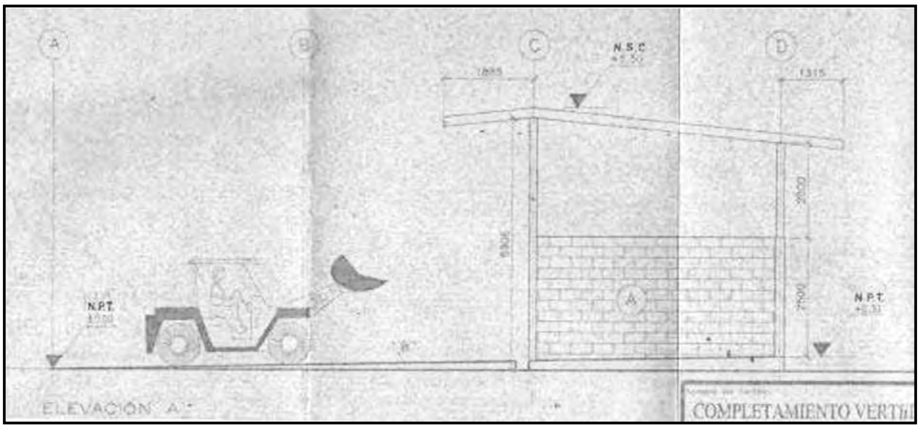


Figure 1-3: Cross Section of the compost facility

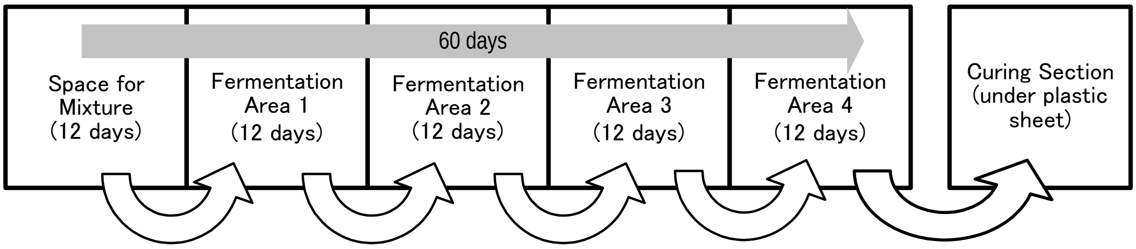


Figure 1-4: Operation method

a.2. Composting in the open air

Although compost is produced in the open air, quantity of raw materials and sub-materials etc is same as the roofed composting.

a.3. Earthworm composting

Beds of 1.2 meters wide by 10 centimeters high by 10 meters long are prepared. Then, earthworms are introduced and fed every 10 days using 10 centimeters organic waste on this size of bed.

4 beds are required in order to treat 400kg (0.6m^3) of organic waste. The operation method is, firstly we fed the waste for 2 days to the first bed, then two days later, another waste for 2 day are given. Following this cycle, we produce compost.

1.3.5 Staffing for the pilot project

The Pilot project will be implemented by the Compost and Biogas Unit in UPPH for collection and composting. The administrator of the Unit supposes that existing staffing will be adequate for the pilot project implementation.

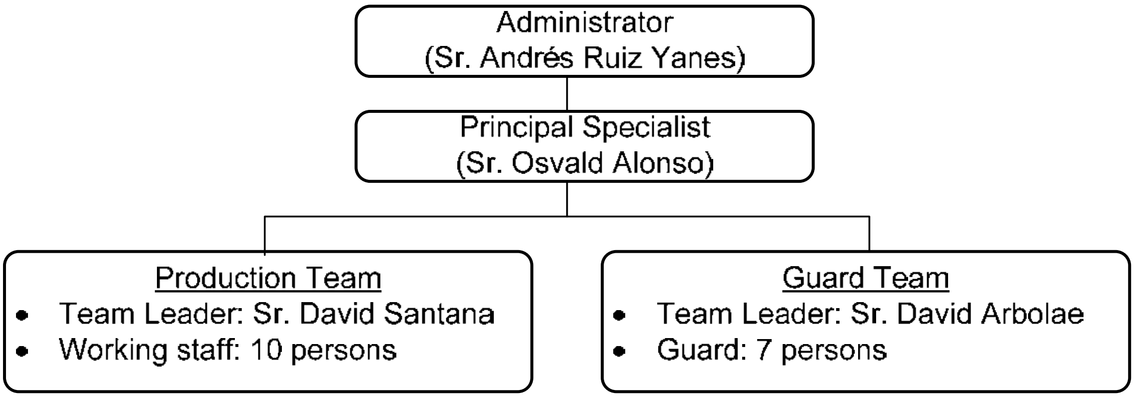


Figure 1-5: Organization chart of Compost and Biogas Unit

1.3.6 Required equipment

a. Selection Process

The detailed planning survey proposed the following equipment as shown in the table below for the pilot project.

Table 1-8: Proposed equipment at the detailed planning survey

No.	Items	Quantity
1	Large containers for organic waste for hotels and restaurants	60
2	Vehicle for organic waste collection	1
3	Construction materials for the composting facility	1 package
4	Equipment for composting (sieve, bucket, thermometer, sheet cover, plastic bags for compost delivery, compost packing machine etc)	1 package

We discussed these items in detail according to the pilot project plan. Then we define specifications and also eliminated some items through discussions among the groups 2. The process of discussion is described below;

a.1. Containers for organic waste

DPSC tries to change the material of containers from plastic to iron because containers made of plastic are imported and its price is more than 200 USD each, thus the procurement is very difficult in Cuba. Containers made of iron can be procured in the country and are easy to repair when broken. Therefore, we selected containers made of iron whose capacity is 50L (effective capacity is 45L) and considered its transportation. As for the transportation of containers, we exchange containers at the sources; thus, the number of containers necessary for collecting organic wastes is double of that daily required for the generated wastes amount.

Table 1-9: Required number of containers for organic waste

Generated waste(L)	Capacity of container (L) (Effectiveness: 90%)	Number (containers)	Spare (containers)	Total (Containers)
4,830	50L (45L)	216	24	240

a.2. Organic Waste Collection Vehicle

We assumed that generated waste, which is 4,830L, will be collected in 3 trips a day; therefore 36 containers are transported in one trip. Weight of one container is, which might be changed by bulk, 45 kg considering its high water content, then total weight of 36 containers is about 1.6 ton. Therefore, we need a vehicle with a loading capacity of 2 tons, In addition, some containers will be double loaded, then the truck requires side panels about 1m. Detailed specifications are shown in Table 1-11.

a.3. Equipment for composting

The following are existing equipment at the compost yard.

Table 1-10: Existing Equipment at the compost yard

Equipment	Number	Specification	Note
Wheel loader	1	Height: 3m Length: 5m	exclusive use in the compost yard donated by UNIDO
Engine driven shredder	1	Input diameter: 50mm, mobile type	Not working donated by UNIDO used in the bio-gas plant
Motor driven sieve	1	Height: 10m Length: 30m 230V 3 phases	Donated by UNIDO Electricity was not supplied Control panel is broken
Stick type thermometer	1	-10°C - 90°C	Donated by UNIDO

Working equipment shown in the above table can be used for the pilot project. Thus, the following equipment shall be procured for the pilot project.

- Crasher
  - ✧ Crash organic waste in order to ferment earlier
- Sieve
  - ✧ The existing sieve is not working, and it is not known when it will be fixed. Therefore, simple structure and small scaled rotary sieve is necessary in order to remove foreign objects from produced compost.
- Stick type thermometer
  - ✧ Measure temperature of produced compost in the composting facility
- Hand balance
  - ✧ Measure weight of organic waste at collection
- Plastic sheets
  - ✧ Prevent produced compost from wetting by the rain while curing
- Shovel
  - ✧ Improvement of works
- Bucket
  - ✧ Buckets for removing water content from organic wastes at kitchens. In order to remove water content, the procured drill makes drain holes at buckets.

- Drill
  - ✧ For making drain holes at buckets, and it can be used for making compost boxes for school composting.

Regarding the compost packing machine shown in Table 1-8 (as part of Item 4), plastic bags for compost product may turn into plastic waste after discharging compost product, and packing works also require cost (i.e., the plastic bags cost and labor cost). Therefore, we agreed to deliver produced compost by track without packing.

The measure for moisture is not required because we can measure its characteristics including water content by hands.

b. Selected equipment

Based on the discussion above, we selected the following equipment to be procured:

Table 1-11: Required Equipment for the pilot project

Number	Item	Specification	Quantity
1	Diesel engine driven, flat body truck	Maximum load: 2 ton, Long body type, side panel height: approximately 1m, Standard tool set attached, Left-hand steering wheel (preferably under standard specifications)	1
2	Electricity driven rotary sieve	Mesh screen with size: 6 - 10 mm, Trommel type, Diameter of rotary sieve: 300mm or above, Geared motor installed, 55 rpm, Adaptable to single - phase 110V, with in-feed hopper	1
3	Stick type thermometer	Range: 0 - 120°C, Scale: 1°C, Body: stainless steel, length: 900-1200 mm, Indicator: 80-100φ,	1
4	Electric drill SET	LP-0102, LP-0401, φ 4 mm, LP-0401, φ10 mm LP-0401, φ 8 mm LP-0401, φ 6 mm	1
5	Hand Balance	Weighing capacity: 100kg, Scale: 1kg, Hand Balance 100 kg (with no metrological certificate)	1
6	engine driven chopper	Capacity: 800 kg/h, Power source: portable engine, In-feed hopper size: 150mm or above,	1
7	Cap-attached steel container	open type drum with cap fixed by external lever band, Capacity: 50 L, Material: steel coated inside, Dimension: inside diameter = 40 cm approximately height = 40 cm approximately	240

Number	Item	Specification	Quantity
8	Plastic cover sheets	3m x 6m	10
9	Buckets	made of plastic, 6L with handle	30
10	Shovel	Square type, length: 80cm approximately	10

1.3.7 Implementation Plan

The pilot project will be started after the procurement of equipment shown in above tables. After the completion of the procurement, we may start from awareness rising to concerned persons such as staff in targeted hotels and markets. At the same time, we make operation manuals for separation, transport and composting. Then we start implementation based on the manual. The process may be reviewed every three months and feedback to the plan and the manual according to the concept of "Project cycle", which are "plan" "do" and "see" (See figure below).

Activity \ Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Awareness rising to concerned persons	○												○						
Manual preparation	○																		
Waste separation transportation and composting																			
Review the process and manuals		○			○			○			○			○			○		

Figure 1-6: Implementation Plan of the pilot project

We also agreed that Cuban side constructs the compost yard and Japan side procure equipment showed in Table 1-11.

1.3.8 Evaluation of the pilot project

a. Quality of Compost and its utilization

The end product will initially be used in the nurseries run by the Green Areas Unit of DPSC. However, it could be traded once its quality and viability for different usage are verified.

b. Effects by organic waste reduction

Reduction of organic wastes leads life extension of landfills and saving operation costs. In addition, utilization of produced compost reduces the cost for purchasing material of soil improvement in the garden unit of DPSC and may produce benefits by selling the produced compost. On the other hands, the cost for composting, such as collection of separated wastes, construction of new facility, procurement of necessary equipment etc., must be increased. In order to evaluate its cost and benefit of this pilot project, we have to understand existing condition quantitatively.

So far we have got following data to see existing condition.

- Cost for waste collection born by generators (The agro market and Chateau Miramar Hotel, wastes not separated)
- Frequency of waste collection at sources
- personnel cost
- distance between the compost yard and generators
- compost production amount
- compost amount sold to the green garden unit and its unit price

We are going to monitor these figures to evaluate the effectiveness throughout the period of the pilot project.

- construction cost for new facility
- procurement cost for new equipment
- maintenance cost for equipment
- amount of collected organic waste
- operation cost (electricity, fuel, personnel cost, etc)
- amount of produced compost
- benefit by selling compost
- construction and operation cost of the new landfill site

1.4 Preparation of the pilot Project (April 2010 to May 2012)

1.4.1 Equipment procured in Japan

Table below shows the equipment which are to be procured by the Japanese side based on the agreement made at the planning stage.

Table 1-12: Equipment for Pilot Project Procured in Japan

Item	Quantity
Diesel engine driven, flat body truck	1
Electricity driven rotary sieve	1
Stick type thermometer	1
Electric drill SET	1
Hand Balance	1
Motor driven chopper	1
Cap-attached steel container	240

We realized, however, that it was difficult for the Japanese side to export the motor of the motor-driven chopper to Cuba because of the existing export regulations. The function of the equipment is to chop organic wastes into pieces for effective fermentation. If this equipment is not available, the compost yield ratio can become lower. As a solution, the Japanese side and Cuban sides agreed that the chopper without motor would be procured in Japan and the motor itself would be procured and assembled onto the chopper in Cuba.

a. Donated equipments:

In October 2011, Donated equipment was arrived and transferred to Cuban side.

Table 1-13: Donated Equipment

Item	Number
Truck	1
Rotating sieve	1
Thermometer	1
Electric drill	1
Spring balance	1
Electric shredding machine	1
Steel containers	240

b. Equipment Protection

Donated equipment will be stored in a safe room within the Biogas Plant until the Compost Yard is finished. To this end, a bar screen is currently being installed to improve the room safety. As from October 24, donated equipment for the Compost Yard will begin to be moved from the Central Workshop warehouse to the room where they will be stored for protection. Similarly, some procured farm implements such as picks, shovels, nets, hoses, machetes, hoes, etc., have been stored in the Biogas Plant warehouse.

1.4.2 Construction of the Compost Yard

a. Activities from Nov. 2010 to Jan.2011

- Negotiations with Aguas de la Habana (Havana water company) for connecting a water pipe to the compost yard
- Contact with Gianni of GTDI to confirm the dimensions, location and contractors of the new platform of the compost plant.
- Contact with the Electric Company in order to provide electricity to the compost yard.
- Collection of all the bibliographic information on the compost production.
- Cleaning of the area where the compost plant was projected

b. Activities from Feb. 2011 to Oct. 2011

In February we were notified of the influence that could be exerted on the compost yard by the planned new railway line.

Two alternative areas for the Pilot Unit location were proposed to the Japanese side (See Figure 1-8). The mobility of the backhoe donated by JICA was tested in the compost yard (See Photo 1 in Figure 1-9), and we confirmed not having problems for the project. The both sides agreed that the compost production should be carried out at the area next to the biogas plant (See Figure 1-9). In order to construct the compost yard as scheduled, following activities are implemented.

- A survey was conducted with Cesar of the Development Group on the arrangements in the new area (water, electricity, drainage, building renovation, roofing, painting and accessibility)
- Hold a meeting every Monday to check the progress of the construction to be completed according to the schedule shown in Figure 1-7.

No.	Activity	Person in charge	March				April				May			
1	Modification of the project	Cesar	■											
	Actual progress		▨											
2	Determination of the necessary materials	Cesar-ASECOM	■	■										
	Actual progress		▨											
3	Material acquisition	Fernando	■	■	■	■	■	■	■	■				
	Actual progress													
4	Exectution of construction	ASECOM					■	■	■	■	■	■	■	■
	Actual progress													
5	Contract preparation for Plant roof	Fernando	■	■										
	Actual progress		▥											
6	Plant roof acquisition	Fernando	■	■	■	■								
	Actual progress		▥											
7	Plant roof mounting	LAMCOMET					■	■	■	■				
	Actual progress													
8	Hydraulic, sanitary and electrial repairs for the plant	ASECOM									■	■	■	■
	Actual progress													

Figure 1-7: Compost Plant Construction Schedule

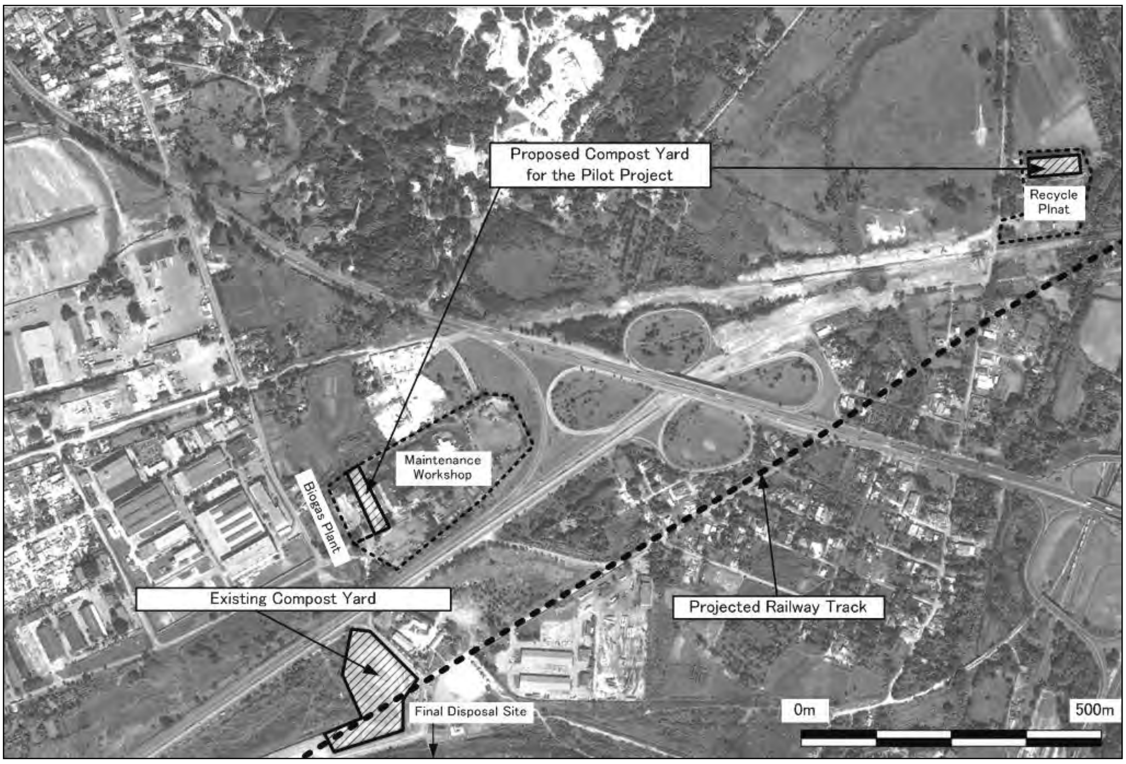


Figure 1-8: Location of Proposed Compost Plant Site and Planned Railway Line

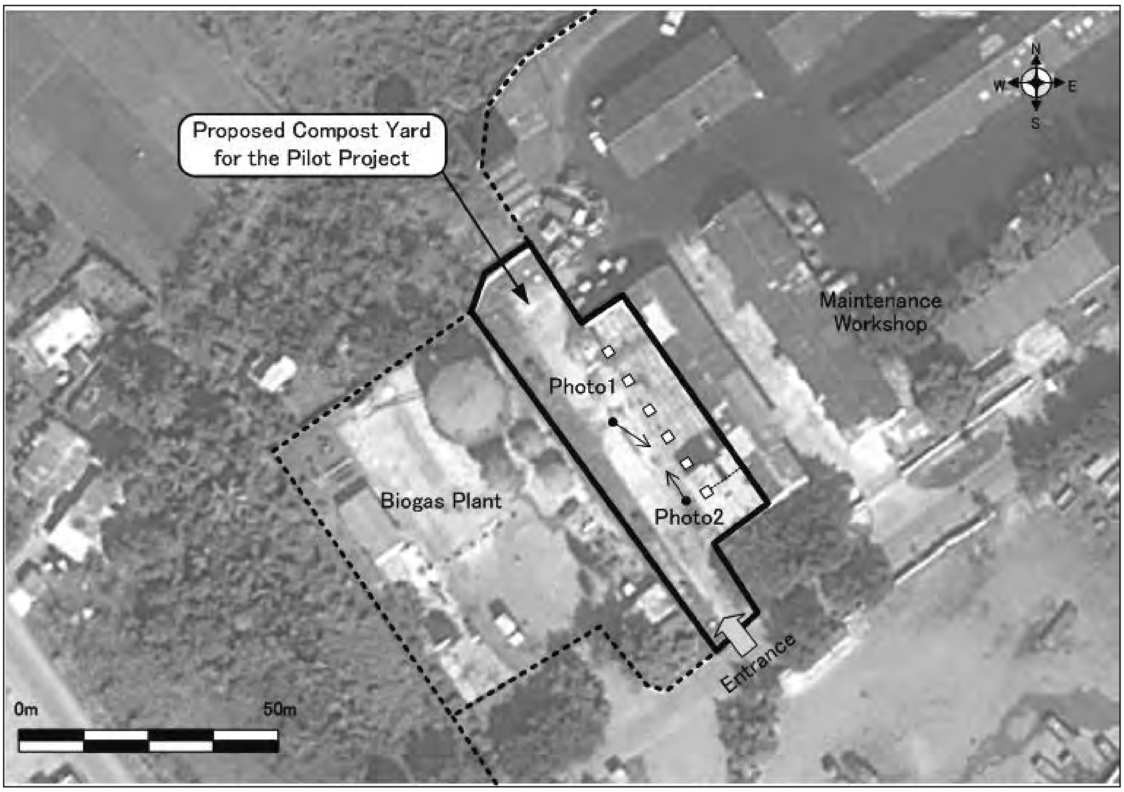



Photo 1-1: Compost yard before renovation


Photo 1-2: New site for the compost yard

Figure 1-9: Details of Proposed Site for the Pilot Project

The request for the land and building use change authorization for the site selected to build the Compost Yard was submitted at the provincial Direction of Physical Planning (DPPF) in June, 2011. A coordination meeting was held attended by DPPF’s expert in charge on October 11 and the required documents were submitted on October 18 in the hope that DPPF could issue the corresponding building permit for October 21. The authorization has not been issued so far. The Project will pay close attention to the authorization procedure so that the permit is granted before the end of October.

In order to make up for the delay in the construction of the pilot compost yard, a number of measures have been adopted into a plan so that the facility can become operational. According to the plan, construction works should be completed by November 15. The works to be carried out during this period are shown below.

- Roof installation
- Build corridor wall
- Fill the holes on the wall at the back of the warehouse
- Build tool room and office
- Build the ramp
- Build drains and cistern (trap)
- Wiring
- Ceiling
- Office and building
- Build the base for the shredder
- Paint
- Prepare the maintenance area

It should be noticed that the area for the compost yard is still occupied by UPPH's tire repair shop, which should be moved elsewhere. This makes it impossible to speed up the works listed above. As soon as the building permit is issued, the tire repair shop staff will move their equipment away and the pending works to finish the building will begin. It is necessary to closely supervise the actual progress of the works in order to ensure the timely beginning of operations at the compost yard.

c. Activities from Nov. 2011 to May 2012

Responding the recommendation of intermediate evaluation (described in 1.4.4), the Pilot Project began on November 13, 2011, at the former tire repair shop within the Central Workshop (Photo 1-3 and Photo 1-4). Therefore, construction works were carried out simultaneously with the operation of the pilot project. The necessary construction materials were gradually acquired and the works went ahead as they were made available (Photo 1-5 to Photo 1-14) until the plant was finally finished in May, 2012.

Photo 1-3: The site before the beginning of construction works (picture taken on February 17, 2011)

Photo 1-4: The site before the beginning of construction works（February, 2011）

Photo 1-5: Pouring concrete for the plant floor (February 13, 2012)

Photo 1-6: Floor building (February 13, 2012)[1]

Photo 1-7: Compost was moved out to allow construction works (February 14, 2012)

Photo 1-8: Drainage works (February 8, 2012)

[1] The floor works were suspended for some time until floor concreting was resumed and completed by late April, 2012.

Photo 1-9: Works for the office/training room (February 7, 2012)

Photo 1-10: Construction of the wall separating the plant from the warehouse (right side) (February 11, 2012)

Photo 1-11: Installation of the fence to separate the shredder area (February 17, 2012)

Photo 1-12: Roof installation (February 14, 2012)

Photo 1-13: Finished compost plant

Photo 1-14 : Finished office/training room

1.4.3 Activities for Awareness Raising among Persons Concerned

a. The summary of the activities

During this stage we have kept in contact with the key persons of the Units involved in the Pilot Project. Visiting them periodically, we have informed them of the current progress of the project and exchanged views with them, which could serve us to grasp their knowledge level regarding the waste management. .

As a result, we found that they laced knowledge about waste management in general and compost production in particular. In order to ensure the appropriate project implementation, we decided to hold several theoretical and practical workshops on waste management targeting at the managers and the employees of Chateau Miramar and Comodoro Hotels, and the Agricultural Market 42 y 19, as they would play an important role in the organic waste segregation for compost production. Figure 1-10 is the program of the first seminar held on February 22, 2011 and Table 1-14 shows the number of the participants from each organization.

"Proyecto para el Fortalecimiento de Capacidades del Manejo de Residuos Sólidos Urbanos en la Ciudad de la Habana, República de Cuba"

Preside: Dirección Provincial de Servicios Comunales
Agencia de Cooperación Internacional del Japón

Taller Teórico – Práctico. Grupo 2: Reducción de Residuos y Compostaje

22 de febrero de 2011

Hora	Lugar	Actividad	Responsable
10:30 am	Agro 42 y 19	Recogida y salida para el Chateau	Ivette
10:45 am	Hotel Chateau Miramar	Recogida y salida para el Comodoro	Ivette
11:00 am	Hotel Comodoro	Salida para Vertedero Calle 100	Ivette
11:20 am a 12:40 pm	Vertedero Calle 100	Recorrido Vertedero y Planta de compost	Pedro y Ricelo
1:00 pm a 2:00 pm	Hotel Chateau Miramar	Almuerzo	
2:00 pm a 4:00 pm	Salón de Hotel Chateau Miramar	Taller	Ivette y Ogawa

Participantes: Trabajadores involucrados en el Proyecto piloto

- Hotel Comodoro
- Hotel Chateau
- Agro 42 y 19

Figure 1-10: Seminar Program

At the beginning of the event, we guided them to the 114th Street where they could have a panoramic view of Calle 100 landfill site. Mr. Pedro provided them with general information related to the waste generated in the city, as well as detailed explanation of the landfill site operation, using the leaflet prepared beforehand by C/Ps. At the Compost Plant, Mr. Andrés Ruiz Yanes, the former C/P member, explained the importance of compost and the production process.

Table 1-14: The number of Participants from each organization

Organization	Number of Participants
Hotel Comodoro	9
Hotel Chateau Miramar	2
Agricultural market 42 y 19	11
Total of 3 Organizations	22
DPSC	7
Total	29

On the way to the hotel where the seminar to be held in a bus, we gave the participants relevant information regarding our project to be implemented, waste management, environmental protection, the cost of waste collection with specialized equipment , etc., which we deemed useful for all of them. At the seminar, Mr. Pedro firstly explained the contents of the leaflet we had handed over (shown in Attachment in the Chapter end). Then, Mrs. Ivette Reyes Agüero made a presentation about the origin and details of the pilot project. Finally, Dr. Ryoichi Ogawa, a member of JET, lectured about the 3Rs, and held a participatory workshop regarding segregation of organic and inorganic wastes.

Photo 1-15: Photos of the Site Visit at the Seminar

Photo 1-16: Lectures and Workshop at the Seminar

1.4.4 Delay of preparation and Summary of Intermediate Evaluation

From October 3 to 7, 2011, the intermediate evaluation of the project was conducted. The summary of the evaluation corresponding to Output 2 is shown below:

- The beginning of the composting pilot project is imperative. If not, the achievement of this Output is deemed to be extremely difficult during the time period established.

In the light of this situation, JICA’s Evaluation Committee requested the following from the Cuban side:

- With regard to the soil use change authorization to build the compost yard requested in June, 2011, the permit has not been granted so far. To this end, JICA’s mission asked Havana City’s Administration Council Vice-president for his support and confirmed to the Cuban side that the authorization should be granted as soon as possible so that the pilot project may begin in middle November, 2011, at the latest.
- JICA’s mission asked the Cuban side to speed up the process required to obtain the license plate for the organic waste collection truck and to procure the electric motor for the organic waste shredder.

1.5 Implementation of Pilot Project

1.5.1 Changes from the Original Plan

The changes made from the original plan and its reasons are shown in Table 1-15.

Table 1-15: Original Plan and Adjustments

Original Plan	Present Plan	Reasons for Adjustments
＜Compost plant＞ Build the new compost plant within the compost yard.	The compost plant was built within the premises of the former tire repair shop adjoining the Biogas Plant.	The compost yard was closed due to the construction of the railway line.
＜Collection containers＞ All the wastes are collected using 50L containers.	For waste collection, 50L and 500L containers are used to collect the wastes at the hotels and agricultural markets. 50L containers are used at agricultural markets for waste segregation.	It is complicated to control small containers as they are easily stolen due to their size. The C/P introduced medium-sized and large containers on their own initiative. Their disadvantages are that the rain accumulates inside them and that waste segregation is reduced. The identification of the most suitable size for containers is still ongoing.
＜Humidity regulator＞ Tree waste is shredded to regulate compost humidity using the equipment donated by UNIDO.	Cigarette waste generated by a nearby factory is used to regulate humidity.	The shredder donated by UNIDO has not been repaired yet.
＜Compost production method＞ Three methods are implemented, namely, under a roof, in the open, and using earthworms.	Compost is only produced under a roof.	The compost yard was closed due to the railway line construction project. As there is not enough room at the present site for compost production in the open, the entire compost production was decided to be carried out under a roof. In addition, due to the use of cigarette waste as humidity regulator, compost production using earthworms was abandoned. Cigarette waste contains an insecticide.

1.5.2 Activities in November in 2011

a. Commencement of Pilot Project Implementation

The Pilot Project began to be implemented on November 13, 2011. The activities carried out as part of the Pilot Project are shown in detail below.

a.1. Implementation Structure

The implementation structure for the Pilot Project is shown in Figure 1-11.

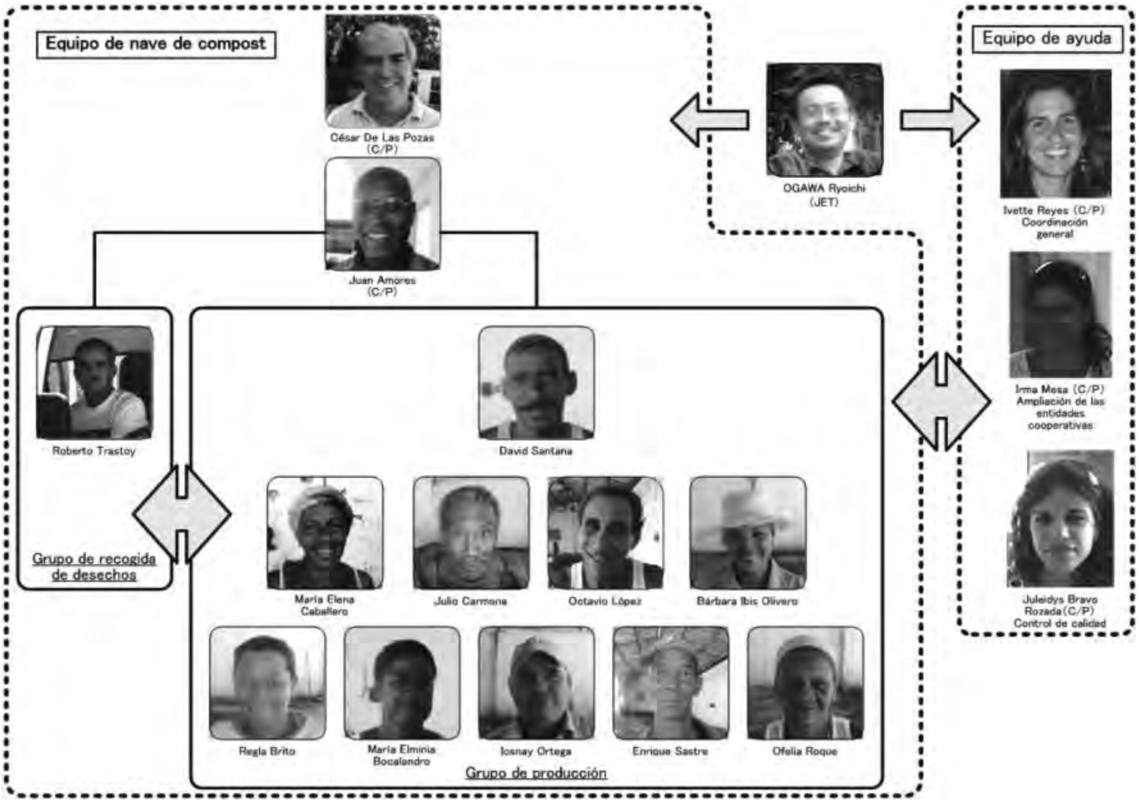
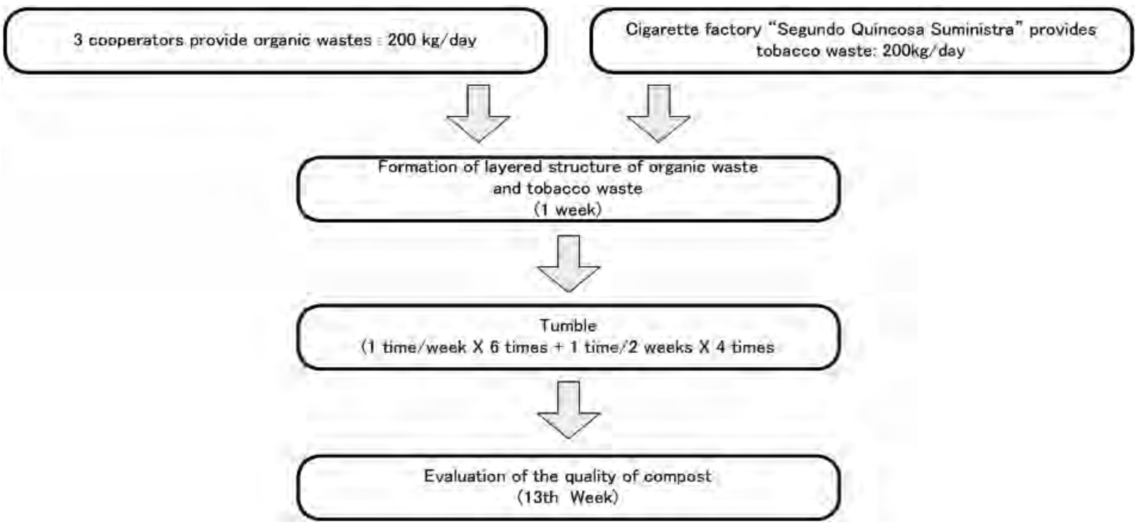


Figure 1-11: Pilot Project Implementation Structure

a.2. Pilot Project Activities

The flow chart of activities carried out as part of the Pilot Project is shown in the figure below.



(The volume shown is the amount at the beginning of the Pilot Project)

Figure 1-12: Pilot Project Flow Chart

b. Record of waste collection

Table 1-16: Actual Organic Waste Collection Data

Date	Agricultural Market	Comodoro Hotel	Chateau Miramar Hotel	Total
Nov. 9	97.7(5)	0-(0)	33.8(2)	131.5 (7)
Nov.10	127.2(5)	97.0 (4)	35.5(2)	259.5(11)
Nov.11	108.4(5)	93.5 (4)	22.7(2)	224.6(11)
Nov.12	124.6(5)	64.4 (3)	30.6(2)	221.6(10)
Total				837.2(39)
Average weight by container(kg)				21.5

kg (Number of containers for waste collection)

Table 1-17: Amount Collected in November

Month	Total amount collected (kg)	Average amount collected per day (kg)	Number of working days
November	2,602	217	12

(Estimated based on an amount of 21.5kg per container)

Table 1-18: Amount of Cigarette Waste Collected

Date	Total amount collected	Description
November 11	800kg	Amount for 2 days (estimated based on the cigarette waste area by its height)
November 14	780kg	Amount for 2 days (60 containers weighing13kg/container)
Average	395kg/day	

(As of December, cigarette waste was weighed at the weighbridge)

Table 1-19: Amount of Mixed Inorganic Waste

Cooperation dischargers	Quantity	Remarks
Agricultural market, Chateau Miramar and Comodoro hotels	20L/week	They attended the workshop about waste reduction and segregation.
“Segundo Quincosa” cigarette factory	500L/week	They did not attend the workshop.

c. Manual Preparation

The workshop organized to prepare the manual was held on November 25 attended by most of the C/P members. The manual then prepared is attached at the end of the present document.


Photo 1-17: Pictures showing the manual preparation workshop

d. Problems Identified at the End of November, 2011

Prior to the Japanese expert's departure in late November, the C/P members and the expert discussed the existing situation (See Table 1-20).

Table 1-20: Problems Identified and Measures Agreed on November 30

Problem	Measure	Person in Charge	Deadline
Lack of gloves, rubber boots, and wheelbarrows.	Ask UPPH for them.	César and Juan	Before the Japanese expert's next assignment in Cuba.
Full containers are too heavy to be moved.	See the possibility of purchasing wheelbarrows.	Juan	Before the Japanese expert's next assignment in Cuba.
Lack of detergent to wash the containers.	The Japanese side will buy the detergent the first time. Then the Cuban side will ask UPPH to buy it.	César, Juan	Before the Japanese expert's next assignment in Cuba.
Lack of containers to be supplied to the cigarette factory.	Deploy 4 large plastic containers (500L each)	César, Juan	Before the Japanese expert's next assignment in Cuba.
Construction of the compost facility has not yet been completed.	Complete construction of the compost facility.	César	December 15.

Moreover, the Japanese expert explained to the C/P the plan of activities to be carried out as of January, 2012. An agreement about the plan was reached. The activities are described below:

- Hold the workshop for the cooperating organizations.
  - Share the problems they are facing.
  - Find solutions for them.

- Analyze how to increase the volume of organic waste currently being collected.
- Find new cooperating organizations within Miramar..
- Think how to use produced compost.

1.5.3 Activities from December, 2011, to mid-January, 2012

a. Current Pilot Project Situation

The results of organic waste collection carried out during this period are shown in Table 1-21.

It should be noted that cigarette waste could not be weighed as the weighbridge is not operational.

Table 1-21: Monthly Organic Waste Amount Collected in December, 2011, and January, 2012

Month	Total amount collected(kg)	Daily average amount collected(kg)	Working days
December	6,042	263	23
January	9,396	336	28

(Estimated based on an amount of 21.5kg per container)

Compost is being produced at the pilot facility by mixing collected organic waste and cigarette waste. It should be noted that on December 1 compost began to be made outside the building due to the floor construction works being carried out there.

b. Modification of Activities

The activities of the Pilot Project were generally carried out according to the manual prepared. However, some problems such as the ones shown in Table 1-22 arose and, consequently, some relevant measures had to be taken.

Table 1-22: Modification of Activities

Problems	Measure taken
Collection hours do not coincide with the compost plant staff's working hours.	New arrangements were made with the cooperating agencies to carry out waste collection in the morning.
Waste collection could not be ensured either for New Year's Eve or New Year's Day.	After consultation with the cooperating organizations, it was decided that the C/P would inform them when collection was not to be carried out in case the C/P is previously informed about it.

1.5.4 Activities from the second half of January, 2012

a. Checking fulfillment of measures agreed upon to cope with the problems identified up to November 30, 2011

The monitoring of the measures agreed upon on November 30 is described in Table 1-23.

Table 1-23: Monitoring of Problems Identified and Measures Taken up to November 30, 2011

Problem	Measure	Person in Charge	Deadline	Results
Lack of gloves, rubber boots, and wheelbarrows.	Ask UPPH for them.	César y Juan	Before the Japanese expert's next assignment in Cuba.	Out of the 3 items, only the gloves were procured.
Full containers are too heavy to be moved.	See the possibility of purchasing wheelbarrows.	Juan	Before the Japanese expert's next assignment in Cuba.	Wheelchairs have not been purchased yet.
Lack of detergent to wash the containers.	The Japanese side will buy the detergent the first time. Then the Cuban side will ask UPPH to buy it.	César, Juan	Before the Japanese expert's next assignment in Cuba.	Detergent was only procured by the Japanese side.
Lack of containers to be supplied to the cigarette factory.	Deploy 4 large plastic containers (500L each).	César, Juan	Before the Japanese expert's next assignment in Cuba.	Containers were deployed.
Construction of the compost facility has not yet been completed.	Complete construction of the compost facility.	César	December 15	Not finished yet.

b. Formulation of the Plan of Activities as of February, 2012

The following activities were planned:

b.1. Workshop Implementation

Now that two months have elapsed from the onset of the Pilot Project, existing problems should be timely identified and possible solutions for them found. Consequently, a workshop is being scheduled to be held as follows:

Date：February 1, 2012
Venues：MINCEX’s Conference Room and Compost Plant
Participants：4 cooperating organizations and the C/P
Workshop Program

08:30~09:30	Moving the participants to MINCEX’s Conference Room
09:30~09:40	Opening speech
09:40~10:00	Explaining the workshop purpose
10:00~10:20	Explaining the compost production process (organic waste generation, collection and transport, and compost production)
10:20~11:00	Discussion to identify existing problems (first part).
11:00~11:10	Break
11:10~12:20	Discussion to identify existing problems (second part). Analyzing the measures to be taken and building consensus.
12:20~12:30	Summary
12:30~13:00	Lunch
13:00~13:20	Moving to the Compost Plant
13:20~13:50	Explaining the plant operation
13:50~14:00	Questions and answers
14:00~15:00	Departure

b.2. Strategies to increase collected organic waste volume and the number of cooperating agencies

To consider some places located near the present collection route in order to include new agricultural markets, especially in Playa and Marianao municipalities, into the Pilot Project.

To discuss the significance of the Pilot Project with the managers in order to commit them to select the organic wastes to be used for compost production.

b.3. Search for new uses of the produced compost.

First, quality tests of the compost produced at the pilot plant should be run as follows:

- Use it for the following plants growing in UPPH’s gardens (their commonly known names are provided below):
  - Crotón
  - Mar Pacífico
  - Isoras
  - Lenguas de Vaca
  - Bougainvillea
- Germination test by using produced compost

Similarly, a market research should be conducted in order to know the interest of plant growers in the product to be able to estimate the demand and the present prices. On the other hand, a compost production cost record should be kept to estimate viable selling prices.

Regarding the use of cigarette waste for compost production, it should be noted that the mosaic virus affecting tobacco is likely to be found in the cigarette waste. This virus has a negative effect on the growth of plants pertaining to the *Solanaceae* family. Therefore, the C/P and the expert decided not to use the compost produced during the Pilot Project to grow these plants.

1.5.5 Activities from Feb. 2012 to Oct. 2012

a. Organization of the Pilot Project

The present organization for the Pilot Project implementation and its operation flow are shown in Figure 1-13 and Figure 1-14.

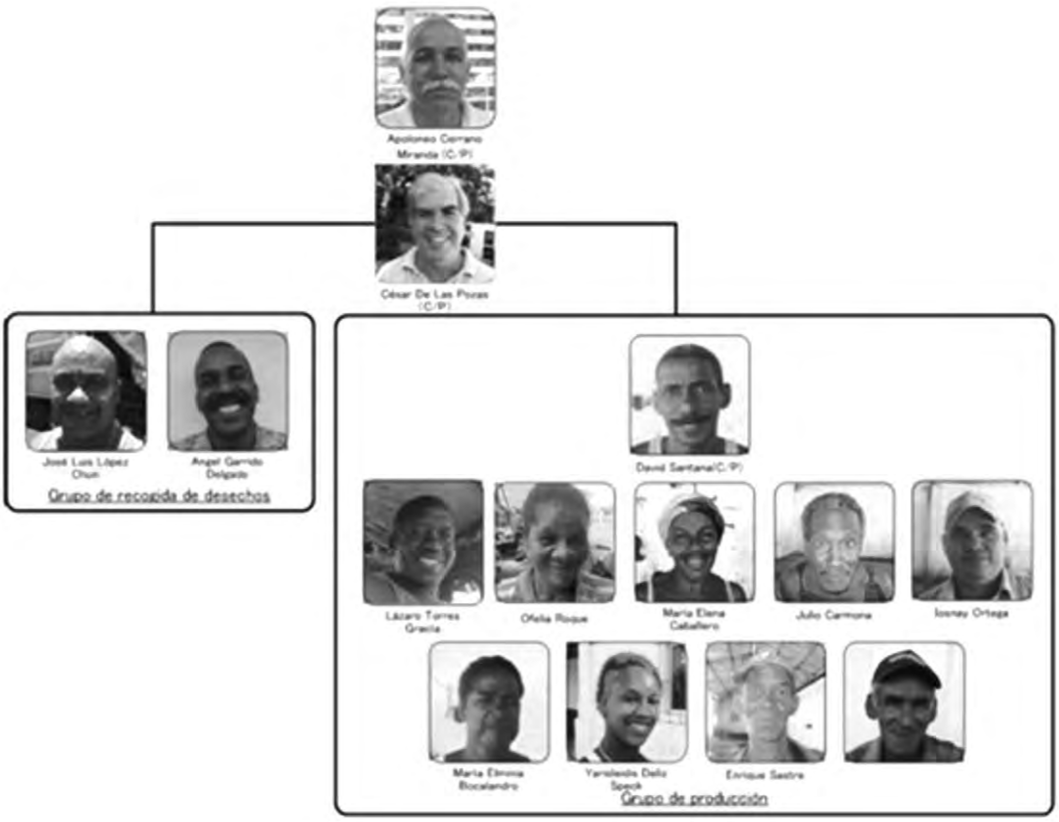


Figure 1-13: Pilot Project Organization Chart (as of October, 2012)

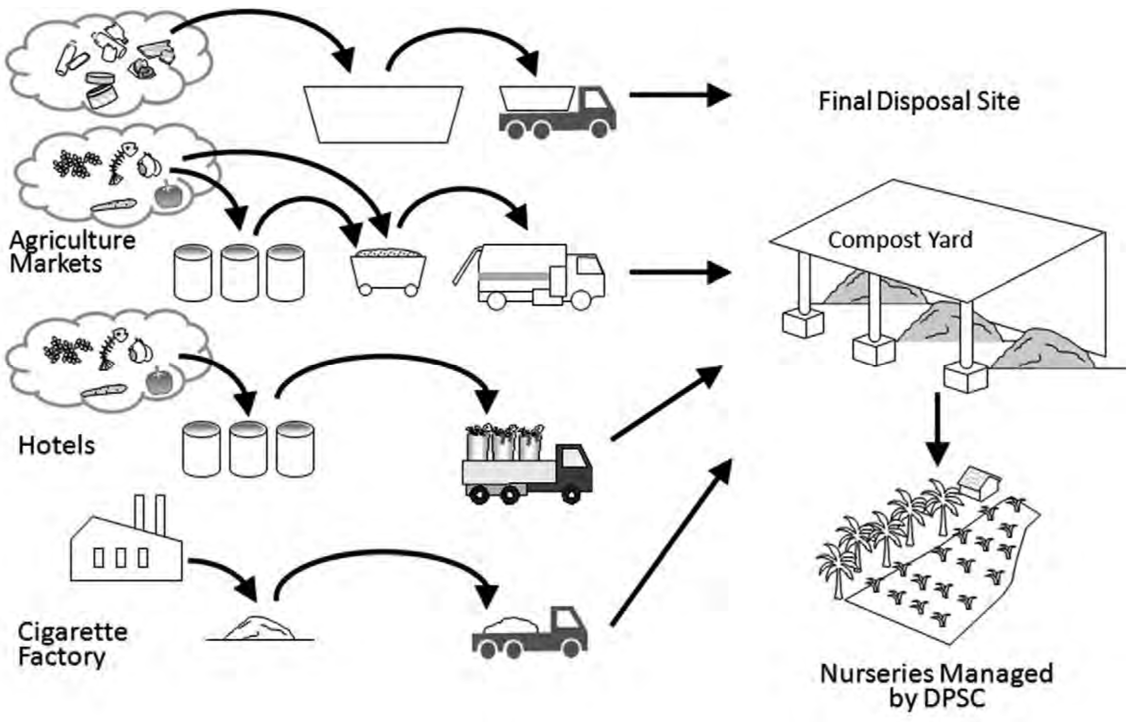


Figure 1-14: Pilot Project Operation Flow

b. Segregated Collection of Organic Waste

b.1. Cooperating Organizations

Table 1-24: Changes in Cooperating Organizations

Cooperation Period	Cooperating Organizations	Reasons for Modification
From November, 2011, to April, 2012	Agricultural Market：42y19 Hotels： Chateau Miramar Hotel Hotel Comodoro	
From May, 2012, to the present	Agricultural Markets: Milagro Plaza Cerro Tulipán Hotels： Chateau Miramar Hotel Comodoro Hotel	When waste collection had to be suspended because of the truck accident, the containers used at the 42 and 19 agricultural market got lost.

(As of May, 2012, the collection of wastes generated at the agricultural markets is carried out using a compactor truck.)

b.2. Waste Amount Collected

The amount of organic wastes collected since the beginning of the Pilot Project is shown in Figure 1-15.

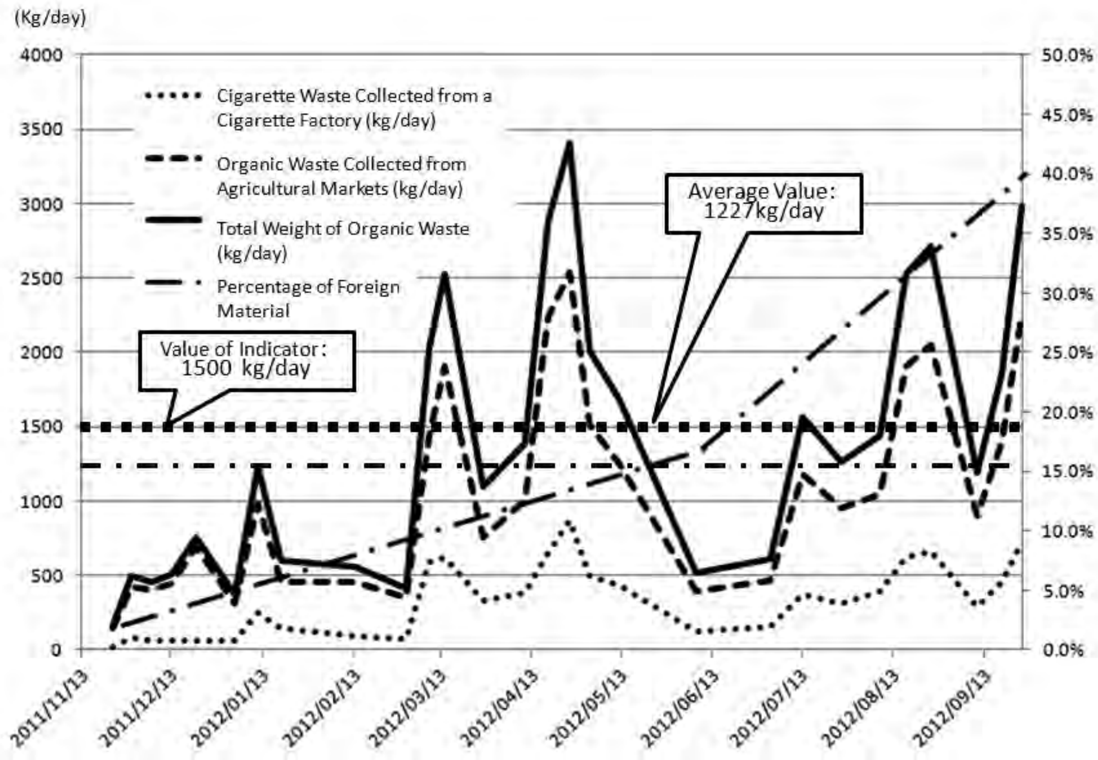


Figure 1-15: Collected Organic Waste Amount (left) and Ratio of Foreign Materials (right)

It should be noted that the daily average amount collected from November, 2011, to October, 2012 amounts to 1,227 kg/day. In addition, due to increased waste collection by using the compactor truck, the amount of foreign materials has also increased.

The reasons why the amount of collected organic waste has thus fluctuated are discussed below. Assuming that the three main reasons for waste amount fluctuations are the assignment of JICA’s expert, the amount of agricultural produce available at the markets, and the weather (rainy and dry seasons), Figure 1-16 to Figure 1-19 were prepared showing the relationship between the amount of collected wastes and the three factors mentioned above.

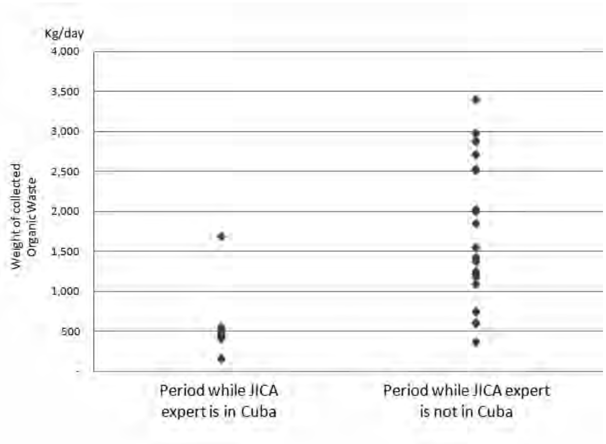


Figure 1-16: Relationship between the assignment of JICA's expert in Cuba and the amount of organic waste collected

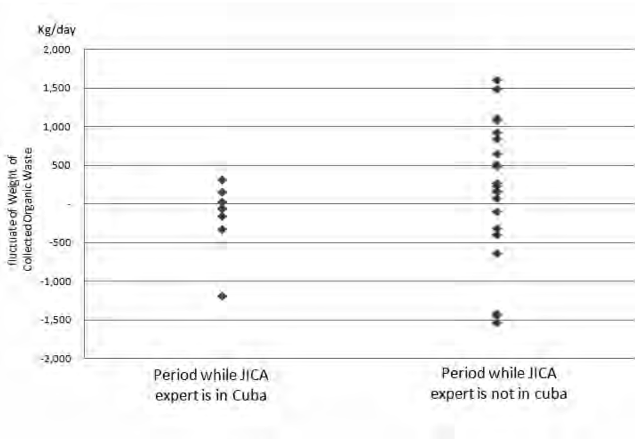


Figure 1-17: Relationship between the expert's assignment and the fluctuation in the amount of solid waste collected

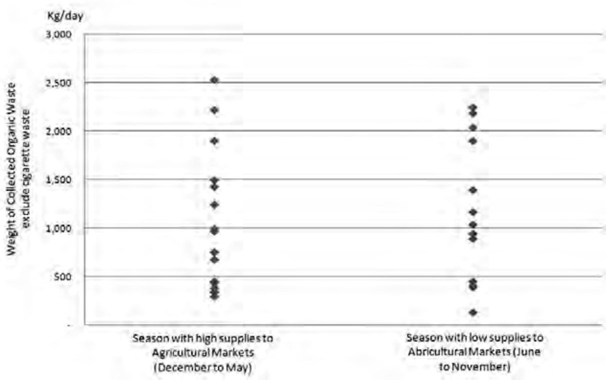


Figure 1-18: Relationship between the amount of produce handled at the agricultural markets and the amount of organic waste collected

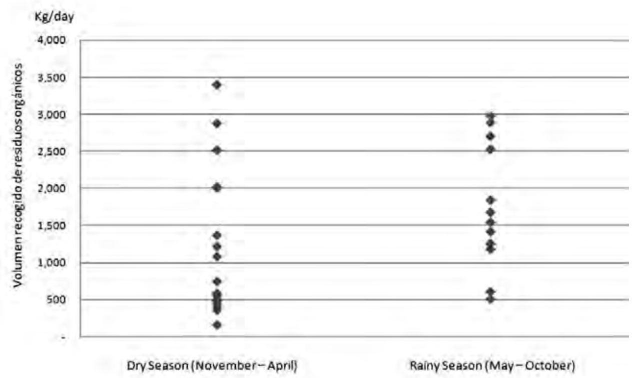


Figure 1-19: Relationship between the weather and the amount of solid waste collected

With regard to the relationship existing between the assignment of JICA's expert in Cuba and the amount of waste collected, Figure 1-16 shows that the amount collected does not necessarily increases during the expert's stay in Cuba. Moreover, Figure 1-17 shows that the amount fluctuates regardless of the expert's presence. Based on these findings, it is clear that the expert's presence does not affect either the increase or the reduction of the collected waste amount, and that the Cuban side makes constant efforts to ensure and increase the amount. Figure 1-18 and Figure 1-19 show that the amount of produce handled at the markets and the dry or rainy seasons do not affect the amount of organic waste collected.

Based on this, it has been concluded that neither the three factors assumed (the expert's presence in Cuba, the amount of agricultural produce, and the weather) as the reasons for the fluctuations in the amount of organic waste collected was right.

Another possible factor is the availability of a vehicle to collect the organic waste. After the accident involving the donated truck, only two vehicles can be used for the Pilot Project, namely, a compactor truck to collect the wastes generated at the agricultural markets and a truck used to collect the wastes at the hotels. Therefore, if either of them breaks and a replacement is not timely found the collection has to be suspended. The vehicles used often undergo breakdowns, thus making it impossible to ensure a stable waste collection. There is no doubt that the accident involving the donated collection vehicle used for the Pilot Project on April 27, 2012, provoked that the amount of organic waste collected from early May to late June plummeted. In order to solve this problem a specific agreement was reached at the Joint Coordination Committee meeting held in June, 2012.

b.3. Problems Related to Collection of Solid Waste for Composting

Waste collection at the Comodoro and Chateau Miramar hotels has been carried out irregularly due to several factors such as the reduced number of tourists and repair work at their facilitites. It has been impossible to include other hotels as in Cuba the tourist sector should hand its food wastes over to the company collecting them to feed pigs, one of the activities deemed to be prioritized according to the country's food policy. These factors were not taken into consideration for the Preparatory Study. For the formulation of the Pilot Project Program, the hotels that supposedly did not have a conflict of interests with the pig company were selected.

Consequently, the Pilot Project group decided to increase the number of activities focusing on agricultural markets in order to ensure the amount of organic waste required for composting, thus achieving the primary goal of "reducing the amount of waste being disposed of and increasing the service life of the landfill site".

The following measures have been identified, of which some have already been implemented:

- Agree to collect the organic wastes generated at 3 agricultural markets (Tulipán y Boyeros, Plaza del Cerro, and Milagros). These 3 markets have been chosen out of over 25 existing markets in Havana based on the proximity from one another, the distance to the landfill site, and the amount of organic wastes contributed by them.
- A seminar was held attended by the staff from the agricultural markets at the compost plant facilities on May 31, 2012 (Photo 1-18 and Photo 1-19). Training focused on the importance of composting, waste selection, segregation of inert materials, and the need for the content of organic waste to exceed 70%. In addition, a training course was taught for stand managers at Tulipán market on November 7 about the specific method to

- Fifteen new medium-sized containers and 3 large metal containers were deployed at these markets to improve waste segregation.
- JICA’s expert and the compost plant staff pay frequent visits to the markets.
- A compactor truck was selected to be used to collect the organic waste generated at the markets. Another compactor truck is used to collect the wastes generated at the hotels.
- The Tulipán market was chosen to deploy 48 containers holding 50 liters to begin appropriate organic waste segregation for composting at the stands.

Photo 1-18: Market staff at the seminar.

Photo 1-19: C/P staff training market personnel.

Photo 1-20: C/P staff training stand managers at the Tulipán market.

Photo 1-21: Containers placed inside the stand to be used for waste segregation.

All these activities have helped to improve organic waste collection and compost production. The compost made is being used at the nurseries run by the Division of Green Areas under DPSC.

c. Compost Production

c.1. Produced Compost Amount

The produced compost amount is shown in the table below.

Table 1-25: Produced Compost Amount

	Produced Amount (m^3)	Produced Weight (kg)	Remarks
April 10, 2012	80		
April 12, 2012	30		
September26, 2012	110		
Total	220	82,500	Specific Weight：0.75
Operation Days		323 días	
Average		510kg/día	

At present, all the compost produced is delivered to the nurseries run by DPSC. It should be noted that by November, 2012, DPSC is not authorized to sell compost to third parties.

c.2. Produced Compost Quality

The quality of the produced compost has not been verified as the Laboratory for Waste Tests (LARE) was shut down and the equipment at the Ministry of Agriculture's Soil Research Institute is out of order. Germination tests are currently being run at the compost plant facilities (see Photo 1-22 and Photo 1-23) using rape seeds pertaining to the broccoli and chard family. The results of the germination tests are shown in the table below.

Table 1-26: Germination Tests Using Produced Compost

Period of Time	Percentage of seeds germinated in the bed made only of compost	Percentage of seeds germinated in the bed made of compost and soil:50%/50%	Remarks
One week as from February 9	78%		
One week as from 22nd November		under testing	We were informed by the nursery staff that the bed made only of compost does not yield good results in terms of seed germination. A mix of compost and soil is being tried.

Remarks: Percentage of germination: percentage of germination using compost (mix of compost and soil)/ percentage of germination using only soil

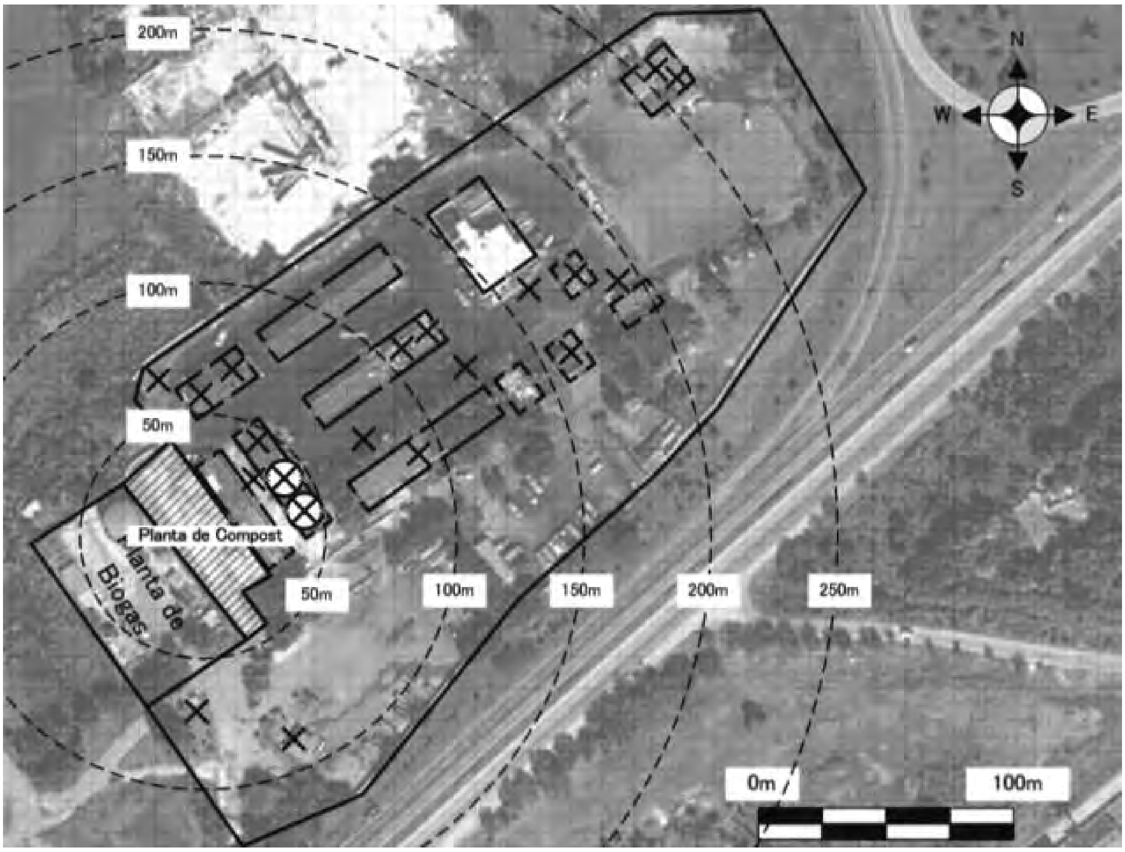
The nurseries receiving the compost produced have reported no problems regarding plant growth.

Photo 1-22: C/P members preparing the germination test

Photo 1-23: Germinated seeds

c.3. Impacts of the Compost Plant on the Vicinity

In May, 2012, people were asked about the generation of foul odors and the breeding of harmful insects in the vicinity of the compost plant. During the interviews, only two people who work inside the Central Workshop warehouse adjoining the compost plant (within a 50 meter radius) said they had noticed the foul odor. However, other warehouse employees working outside it (within the same radius) did not perceive any unpleasant smell. Therefore, it is concluded that there is no such thing as a foul odor generated by the compost plant spreading to the adjoining Central Workshop, despite a different perception in a closed space next to the plant.



(X : Place where the workers who said they did not perceive any foul odor stood. ⓧ : Place where the workers who said they did perceive some foul odor stood.)

Figure 1-20: Results of the Interviews about Foul Odor Generation and Harmful Insect Breeding

On the other hand, some complaints were made regarding the flow of leachate from the compost and the cigarette waste into the premises of the Central Workshop. Therefore, the sand in the gravel drain (see Photo 1-24) was removed to facilitate drainage (Photo 1-25).

Photo 1-24: Drainage using gravel

Photo 1-25: Modified drainage

1.5.6 Activities from Oct. 2012 to Mar. 2013

a. Collection of Organic Waste

On average, 962 kg /day of organic waste has been collected since the pilot project started in November 2011. The amount of tobacco waste gathered from a tobacco factory has been stable but the total organic waste amount from hotels and agricultural markets has varied largely Especially the amount significantly dropped in October in 2012 and stagnated for a couple of months. It is mainly because the decision to take corrective actions for the breakage of the collection vehicle was late.

The amount is recovering from January in 2013 after a meeting with the new UPPH director was held for taking countermeasures.

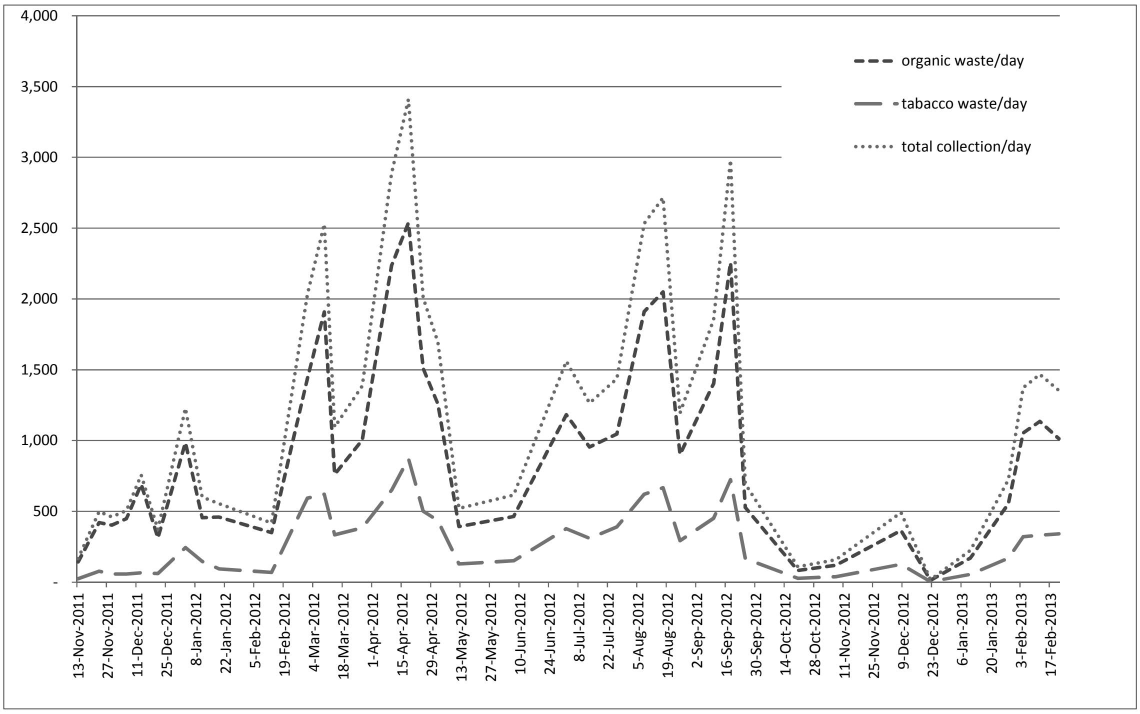


Figure 1-21: Amount of Organic waste collected (after segregation)

b. Segregation of Organic Waste

Organic waste collection is classified into three types: hotels by using small containers, a tobacco factory, and agricultural markets by a compactor truck. The figure above shows variation in amount of foreign materials included in organic waste. The amount of foreign materials in organic waste collected from hotels and a tobacco factory is steadily low from the beginning of the project, presenting good segregation, while the percentage of foreign material in organic waste from agricultural markets was about 30% at the beginning of the assignment of a compactor track and later jumped up to 50%, which shows an unstable condition.

However, since small containers for organic waste and large containers for non-organic waste were installed at kiosks in agricultural markets for waste segregation as the countermeasure to reduce foreign material inclusion, as informed in the Progress Report No.6, the percentage of foreign materials has decreased.

This result clarifies that installation of small and large containers respectively for organic and non organic waste together is effective for waste segregation in agricultural markets.

In addition, we developed a manual for measurement of foreign materials amount at the compost yard.

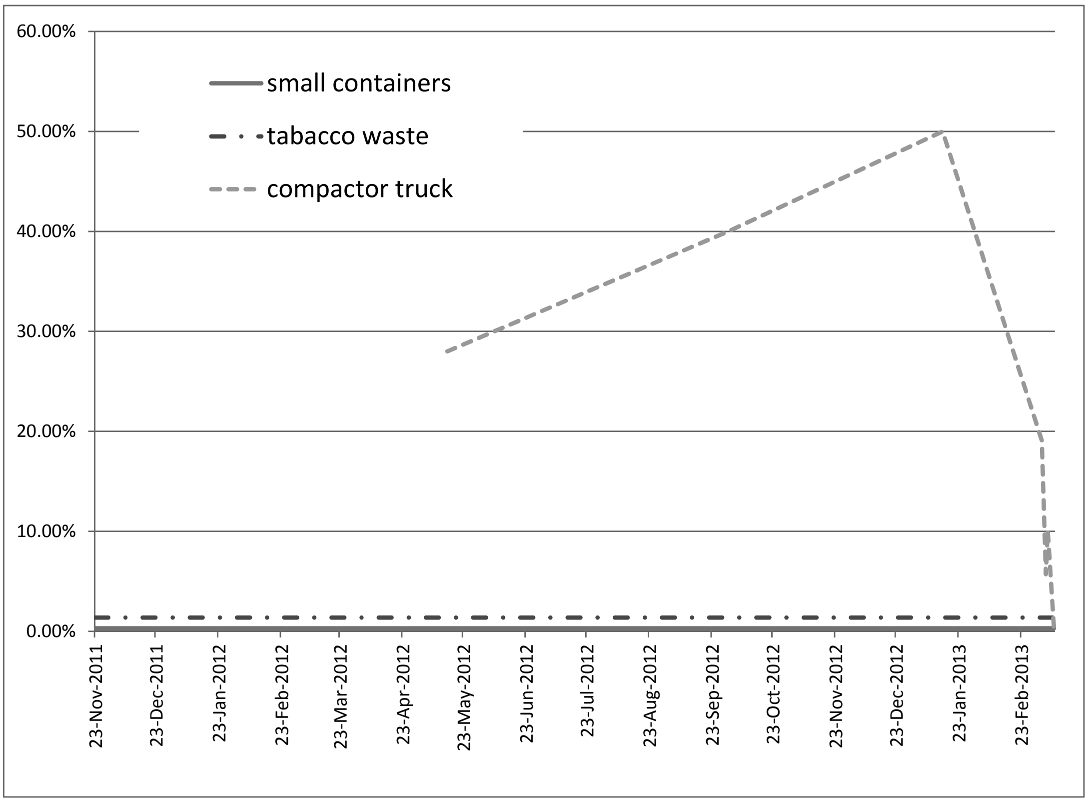


Figure 1-22: Variation in amount of foreign materials in organic waste collection

Photo 1-26:
Foreign materials count for 40% of waste collected by compacter truck

Photo 1-27:
Foreign materials count for 10% of waste collected by compacter truck

Photo 1-28:
Little amount of foreign materials in waste collected by compactor truck

c. Production of Compost

Essentially the quality of compost product should be verified by analyzing basic constituents of compost, including C/N ratio, amount of nitrogen, phosphoric acid (P_2O_5) and potash (K_2O), as well as heavy metals such as mercury, cadmium and arsenic. However, the analysis of compost product cannot be performed because the laboratory of DPSC having analysis instruments was closed and the laboratory in the soil research institute cannot serve due to shortage of reagent and breakdown of equipment. Therefore, as a minimum measure to verify the quality of compost, we implemented germination tests to observer whether the compost product causes problems in growth of plants by using seeds of cruciferous vegetables such as broccoli, Chinese cabbage, and cauliflower (refer to the manual for test procedure). The test result shows that the germination ratio was 100% when the ratio of compost in the soil was 1/3 (Photo 1-29). It should be noted that the result suggests only that the produced compost does not cause any problem in growth of plants but no safety is guaranteed in using this compost product in agricultural production, and the counterpart recognizes this issue.

Tap water is supplied according to necessity when compost is too dry in order to control the moisture in compost, but frequent stops of water supply make it difficult to control the moisture. On the other hand, the operation of the biogas plant, located next to the compost yard, started in November 2012 and surplus fermentation liquid is being produced from an anaerobic fermentation tank. The C/Ps started using this liquid for controlling the moisture of the compost from December 2012 (Photo 1-30). The quality of the compost moisturized by the liquid must be examined by germination tests.

Some private waste collectors collect organic waste from agricultural markets and hotels that generate a large amount of organic waste. The waste collected by such private collectors is sold to pig farmers or used directly for pig farming in houses. If the organic waste is segregated in a more appropriate manner, the value and demand of organic waste using for pig farming will increase, and this can contribute to a reduction of final disposal amounts. Meanwhile, other organic waste such as green waste which cannot be used for pig farming is dumped in final disposal sites. In order to find a way to use the waste, we started a trial production of composts with the green waste and tobacco waste which neither can be used for feeding animals (Photo 1-31).


Photo 1-29:
Result of germination test
(Left: soil only Right: soil with compost mixed)


Photo 1-30:
The wheel loader receiving fermentation liquid from the anaerobic fermentation tank


Photo 1-31:
Composting with green waste and tobacco waste

It should be mentioned here that the compost which we have produced should be limited to apply for the zoo and green nurseries managed by DPSC to be used for plants. If selling the compost, the compost should be sieved so as to remove small foreign materials and unfermented matters from it.

d. Summary of Problems and Solutions

The table below shows a summary of problems and measures taken since October 2012;

Table 1-27: Problems and measures of the pilot project

Problems	Measures
Decision to take actions for the broken vehicle was delayed (January 2013)	● C/Ps, Mr. Yamamoto and Mr. Cuellar had a meeting with the new director and explained the details of the project and the new director agreed to keep cooperating in the pilot project. Later Mr. Ogawa also met him and confirmed that the director will provide solutions when the pilot project has problems,
Waste segregation at agricultural markets is not appropriate.	● Workshops for staffs of agricultural markets were held and small and large containers respectively for organic and non-organic waste were installed at kiosks (as reported in Progress Report 6)
Although organic waste was collected from agricultural markets by a compactor truck, the waste was sometimes not carried to the compost yard. When the C/Ps asked the driver to explain the situation, the driver raged with a hatchet (January 2013).	● The driver was changed. ● Staff of the compost yard get on the collection vehicle. ● Find out how to use other organic waste incompatible with organic waste for feeding pigs. For example, produce compost with green waste and tobacco waste.

1.5.7 Activities from April 2013 to February 2014

Showings below are activities during this period.

- Pilot project implementation
- Analysis of material balance
- Evaluation of the pilot project (described in 1.6)

a. Material Balance

While more than 1 year has passed since the pilot project started, the waste collection system has changed. At the beginning of the project, organic waste was collected from two hotels, a tobacco factory and an agricultural market by using small containers. In February 2012, one of the staff of the agricultural market complained about troublesome waste segregation and the cooperation with them ended, resulting in termination of waste collection from the market. The C/P assigned a compactor truck to collect organic waste from other agricultural markets. At the end of April 2012, the vehicle collecting small containers for organic waste had an accident and collection of organic waste segregated in small containers was stopped. After one month from the accident, an alternative vehicle was introduced to restart organic waste collection by using small containers. As the C/Ps achieved a cooperation agreement with other agricultural markets generating large amount of waste, organic waste is now collected from them by a compactor truck.

The following sections explain material balance. The material balance is classified into three stages, according to the abovementioned collection system changes, which are; "1st stage: Collection by using small containers mainly", "2nd stage: Collection by using small containers and by a compactor truck" and "3rd stage: Collection by a compactor truck mainly.

b. Material Balance (1st stage: Collection by using mainly small containers)

The figure below shows the material balance in weight per day at the first stage from November 2011 to February 2012. The percentages of foreign materials in organic waste collected by using containers, by a compactor truck and from the tobacco factory are estimated to be 0.31%, 27.5 % and 1.37%, respectively.

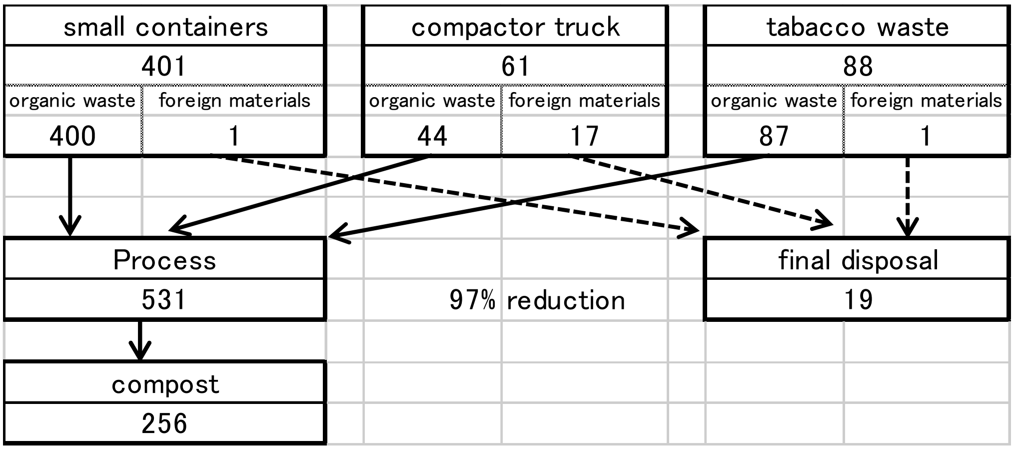


Figure 1-23: Material Balance at the 1st stage (kg/day)

c. Material Balance (2nd stage: Collection using small containers and by a compactor truck)

The figure below shows the material balance in weight per day at the second stage from March 2012 to April 2012. The percentages of foreign materials in organic waste collected by using containers, by a compactor truck and from the tobacco factory are estimated to be 0.31%, 27.5 % and 1.37%, respectively.

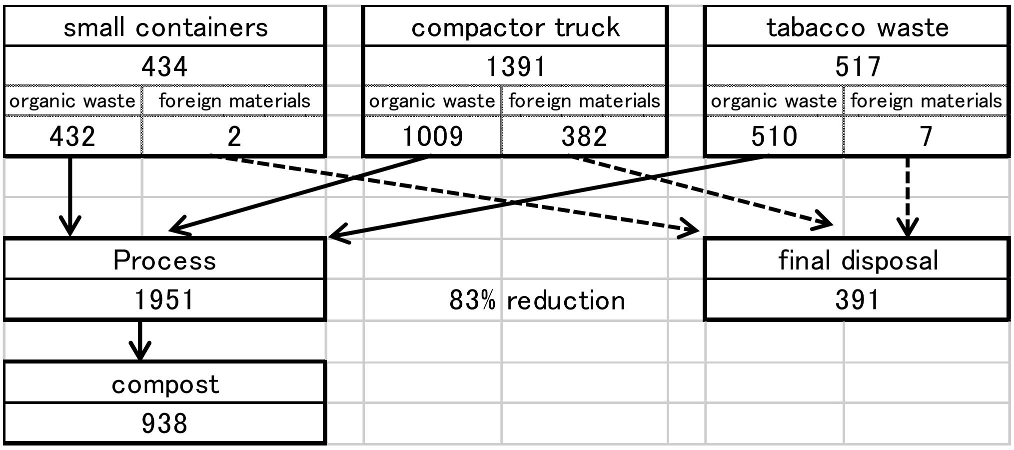


Figure 1-24: Material Balance at the 2nd stage (kg/day)

d. Material Balance (3rd stage: Collection by a compactor truck mainly)

The figure below shows the material balance in weight per day at the third stage from May 2012 to September 2012. The percentages of foreign materials in organic waste collected by using containers, by a compactor truck and from the tobacco factory are estimated to be 0.31%, 40.0 % and 1.37% , respectively.

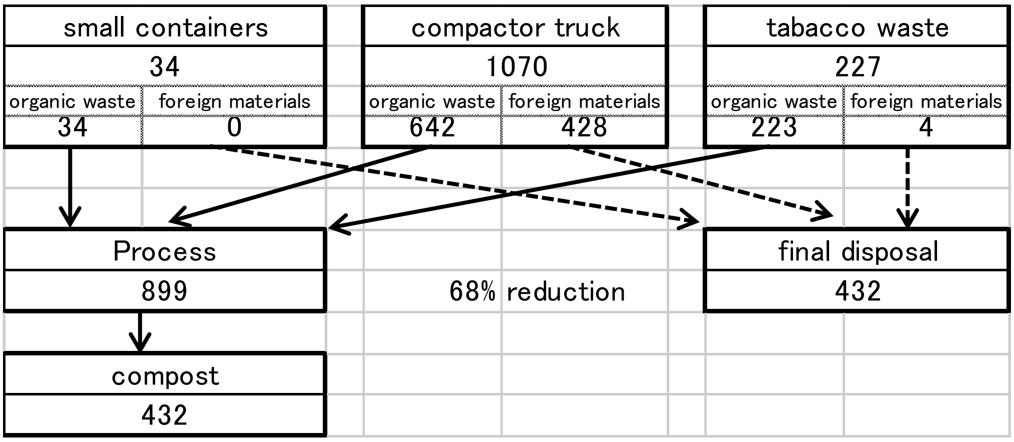


Figure 1-25: Material Balance at the 3rd stage (kg/day)

e. Comparison among 3 stages

Table 1-28 shows comparison among 3 stages.

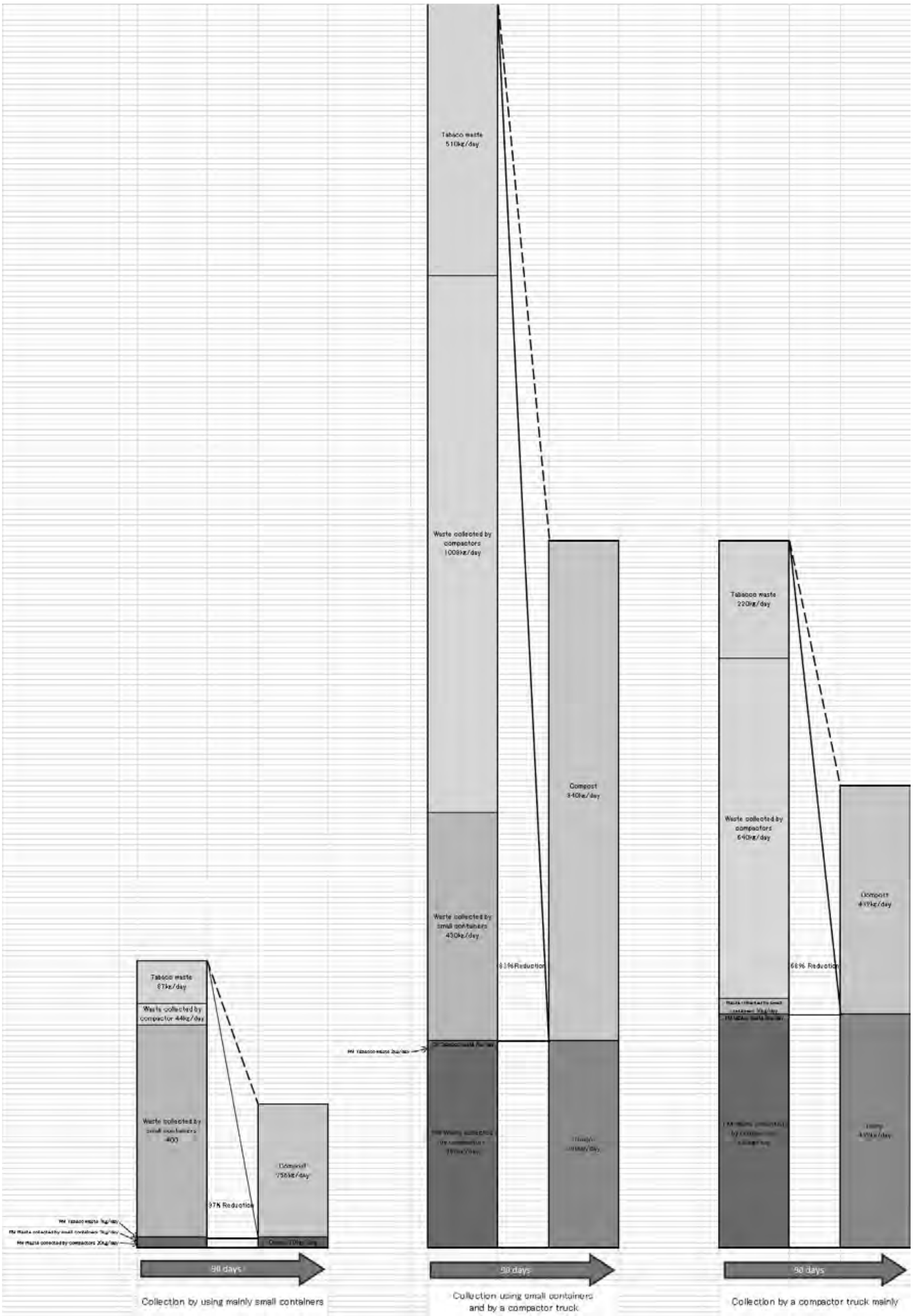


Figure 1-26 Material Balance of 3 stages

Table 1-28: Comparison among 3 stages

	Collection by using mainly small containers	Collection by using small containers and a compactor truck	Collection by a compactor truck mainly
Amount of Organic Waste Collected	Little	Much	Much
Waste segregation	Good	Medium	Bad
Waste reduction rate	High	Medium	Low
Amount of waste reduction	Little	Much	Much
Main cooperation Institutions	Hotels, agricultural markets tobacco factory	Hotels, agricultural markets, and tobacco factory	Agricultural Markets, tobacco factory
Burden of cooperative institutions	Heavy, (transportation of heavy containers, necessary of storage space for containers)	Heavy in collection by using containers, but little in collection by a compactor truck.	Light, but a space large enough to install large containers for non-organic waste is required
Sections that collection vehicles belong to	Compost Yard	Truck: Compost yard Compactor Truck:: Waste Collection Section	Waste Collection Section
Problems	Burden of Cooperative institutions is heavy and amount of organic waste collected is small.	Burden of Cooperative institutions is heavy.	The percentage of foreign materials is high and regular operation of vehicle is difficult.
Measures and future developments	DPSCs' strong commitment is required to strengthen cooperation system with institutions concerned, but DPSCs' personal is not enough. Burden of cooperative institutions is heavy, thus this system confronts difficulties in continuous operation.	Compactor truck operating ratio should be improved in order to increase the amount of waste collected.	As Agricultural Markets are public organizations, it is easy for DPCS to establish a cooperation system with them. For regular and smooth operation of a compactor truck, the compost yard section should have its own compactor truck.

The effect of waste reduction is low in waste collection by using a compactor truck because the percentage of foreign matters in the waste collected is high, as shown in Table 1-28, but it shows that the percentage of foreign matters is recently decreasing. Therefore we consider there is plenty of room for improvement. It is expected that it can be reduced burden on landfills if we can manage to operate a compactor truck smoothly to collect well-segregated waste from agricultural market, under condition that large containers for inorganic waste are installed in these markets having space for them for better segregation. So far the compactor truck we use does not belong to the compost yard and it takes time to ask for repair and repair it when the vehicle is broken due to troublesome transaction. In order to solve this problem, the compost yard should have their own compactor truck having a function for lifting containers.

The pilot project implements continuously and we start analyzing effectiveness and economical impacts of the pilot project such as comparison of different collection methods etc. Details are described in following sections.

1.6 Evaluation of the Pilot project

1.6.1 Definition of the pilot project

Before evaluating the pilot project, we confirm its definition. This pilot project includes following all activities.

- Waste segregation by waste generators
- Collection of segregated waste only.
- Composting at the compost yard
- Utilization of produced waste

1.6.2 Improvements by the pilot project

a. Waste Generation

Pictures from Photo 1-32 to Photo 1-34 show improvements at waste generations.

Before Project Implemetation During Project Implementation

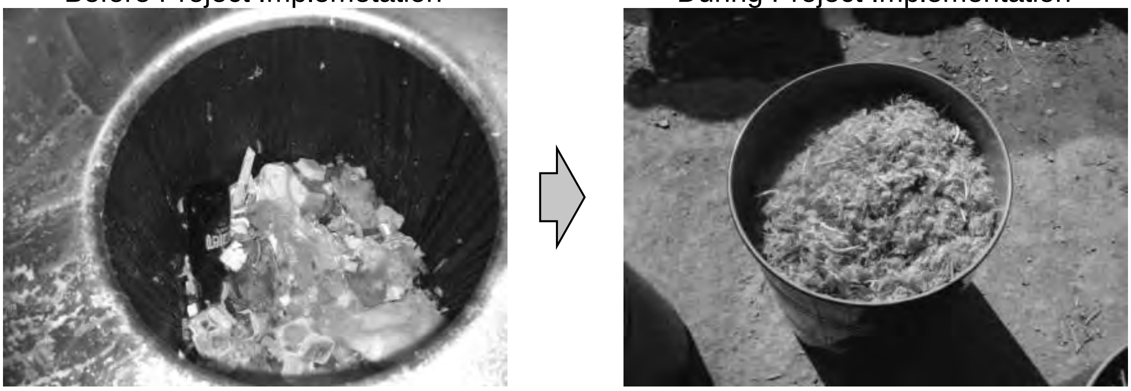


Photo 1-32: A waste bin at a kitchen in a hotel (1)

Photo 1-33: A waste bin at a kitchen at a hotel (2)

Photo 1-34: Waste storage at a market

b. Waste collection and transportation

Pictures from Photo 1-35 to Photo 1-36 show improvements of waste collection and transportation.

Before Project Implemetaion

After Project Implementation

Photo 1-35: Waste collection method (combined waste collection and waste collection only for organic waste)

Photo 1-36: Trasnfered waste for composting at a compost yard

c. Compost yard

Pictures from Photo 1-37 to Photo 1-42 show improvements at the compost yard

Before Project Implemetation

During Project Implementation

Photo 1-37: The compost yard

Photo 1-38: Organic waste for composting

Photo 1-39: Composting process

Photo 1-40: Method of mixing compost

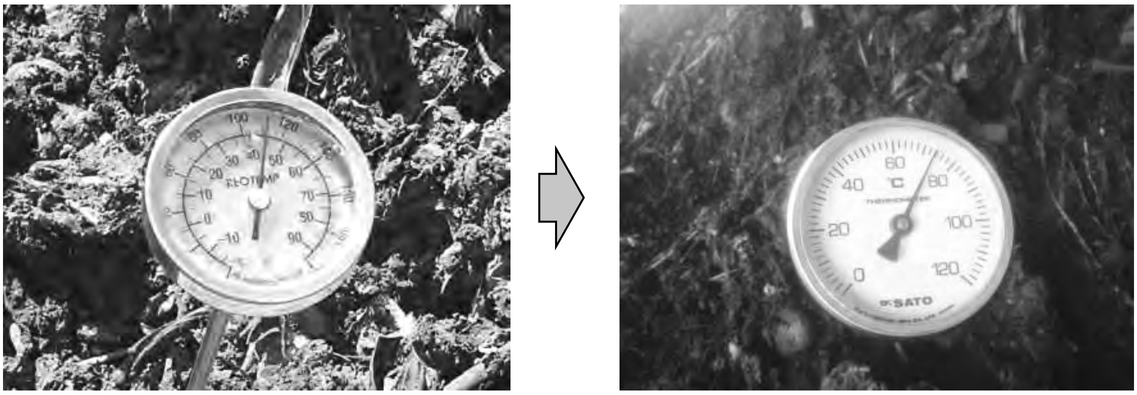


Photo 1-41: Fermentation temperature

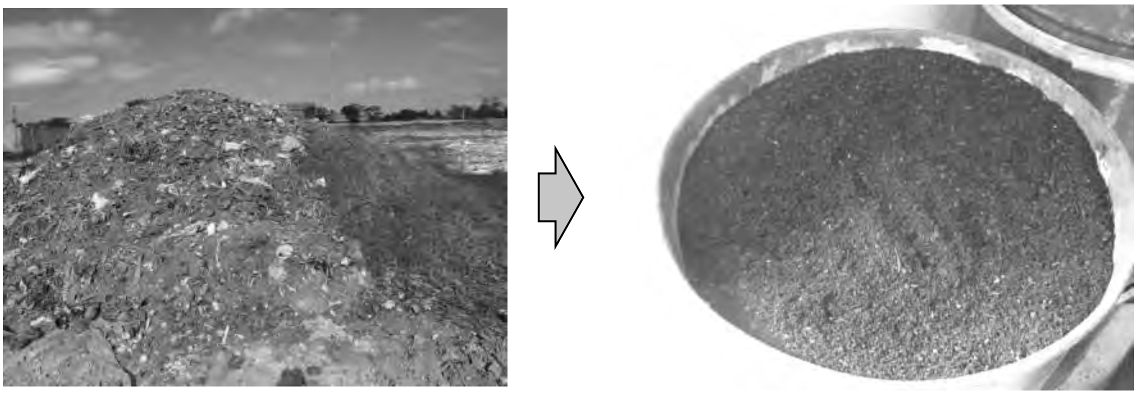


Photo 1-42: Produced compost

1.6.3 Quantitative Analysis

a. Segregated waste collection amount

a.1. Variation in amount of segregated organic waste collection amount

Figure 1-27 shows variation in amount of organic waste collected during the pilot project implementation. Its objectively verifiable indicator is 1500kg/day. On average, 1141 kg /day of organic waste was collected since the pilot started. As shown in the figure, the trend has fluctuation. This issue is discussed at 1.6.4.

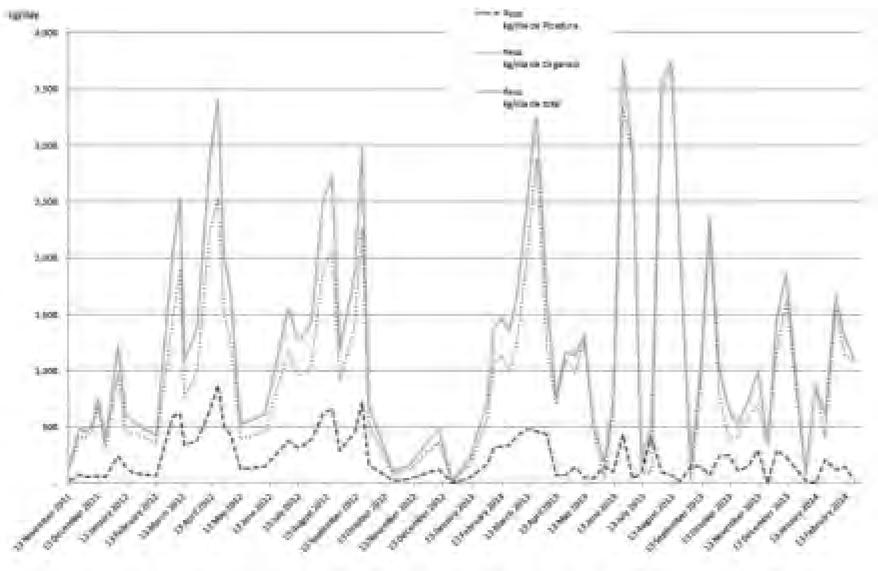


Figure 1-27: Variation in amount of organic waste collected (after segregation)

Due to the accident of the donated truck in April 2012, we changed the method for collecting and transporting organic waste. At this moment, organic waste collection is classified into four types: a tobacco factory by using a normal truck without containers, agricultural markets by using a compactor truck and medium sized containers or an arm roll typed truck and a large sized container and hotels by using a normal truck and small containers.

a.2. Issues of data collection

Weights of small sized containers having organic wastes can be measured by a weighing machine, but a weighbridge is required for measuring weights of waste collected by compactor trucks and arm roll typed trucks. The weighbridge is located at the entrance of the landfill, but it is often broken during the pilot project implementation. The weight of collected waste is calculated from the volume measured by eye estimation when it is broken. Therefore it can be said that the some data might not be correct.

b. Compost Production

b.1. Production amount

Table 1-29 shows production amount of compost.

Table 1-29: Amount of compost produced from segregated organic waste

Date of Delivery	Amount (Volume: ㎥)	Amount (Weight: ㎏)	Delivered Place
2012/4/10	80	40,000	Zoo
2012/4/12	80	40,000	Zoo
2012/9/26	110	55,000	Nursery / DPSC
2012/5/10	100	50,000	Recycle Plant
2013/7/25	126	63,000	Nursery / DPSC
2013/10/21	100	50,000	Recycle Plant
2013/10/23	60	30,000	Nursery / DPSC
2013/11/23	60	30,000	Calle 100 Landfill
2013/11/25	60	30,000	Calle 100 landfill
2013/11/26	6	3,000	Tarara Landfill
2013/11/27	6	3,000	Tarara Landfill
2013/11/28	6	3,000	Tarara Landfill
2013/12/31	100	50,000	Recycle Plant
2014/2/3	50	25,000	Nursery / DPSC
2014/2/3	50	25,000	Nursery / DPSC
2014/2/3	50	25,000	Nursery / DPSC
2014/2/27	280	140,000	Nursery / DPSC
Total	1,324	662,000	
Average	1.58m^3/day	789kg/day	

Table 1-30 shows relationship between amount of waste collection and produced compost.

Table 1-30: Relationship between amount of waste collection and produced compost

	Collected Amount (After segregation)	Produced Amount	Ratio of reduction (Collected amount / Produced amount)
Average of 839 days	957,373kg	662,000kg	0.69
Average / day	1,141kg	789kg	0.69

b.2. Issue of data collection

The weighbridge is often broken. The weight of produced compost is calculated from volume measured by eye estimation. Therefore it can be said that the some data might not be correct.

b.3. Quality of compost

Size of grain of produced compost is acceptable as shown in Photo 1-42. The safety is tested by germination tests (Photo 1-43 and Photo 1-44). Germination tests are implemented almost every half year. A planter having only soils and one mixed 1/3 of produced compost and 2/3 of soil are used for comparison. The period of this test is about 10days. Germination ratio (number of germinated seeds at a planter having only soil / number of germinated seed at a planter with compost) are about 90%. The result explains that the compost is ensured for germination of plants. In order to ensure the compost, the amount of carbon and nitrogen contest, heavy metals should be measured, but Cuba does not have facilities to measure these.

In addition, tobacco waste may be contaminated by mosaic virus, thus compost must not be used to the plants of Solanaceae which can be infested.

Photo 1-43: Germination Test

Photo 1-44: Germinated seed

b.4. Difficulties for selling compost by UPPH / DPSC

As of 31st of August 2013, UPPH cannot sell produced compost. UPPH and DPSC applied to an administration in order to get permission to sell it in May 2012, but they have not been permitted. It takes long time to change institutional system in Cuba.

Therefore, they give produced compost to the section of nursery in DPSC and a zoo in Habana. The compost is not sieved because it is not necessary for them to improve quality to production level for selling at this moment.

c. Ratio of Foreign materials

c.1. Variation in ratio of foreign materials

Figure 1-28 shows verification in ratio of foreign materials at the compost yard. It explains that types of collection influence the ratio. Table 1-31 shows average foreign material ratios by each waste collection types.

Table 1-31: Type of collection and ratio of foreign materials (average figure until end of Sep. 2013)

Type of collection	Compactor and middle sized containers	Arm roll typed truck and large sized containers	Small sized contrarians and normal trucks
Ratio of foreign materials	29.88%	22.30%	2.65%

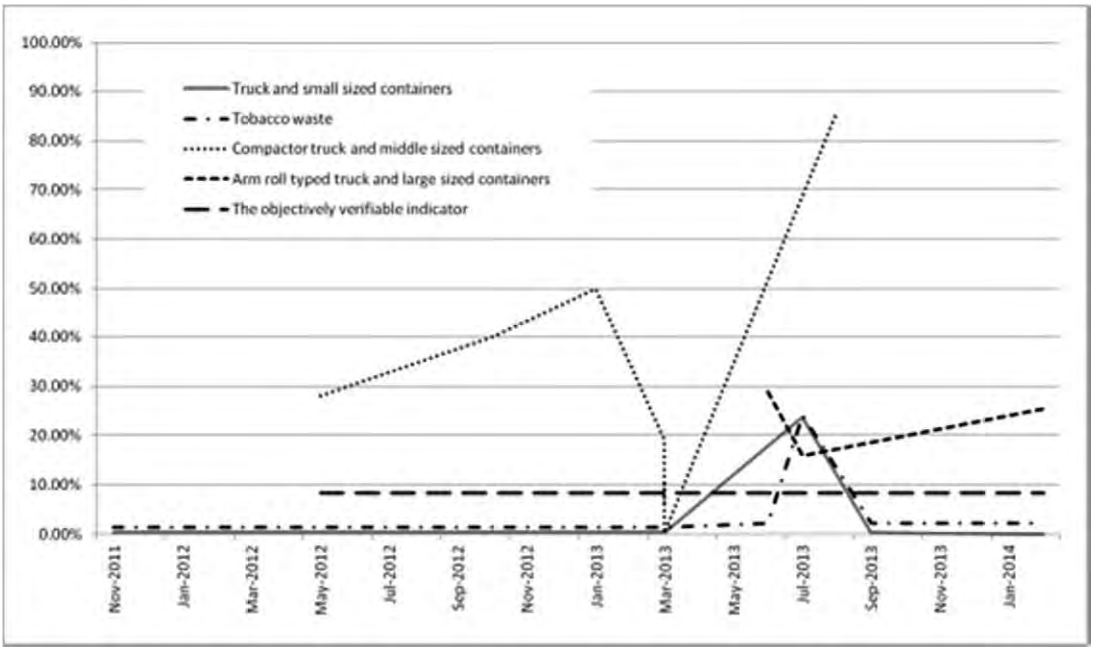


Figure 1-28: Variation in ratio of foreign materials

The ratio of foreign material was increased after June 2013 because waste collection became unstable, inorganic waste dumped into containers for organic wastes and these containers were carried into the compost yard.

c.2. Comparison by collection types

As described, types of collection influence the ratio of foreign materials. In this section, it is calculated numbers of required containers and analyzed characteristics of operation for 3 types of collection respectively in order to collect 1500kg/day of organic waste as objectively verifiable indicator.

c.2.1 Collection by a compactor truck and middle sized containers

Photo 1-45: Compactor truck and middle sized containers

Table 1-32: Calculation result for collecting by a compactor truck and middle sized containers

Weight of Organic wastes to be collected	Ratio of foreign materials	Weight of waste to be collected	Volume of waste to be collected (specific gravity: 0.41)	Required number of containers	Capacity Load / Vehicle	Waste volume to be collected /capacity load of a vehicle
1,500 kg	29.9%	2,139 kg	5.22m^3	11	18.00m^3	29%

- Ratio of Capacity Load (Waste volume to be collected / Capacity Load of a vehicle) is low.
  - The compactor truck may collect other containers having unsegregated waste in order to increase waste collection amount because collection amount reflects their salary.
  - The efficiency of collection may be improved if number of cooperators is increased.

c.2.2 Collection by a arm roll typed truck and large containers


Photo 1-46: Arm roll typed truck and large sized containers (20m^3)

Table 1-33: Calculation result for collecting by a arm roll typed truck and large sized containers

Weight of Organic wastes to be collected	Ratio of foreign materials	Weight of waste to be collected	Volume of waste to be collected (specific gravity: 0.41)	Required number of containers	Capacity Load / Vehicle	Waste volume to be collected /capacity load of a vehicle
1,500 kg	22.3%	1,931 kg	4.71m^3	2	20m^3	24%

- Ratio of Capacity Load (Waste volume to be collected / Capacity Load of a vehicle) is low.
  - The containers may not be collected until it became full capacity.
  - It is appropriate for organizations generating much waste.
- Two containers are required for one place because it is replaced at a site.

c.2.3 Collection by a truck and small sized containers


Photo 1-47: A truck and small sized containers (50L)

Table 1-34: Calculation result for collecting by a truck and small sized containers

Weight of Organic wastes to be collected	Ratio of foreign materials	Weight of waste to be collected	Volume of waste to be collected (specific gravity: 0.41)	Required number of containers	Capacity Load / vehicle	Waste volume to be collected /capacity load of a vehicle
1,500	2.7%	1,541	3.76	152	1.26	298%

- Number of trips for waste collection is increased.
- It can be collected from generators producing small amount of organic waste.
- Containers are replaced at the sites, then numbers of containers is increased (e.g., if 4 containers are introduced at a site, other 4 containers are required for replacement.)
- Workload for labors is increased because containers are carried and loaded manually to the truck.
- Special equipment for trucks are not necessary, then any kinds of trucks can be used for waste collection.

d. Number of Cooperators

Table 1-35 shows Cooperating organizations as of September 2013.

Table 1-35: Cooperating organizations of the pilot project

Category	Name
Agriculture Markets	Tulipán Agriculture Market
	Ciudad Deportiva Cerro Agriculture Market
Hotels	Hotel Comodoro
	Hotel Chateau Miramar
Factories	Empresa de Cigarro Factory

Figure 1-29 shows variations in amount of cooperators. It is noted that 42 y 19 agricultural market has left from the scheme of the pilot project. The reasons are follows;

- The person in charge of waste segregation complained because of no incentives for committing the pilot project.
- Waste was not collected for about 3 weeks because of the truck accident at the end of April.

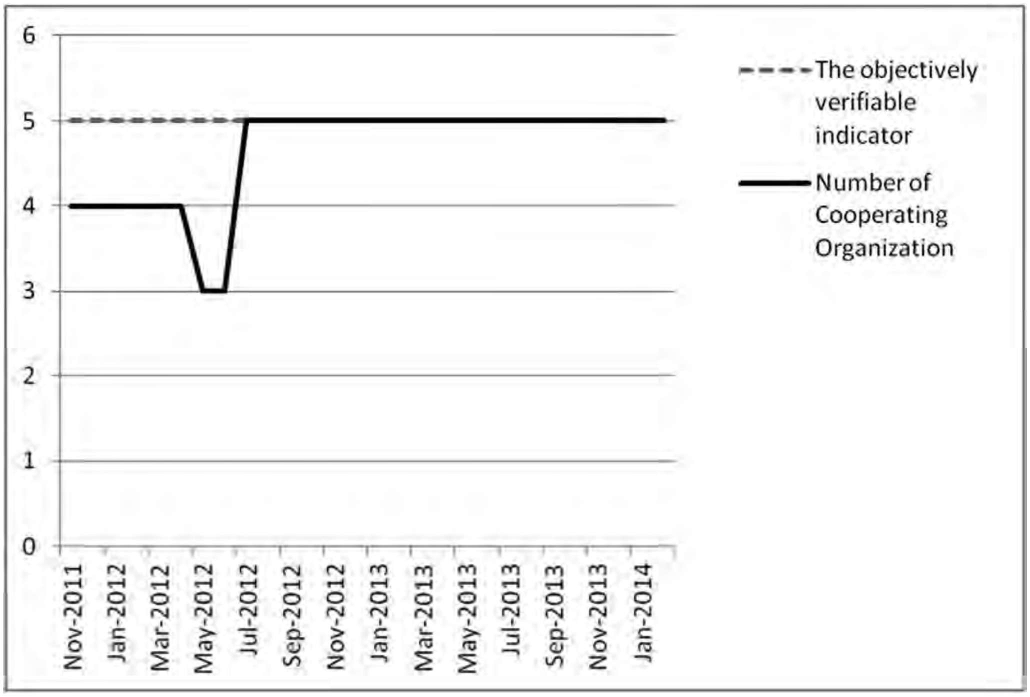


Figure 1-29: Variation in numbers of cooperators

e. Number of organizations to be trained

Figure 1-30 shows variation in numbers of organizations to be trained. According to the analysis of hearings and questioners of seminars, many participants are interested in implantation of the compost pilot project and they have willingness to commit it.

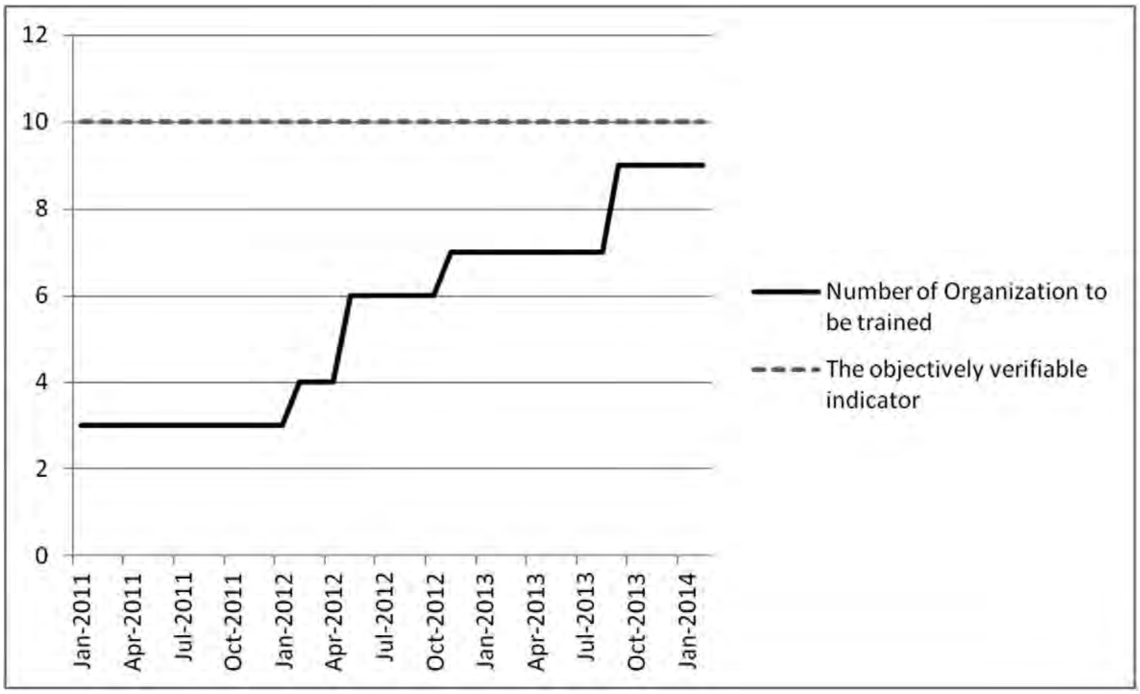


Figure 1-30: Variation in numbers of organizations to be trained

Table 1-36: List of organizations to be trained

Name of organizations	Date of training / seminar
Hotel Comodoro	22 February 2011
Hotel Chateau Miramar	22 February 2011
Agro Mercado 42 y 19	22 February 2011
Empresa de Cigarro	1 February 2012
Habana Zoo	15 November 2012
Tulipán Agro Mercado	31 May 2013
Ciudad Deportiva Cerro Agro Mercado	31 May 2013
Escuela secundaria "Manuel Bisbé"	18 September 2013
Escuela secundaria "Antón Makarenco"	18 September 2013

f. Economic analysis

f.1. Cost of Composting

The costs are estimated separately between CUC as foreign currency for imported items and CUP as local currency for local costs respectively. The costs for composting are calculated by the data of the 1st year of the pilot project because its condition is more stable comparatively than one of the 2nd year.

Table 1-37: Operation Costs for the Pilot Project

		Foreign Currency (F/C)	Local Currency (L/C)
Operation Cost	Electricity	23.0	
	Water	9.9	9.9
	Fuel for trucks	272.3	
	Fuel for loader	49.5	
Salary	Labor（10 persons）		3,250.0
	Technicians（1 person）		385.0
Total Cost / Month		354.7	3,644.9
Total Cost for 323 days		7,672.1	78,849.7

Table 1-38: Pilot Project Equipment Depreciation

Items	Quantity	Service life (year)	Operation days for Composting /Month	Price in F/C	Price in L/C	Cost in Foreign Currency /Month	Cost in Local Currency /Month
Containers (Large)	4	10	30	5,000	3,000	166.7	100.0
Containers (small)	100	1	30	50		416.7	0.0
Containers (medium)	15	5	30	185		46.3	0.0
Truck	1	15	30	28,024		155.7	0.0
Compactor Truck	1	10	30	90,770	16,050	756.4	133.8
Compost Yard	1	20	30	15,000	60,000	62.5	250.0
Loader	1	15	30	35,000		194.4	0.0

Items	Quantity	Service life (year)	Operation days for Composting /Month	Price in F/C	Price in L/C	Cost in Foreign Currency /Month	Cost in Local Currency /Month
Chopper	1	15	30	1,750		9.7	0.0
Thermometer	1	5	30	72		1.2	0.0
Rotary Sieve	1	5	30	625		10.4	0.0
Total Cost / Month						1,820.0	483.8
Total Cost for 658 days						39,371.0	10,464.9

Table 1-39: Summary of the costs for treatment

	Foreign Currency	Local Currency	Waste Amount Collected for 658 days (t)
Operation Cost	7,672.1	78,849.7	
Equipment	39,371.0	10,464.9	
Total	47,043.1	89,314.6	779.9
Cost / ton	60.3	114.5	
Cost[2] / m^3	44.0	83.6	

f.2. Comparison the cost between landfilling and composting

In this section, the costs are compared between composting and landfilling. The cost for new landfill construction and operation is not identified clearly at this moment thought the planning is in progress, thus the landfill cost is shown is reference figures from the master plan study[3].

Table 1-40: Cost of construction and operation for new landfill

<Landfill : New Site>		
Total volume of waste layer with cover soil	1,705,000 m^3	
The percentage of cover soil	20%	
Volume of waste layer	1,364,000m^3	
<Construction and operation cost>		
Currency	F/C	L/C
Construction and operation cost	12,200,000	11,000,000
Cost / m^3	8.9	8.1

Table 1-39 and Table 1-40 explain that the composting costs in F/C are about 5 times and L/C is about 10 times larger than the costs for landfilling to treat certain amount of waste and reduce waste for dumping at the landfill.

[2] The specific gravity of compost is assumed 0.73.

[3] JAPAN INTERNATIONAL COOPERATION AGENCY (JICA), NIPPON KOEI CO., LTD. and PACIFIC CONSULTANTS INTERNATIONAL, Final Report Volume II The study on Integrated Management Plan of Municipal Solid Waste in Havana City, pp 2.5-67 – p2.5-93 (2007) and pp2.5-119 – pp2.5 – pp2.5-123

1.6.4 Qualitative aspects

a. Analysis of Problem strucure

On 12th September 2013, the meeting was hold for sharing information and issues regarding implementation of the pilot project. The details are described below.

a.1. Participants

Participants of the meeting are shown in Table 1-41.

Table 1-41: Participants of the meeting

Organization	Number of participants
UPPH and DPSC	6
Tulipán Agricultural Market	1
Ciudad Deportiva Cerro Agricultural Market	1
Hotel Comodoro	2
Hotel Chateau Miramar	2
Empresa de Cigarro Cigarette factory	1
Total	13

Photo 1-48: Meeting with cooperators and UPPH/DPSC

a.2. Opinions of participants

- Tulipán Agricultural Market
  - Waste overflows from containers because these are not collected.
  - Waste was not collected because waste overflowed.
  - The administrator made a phone call to UPPH, but UPPH did not collect the waste.
  - The administrator had to pay fines twice because leachate leaks from the containers to outside of the market.
  - The provincial council asks the administrator to explain about leachate issues.
  - Clean environment is required because the market is located in the area where governmental offices locate.
  - If waste is not collected regularly by UPPH, the organic waste can be transferred by the truck carrying vegetables to the market.
  - Some vegetables in containers uncollected were stolen and these are sold.
  - Harmful insects occur from uncollected containers
  - Problems become serious in summer because of high temperature and much rain.
  - If this problem is not resolved, the market must consider other methods for waste collection.

Photo 1-49: Uncollected waste at a agricultural market

- Hotel Chateau Miramar
  - Uncollected wastes become putrid and these produce odour. These were collected with normal waste.
  - Containers were dirty and it is a problem to use these in the hotel, but these are replaced to new containers.
  - According to the regulation, the waste bins without lids cannot be used in the kitchen, but we decide to use these in the kitchen as far as these are clean.
  - We considered that we stopped cooperating with the project because the problem was not solved although we contacted UPPH.
  - Organic waste is collected more regularly in September 2013.

- Hotel Comodoro
  - We have a fridge for waste, we can keep these waste if UPPH has problems for waste collection.
  - In the kitchen we have bins with pedals for opening lids.
  - We segregate organic waste by hand.
  - Waste is collected regularly except the period when the waste collection was stopped due to the accident.

- Ciudad Deportiva Cerro Agricultural Market
  - Large sized containers are not delivered for waste segregation, then we cannot start waste segregation, although we asked UPPH to deliver it many times.
  - Unsegregated waste is collected regularly

- Empresa de Cigarro Cigarette factory
  - Waste is collected regularly.

- DPSC, UPPH
  - The former director did not understand importance of the project.
  - It will be difficult to keep employment at the compost yard if composting is stopped.

a.3. Discussions

Based on the issues described above, following topics are discussed.

Topic1: Why organic waste from markets was not collected regularly although waste from the cigarette factory is collected regularly?

- The factory is located in a short distance from the compost yard.
- Cigarette waste can be collected by any kinds of trucks
- Types of trucks are fixed for organic waste collection. For example, waste from markets must be collected by arm roll type, and one from hotels must be collected by a normal truck. Number of truck is also limited. In addition, dirty tracks cannot be driven on 5th Avenue and area where locates hotels.

Topic2: Why waste collection is stopped?

- The former director did not understand importance of the pilot project.
- Lack of equipment.

Topics3: How we can resolve the issues of waste collection?

- If there are problems, contact Ceser[4]. (his mobile number was shared among cooperators)
- Jynet[5] visits site once a week.
- New director understands importance of the pilot project.
- Number of containers is sufficient. Locations of containers are not optimized.
- 4 arm roll type trucks can be operated. Other new 4 arm roll type trucks will be procured from China.
- Large sized container will be delivered to Ciudad Deportiva Cerro Agricultural Market today.

Topic 4: Future planning

- Cuban side decides whether the compost project is implemented continuously or not at the end of the pilot project.
- We should stop implementing the compost project if we make problems by this project.
- Waste can be segregated if waste is collected regularly.
- Compost can be made at the compost yard if segregated waste is transferred into the compost yard
- Composting is about 5 times larger than the cost of landilling on foreign currency. The cost can be re reduced by selling compost.
- Is DPSC going to treat waste by composting whose cost is 5 times larger than the cost of landfilling within the limited budget?
- Social responsibility and benefit of composting is significant, thus, we should not decide its appropriateness by only the cost.

a.4. Problem Strucutre

Issues and discussion mentioned above are analyzed by making a problem tree shown in Figure 1-31.

[4] One of the C/P members.
[5] One of the C/P members

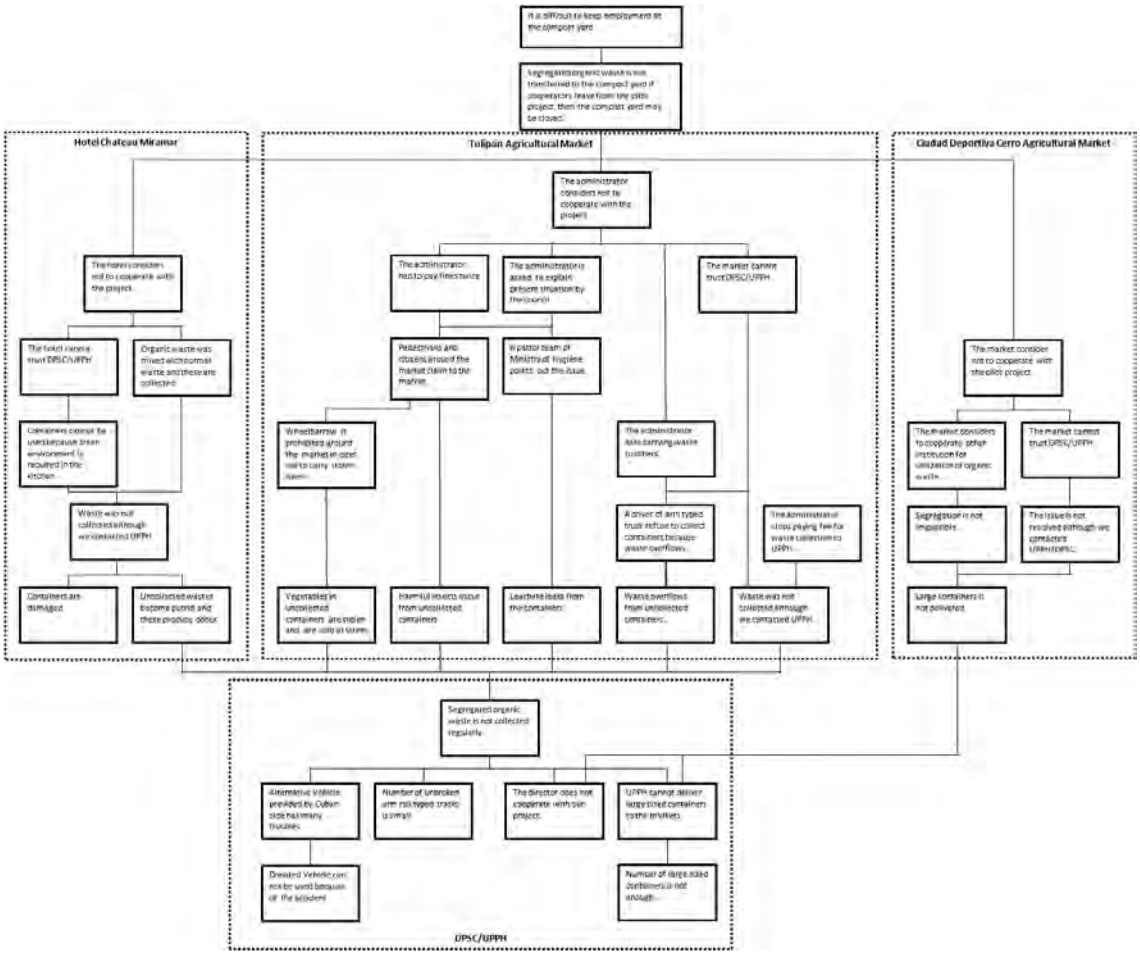


Figure 1-31: Problem Tree of the Pilot Project

This problem tree explains that issues that UPPH/DPSC cannot collect segregated organic waste regularly make other issues at cooperators.

b. Frequent personnel replacement

Cuban economic situation changes rapidly. This influences personnel of C/Ps. Many C/Ps in Group2 are replaced or quitted frequently. This situation disturbs projects' continuousness.

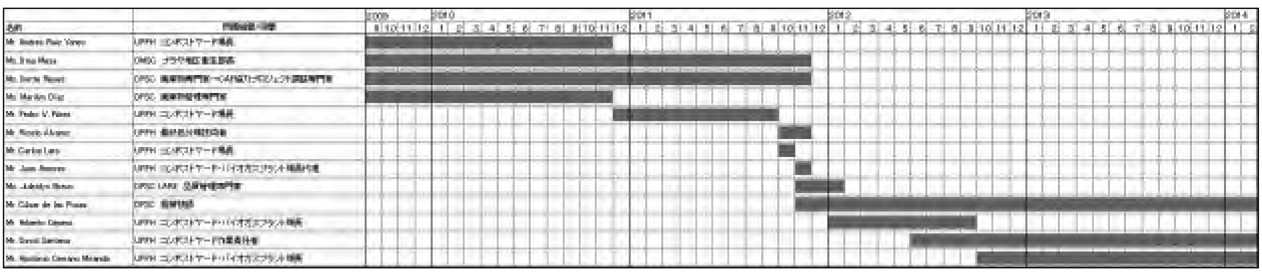


Figure 1-32: Replacement History of C/Ps on Group2.

c. Monitoring and Coordination of the pilot project by C/Ps

UPPH/DPSC does not have enough human resources and transportation to monitor the project and coordinate among cooperators, but they understood its importance by attending seminars and meetings with cooperators. They start visiting present cooperators and cooperators to be joined the project to grasp their issues. The monitoring report is shown in the Attachment in the Chapter end.

1.6.5 Conclusions

Conclusions are described below by analyzing quantitatively and qualitatively.

- Waste collection is unstable. If waste is not collected regularly and adequately, waste exceeds storage capacity and it makes serious problems at generators.
- Type of collection influences ratio of foreign materials.
- If segregated organic waste is transferred, compost can be produced.
- Many organizations and people interested in composting.
- Capacity of coordination among organizations related to the project (such as cooperators, units of waste collection vehicles and a compost plant in UPPH) is not enough in the present circumstances.

1.6.6 Conditions for continuing the project

Followings are conditions to continue the project according to conclusions of the evaluation.

- Strong commitment of directors at UPPH and DPSC
- Necessary of total coordination from generators, transportation and composting by DPSC
- Encouragement and support to leaders of generators to segregate wastes by DPSC
- Introduction of vehicles only for organic waste collection that belong to the compost yard
- Introduction of containers for waste segregation at waste generators, which can be collected by the introduced vehicles (combination of containers and vehicle are shown at 1.6.3c.2).
- Stable personnel

1.7 Future Plan by C/Ps

DPSC/UPPH considers carefully about the conditions mentioned at the above section and they are going to expand scale of the pilot project. The plan includes additional three agricultural markets and a canteen of a collage for collecting segregated organic wastes. Locations are shown in Figure 1-33. C/Ps are studying the amount of organic waste generated by these organizations (see the Attachment in the Chapter end).

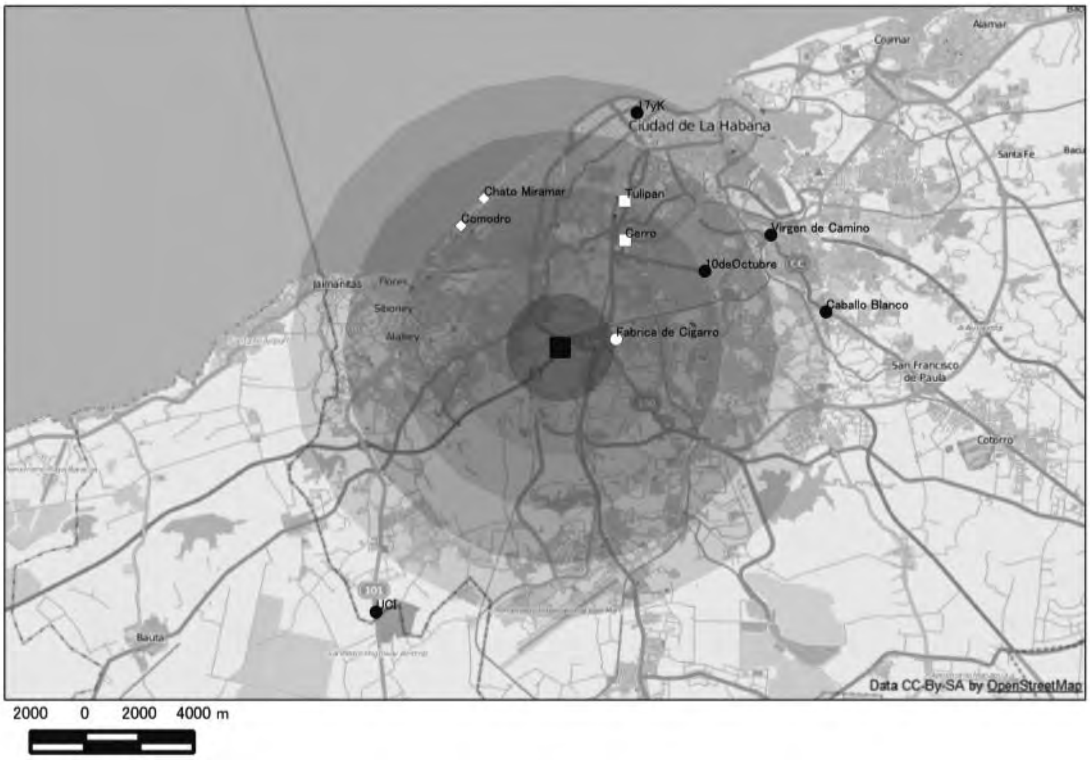


Figure 1-33: Location of present cooperators and cooperators to be participated in the expansion plan.

(■:Compost yard、□:Agricultural market、○:tobacco factory、◊:hotels、●:organizations to be involved in the expansion plan)

1.7.1 Proposal of Japanese expert

4 years and 9 months has past since the project was planned and implemented since September 2009. As indicated in this report, there are several problems occurred in each stage of the project. However, the C/P always trying to coordinate with "stakeholders" (as generators, UPPH and DPSC), share information and implement the pilot project.

Cuba is showing social changes such as introduction of market economy partially. The organizational structure and personnel administration in the future can be anticipated in the future. It will be important to establish a platform between "stakeholders" to share and exchange information for any changes. This is one of the keys to sustaining the activities of composting.

Project Completion Report

Section 4: Report on Output 3

～Report on Capacity Development of Vehicle and Heavy Equipment Maintenance～

1 Introduction

The most serious problem on repair and maintenance of waste collection vehicles in Havana city comes from lack of maintenance equipments, namely machine tools, equipment and hand tools. The machine tools were too old to function, and hand tools were extremely lacking both in types and quantities, that led to a major trouble for waste collection service. Heavy equipment for operation at final disposal site had also same situation caused by lack of maintenance equipment.

This project aims at donation of necessary equipment for waste collection vehicles and heavy equipment at final disposal site at first, and capacity development of maintenance capability to level up operation rate of both collection vehicles and heavy equipments, and finally improvement of waste collection service and operation of final disposal site.

Regarding to donation of maintenance equipment, necessary equipment for maintenance of both collection vehicles and heavy equipment, from machine tools to hand tools and measuring instruments, were donated, and Cuban side has made preparatory works for installation and storage for donated items as well as improvement of maintenance workshop facilities.

About capacity development activities on maintenance capability, both JET and C/P have cooperated to prepare maintenance manual, which has been used for training by JET targeting to maintenance men, as well as training by C/P, to level up their maintenance capabilities. To evaluate maintenance men’s capacity, written examinations were conducted and got good results.

However, it is very difficult to level up maintenance capability and behavior to keep things tidy up to Japanese level. This is mainly due to number of staff involved in at the workshop, not only maintenance crew but also drivers who handle the vehiclesas well as difficulty in purchassing equipments and parts. Nontheless, further improvement of vehicle maintenance is surely expected as capabilities of core C/Ps are well developed.

The progress, result and evaluation of this project is reported below as a final report.

2 Present Situation and Needs, Equipment Procurement Plan (September 2009 – March 2010)

2.1 Preparations for Equipment Purchase

2.1.1 Preparations Procedure

The following items were reviewed by the Japanese team and the Cuban C/P in order to prepare the list of equipments necessary to purchase: maintenance works currently performed at the workshops, type of the existing equipments and their conditions, workers' skills, and the possibility to contract external services.

Subsequently, in order to identify the equipment requested by the Cuban Side and their use and required quantity, they were verified with the technical specifications and photos showed in catalogues. In order to verify the appropriateness of the equipment request, their expected results and layout design were also evaluated. This procedure is shown in the flow chart below.

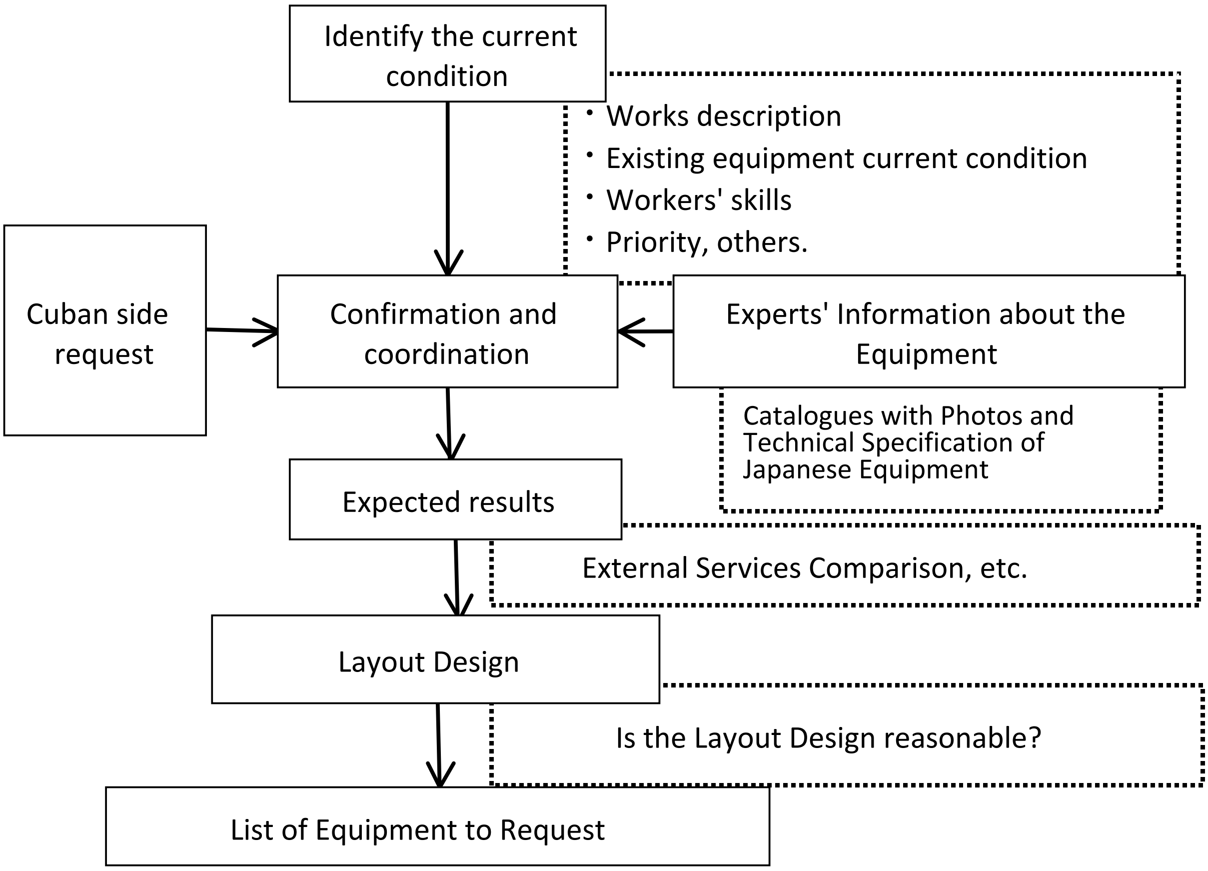


Figure 2-1: Examination of Necessary Equipment

2.1.2 Identifying the Current Condition

Every detail in maintenance work, equipment used and places in which they are done were verified at the Central Workshop and the Heavy Equipment Workshop. The following table summarizes the verification.

Table 2-1: Current Condition of Central Workshop

Central Workshop	
Place	Work description, equipment condition, etc.
Machine tools area	• Only one of three lathes, 1981 dated medium-sized unit is actually working although with difficulty and it does not serve to make threads. • Electric hacksaw has an excessive tolerance that does not allow perform straight cutting. • Grinder has unusual noise and eccentricity. • Vertical drill is no longer able to operate in reverse mode. • Only one of three milling machines is barely working. Due to poor condition of its cutting head, it does not work as it should. • Bench drill is out of service. • Machine tools have 30 to 40 years of usage and worn-out. • Workers seem skilled in technical abilities, because they are fully capable to produce parts needed for vehicle maintenance using available equipment, which are old and very limited in performance.
Tire maintenance	• Only one of two existing machines is actually operative, and works just for removing tires. • Due to the abovementioned reason, almost every tire removal and setup jobs are manually done. • Repairing of punctured tubeless tires is done as well. • As the air compressors are old and inefficient, the tires inflation takes very long time. • There are a lot of punctured tires repairing work. In particular, lateral damages on tires were frequently observed.
Compressors	• There are an insufficient number of compressors for workshop maintenance services that are necessary for the workshop. • Compressors are currently working in Tire repairing area, Radiator leakage inspection area, and bench cleaning at the Injection pumps testing area, (one on each). However, lack of compressor for pneumatic devices is causing low efficiency of works.
Hydraulics	• Because hose crimping machine (that connects hydraulic hose with nozzle) is not available, external services are required, which takes time. This causes delay in waste collection work.
Welding	• There is one arc welding machine available. However, its amperage can not be regulated because of its obsolescence. • Gas welders are aged and do not have enough number of welding torches. • These situations impede completion of necessary welding works.
Grease and lubrication	• None of the pumps intended for this purpose are actually on duty. • All works are manually done, causing huge oil dirtiness on working floor.
Vehicle Wash Cleaning	• None of cleaning pumps is actually on duty. • Lack of cleaning accelerates vehicles worn-out due to sand and dust.
Laboratory	• Regardless of being aged, fuel injection pumps testing bench is somehow fulfilling its purpose. • Injection tester also suffers from being aged, but it still works. However, diesel fuel leakage from the tester pollutes working environment inside testing room.
Repairing	• In general, a lack of tools causes problems in timely execution of maintenance work.
Engine overhauling	• Because of difficulty for procuring specifically required engines, engines designed for different models are currently being placed instead. This requires part fabrication for adapting those engines to vehicles. (Necessity of machine tools)
Gearbox	• Damages on gearboxes are being repaired using welding and angle grinder machine.
Spring set	• Damages are being repaired by welding.

Table 2-2: Current Condition of Heavy Equipment Workshop

Heavy equipment workshop	
Place	Work description, equipment condition, etc.
Maintenance workshop	• A concrete floor is under construction at the maintenance premises. Components repair work is requested to Central Workshop and third parties.
Fuel, grease and lubrication	• Heavy equipment receives diesel fuel from tank trucks. Vehicles use city gas stations for fuel supply. There is a very simple lubricant deposit within the workshop, and workers take it off manually every time they need to use it.
Tire maintenance	• Tire rim removal and inner tube repair is done manually. Due to the lack of an equipment to repair damaged tires, this work is requested to Central Workshop.
Engine Repairing	• Exiting facility is scarcely able to give simple maintenance services, so most of repair works are requested to external entities.
Hydraulic hoses repair	• This work is requested to external entities or specialized repair agents.
Welding and Cutting	• Due to lack of welding and cutting equipment, this work is requested to Central Workshop.
Compressor	• Due to lack of necessary compressors, filters can not be cleaned and pneumatic tools are unable to be used.
Wash Cleaning	• Cleaning area is actually on changing process. Tank is available, but cleaning equipment is not. Drainage system is also required.
Machine tools area	• Building of indoor room is already finished, but machine tools are not placed in.

In addition to the equipment and works mentioned, experts and counterpart jointly reviewed items listed in table below.

Table 2-3: Current Condition of Maintenance and Repair

	Reviewed issues	Results
Collection Trucks	Mechanical staff skills	• Works are divided into hydraulic, welding, tire repairing, equipment and devices repairing, maintenance, pumping, and steering systems, being executed by workers on each. • There are experienced and skilled people on each working area. Technical level of some elder workers comes close to mastery. • Although work is correctly performed, lack of accurate measuring devices and tools makes precision level lower than similar jobs done in Japan. (Accuracy in Japan is due to availability of precision equipment and tools, as well as widespread method of using parts at an aggregates level.) • Maintenance staff is classified on four categories: A, B, C and assistant; and most experienced workers teach others during execution of actual works.
	Handbook availability	• Operating handbooks are available. • Not every collection vehicle has its maintenance handbook. Handbooks for compactor box are specially needed. (Such as hydraulic circuit diagrams.)
	Maintenance program and its implementation	• Three different maintenance programs are applicable according to vehicle’s mileage. However, insufficient financial resources makes program not fully carried out. (Occasionally, through inspection, extending maintenance period is decided.) • There is a scheduled maintenance guide for compactor box detailing inspection and maintenance to be done every six months and every year, although not every scheduled work is carried out.

	Reviewed issues	Results
		• Technical inspection list used for compactor vehicle is almost identical to monthly and quarterly inspection list in Japan. List includes inspection of chassis and compactor box.
	Inspection	• Daily inspection guide and inspection forms for compactor vehicles are available. This inspection must be performed by vehicle's driver before and after operation. Although inspection content is almost identical to the Japanese one, it seems that every scheduled task is not performed.
	Material management	• Parts and supplies storage is properly managed, using a system similar to the Japanese one. (But not computerized.) • Parts and supplies are neatly arranged on shelves inside. Each one is placed over a sheet of paper indicating name of every article. • Inventory is monthly made for each one-tenth of existing storage items for verifying purposes.
	Bookkeeping and registering control	• Repairs and inventory registering books are well ordered and properly managed. (Audits take place regularly.) • Statistical data analysis on fuel consumption, transportation efficiency, and other statistics are usually performed. There might be a room for improvement.
Heavy Equipment	Mechanical staff skills	• Two mechanics and an engineer were trained in China for maintenance of Chinese-made heavy equipment. Their technical capacity is not fully exploited, because of insufficient number of equipment and devices necessary for the maintenance and repair. This area mainly performs small repairs and some maintenance works.
	Maintenance program and its implementation	• There are three different maintenance programs, each one consisting of three steps. When first program has been completed, it comes to second, and then to the third program. Ending third program, the maintenance process returns to the first program. Whole process of program implementation is recorded on the CT-2 format (CT: Control de Taller). Time spent on first program is four hours, six hours on second and eight hours on third program.
	Bookkeeping and registering control	• Works are recorded according to maintenance programs in the existing forms. Information about parts and supplies used, like lubricants, is also registered in those forms. • Supplied and consumed fuel volume is also estimated to be used as parameters of functional conditions of the equipment. • Heavy equipment operating time, measured in hours, is carefully recorded to provide essential data for calculating workers' wages.
	Material and parts management	• In the workshop, there is a small room for material and parts storage, but most parts and supplies are managed and taken from the Central Workshop store.
	Operating handbook availability	• Handbooks are only available for Chinese-made heavy equipment.

Referring to maintenance work for both collection vehicles and heavy equipment, mechanics have outstanding skills, performing every possible inspection and maintenance jobs. Materials and their records are satisfactorily controlled, however, registration is only manually done on papers.

Lack of maintenance materials, such as spare parts, tools, equipment and devices, can be considered the main problem. It is important to take note that every effort to keep functioning vehicles and heavy machinery is being made. Workshop staff is trying to solve material shortage problems, making unavailable parts by themselves and adapting supplies from other manufacturers.

For these reasons, equipment procurement will bring about huge impact on strengthening maintenance work of collecting vehicles and heavy equipment.

2.1.3 Verification and Consensus on Cuban Requested Equipments

Cuban side's requests related to maintenance of collection vehicles and heavy equipment are shown in Annex. Review on every requested article was made jointly in order to determine the justification for its necessity and to reach a consensus on definition. Catalogues with photos and technical specifications provided by experts were referred for that purpose. Also, maintenance practices in Japan for similar equipment were explained.

As a result of this work, both sides agreed the following changes as shown in the table below.

Table 2-4: Summary of Request Equipment Revised

	Equipment	Change	Reasons for Change
Collection Trucks	Forklifts	Reduce maximum load from 5 tons to 2 tons	Usual loads do not exceed 2 tons.
	Cleaning equipment	One equipment with hot water and the other with cold water instead of both with hot water.	Avoiding the occasional lack of fuel for heating water.
	Compressor	Reduce number of compressors from 4 to 3.	The laboratory compressor is relatively new.
	Shearing machine	Change from mechanical model to manual.	The joint inspection enabled to identify required uses correctly.
	Lathe	Reduce distance between axes, from 2,500mm to 1,500mm.	Most jobs can be done with a lathe of 1,500mm.
	Lathe and milling cutter	Increase the number of blades.	Required blades are not available.
	Lubrication equipment	Changing the equipment type.	New specifications were defined to serve both for lubrication and greasing.
Heavy equipment	Compressor	Change of specification	New type more suitable for tire repair.
	Pedestal for grinder	Addition	It was not included in the original request.
	Impact wrenches	Addition	They were added for tire repairing.

2.1.4 Expected Results of Equipment and Tools Provision

Reviewing the current condition of collection and heavy equipment, it was considered that equipment and tools provision will improve vehicles maintenance works. Furthermore, the main expected result for each equipment was reviewed again and are shown in the table below.

Table 2-5: Expected Results of Equipment and Tools Provision in Vehicle Maintenance

Collecting Vehicle Maintenance	
Equipment Supplied	Expected results
Machine Tools	Introduction of the high precision lathe and the milling machines will allow new parts manufacturing and rectifying aged parts of collection vehicle and therefore it will be possible to make repair and maintenance works that currently cannot be done.

Collecting Vehicle Maintenance	
Equipment Supplied	Expected results
	Introduction of hacksaw and drilling machines will increase parts manufacturing accuracy, and reduce the time required to perform maintenance work.
Tire repairing equipment	Tire repair by a contracted third party delays the waste collection operation because external entities tend to delay in accepting and carrying out contracted work. New equipment such as tire remove machine installed in the workshop will allow reducing the time required for repairing. Safe operations will be promoted (There was a fatal accident in tire changing.)
Compressors	Time required to inflate the tires can be reduced, and thus, work efficiency will increase. The use of pneumatic tools (impact wrench, etc.) will be possible and will reduce the time required for the job.
Equipment for hydraulic system repairing	The hose repairing performed by a contractor delays maintenance work time and paralyzes waste collection operations. Introduction of hose crimping machine could drastically reduce the time required for the maintenance work.
Welding	The newly installed welder will improve sheet metal works which have not been accurate until now. Particularly the arc and TIG welders installed will cover more work and will considerably expand the range of repairing.
Lubrication pumps	They will facilitate lubrication in a shorter period. They will eliminate oil leakage and consequently improve working environment.
Vehicle Cleaning Machine	It will allow vehicles washing, reducing wear and corrosion. Cleaning before maintenance will improve the accuracy of vehicle maintenance and repair.
Laboratory	The new injector tester will improve the accuracy of maintenance work. The new tester without fuel dispersion will not influence human health, and improve the work environment.
Tools and Measurement Devices	The provision of general tools will increase the maintenance work efficiency. Introduction of measurement devices will allow precise works and will improve the maintenance work quality.

Table 2-6: Expected Results of Equipment and Tools Provision in Heavy Machinery Maintenance

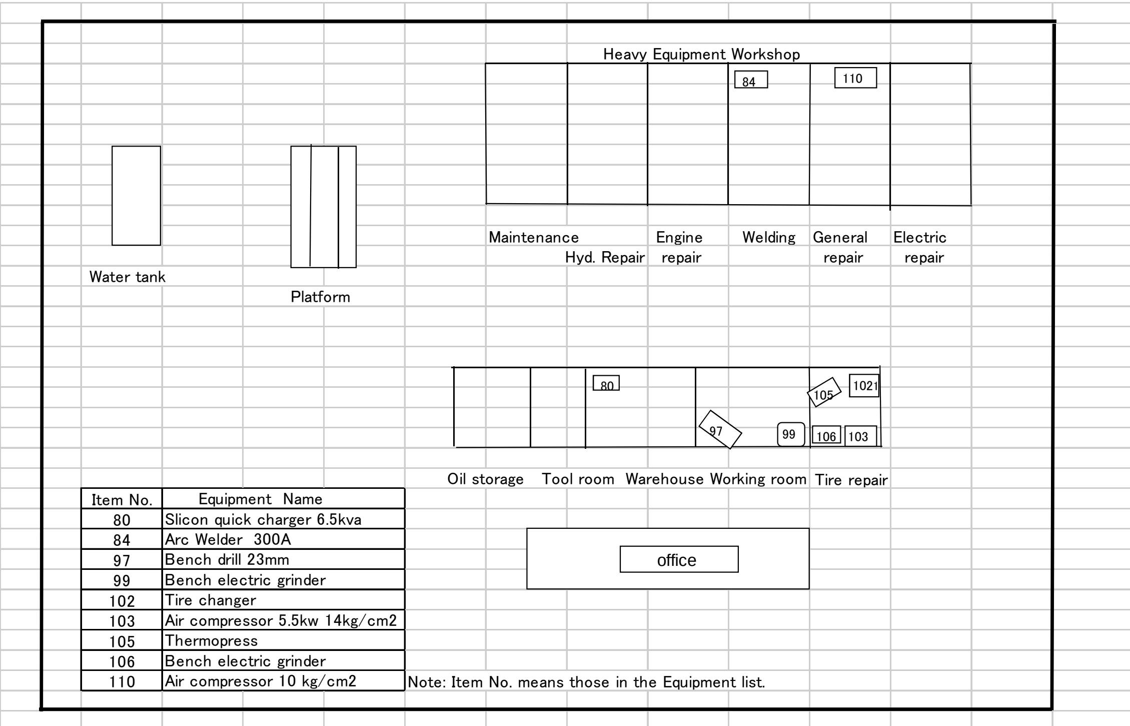
Heavy equipment	
Equipment supplied	Expected results
Jacks	With pneumatic lifting jacks, repairing works can be done safely and more effective.
Tools	With tools, maintenance and repairing can be done safely and efficiently.
Battery charger	Battery recharging, currently requested to the Central Workshop, to be made inside the Heavy Equipment Workshop, reduces the time required for repairing work.
welding and oxygen cutting equipment	The use of welding and oxygen-cutting equipment installed in the workshop will reduce the repairing time needed.
Equipment for tire puncture repairing	Tire repairing equipment in its own workshop will ensure safer and efficient repairing work.

2.1.5 Equipment Layout

Since a considerable number of equipment and devices are listed, it is necessary to examine and plan the equipments layout to ensure their proper and efficient use. Since there were no drawings of the Central Workshop or of the heavy equipment workshop, Cuban counterpart prepared them, and based on those plans both sides discussed to develop ideas about optimal layout of working areas including the new equipment. The basic conclusion is to keep up the current working layout as far as possible, and to give a special attention to the compressors location.

The jointly designed layouts of Central Workshop and Heavy Equipment Workshop are shown below.

Regarding machinery that requires installation works and electrical wiring, necessary information such as electric motor capacity, no-fuse-breaker (NFB) capacity, wiring diameter, etc. were provided, and related basic regimen such as electric capacity and circuit breaker protection system was explained by the experts.



Item No.	Equipment Name
80	Slicon quick charger 6.5kva
84	Arc Welder 300A
97	Bench drill 23mm
99	Bench electric grinder
102	Tire changer
103	Air compressor 5.5kw 14kg/cm2
105	Thermopress
106	Bench electric grinder
110	Air compressor 10 kg/cm2

Figure 2-2: Jointly Designed Layout of Heavy Equipment Workshop

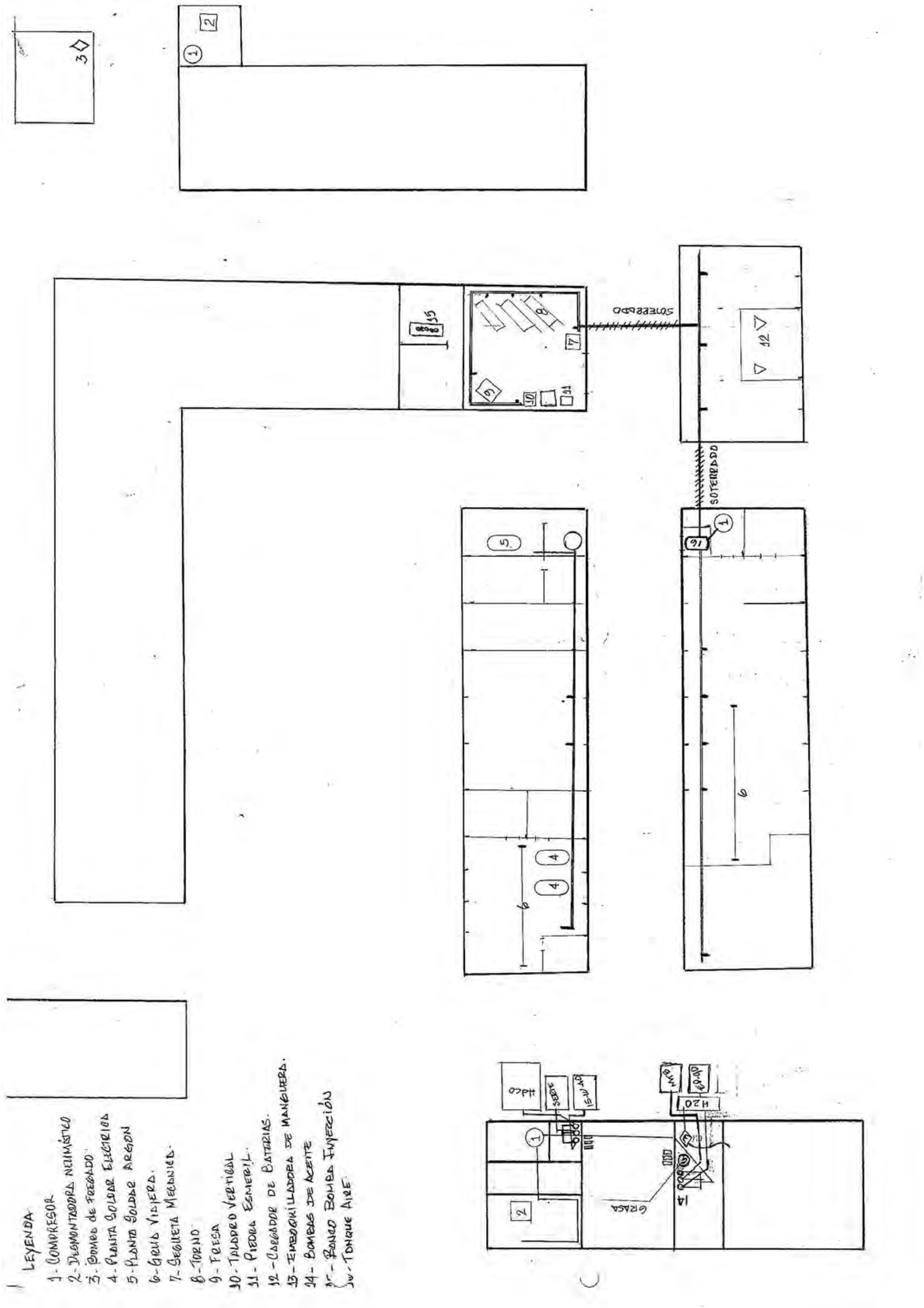


Figure 2-3: Jointly Designed Layout of Central Workshop

2.1.6 Proposed equipment final list

After defining the necessary equipment detailed in preceding paragraphs, prices were estimated. Since this estimate showed small chance to purchase all the equipment listed, the following actions were intended:

1. Total cost reduction by alternative equipment with more economical technical specifications.
2. Give priority to every listed equipment.

The main target was focused in finding out more affordable equipment prices by down-grading their specifications with a minimum down-grading of their technical features. The following table summarizes those changes:

Table 2-7: Specification of Proposed Equipment

Equipment	Specification originally intended	Changed Specification	Reason
Chain block	Electrical lifting	Manual lifting	Although laborious manual handling is required, equipment allows move heavy objects.
Forklifts	Two tons top loading	One ton top loading	Priority was given to compactors parts movement.
Universal precision lathe	Distance between axis: 1,500 mm	Distance between axis: 1,000 mm	Although the equipment will not be able to perform works requiring longer distances between axes, it allows satisfying the repair needs of compactor trucks.
Milling machine	Two-axis (vertical and horizontal)	One-axis (vertical)	To attend most needs. (The vertical one is more frequently used for parts fabrication.)

Moreover, the equipments were listed with priority for both collecting vehicles and heavy equipment, in view of the case the budget were not enough to cover all the proposed equipment. The result of such prioritization is shown in Annex-1. The main purpose of this prioritization was, first of all, to give a higher priority to those equipments currently not enough or out of service, whose introduction will mean higher effectiveness to maintenance work, although, of course, most of the requested equipment have this purpose.

On the other hand, less priority was given to the equipment currently in operation, despite its deterioration and working troubles. It should be noted that, due to this prioritization, the number of new list appears more than that in the original list requested by Cuban side. This is due to that all the items were reviewed and prioritized by classifying one item into several sub-items, where requested quantity is more than one and priority is given depending on each working place or its intended use. In any case, the requested quantity per item was not increased and the total number of requested items was slightly reduced after prioritization.

2.2 To Develop a Plan to Improve Vehicle Maintenance Workshop

A thorough review of vehicle operation, repair and maintenance in UPPH and Communal Services as a whole was carried out together with JICA experts during the first year of the project. The following issues were therein identified:

- Survey of existing broken vehicles
- Identification of tools required for repair
- Periodical checkup and maintenance

- Inventory control of spare parts and tools
- Identification of tools to be procured
- Facilities, including tool and equipment location within the facility and/or power connections
- Workshops network operation.

2.2.1 Survey of existing broken vehicles

A survey of all compactor trucks and heavy equipment was carried out in order to identify their technical condition, most frequent breakdowns, possible repairs, and existing vehicles out of service in the short, middle, and long terms, including cause of breakdown, possible repair solutions, and time required for repair under the present circumstances.

The number of compactor trucks out of operation as of Nov. 20, 2009 is as follows:

Total Compactor Trucks	Available on Average	Out of Operation
115	78	37

Out of the 37 vehicles out of operation, 13 have already been repaired. Lately, however, another 6 vehicles have broken. Therefore, the present situation as of Feb.27, 2010 is as follows:

Total Compactor Trucks	Available on Average	Out of Operation
115	85	30

For the purpose of improving the repair system in the workshops, future implementation of the technical diagnosis was considered to be necessary in order to identify breakdowns, and thus minimize both vehicle disassembly and time required for repair.

2.2.2 Identification of tools required for repair

A list of tools and equipment required for each workshop section was prepared by the Cuban side, and later discussed together with the Japanese experts using existing catalogs in order to identify the really needed ones to expedite repair and maintenance. Finally, the most suitable list in terms of both quality and quantity was finalized. It includes corresponding parts list number, specifications, and pictures for each item requested.

2.2.3 Periodical checkup and maintenance

Existing procedures, regulations, and workshop control forms used for technical maintenance were reviewed. It is clear that Communal Services follow the maintenance policy established and enforced by the Ministry of Transport.

Maintenance guidebooks for most vehicles with their corresponding operations, maintenance cycles (see tables below), planning, and control are available. However, low-quality maintenance is a fact. Therefore, emphasis was laid on daily checkups by drivers, identification of tools and equipment required to improve maintenance quality and implement automated operations, and staff training. Workers are to be trained in fields such as electricity and hydraulics, while managers are to learn how to increase the life span of vehicles by implementing an appropriate preventive maintenance policy.

As for existing preventive maintenance system for collection vehicles, check and maintenance are implemented deprnd on mailage of each vehicle, and maintenance schedule is shown at Table 2-8, and Table 2-9, due to various types and manufactueres of vehicles. “Maintenance 1” includes simle check, for example battery and tire pressure check. “Maintenance 2 ” includes oil and filter exchange with “Maintenance 1”. “Maintenance 3” shows engine tune-up, transmission check, pump check, alternater check in addition with “Maintenance 1” and “Maintenance 2”.

However, it is hard to conduct them perfectly now, due to difficult acquisition of parts to exchange.

On the other hand, in case of preventive maintenance of heavy equipment is done depend on operating time, but data and implementation are not imcomplete.

Table 2-8: Maintenance Cycle (Collection Vehicles) (Unit: km)

Brand	Model	Maintenance I			Maintenance II	Maintenance III
ROMAN	1921	3,000	6,000	9,000	12,000	
URAL	5557	15,000	18,000	21,000	24,000	
KAMAZ	53212	27,000	30,000	33,000	36,000	
HINO	TE 220	39,000	42,000	45,000		48,000
KRAZ	256					
ZIL	130					
GAZ	66					
PEGASO	1121	5,000	10,000	15,000	20,000	
	1126	25,000	30,000	35,000		40,000
	1127					
	1135					
	1217					
RENAULT	GC 191					
	GR 191					
	G 210					
EBRO	P 119	3,000	6,000		9,000	
DODGE	S 50-300	12,000	15,000		18,000	
MAZ	500	21,000	24,000		27,000	
MAZ	700	30,000	33,000			36,000
AVIA	30-N					
NISSAN	CWL	4,000			8,000	
		12,000			16,000	
		20,000				24,000
LADA		5,000	10,000		15,000	
VOLGA		20,000	25,000			30,000
UAZ						
LAND R,						
DONG FENG		4,000			8,000	
		12,000			16,000	
		20,000			24,000	
		28,000			32,000	36,000
ISUZU		5,000			10,000	
		15,000			20,000	
		25,000			30,000	
		35,000				40,000

Table 2-9: Maintenance Cycle (Heavy Equipments) (Unit: hour)

Brand	Model	Maintenance I			Maintenance II	Maintenance III
TAINO	CV 8	200			600	
FIAT	FD 20					
KOMATSU	D 85 A					
C 100						
DZ	42					
DZ	75					
DZ	99					
DZ	122 A					
VOLVO	4400					

The tools and equipment identified as necessary will help to reduce drastically the average daily breakdowns, the breakdown rate, and the number of vehicles kept out of operation for an extended period of time.

2.2.4 Inventory control of spare parts and tools

Existing accounting procedures for control of spare parts, supplies, and tools established under the National Accounting System were reviewed by visiting the Central Warehouse and the tool room, and all the sheets for control implemented were checked (see photos below).

All accounting sheets are prepared although hand-writing-style, and approval and confirmation are executed by checking the sheet with signature of the person in charge at each supply and delivery stage by the person in charge. The doors with keys and fences are installed at the warehouses and articles are stricktly storaged to avoid delivery without permission and robbery. The inventory control is done perfectly by setting the articles orderly at designated shelves, and paper tags with name and quantity are sticked, but little bit dusty condition.

Building 1 Parts Warehouse

Building 2 Consumables Warehouse

2-1: Warehouse

Tool Room

Building 2 Consumables

Photo 2-2: Tool room

Besides, the methods of purchasing parts and estimating the finance necessary for the annual sustainability were analyzed.

2.2.5 Identification of tools to be purchased

A priority rating was used for the garage tools and equipment to be purchased emphasizing their quality and taking into account available JICA funding. Ultimate tool and equipment selection is to be decided by Japanese experts.

2.2.6 Facilities, including tool and equipment location within the facility, and/or power connections

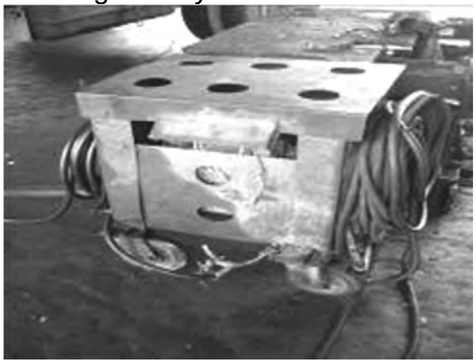
Existing conditions at the facilities were reviewed to identify the most suitable location for each machine tool and garage equipment. A survey of each facility was conducted to identify the following (see photos below):

- Power system condition, including ground connection and interlocking protection
- Drainage condition of vehicle wash yard
- Condition of machine tool facilities, injection laboratory, and other relevant areas
- Roofing conditions
- Completion of rehabilitation works for the Heavy Equipment Workshop.

The above-mentioned items are to be taken care of by the Cuban side. A Project Company is to be hired to carry out the necessary works.

Area for Hydraulic Equipment Repair

Welding Facility



Greasing Facility

Building 1 Mechanical Repair Sections

Machine Tool Area

Washing Facility

Drainage at the Washing Facility

Area for Mechanical Repair

Photo 2-3: Areas and Equipments of Central Workshop

2.2.7 Workshop Network Operation

A number of repair workshops under Communal Services were visited to review their structure in order to maximize their potential (see figures below). At present, the Cuban side is working for utilizing the 3 proposed territorial workshops with some tools. This is increasingly crucial after the implementation of nighttime collection and double collection, which has led to set up 3 work shifts at the Central Workshop.

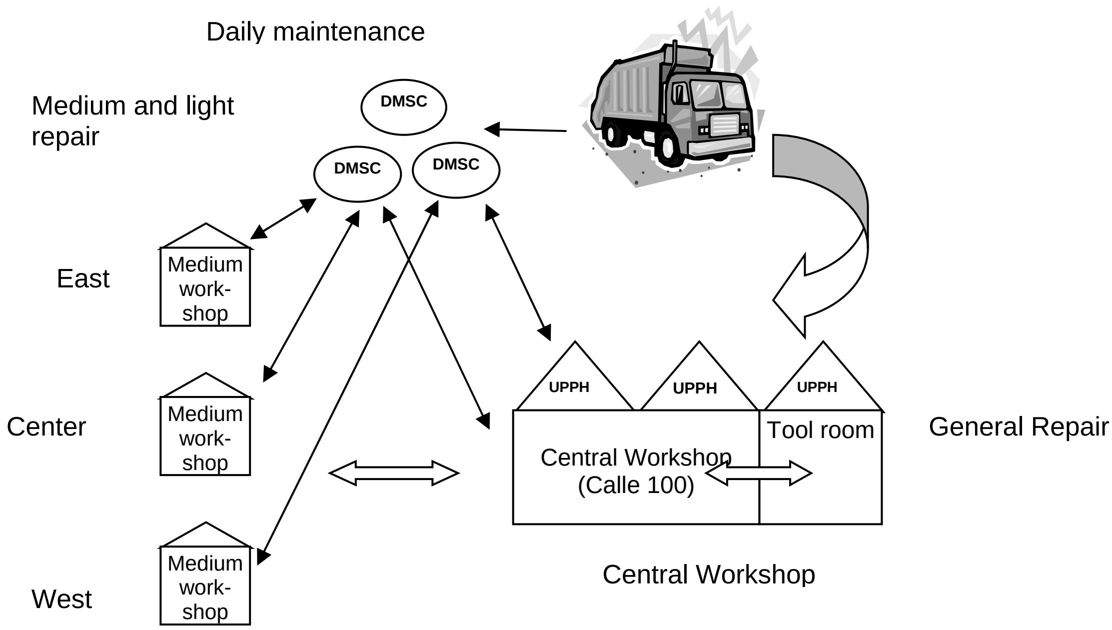


Figure 2-4: Function of Proposed 3 Workshops for Collection Vehicles

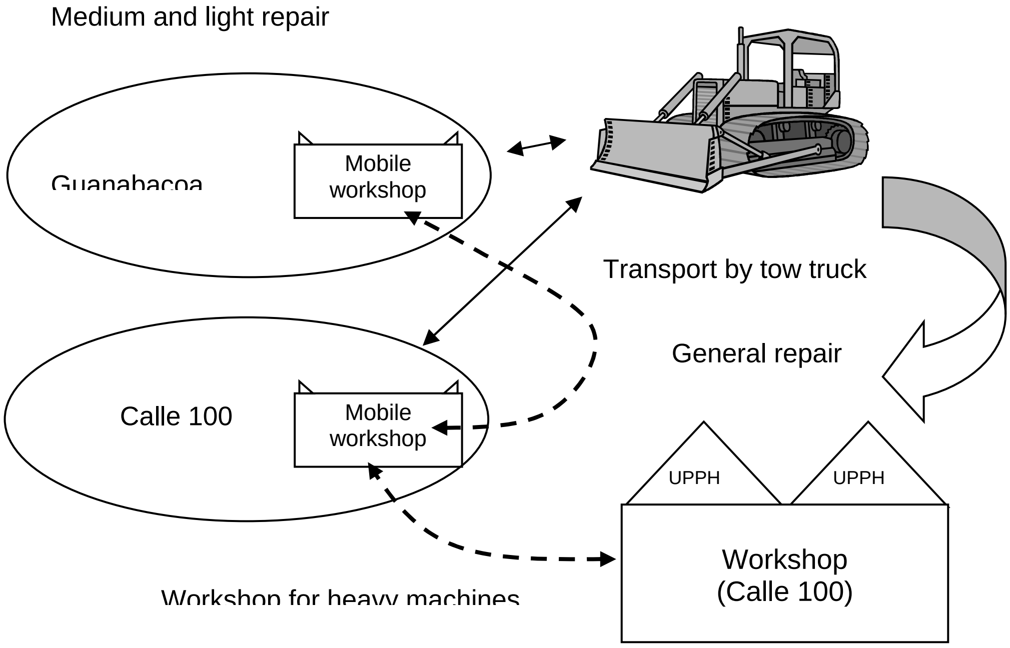


Figure 2-5: Function of Proposed 2 Workshops for Heavy Equipment

2.2.8 Expected Results with the Implementation of the Project to Improve the Abilities of Urban Solid Waste Management and Future Perspective of the Workshop

The initial concept of the project was, in a modest way, to improve the working conditions in the workshops and introduce technologies that could facilitate the works of the staff and elevate the quality of the maintenance, accelerate the response to the breakdowns. Based on this conception, the request for the equipments and tools was elaborated. The request has been analyzed and revised in a very thoughtful and professional way by the Japanese experts, and therefore the counterparts in the workshops can conclude that this project will represent a solid foundation to give continuity to the improvement in all the workshops conditions, to organize a technological flow enabling the coefficient of technical availability to be maintained elevated and to guarantee the substantial increase of the lifetime of all the transport media used in the Communal Services.

3 Preparation of Equipment Installation and Maintenance Training (April – December 2010)

3.1 Central Workshop

The following is a summary of the activities initially planned for the second year (at the time the Inception Report was submitted):

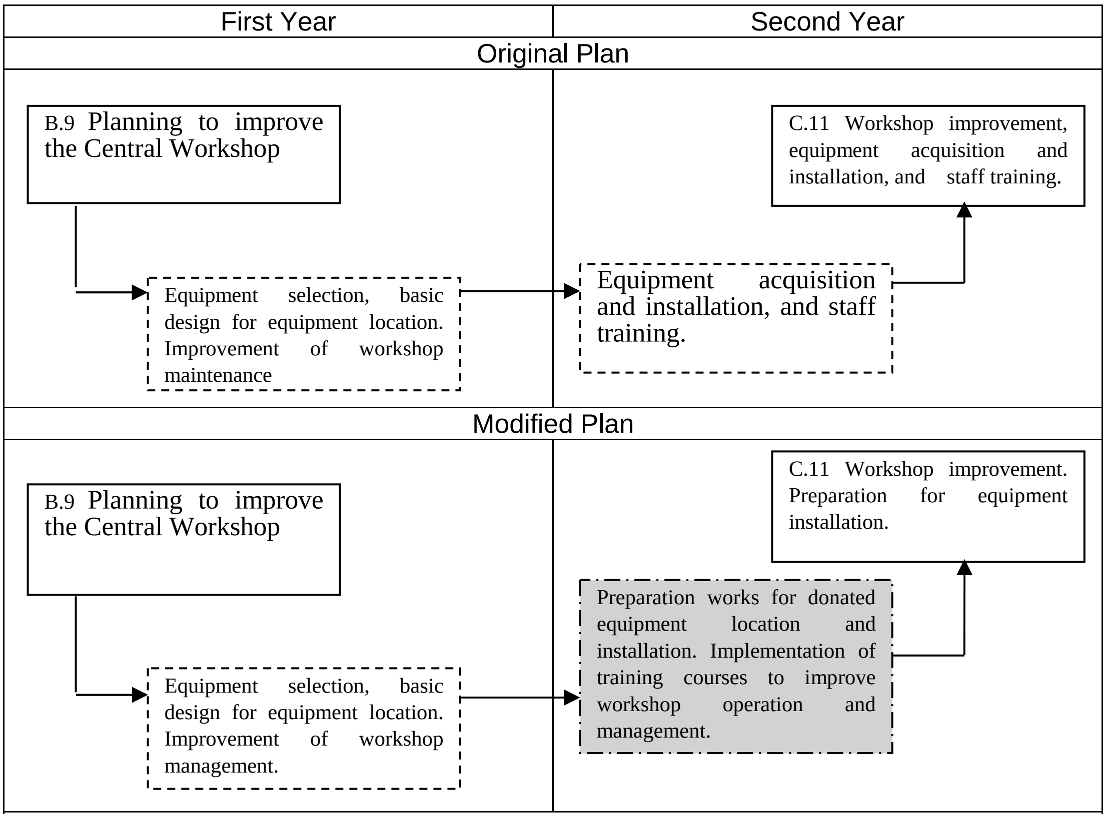
- Preparation and installation of equipment based on the plan formulated during the first year. Equipment purchased in Cuba will be mainly handled by the Cuban side, whereas those acquired in Japan will be handled by the Japanese side. The Cuban side will be in charge of equipment installation. When technical assistance by the supplier is required, the Cuban side will be trained accordingly.
- A number of activities will be carried out to improve the present condition of this repair and maintenance workshop based on the existing program for improvement of compactor trucks maintenance, including technical advice for the equipment to be installed during the second year. In this case, the Japanese experts will act as trainers.

However, due to delays in donated equipment acquisition, their arrival in Cuba was postponed for the third year. The activities corresponding to the second year was modified as shown below:

- Speed up preparation works required for installation of equipment scheduled to be received during the third year.
- Hold training courses to improve the technical, operational and management capabilities of the Central Workshop.

Plan modifications are shown in Figure 3-1.

Regarding equipment installation, it is worth noticing the fact that a number of preparation works should be carried out by the Cuban side. Mr. César de las Pozas was appointed as a C/P member especially in charge of preparation works.



Note: The square highlighted in yellow color shows the activities planned for the second year.

Figure 3-1: Modified Plan of Activities

3.1.1 Equipment Specifications Identification

Delivery of donated equipment for composting and maintenance of compactor trucks and landfill site heavy machineries was originally scheduled for the second year. However, due to delays in the bidding process, delivery (arrival in Cuba) was postponed for the third year.

The list of donated equipment was divided into two batches for bidding. The first bid was held on September 14, and the second one on November 9, 2010, and the same equipment supplier won both contracts. As the supplier promised to deliver both batches at the place in Japan designated by JICA on March 16 and March 17, respectively, equipment arrival in Cuba is estimated for June, 2011.

The list of equipment is shown in Annex-1.

It should be noticed that equipment specifications for the first batch have already been decided. However, neither the manufacturer nor the technical specifications have yet been decided for the second batch.

3.1.2 Preparation works for the second year

a. Preparation works for equipment installation

As the Cuban side is held responsible for the preparation works required for equipment installation, collection and accurate conveyance of the information required by the Cuban side for the works to be carried out should be ensured.

Since both the manufacturers and the specifications for the first equipment batch have already been decided, JICA experts gathered the required information, and the relevant data were translated into Spanish. The Comprehensive Table for Equipment Installation Specifications was also prepared, including data necessary for the preparation works to be carried out. Moreover, a plan (ground plan) of the Central Workshop was prepared to be used for equipment installation design. Workshop measurement was conducted during the first year as shown in the Excel file. The Cuban side needs all these data, so the relevant guidance for preparation works will be carried out according to this information.

b. Preparation for training courses

The materials to be used for the training courses requested by the C/P during the first year about interpretation of electric charts and hydraulic plans, and compactor trucks maintenance management, were prepared.

Regarding electric charts and hydraulic plans, an information abstract issued by the Environment Authority of the City of Osaka, in cooperation with the manufacturer of compactor trucks, to be used to train Osaka City Hall staff, was prepared and adapted.

On the other hand, in preparation for the course on compactor trucks maintenance management, a material was prepared based on the plan for compactor trucks maintenance management published by the Environment Management Bureau of the City of Osaka.

3.1.3 Summary of Minutes of Meetings Held with C/P staff

The following is a summary of the minutes of meetings held to coordinate the preparation works scheduled for the second year.

Date	Nov. 11, 2010	Description
Participants	Raúl and Hiraga Vicente (Interpreter)	Mr. Hiraga explains the progress made in terms of equipment acquisition: ● Both manufacturers and specifications for the first batch of equipment are already known, whereas the information about the second batch is still unknown. ● Explanation about the reasons for equipment priority as Mr. Raúl asked why the injection pump test bench was not included instead of the milling machine. Mr. Hiraga explained that the injection pump test bench is still operational, although in bad condition, while the milling machine is having troubles and its replacement is necessary. ● Expanation about equipment installation. ➢ How to read the Integrated Table for Installation Specifications. ➢ Method for installation of machine tools, including foundations. Mr. Raúl proposed the following: ● Hold a working meeting to be attended by the following people: ➢ César De Las Pozas(DPSC) ➢ José Carlos (UPPA secon, director) ➢ Alejandro Louro (Economic vicedirector) Mr. Hiraga explains the procedure to plan preparation works. (1) Identify the location of equipment, and the area design. (2) Identify which preparation works should be carried out (equipment foundations, wiring, etc.) (3) Identify the contents of the preparation works. (4) Formulate a general schedule for preparation works. ⇒ Mr. Raúl agreed.
Place	Central Workshop	

Date	Nov. 11, 2010	Description
		Mr. Hiraga explains the training plan ● Compactor trucks maintenence: (1) Course on hydraulic and electric systems of compactor trucks, (2) Course on compactor trucks maintenance management to be attended by managers. (3) Practical course on Japanese compactor trucks donated to Regla municipality using those same trucks for staff training. ● Heavy Equipment Workshop: (1) Cummins engine maintenance, (2) Heavy equipment maintenance, and (3) Heavy equipment maintenance. Training will be implemented during Komatsu engine overhauling ⇒ Mr. Raúl agreed to this. Dates and participants for the training courses will be later decided.

Fecha	Nov. 15, 2010	Descripción
Participants	Raúl, Nury, Fernando, Hiraga, Yamanaka Hashimoto (Interpreter)	Mr. Hiraga proceeds as follows: ● He asks Mr.Raúl to make a presentation at the Seminar to be held on November 30. ● Detailed explanation of the Comprehensive Table for Equipment Installation Specifications, using the lathe as an example. ● He requests that a schedule for preparation works required for equipment installation be prepared, and that the Japanese side be informed about actual progress. ⇒Mr. Raúl agreed. ● It was agreed to hold a meeting at the GTDI office on 30st on November 16, at 10 a.m, in order to explain to Mr. Raúl, Mr., César, and UPPH staff all the preparation works required. At the Machine Tools Area, possible locations for donated equipment were discussed, and the following was agreed: ● Remove the large lathe near the entrance, and install the new lathe there. ● The new milling machine will be installed in the back of the machine tools area in the place currently occupied by an old milling machine which will be removed. ● The bench drill press will be installed next to the wall in the back of the area. ● The new grindstone with pedestal will be installed next to the wall, near the new lathe. ● NFB's will at least be installed at the power source for the wiring of the new equipment. ● For the wiring of the new lathe, the existing underground pipe will be used, and new cables will be laid. Joint survey of the lubrication system ● For the air compressor, the air tank installed nearly 20 years is expected to be used. (remark by Mr. Hiraga: The inside of the tank has to be checked for corrosion. ● The existing power source is expected to be used. (Mr. Hiraga recommends that a new one should be used.) Arrangements to decide the dates for training courses ● November 25 at 9 am. Course on compactor trucks maintenance management, and preventive maintenance, to be attended by some 5 people in managing positions. (Hiraga) ● December 1 and 2. Course on operation and daily inspection of compactor trucks to be attended by truck drivers and other staff. (Yamanaka)
Place	Central Workshop	

Date	November. 16, 2010	Description
Participants	Raúl, César, Hiraga,	Meeting to discuss preparation works

	Yamanaka Hashimoto (Interpreter)	Mr.Hiraga' explanation : ● He explains the Comprehensive Table for Equipment Installation Specifications, as well as the installation plans for machine tools. ● Regarding the possibility to use existing foundations, the Japanese side will consult the manufacturer. Mr. Raúl and Mr. César: ● It is necessary to convey and explain the information to UPPA person in charge.
Place	Calle 30	

Date	November 17, 2010	Description
Participants	Raúl, Hiraga, Yamanaka Hashimoto (Intérprete)	● Location of lubricants and grease tanks, and hose reels, was identified. Measurement works began. ● Dates and time for the courses were decided. ● A meeting was scheduled for tomorrow at the Central Workshop to be also attended by UPPA people.
Place	Central Workshop	

Date	November 18, 2010	Description
Participants	Sergio, Odalys, Rolando, César, Jesús, Raúl, Hiraga, Yamanaka Hashimoto (Interpreter)	General meeting to coordinate preparation works. Mr. Hiraga's explanation and request: ● He explains how to interpret the Comprehensive Table for Equipment Installation Specifications using the lathe as example. ● He asks for good coordination, ultimate concentration of relevant information in one section, and the uniform conveyance of the information to all concerned sections as each section involved is hold responsible for some specific activities. ● A periodic meeting with the Cuban side should be held to this end. Mr.Sergio's comments: ● Preparation works had been initially outsourced. However, as César was appointed as a C/P member, an organization under DPSC was hired to execute construction works. The budget has already been ensured. ● The Cuban side expects that the improvement of the Central Workshop by introducing the new equipment becomes a benchmark for other projects, as was the case of the successful biogas plant in cooperation with China. ● Progress of preparation works will be checked onsite weekly on Wednesdays, and at the periodic investment meeting on Fridays.
Place	Central Workshop	

Date	November 26, 2010	Description
Participants	Raúl, Hiraga, Yamanaka Hashimoto (Interpreter)	Mr. Raúl: ● Coordination with UPPA staff has been difficult. (He has not been able to contact him.) ● For coordination with Regla municipality people regarding the practical training course on compactor trucks, he asks the JET to also arrange it with Mrs. Odalys.
Place	Central Workshop	

Date	November 26, 2010	Description
Participants	Odalys, Hiraga, Yamanaka Hashimoto (Interpreter)	Mr. Hiraga asks Mrs.Odalys to summon a general meeting to discuss equipment installation, and coordination arrangements for the practical training course to be held in Regla municipality. ● According to Mrs.Odalys, internal coordination by the Cuban side is satisfactory. However, in order to share the information regarding coordination arrangements, a general meeting was agreed to be held at the GTDI office on December 2, at 10 am. ● The training course scheduled to be held in Regla municipality on December 1 should be confirmed.
Place	Calle 30	

Date	December 1, 2010	Description
Participants	Raúl, Hiraga, Yamanaka Hashimoto (Interpreter)	● As spare parts to repair broken donated Japanese compactor trucks have been acquired, a meeting to be attended by all concerned organizations was agreed to be held on December 3 to discuss spare parts management.

Place	Central Workshop	● Discuss with Mr. Raúl about his contribution to the Progress Report. Ask him to make a summary of repair time as an indicator for the project evaluation.

Date	December 2, 2010	Description
Participants	Odalys, Fernando, Ernesto, Nury, Raúl, Carlos, César, Diego, Félix, Rolando, Kawaji, Hiraga, Yamanaka, Dosho Hashimoto (Interpreter), Vicente	Mr. Hiraga's explanation: ● Need to monitor preparation works for equipment installation by stages. ● How to formulate the schedule for preparation works. ➢ Identification of works to be executed. ➢ Assignment of people responsible for work execution. ➢ Identification of works by stages. ➢ Preparation of the comprehensive schedule. ● Setting up a communication channel between the Cuban side and the Japanese side. ➢ The Cuban side will send a monthly report of the progress made regarding work execution. ➢ The Japanese side will send any new relevant information required. ➢ Information exchange will be implemented through Mr. Raúl Aguilar (Cuban side) ⇔ Mr.Kawaji (JICA) ⇔ Mr. Hiraga (Japanese side) ● Explanation about preparation works. ➢ About the foundations for the lathe and the milling machine. • According to the Cuban standard, equipment should be anchored. ➢ About the foundations for the bench drill press and the grindstone, they should be anchored to the floor. ➢ Both the Cuban side and the Japanese side will be in charge of the connection of the lubrication system piping. • The Cuban side will be in charge of the air piping in the compressor room. • The Cuban side will be in charge of the oil pipe up to the oil depot. • The Cuban side will be in charge of the electric installation. • The Japanese side will be in charge of the rest. • A Japanese expert will be sent to guide equipment installation, and the Cuban side will implement it. • The Japanese side is concerned about the lack of the specified pipe. Can the pipe STPG370 be acquired in Cuba? ⇒ The Japanese side is waiting for a response by the Cuban side. ● Mr. Yamanaka explains the following: ➢ Equipment included in the second batch requiring preparation works. ● Mr. Diego and Mr. Dosho explain what needs to be carried out to improve the Heavy Equipment Workshop.
Place	Calle 30	

Date	December 3, 2010	Description
Participants	Raúl, Alejandro Hiraga, Yamanaka Hashimoto (Interpreter)	● About the present condition of Japanese compactor trucks operating in Habana Vieja municipality. ➢ Out of a total 6 trucks, 4 are out of operation. ➢ A visit to the workshop was scheduled for December 6.
Place	Central Workshop	

3.1.4 Guidance to Improve Compactor Trucks Maintenance.

The C/P was informed about the equipment to be received during the third year of the project, for the installation of which wiring, water and air piping should be prepared in advance. They were also informed about preparation works to install machine tools for which bases need to be built.

With regard to equipment installation, the following was recommended:

(1) Identification of equipment location and area design,
(2) Identification of design, preparation works, and materials and supplies to be purchased,
(3) Appointment of the staff for each activity,
(4) Identification of the specific contents of each activity, and
(5) Preparation of the general schedule.

A Japanese installation expert is planned to be sent to Cuba during the third year to guide onsite equipment installation. Therefore, it is absolutely indispensable that all preparation works are finished prior to his arrival. Some strict monitoring by stage should be implemented, and the Japanese side should be timely informed of the actual progress made in order to prevent that both JICA experts and the Japanese installation specialist are untimely sent to Cuba.

Although the bid for the second batch of donated equipment was already held, the equipment has not been selected yet. Consequently, the Japanese side should inform the Cuban side about equipment specifications when the information is disclosed. Close communication between the two sides is expected, especially when the Japanese experts are not based in Cuba. A communication channel to convey relevant information should be ensured as communication via Internet is difficult in Cuba.

In order to ensure all this, the Cuban side was instructed regarding equipment installation method, location design, as well as the way to monitor the progress of preparation works. Guidelines are shown below.

a. Equipment Installation and Location Design

Donated equipment and tools may be classified into three categories, namely, 1) those not requiring preparation works as in the case of tools, 2) those requiring base building for installation such as machine tools, and 3) grease and lubrication supply system equipment.

A Comprehensive Table of Equipment Installation Specifications was prepared to be used for the explanation to the relevant sections of the Cuban side, including detailed information about wiring, compressed air piping, water piping, and base building for each piece of equipment.

Moreover, some specific information (partially translated into Spanish) obtained from the manufacturer, including foundations plans, about machine tools for the installation of which bases need to be built was conveyed and explained to the Cuban side.

The Cuban side was also informed that the regular procedure in Japan is to install a machine tool such as a lathe on a leveled surface without using anchor bolts. However, the Cuban side, based on the existing standard, has planned to anchor the machine tools.

Equipment requiring accurate location design planning are the machine tools (lathe, milling machine, bench drill press, and grindstone), and the lubrication system equipment (five pumps for lubricants, one pump for grease, and the air compressor).

Japanese experts and the C/P jointly checked the future equipment location layout for the Machine Tools Area.

The new equipment (the lathe and the milling machine) are to be installed respectively where a lathe and a milling machine currently out of operation stand. When taking into account cost reduction for foundation building, the experts suggested the Cuban side should use existing bases by just pouring some fresh concrete. Regarding the bench drill press and the grindstone with pedestal, the experts recommended they locate them next to the walls of the machine tools room for the sake of space efficiency as the existing bench drill press and grindstone are still operational after all.

Present and future location of equipment in the Machine Tools Area is shown in Figure 3-2.

For the lathe and the milling machine requiring base building, the basic concept of the milling machine base is shown as reference in Figure 3-3. The experts suggested the Cuban side that if for some existing requirement (a Cuban standard, for example), machine tool anchoring is deemed necessary, they should use anchor bolts. In case vibrations generated elsewhere affect the milling machine operation, the equipment base should be isolated from the floor by digging a trench around it and using some vibration-absorbing material.

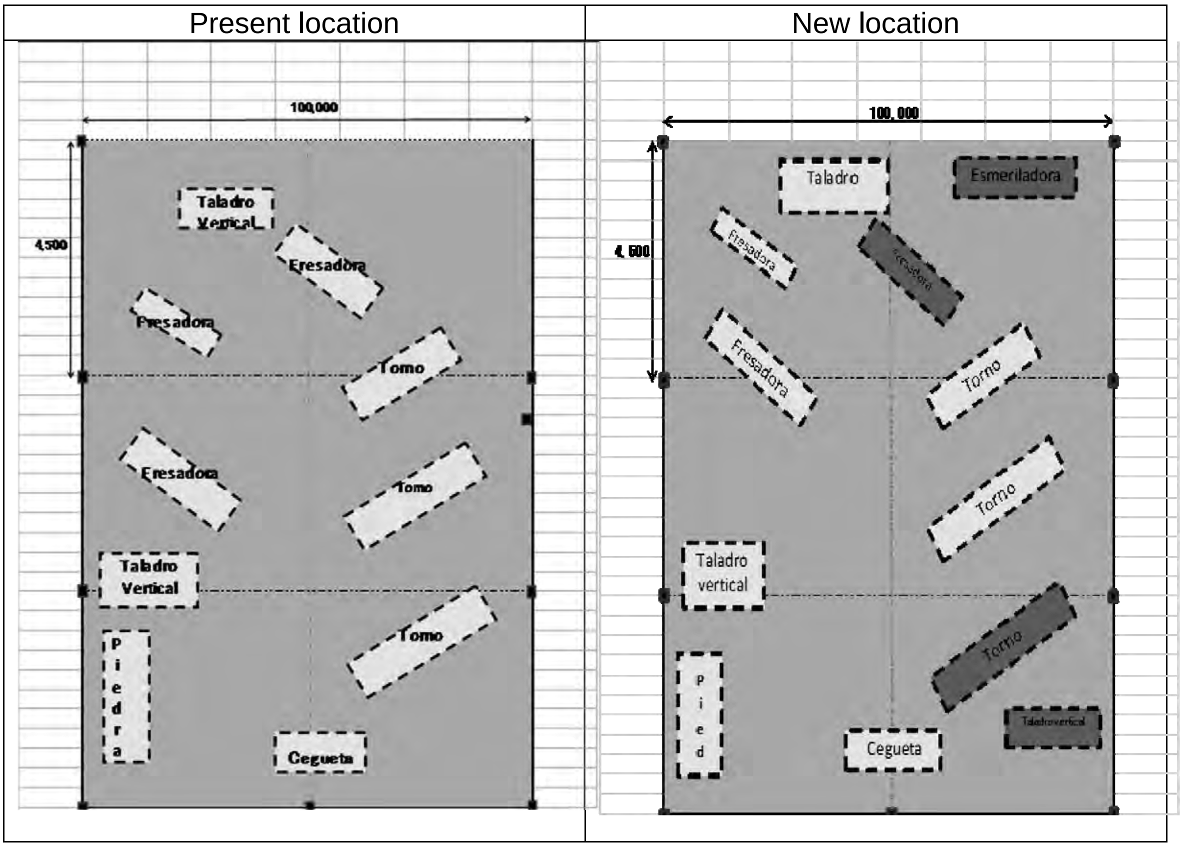


Figure 3-2: Concept of Equipment Location in the Machine Tool Area (Unit: mm)

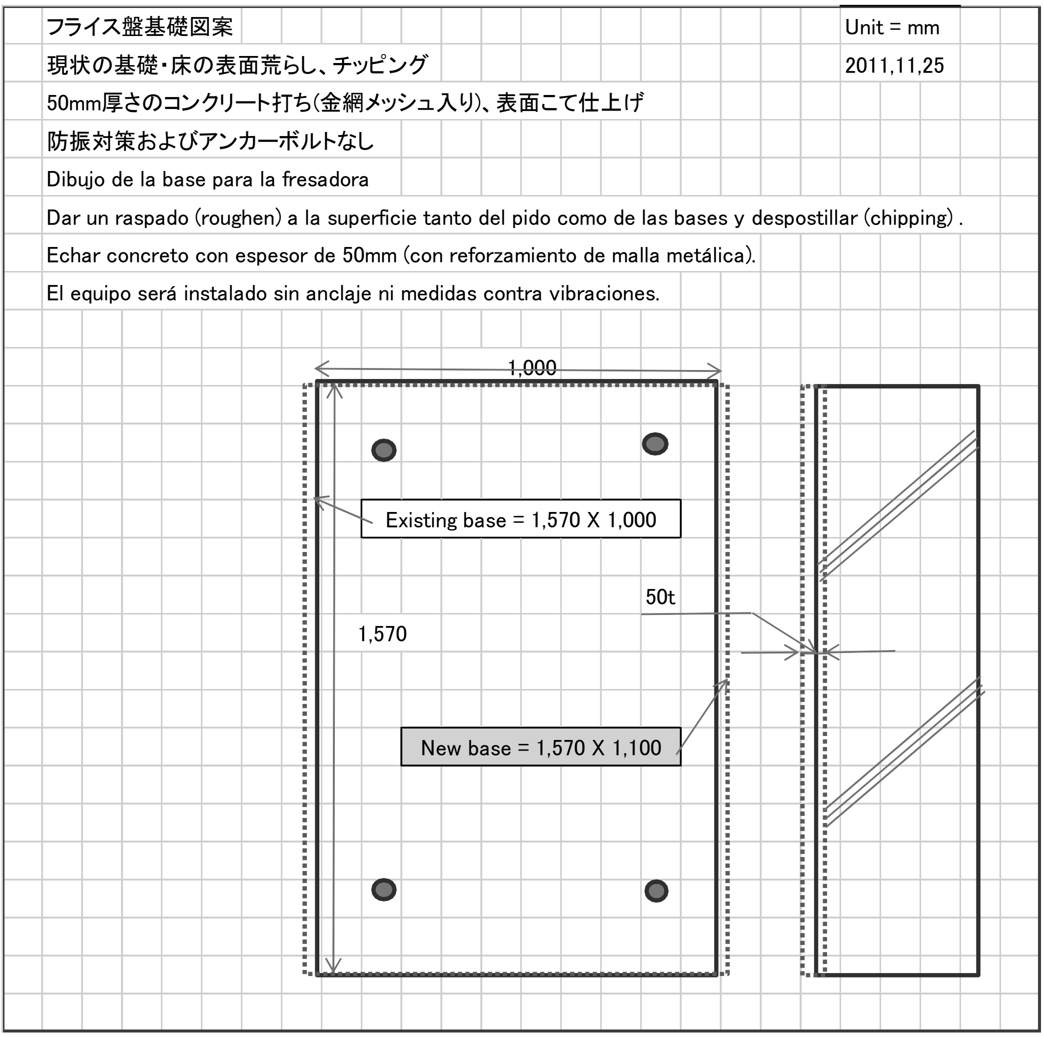


Figure 3-3: Example of Base for the Milling Machine (Unit: mm)

The power supply breaker box at the Machine Tools Area is equipped with an NFB at the top, and power reaches the equipment side after the junction passing through the breakers. The existing box is rather worn, and the experts suggested they replace it with a new one. However, if due to some financial restriction, replacement was found difficult, the experts recommended that the Cuban side should at least install NFB's exclusively for the new equipment.

On account of the need to remove existing equipment currently out of operation, to repair the bases, and to install the new donated equipment, a number of coordination meetings were held between the two sides. Instructions for lathe installation are shown in Table 3-1.

Table 3-1: Instructions for Lathe Installation

Location	Remove existing broken lathe and install the new donated lathe in the same place. As the new lathe is smaller than the existing one, there is enough room for it, so no problems for installation are anticipated.
Base	The floor of the Machine Tools Area is made of concrete, and there exist a two-piece base (70 mm high) used for the existing large lathe. The surface of both the base and the floor was recommended to be roughened, and concrete (50mm thick) was suggested to be used together with a reinforcing metal mesh.
Wiring	Existing wiring is laid inside the underground pipe. If wiring can be removed, it was agreed to possibly use existing pipe. The experts suggested that the Cuban side should install 20A NFB in the electric box, and use a CV2.0 mm² x 4c cable (3-phase 220V + ground connection) or a similar one.
Steps to be followed	(1) Remove the existing lathe. (Turn off power first to avoid electric shocks). (2) Prepare the surface. Roughen the surface of both the floor and the base. (3) Install the metal mesh and pour the concrete. (4) Finish the surface by leveling it. (5) Install the new lathe. (6) In case anchor bolts are used, the lathe should be placed on top of the base tentatively, and the position of the anchor bolts is checked. After any adjustments necessary, anchoring holes are filled with mortar so that the anchor bolts are fixed shaping a letter L. (7) Wiring (install NFB's and wires) (8) Extend wiring to reach the equipment side (Do not connect it). Wait for instructions to be given by the Japanese installation expert to be sent to Cuba.

Regarding the location of the lubricant system piping, it was recommended that the place where grease and lubricants will be supplied should be identified first, and then the place for the location of the air compressor. It was agreed that the new lubrication system will be installed in the same place where grease and lubricants are currently been supplied at the Central Workshop.

(1) In the large room (warehouse), 3 pumps will be installed for lubricants (transmission oil, engine oil, and reserve oil), as well as a pump for grease.
(2) In the small room two containers will be available for frequently used hydraulic and engine oil. These containers will be equipped with pumps, and they will be connected to the tanks installed outside the small room.

To operate these 6 pumps (pneumatic pumps), compressed air supplied by the newly acquired compressor is required. Air pipes will be connected from this new compressor to each pump. The compressor will be installed in the compressor room located next to the above-mentioned small room, and the existing air tank will be used. The air tank has not been used for some time, so it should be checked thoroughly to detect any sign of corrosion.

The ground plan of the lubrication system is shown in Figure 3-4.

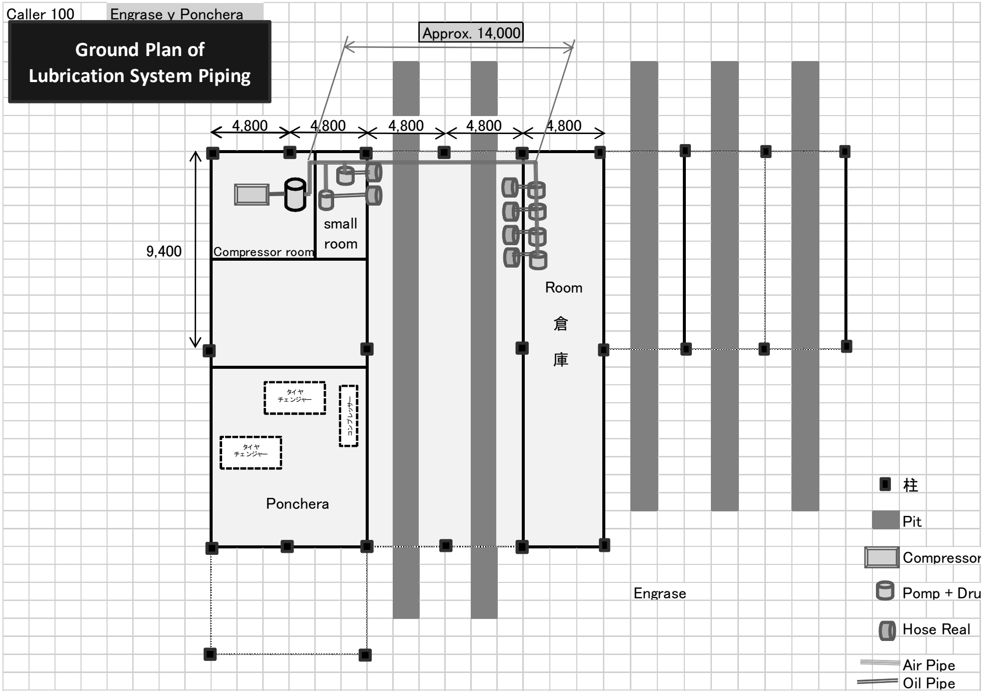


Figure 3-4: Ground Plan of the Lubrication System Piping (Unit: mm)

The experts explained to the C/P the general characteristics of the grease and lubrication system and the dimensions of some system components (pumps and hose reels). The C/P was requested to prepare the systematic piping plan.

b. Preparation Works Progress Monitoring

Due to the urgent need to timely and accurately conclude all preparation works for equipment installation, several meetings were held with concerned organizations, including C/P members, to explain the precautions to be taken for equipment installation, and the items necessary for preparation works monitoring. The man points of such an explanation are shown below.

(1) Identify the items to be prepared.
(2) Appoint people responsible for execution of each activity, namely, equipment location, works design, material acquisition, construction works, onsite inspection, etc.
(3) Identify equipment location, basic design, and acquisition of required materials.
(4) Preparation of the Specifications Sheet for works and project design.
(5) Acquisition of necessary materials and execution of preparation works.
(6) Tentative installation.
(7) Inspection.

All these activities were instructed to be included in a single schedule, and work progress should be recorded by comparing it to planned progress. Periodic meetings attended by all people involved in works preparation were also recommended. It was agreed that progress will be checked at the Investment Meeting held by the Cuban side every Friday after onsite inspection conducted on Wednesdays.

Close and timely communication between the two sides is also required as preparation works should be completed by the time JICA experts and the Japanese installation expert are assigned to Cuba. The Japanese side will be sending relevant information to the Cuban side. However, due to existing difficulties regarding communication via Internet, it was agreed to set up a formal communication channel between the two sides supported by JICA's technical cooperation coordinator in Cuba.

c. Courses on compactor trucks maintenance

c.1. Courses on compactor trucks maintenance management

During the first year of the project the C/P requested the Japanese experts to hold training courses about compactor truck maintenance and preventive maintenance. Likewise, as the experts realized some potential for improvement of maintenance currently being implemented, during the second year a general course on compactor truck maintenance management was held focusing on maintenance managers. The contents of this course are shown in Table 3-2.

Table 3-2: Course on Compactor Truck Maintenance Management

Ítem	Description
Management issues	(1) Trucks acquisition, (2) Trucks Operation, (3) Inspection, (4) Maintenance. These issues should be improved.
Compactor truck acquisition planning	Based on the Basic Plan for Solid Waste Management, a truck acquisition program should be planned. Prepare the basic criteria to evaluate life service of trucks. Even if acquisition is found difficult, timely acquisition should be appropriately planned. Precautions should be taken to select truck type and capacity.
Truck operation	(1) Safe operation, (2) Daily inspection prior to operations, (3) Importance of washing the truck after operations.
Inspection	(1) Daily inspection before operations conducted by the truck driver, (2) Scheduled workshop maintenance, (3) Inspection results report, and use of the information resulting from inspection.
Maintenance	(1) Maintenance workshop improvement, (2) Availability of the necessary tools and equipment, (3) Technical improvement of maintenance.
Preventive maintenance	Differences existing between corrective maintenance and preventive maintenance. Interval-based maintenance and condition-based maintenance. To carry out preventive maintenance, technical level of maintenance and breakdown diagnosis should be improved to enable inspection, parts replacement (filters and oil) and scheduled maintenance.
Introduction to maintenance procedures implemented in Japan	Initial inspection ⇒ Washing ⇒ Maintenance ⇒ Final inspection. Besides explaining above-mentioned concepts, refer to existing differences between maintenance procedures in Japan and in Cuba. (In Japan, all maintenance operators perform all kinds of maintenance works.)
Inventory control	Explanation of monitoring of materials necessary for maintenance, as well as monitoring records. Need to identify relevant information. Inventory checks, etc.
Safety and hygiene	By showing some serious accidents occurred in Japan related to solid waste collection and compactor trucks maintenance, refer to the need to set up a labor safety commission in order to promote safe truck operations and maintenance. Presentation of a number of activities carried out in Japan to improve safety, as well as training in KYT (Risk prediction training)
Date	November 25, 2010 9:30 – 12:30
Lecturer	Ryo Hiraga

Ítem	Description
Participants:	
Dagoberto Sierra Escalona	Grease and lubricant technician
Juan Estrada Sarría	Head of Transportation
Reynaldo Boloy Gómez	Mechanic
Frolián Portillo Romero	Technician
Isabel Tamayo Domínguez	Transportation expert
Sanyi Marrero Stuar	Technician
Blanca Almagre Jaime	Technician
Niurka Páez Blanco	Technician
Félix Abreu La Calle	Central Workshop manager
Nury Cárdenas Véliz	Repair and maintenance expert

c.2. Training Course on Hydraulic and Electric Systems of the Compactor Truck

In Havana City, compactor trucks manufactured in various countries, including Japan, are used for solid waste collection. Japanese trucks are especially equipped with mechanisms devised to facilitate loading (automatic loading), and operational safety (both of the truck and the driver). Consequently, their hydraulic and electric systems are rather complex. As long as the staff do not manage to read (understand) these hydraulic and electric systems, not only will accurate failure diagnose be difficult, but also repair using empirical intuition will prove risky.

A course on this topic was planned and carried out in order to enable staff to understand the hydraulic and electric systems of Japanese compactor trucks donated to Habana Vieja municipality. The course was intended for maintenance operators, electricians, hydraulic works experts, repair mechanics, and technicians.

Firstly, in order to help them understand the various truck maneuvers, the basic functions of loading and unloading, including existing differences depending on truck model and brand, were explained. As the Japanese compactor truck is equipped with several safety devices and mechanisms, safety measures such as prevention of excessive hydraulic pressure and care to prevent operator accidents, should be known. Therefore, details of safety functions of the compactor truck were shown.

The course lasted three days (November 19, 22, and 26). The first day was devoted to maneuvers and safety measures.

The second day a compactor truck was used to explain actual maneuvers, and location of some parts, switches, and sensors.

The third day attendants were taught how to interpret hydraulic and electric circuits for each maneuver (function).

The specific contents of the course are shown in the three following tables.

Table 3-3: First Course on Hydraulic and Electric Systems of the Compactor Truck

Ítem	Description
Compactor type	(1) Tilting-type box, (2) Rotating-type board, (3) Expelling type. Maneuvers of each type of truck.
Truck maneuvers	Loading, unloading, compacting, dumping, etc.
Safety measures	(1) Measures to prevent abrupt tailgate descent, (2) Safety valve (relief valve) valve, (3) Tailgate self-locking device, (4) Safety rods (tailgate an truck body), (5) Safety switch for tailgate descent, (6) Emergency stop switch, (7) Emergency stop lever, (8) Moving tailgate alarm, etc.
Safety measures during loading	Emergency stop switch, emergency stop lever, function of the self-locking device, maneuvers, and hydraulic and electric systems.
Safety measures during unloading	Open and close the safety lock, check tailgate descent, mechanism preventing the tailgate from descending abruptly in case the hydraulic hose breaks, maneuvers, and hydraulic and electric systems.
Electric parts	(1) Relay types, (2) Timer functions
Relief valve	Structure of the relief valve (safety valve) and functioning and adjustment method.
Date	November 19, 2010 9:00 – 12:00
Lecturer	Tadayuki Yamanaka
Participants	
Name	Position
Cecilio Lázaro Alfonso Junco	Mechanic (hydraulic system)
Juan Rodríguez Martínez	Mechanic (hydraulic system)
Daniel Pedro García Cardet	Mechanic (hydraulic system)
Elidáis Sanz Lima	Electrician
Carlos Sanz Lima	Electrician
Juan Estrada Sarría	Head of Transportation
Enrique García	Technician
Isabel Tamayo Domínguez	Transportation expert
Nury Cárdenas Véliz	Repair and maintenance expert
Félix Abreu La Calle	Central Workshop manager
Fernando Amil Leal	Technical Department Head
Raúl Aguilar González	Vicedirector of Mechanization

Table 3-4: Second Course on Hydraulic and Electric Systems of the Compactor Truck

Ítem	Description
Practical course using a compactor truck	Practical training using a compactor truck to teach maneuvers and functions.
Functions	Loading, unloading, tailgate ascent and descent, expelling and return of the expelling device, hook check switch, extraction switch, PTO, etc. Verification of on-off switch.
Tailgate	When the tailgate is up, it is extremely dangerous to be under it, so the safety lock switch should invariably be on.
Expelling device	Forward movement and reverse of the expelling device. Explanation of the mechanism for automatic reverse.Avance y retroceso del expulsor y explicación del mecanismo de retroceso automático.
Importance of communication	Safety and hygiene issues related to communication between driver and operators.
Theoretical explanation	Explanation using a PowerPoint presentation
Relay	Function, type, structure, and name of each part. Functioning within the electric circuit.
Tailgate	Showing of a number of accidents occurred in Japan in which operators have been caught between the tailgate and the truck body. Japan's labor safety law establishes that this type of truck must be equipped with a mechanism to avoid abrupt tailgate descent. The experts explained to the trainees the special cylinders used for this device. The tailgate does not fall abruptly in case the hydraulic hose breaks.
Safety valve	Function and structure of the safety valve, movement of the needle-type valve) The experts explained that the valve breakdown may bring about the hydraulic

Ítem	Description
	hose failure, damage to the hydraulic pump, or the breakdown of the connecting parts of the pipes or cylinders.
Date	Noviembre 22, 2010 9:30-12:30
Lecturer	Tadayuki Yamanaka
Participants	IDEM

Table 3-5: Third Course on Hydraulic and Electric Systems of the Compactor Truck

Ítem	Description
Multivalves (5)	Structure and function
Hydraulic and electric systems	How to interpret (read) hydraulic and electric circuits during dumping, loading, ascent and descent maneuvers.
Proximity switch	Location of proximity switches and how to read them in the electric circuit.
Type of cables	How to distinguish low voltage cables used for automobiles by their color.
Arnés	Connection of switches used for each control, and structure.
Date	November 26, 2010, 9:30 – 12:30
Lecturer	Tadayuki Yamanaka
Attendants	IDEM

c.3. Practical Training with the Compactor Trucks (safe operation and maneuvers, and daily inspection)

Taking advantage f the donation of five (5) used Japanese compactor trucks to Regla municipality through the non-refundable cooperation scheme, a training course on truck operation and maintenance was held. Compactor truck drivers from Regla municipality were also invited to attend the course focusing on (1) safe operation and maneuvers, (2) daily inspection method (3) truck safety devices.

The Japanese compactor truck is rather automated and it is equipped with a number of safety devices. Therefore, operators should know their functioning as otherwise problems related to safety operations may arise. Likewise, not knowing the location of switches and sensors, as well as their specific functions, may affect appropriate failure diagnosis. Moreover, from the point of view of preventive maintenance, daily inspection prior to operations, and daily truck washing after operations, help increase its life service.

Consequently, newly donated compactor trucks are ideal teaching materials for training. Details of the training course held are shown in Table 3-6.

Table 3-6: Training Using the Newly Donated Compactor Trucks

Ítem	Description
Safety measures	Explanation of safety measures using a PowerPoint presentation. ● Tailgate safety device, and cylinder structure ● Explanation of locking switches located in the back of the truck (Preventing incorrect operation by the driver).
Safe operation	Presentation of safe operations using a PowerPoint presentation. ● No turning on the PTO switch while the truck is moving. Close communication between the driver and the operators is indispensable. ● The tailgate lock device should be engaged during loading. ● Operators should avoid getting stuck in the blade. ● Avoid loading inappropriate wastes. ● Precautions to be taken while working inside the compacting box (the operator entering the box should turn off the engine). ● Adjustment and verification of the loading cycle. ● Meaning of the tailgate emergency stop devices. ● Use of safety rods (for the tailgate and the truck body)

Ítem	Description
Safe operation measures	● Assignment of the safe operations supervisor. ● Warming prior to beginning of operations ● Use of safety shoes and gloves. ● Preventive measures to avoid back and waist injures.
Practical explanation of the compactor truck	Explanation of the truck parts ● Control panel in the truck cabin. ● PTO switch function. ● Verification of each maneuver (loading, tailgate ascent and descent, revolving board turns, expelling reverse, locking) using the switches.
Initial daily inspection	Practical training related to daily inspection before operations. ● A list of daily inspection activities was handed in, and inspection was simulated.
Instructions to repair current failure	Oil leakage through the clutch cylinder HOW835. The experts explained how to replace the part.
Questions and answers	The drivers of the 5 compactor trucks asked a number questions about operation and maneuvers, types of lights, fuses, etc. All questions were properly answered.
Date	December 1, 2010 9:00 – 12:30
Trainers	Yamanaka y Hiraga

Attendants:

Name	Position
Félix Sehwenent Suárez	Head of Services
Alejandro González Rodríguez_	Director
Miguel Sánchez Caraballo	
Rafael Cruz Sebastián	
Leopoldo Luis Yaestaey López	
Rabel Calá Ríos	
Lázaro Valles Peña	
Alfredo Rubino	
Claudio Brown Pino	Repair and maintenance technician
Angelina Moya Vidal	Technician (fuel)
José A. Catete	Mechanic Class A
José M. Hernández	Head of Mechanization
Others	

3.1.5 Progress in the Preparation Works for the Improvement of the Workshop

a. Introduction

During the first stage of the project, the current condition of the workshop, both in terms of facilities and tools and equipment, was analyzed. The names and number of tools and garage equipment necessary for appropriate workshop operation were identified by each area for their location.

The Japanese experts have already thoroughly identified the tools and equipment to be received in June-July, 2011. Once installed, we will be in a position to profit from the works so far executed.

b. Main Activities Carried Out During This Stage of the JICA Project

- By the Japanese side:

  - The lists of tools and equipment approved for the workshop were submitted.
  - Tools and equipment manuals, as well as the manufacturer’s technical requirements for electric and hydraulic installation, were also submitted.
  - Training

- By both sides:

  - Exact dimensions for the future location of the machine tools were identified, and the plans for the foundations were prepared.
  - Both the dimensions and the positions for the location of the air piping system for lubricant and grease supply were identified.
  - The future location of the air compressor for the lubrication facility, as well as the air piping system, was identified.

- By the Cuban side:

  - The number of C/P members was increased with the appointment of two new people to ensure the completion of the construction stage prior to the reception of the tools and equipment.
  - The workshop electric panels are being remodeled.
  - A survey of the existing electric installation was conducted, and GEYSEL is currently working on a project for the required electric installation.

c. List of Tools and Equipment and Technical Characteristics for Installation

JICA experts submitted to the Cuban side the official lists of tools and equipment approved according to the available budget, as well as the numbering of the two bids.

The technical characteristics to be taken into account for installation and protection of machine tools and garage equipment, as well as the equipment manuals, were also submitted.

d. Exact Location of Machine Tools

In this stage we endeavor to identify the exact location within the machine tool area for each machine tool to be received. We also identify which machine tools will be discontinued, and the necessary foundations to be built to anchor the machine tools, if necessary, as shown in the two figures below.

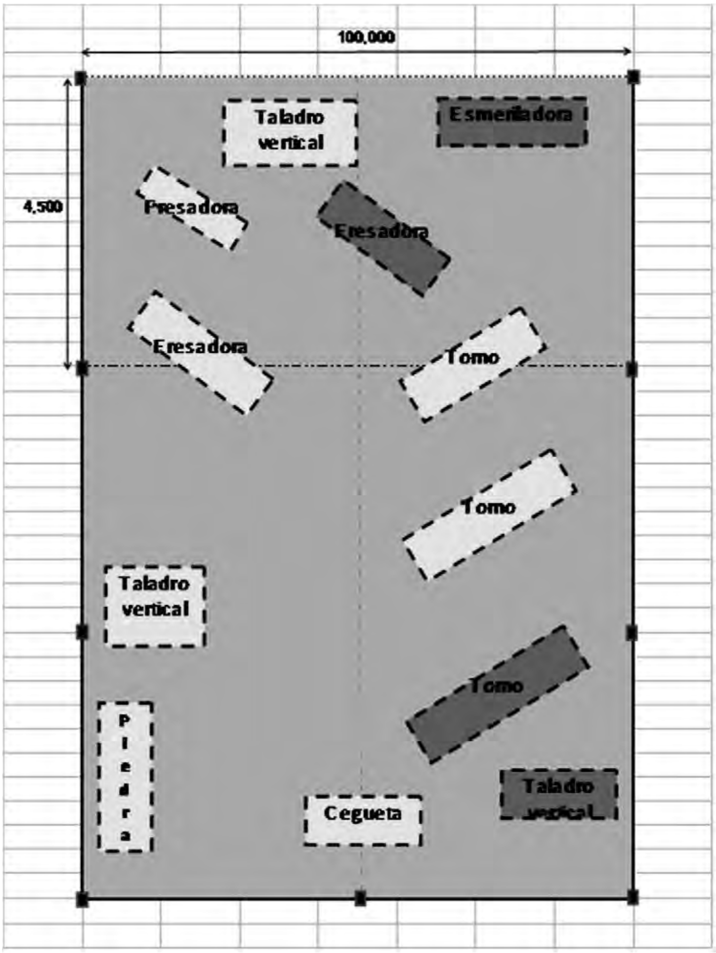


Figure 3-5: Exact Location of Machine Tools (Unit: mm)

Foundations with the necessary dimensions for machine tools installation according to the manufacturer's requirements were identified. An example of such a foundation is shown below:

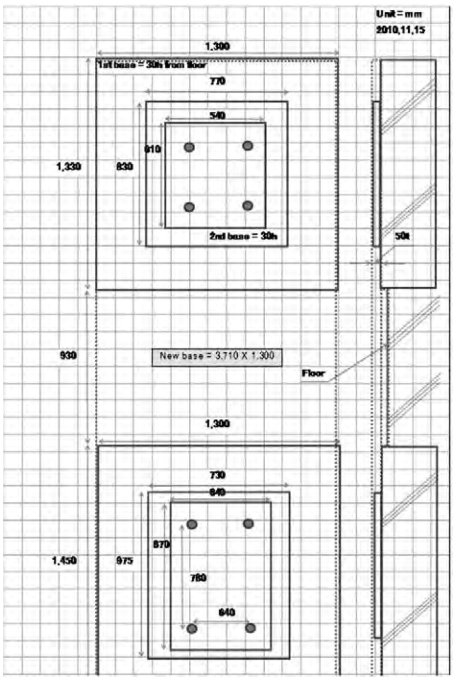


Figure 3-6: Example of foundation building for the lathe installation (Unit: mm)

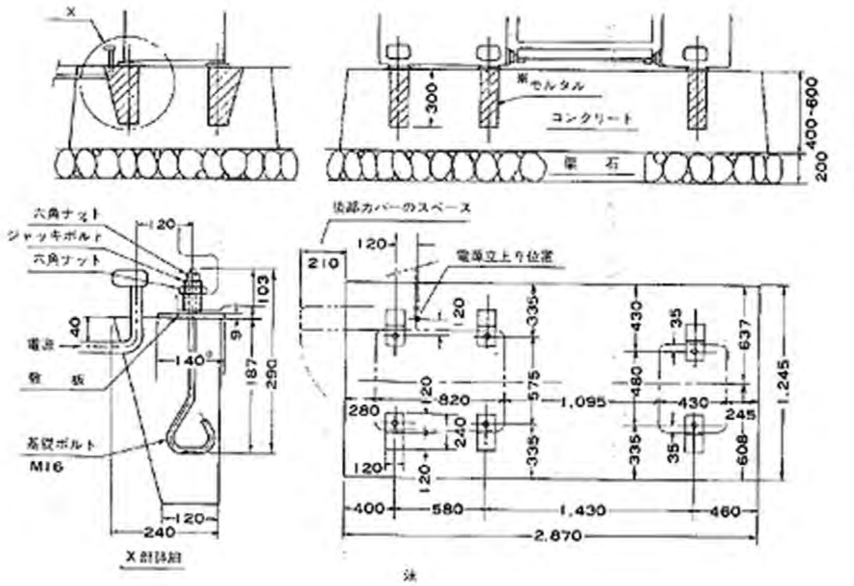


Figure 3-7: Manufacturer's Requirements for the Lathe Installation (Unit: mm)

e. Installation of air piping and compressor for the grease facility

- The location of each lubrication pump and hose reel by type of oil was identified.
- The places to store lubricants in the future, as well as the pumps to be deployed both inside and outside the facility, were identified.
- Accurate measurements for the location of the tanks and the hose reels were identified in order to be able to estimate the length of pipes necessary for installation, which will be acquired by JICA.
- The location for the installation of the compressor was identified.

All the above can be seen in the six (6) following figures:

As can be seen, all the preparation works necessary for equipment installation have been calculated and planned. The Cuban side should accomplish all the works planned during the construction stage to realize this project.

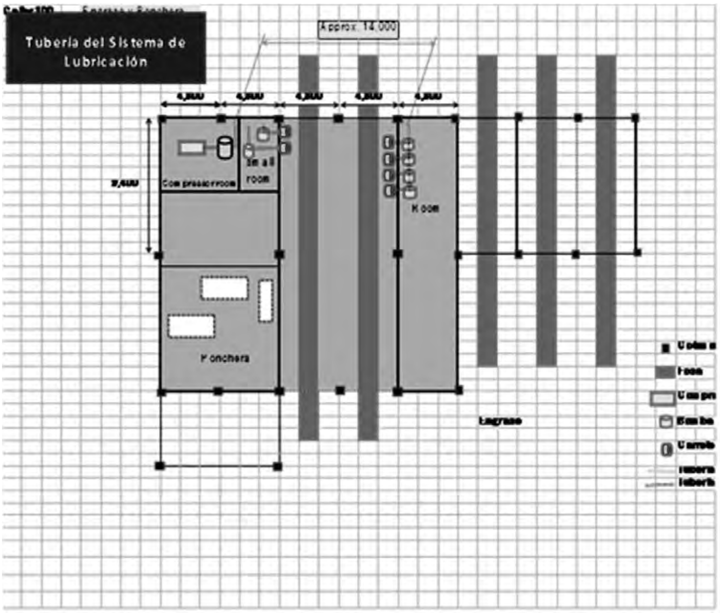


Figure 3-8: Lubrication System (Unit: mm)

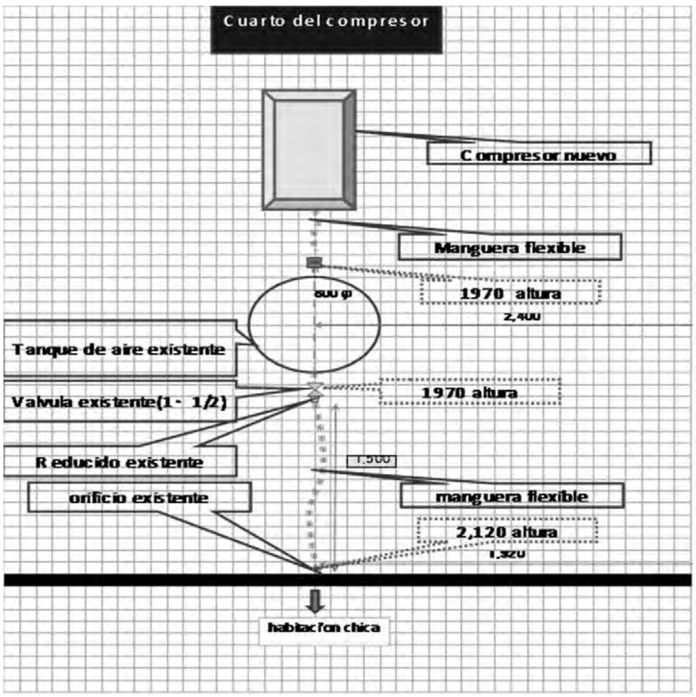


Figure 3-9: Compressor Room (Unit: mm)

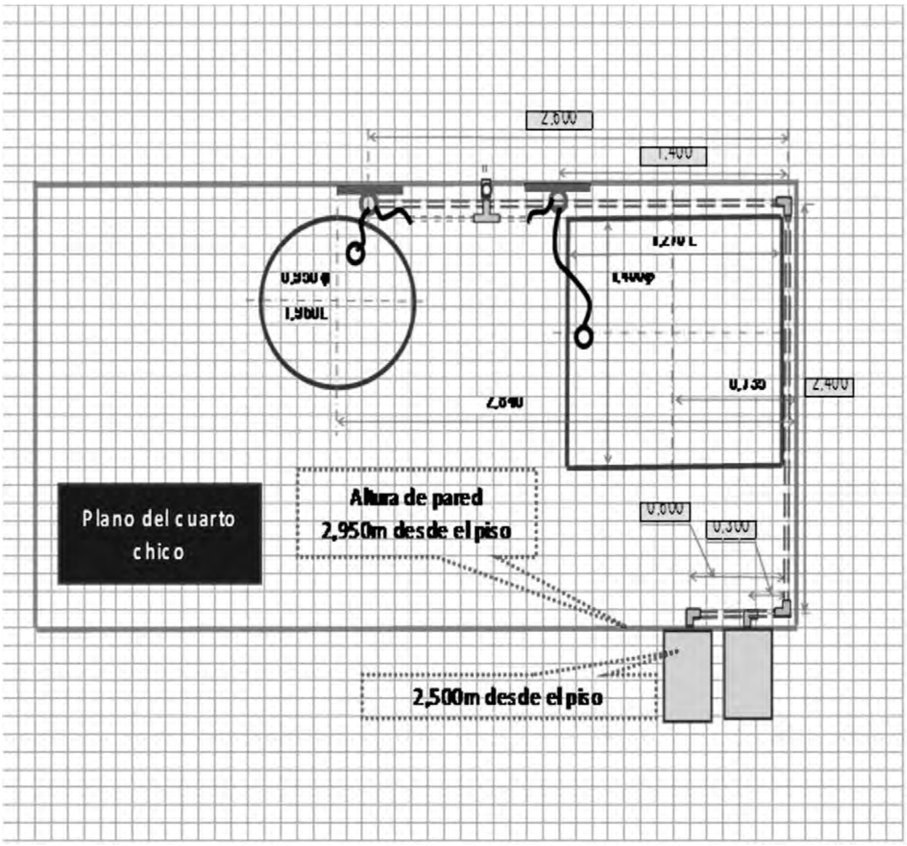


Figure 3-10: Small Room Layout (Unit: mm)

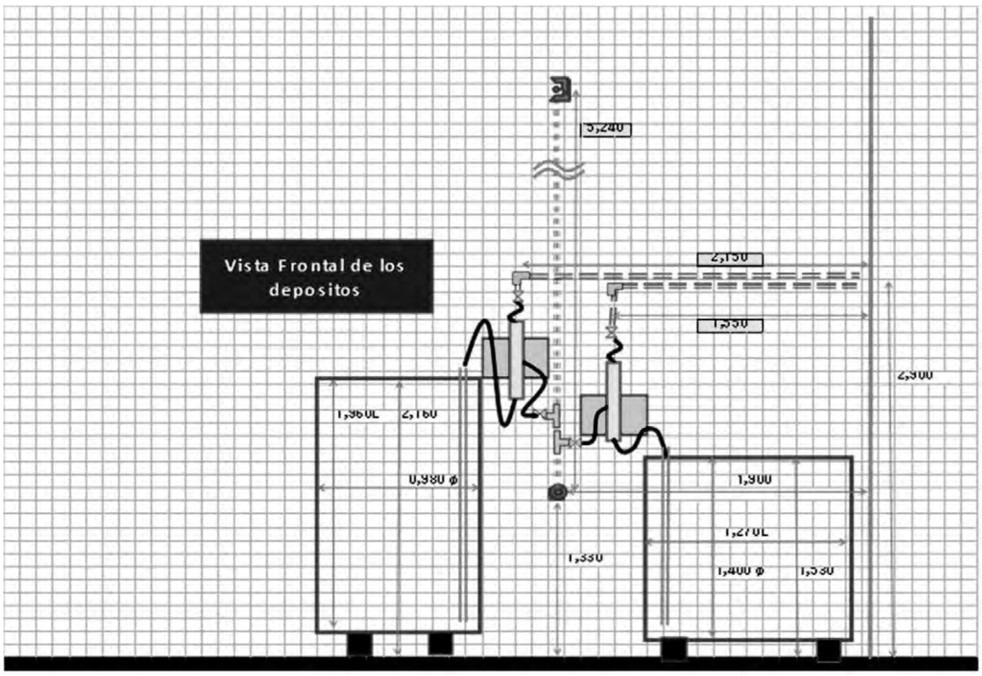


Figure 3-11: Equipment Front View (Unit:mm)

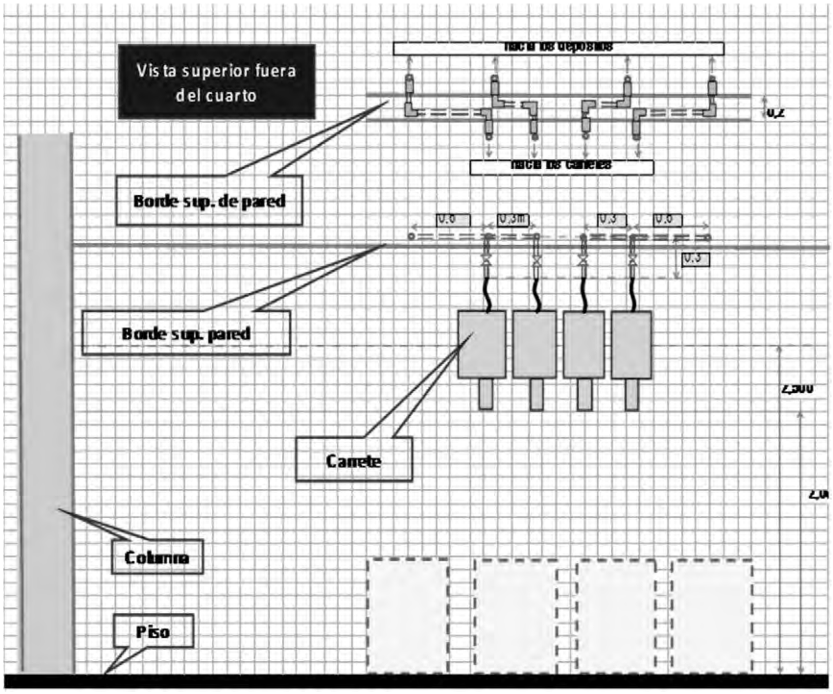


Figure 3-12: Piping Layout (Outside the Room) (Unit: mm)

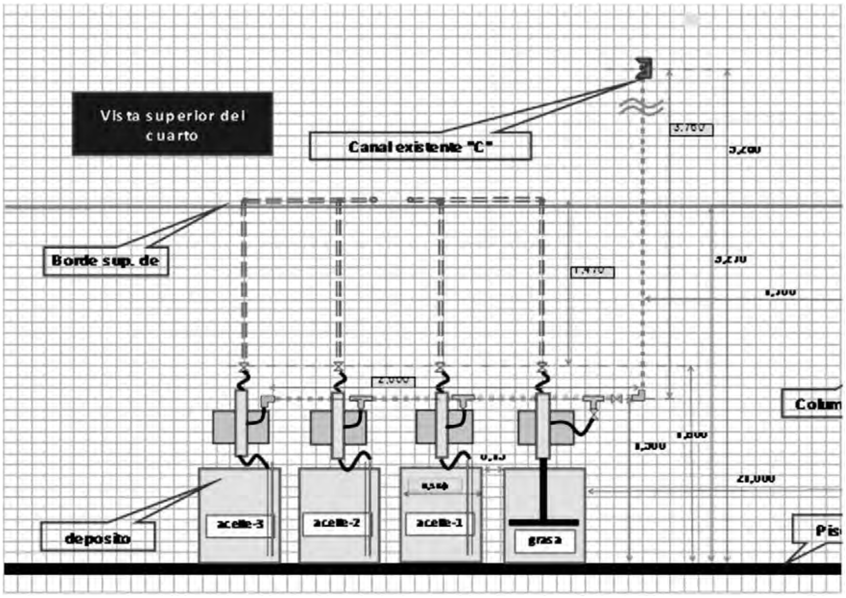


Figure 3-13: Piping Layout (Inside the Room) (Unit: mm)

The specifications of some equipment (the traveling crane, for example) have not yet been received. The Japanese side has promised to send us the required specifications in order to ensure the necessary preparations for installation.

f. Monitoring of the Progress of Preparation Works

The initial proposed schedule for the preparation works to be carried out at the workshops is shown below.

Table 3-7: Schedule for Preparation Works

No.	Activity	People in Charge	Dec.		Jan.		Feb.		Ma
	I Machine Tool Room								
1	For the machine tool room	Raul		■					
2	Remove equipment to be replaced	Raul		■					
3	Decide building of windows	Raul		■					
4	Windows acquisition	Diego			■	■	■	■	■
5	Remove all windows	Rolando							
6	Installation of all windows	Rolando							
7	Decide ceiling installation taking into account use of sunlight	Raul		■					
8	Ceiling acquisition	Diego			■	■	■	■	■
9	Hire ceiling removal and installation works	Diego							■
10	Assembling and installation of the ceiling	Raul							
11	Check hydraulic and sanitary facilities	Cesar		■	■				
12	Prepare hydraulic and sanitary project for the workshop, and a list of necessary materials	DCH				■			
13	Acquisition of hydraulic and sanitary materials	Diego					■	■	■
14	Execution of the hydraulic and sanitary projects	Rolando							
15	Decide electric project, including equipment connection and lighting	GEYSEL		■	■				
16	Identify necessary materials for work execution	GEYSEL		■	■				
17	Acquisition of necessary electric materials	Diego			■	■	■	■	
18	Prepare new electric ducts	Rolando							■
19	Prepare new hydraulic ducts	Rolando							■
20	Prepare new sanitary ducts	Rolando							■
21	Repair floors and build new bases	Rolando			■	■	■	■	
22	Installation of electric pannels	Rolando					■	■	
23	Fix outside electric boxes	Raul		■	■	■			
24	Preparation and painting of walls and floors	Rolando							
25	Maintenance of remaining equipment	Diego							■
26	Project for the compressed air system for the machine tools area and the injection lab	Cesar					■	■	
27	Materials acquisition	Diego							■
28	Project execution	Rolando							
29	Decide air extractors	Cesar		■					
30	Air extractors acquisition	Diego			■	■	■	■	■
31	Air extractors acquisition	Rolando							

No.	Activity	People in Charge	Dec.		Jan.		Feb.		Ma
	II Injection Lab								
32	Decide ceiling	Cesar							
33	Hire ceiling installation works	Diego							
34	Ceiling installation	Rolando							
35	Decide electric project, including equipment connection and lighting	GEYSEL							
36	Identification of necessary materials	GEYSEL							
37	Acquisition of necessary electric materials	Diego							
38	Electric project execution	GEYSEL							
39	Acquisition of air conditioners	Diego							
40	Montaje del aire acondicionado	Rolando							
41	Preparation and painting of the area	Rolando							
42	Decide air extractors	Cesar							
43	Acquisition of air extractors	Diego							
44	Installation of air extractors	Rolando							
45	Decide building of windows	Raul							
46	Acquisition of buildings	Diego							
47	Remove all the windows	Rolando							
48	install all the windows	Rolando							
	III Greasing Facility								
49	Prepare electric project, including equipment connection and lighting	GEYSEL							
50	Identification of necessary materials	GEYSEL							
51	Acquisition of necessary electric materials	Diego							
52	Electric project execution	Rolando							
53	Air compressor room remodeling	Rolando							
54	Decide compressed air system	Cesar							
55	Prepare project for the lubrication system	Ryo Hiraga							
56	Preparation and painting of the tire repair shop and greasing facility	Rolando							

No.	Activity	People in Charge	Dec.		Jan.		Feb.		Ma
	IV Repair Workshop (area #1) y welding (area #2)								
57	Prepare electric project	GEYSEL			■	■			
58	Prepare hydraulic project	DCH			■	■			
59	Prepare sanitary project	DCH			■	■			
60	Prepare compressed air system project	DCH			■	■			
61	Acquisition of necessary resources for projects execution	Diego					■	■	■
62	Execution of the electric project	Rolando							■
63	Execution of the hydraulic project	Rolando							■
64	Execution of the sanitary project	Rolando							■
65	Execution of the compressed air system project	Rolando							■
66	Preparation and painting of the area	Rolando							
67	Floor improvement	Rolando							
	V Sanitary Washing Facility								
68	Prepare electric project	GEYSEL			■	■			
69	Prepare hydraulic project	DCH			■	■			
70	Prepare sanitary project	DCH			■	■			
71	Acquisition of materials necessary for project execution	Diego					■	■	■
72	Execution of the electric project	Rolando							■
73	Execution of the hydraulic project	Rolando							■
74	Execution of the sanitary project	Rolando							■
75	Preparation and painting of the area	Rolando							
76	Floor improvement	Rolando							
	VI General activities Central Workshop								
77	Decide load to be connected to the biogas plant to keep a reliable service	Raul			■	■			
78	Check drainage system, especially for the truck washing facility	Raul			■	■	■	■	
79	Check water supply, water tanks, and cistern	Raul		■					
80	Carry out survey of installed electric equipment, and decide installed load, and maximum demand	Raul		■					
81	Hire Havana Waters company to repair sanitary and stormwater drainage	Diego			■	■	■	■	
82	Reorganization of PGD, replacement of power supply cable, and earth connection	Raul		■					
83	Decide fire extinguishing system with specialized company	Raul			■	■			
84	Clean grease screens	Raul		■					
85	Clean workshop floors	Diego					■	■	

No.	Activity	People in Charge	Dec.		Jan.		Feb.		Ma
	VII Heavy Equipment Workshop								
86	Prepare electric project	GEYSEL			■	■			
87	Prepare hydraulic project	DCH			■	■			
88	Prepare sanitary project	DCH			■	■			
89	Prepare compressed air system project	DCH			■	■			
90	Acquisition of materials necessary for project execution	Diego					■	■	■
91	Execution of the electric project	Rolando							
92	Execution of the hydraulic project	Rolando							
93	Execution of the sanitary project	Rolando							
94	Execution of the compressed air system project	Rolando							
95	Decide ceiling	Cesar		■					
96	Acquisition of ceiling pannels	Diego					■	■	■
97	Ceiling installation	Rolando							
98	Project for offices	DCH					■	■	
99	Acquisition of necessary materials	Diego							■
100	Execution of the offices project	Rolando							
101	Painting of water tanks and structures	Rolando			■	■			
102	Decide with specialized company cistern to be used in case of fire	Raul					■	■	
103	Clean grease screens	Raul		■					

GEYSEL Enterprise has been hired for the electric projects. Hydraulic projects are in the final stage of contract negotiations with DSH. Building staff for execution of civil works is available. Materials estimation and acquisition are still pending.

3.1.6 Evaluation of Training Courses

This time (second year of the project) the following training courses were taught:

(1) Compactor trucks maintenance management,
(2) Hydraulic and electric systems of the compactor truck, and
(3) Practical training using compactor trucks.

A summary of the results of the evaluation conducted by both JICA experts and the C/P is shown below.

a. Training Course on Compactor Trucks Maintenance Management

Evaluation by JICA experts:

(1) Impacts:

- It seems that the need of an integrated compactor truck maintenance management was understood.
- It seems that they were aware of the need to improve labor health and safety.
- Learning maintenance steps as implemented in Japan is deemed useful in order to improve maintenance works in Cuba.

(2) Reflections

- As the course material was not handed in to the participants, it is uncertain whether they will remember it or not.
- It seems there was a certain discrepancy between the selection of participants and the contents of the course. The course should have rather been oriented for managers involved in maintenance management.
- As the scope of the course was rather comprehensive, it is uncertain whether or not the time devoted to it was sufficient, or that the attendees could grasp the whole extent of the contents taught.

(3) Prospects

- Some appropriate arrangements should be made with the C/P in advance regarding the course contents and the selection of participants, or the contents should be adjusted to meet the needs of the attendees.
- The courses should be planned in such a way as to not include so many topics, or the topics taught should be more specific, for instance, truck repair, maintenance, labor health and safety, etc.

b. Training Course on Hydraulic and Electric Systems of the Compactor Truck

Evaluation by JICA experts:

(1) Impacts:

- Even if so far they have been using their “empirical intuition”, it was well understood that in order to correctly identify existing hydraulic and electric failures it is necessary that the relevant plans are available, and that they are appropriately interpreted to pinpoint the problem.
- The meaning and function of safety measures were rather well understood.
- The functions and maneuvers of the compactor truck were rather well understood.
- The operation of relays, switches, and sensors was understood.

(2) Reflections

- Some of the people did not know the basic principles of a relay, for example. It was evident that the basic technical expertise of the participants was rather uneven.
- As the trucks in operation, save for the Japanese compactor trucks, are not equipped with complex hydraulic and electrical systems, some of the trainees felt they did not need to learn about them.
- As only few texts were translated into Spanish for the course, understanding was made more difficult.
- It is impossible to understand all the electric circuitry in such a short period of time.
- It is difficult to organize an extended course due to the long hours of work of the participants. Neither the JICA experts have enough time to devote to such a prolonged course.

(3) Prospects

- It is necessary to have some very basic information and the visual teaching material (models of relays, valves, etc., as well as the material required to practice how to assemble a circuit).
- Texts should be translated into Spanish.
- Courses related to simpler hydraulic and electric systems as the ones used by Chinese compactor trucks can certainly be more practical. However, it is extremely difficult for Japanese experts to gather information about Chinese compactor trucks and prepare the course materials based on physical observation of Chinese trucks.

c. Practical Training with Compactor Trucks (Operation, maneuver, and daily inspection)

Evaluation by Japanese experts:

(1) Impact

- As the drivers had not attended any course or received any explanation about their trucks, they asked many questions and had many doubts. The Japanese experts answered all questions and clarified all doubts.
- There existed hitherto some dangerous collection practices. Training is expected to bring about some positive changes in terms of operational safety.
- As they were not familiar with the method for daily inspection (the manual itself is rather insufficient), preventive maintenance is expected to be implemented from now on.

(2) Reflections

- We were dealing with five different kinds of trucks, so individual explanation to every driver was time-consuming.
- Participants suddenly begin discussions among themselves loudly, which made it more difficult for the experts to proceed with the lecture.
- Although the operation manual is available in Spanish, they have either not read it, or the information they look for is not therein contained. All the doubts expressed by the drivers cannot be clarified in such a short period of time.

(3) Prospects

- Sufficient time should be allotted for such a course for beginners.
- Selected invitation of key people to the course may increase training effectiveness as the number of participants to be taught is reduced.
- Cooperation with the manufactures of the truck body and the compacting box, and with the organizations and agencies concerned, should be implemented in order to obtain the

operation and maintenance manuals in Spanish.

- Some research needs to be done about how to acquire spare parts, etc., and it should be explained to them.

d. Evaluation by the Cuban Side

The Cuban side requested JICA experts to teach several training courses during the second year of the project in order to help enhance the skills of the technical staff, workshop personnel, and compactor trucks drivers and operators. The topics taught were the following:

d.1. Vehicle Maintenance Management and Preventive Maintenance

Ten people attended this course, their composition being as follows:

2engineers
4 technicians
4 workers

d.2. Hydraulic and Electric Systems of Compactor Trucks

Twelve people attended this course, their composition being as follows:

3 engineers
2 technicians
7 workers

d.3. Training Course on Compactor Trucks Donated by Japan

Eleven people attended this training course, their composition being as follows:

1 manager
4 technicians
6 drivers

The training courses were taught by JICA experts in a most professional way. When asked, attendees pointed out that the courses had been extremely useful to improve their skills, that the experts' explanations had been very clear, and that the information gathered would help them improve the quality of repair works.

Taking into account the great reception the courses had among our employees, we requested JICA experts to teach other courses during the third year of the project on topics such as the following:

- In-depth analysis of the hydraulic and electric systems of compactor trucks
- Hydraulic system of the Chinese compactor truck
- Topics related to the engine of the Mitsubishi compactor truck

Besides the courses taught, the Japanese experts also trained Habana Vieja workshop mechanics in both rotating and in-line injection pumps timing adjustment. Two trucks were out of operation due to pump-related problems. Thanks to the support by the experts, today (December 9, 2010) both trucks are being tested to get back to operations.

3.1.7 Technical Availability Coefficient (CDT)

The table below shows Technical Availability Coefficient (CDT) and Downtime of compactor trucks from January to November, 2010

Table 3-8: Monthly Downtime, Repair Time, and Standby Time

Month, 2010	TT	TR	TE
January	13.1h	9.23h	4.29h
February	7.11h	5.2h	2.3h
March	10.14h	8.53h	1.6h
April	9.08h	7.45h	1.23h
May	16.2h	8.21h	8.0h
June	9.35h	6.36h	3.38h
July	7.3h	5.18h	2.53h
August	39.38h	16.55h	22.34h
September	13.2h	8.41h	5.19h
October	8.58h	6.29h	2.28h.
November	17.38h	8.33h	9.04h

Note:
TT: total downtime in the workshop
TR: repair time
TE: standby time

- Average total downtime by truck: 13.45h
- Average repair time by truck: 8.38h
- Average standby time by truck: 5.46h

a. Technical Availability Coefficient (CDT) During the Time Period

- CDT~ 55.3% It includes trucks proposed to be discontinued
- CDT ~ 63.2% It does not include trucks proposed to be discontinued.

Note: The five (5) Mitsubishi compactor trucks donated by JICA to Regla municipality are not included in any CDT value.

3.2 Heavy equipment repair by using spare parts donated by the JICA Follow-up Assistance

On the occasion of acquisition of spare parts donated by the follow-up assistance of Japan, the Japanese expert team started repair of Komatsu's bulldozer D41E-6C by using the donated spare parts. The team at the same time conducted training of Cuban mechanics as the OJT on repair.

3.2.1 Target heavy equipment for repair

a. Situation before repair

The target heavy equipment for repair is a bulldozer of Komatsu donated in 2006 as part of follow-up assistance. The bulldozer type is D41E-6C, and is classified as middle sized one. It had been working for two years and for 2,475 hours net at November 2009 and remained nonoperational state.

The engine has proved unable to start even though we tried starting by ranking. This implied that the pressure of compression inside the cylinder did not reach the enough level to start. Then we judged the situation was caused by an abnormal abrasion of piston ring and that it was necessary to disassemble the entire engine for further examination and repair. We also assumed that the abnormal abrasion was caused by inferior maintenance of air filter.

b. Donated parts

The spare parts, which were manufactured by Komatsu in Brazil, were transported as airborne cargo through Canada. The parts list exhibits the contents of the airway bill attached to the airborne cargo as shown below. We confirmed the contents of the cargo by verifying the parts code written in both airway bill and the tag pasted on the plastic bag of parts one by one in the presence of Cuban officer who was appointed as the consignee. The all parts were handed over immediately after verification and stored in the designated space of the parts storage. We would use some of the parts by receiving them one after another according to the necessity that would be clarified as the repair goes on.

Table 3-9: Parts list provided by follow-up assistance

parts	code	qty	coincide or equivalent		no.
Filtro de combustible (Fuel filter)	6232-71-6112	4pcs	OK		
Filtro transmisión (0il Filter Gearbox)	23S-49-13122	2	OK		
Filtro hidráulico (Filter hydraulic system)	113-60-43321	2	OK		3
Filtro-elemento externo filtro AR	600-181-6550	2	OK	600-181-6050	4
Conjunto de biela (Rod Bearing set STD.)	6737-32-3100	6	OK		5
Retentor de borracha (seal dust (K4))	07145-00050	4	OK		6
Gaxeta de borracha (packing rod (K4))	707-51-50211	1	OK		7
Retentor de borracha (seal dust (K4))	176-63-92240	1	OK		8
Aro o de borracha (o-ring(K4))	0****-12100	1	OK	07000-12100	9
Aro de Teflon (ring, backup(K4))	707-35-52360	1	OK		10
Aro o de borracha (o-ring(K41))	07000-12105	1	OK	07000-02105	11
Aro do pistón (ring-piston(K4))	707-44-10280	1	OK		12

parts	code	qty	coincide or equivalent		no.
Aro de Teflón (ring, wear(K4))	707-39-10510	1	OK		13
Kit rep cilindro de inclinación (Blade tilt cylinder (inner parts))	707-98-42420	1	OK		14
Kit rep cilindro de angulacion (Blade angle cylinder (inner parts))	707-98-34590	1	OK		15
Polea tensora de correa (Tension pulley of leather belt)	6732-61-4110	2	OK		16
elemento interno (Air filter internal element)	600-181-6560	1	OK		17
Tornillos (Bolt)	0****-81040	4	OK	01010-82040	18
Tornillos de acero (Bolt)	01010-80840	2	OK		19
Arandela (Washer)	01643-70823	16	OK		20
Arandela de presión (Washer)	01643-31032	4	OK		21
Arandela plana (Washer)	01643-31232	4	OK		22
Aro o de borracha (O-ring)	07000-13048	1	OK		23
Aro o de borracha (O-ring)	07000-73022	1	OK		24
Aro o do tren de fuerza (O-ring)	07000-73030	1	OK		25
Aro o (O-ring)	07000-73042	1	OK		26
Manguera de borracha (Hose)	07260-03216	1	OK		27
Esparcidor (Flange)	07373-00640	1	OK		28
Tubo de acero (Tube)	KB151122	1	OK		29
Jg. de juntas (Gasket kit)	6731-11-9980	1	OK		30
Rodamientos (Bearing)	6754-22-8100	1	OK		31
Tubo (Tube)	KB151130	1	OK		32
Tubo (Tube)	KB151212	1	OK		33
pinzas de acero (Clamp)	07281-00549	3	OK		34
Filtro de aceite (250 horas) (Oil filter)	6***-51-5143	2	OK	6735-51-5143	35
Forro del cilindro (Cylinder liner)	6736-29-2110	6	OK		36
Jg. de aros do motor (Piston rings)	6736-31-2030	6	OK		37
Pistón (Piston)	6735-31-2140	6	OK		38
Juego de juntas (Engine gasket kit)	6735-01-1210	1	OK		39
Rodamientos (Bearing)	6732-31-3410	12	OK		40
CJ. bomba direccional (Pump assy.)	705-52-21070B	1	OK		41
Bomba da agua (Water pump)	6731-62-1120	1	OK		42
Correa de polea del motor (Belt 160 cm)	6734-81-6410	2	OK		43
Tornillo (Bolt)	01010-30865	4	OK		44
Tornillo de acero (Bolt)	01010-80850	4	OK		45
Tornillo de acero (Bolt)	01010-81240	4	OK		46

3.2.2 Training in repair

a. Deployment of mechanics at workshop for heavy equipment and participants in repair training

The workshop for heavy equipment has 16 mechanics at present, and the mechanics are classified into 12 class A mechanics, 1 class B, 0 class C and 3 assistant mechanics. Average age of mechanics was 49 years old in 2009 and has come down to 44 years old this year due to the entry of three youngsters. Each of the assistant mechanics is able to promote to mechanic by the result of the evaluation on capacity, which is done by the master mechanic Mr. Teddy, 43 years old. It usually takes a few years of experience before promotion. The title of master mechanic id conferred by the state government and regarded as the highest grade of the mechanic. Mr. Teddy is the only one person who is referred to as the master mechanic. The overhaul of engine this time is an ideal opportunity of On-the-Job-Training. We chose the master mechanic Mr. Teddy as the partner to conduct the repair and he instructed 3 assistant mechanics to join the repair and guided them.

b. Preparatory work to disassembly of engine

On November 5th, we held talks with the master mechanic Mr. Teddy on the repair work of engine and handed over the goods brought from Japan to make use for disassembly and assembly of engine. The goods consisted of such supplementary materials as Three-bond 1207C, steel paint, packing tape and luggage tag. These materials are used for identifying the disassembled parts and prevent them from mixing with the others at the time of assembly. We confirmed each other the following three points concerning the work of disassembly:

a. To take care of the disassembled parts to prevent from intrusion of water drops or foreign bodies
b. To give the highest priority to the safety

We have got 6 plastic boxes for the use of containing disassembled parts owing to the intermediation of Mr. Fernando Vice-Director of Logistics. In addition, we went to collect angle steel to the scrap yard included in the jurisdiction of landfill site. We intended to use the angle steel for putting up an engine stand by ourselves. We have got several pieces of angle steel with appropriate shape and size at the scrap yard. We ordered a person in charge of welding to cut the pieces of angle steel into the indicated size by the Japanese expert and built up an engine stand by welding.

Photo 3-1: Hasty engine stand

c. Total disassembly of engine

The procedure of total disassembly of engine is shown in the Table 3-10 together with necessary tools (ordinary and special) and equipment.

Table 3-10: Procedure of total disassembly of engine and tools or equipment to use

No.	works or removed parts	ordinary tool	special tool, equipment	note
1	starter	○		
2	to fix the engine on the engine stand	○	engine stand portal crane	engine stand is made by ourselves
3	remove engine oil	○		no mixing of metal powder
4	fan belt	○		
5	fan pulley	○		
6	damper crank pulley	○		
7	belt tensioner	○		severely abraded
8	fan hub	○		
9	alternator	○		
10	thermostat	○		
11	turbo supercharger	○		damage in pleated flexible hose
12	exhaust manifold	○		
13	fuel filter		filter wrench	
14	fuel filter head	○		
15	piping for fuel	○		
16	oil level gauge	○		
17	intake manifold	○		
18	cylinder head	○		
19	fuel injection nozzle	○		screwed too tight
20	rocker lever	○		
21	bush rod			
22	cylinder head	○		confirmed damage of piston
23	front cover	○		
24	water pump	○		
25	flywheel	○		
26	flywheel housing	○		
27	fuel pump	○		
28	feed pump	○		
29	tappet cover	○		
30	fill opening	○		
31	oil cooler	○		
32	water inlet	○		
33	oil pan	○		cloudy oil sediment at the bottom
34	oil pan suction tube	○		
35	rear seal cover	○		
36	cam shaft	○		
37	tappet	○		
38	oil pump	○		
39	timing housing	○		
40	balancer	○		
41	to remove cylinder block from the engine stand		engine stand portal crane	
42	piston & con-rod	note: Because we contracted out the machine work of cylinder block to Motor de Centro, those parts stated in the left column remained on the cylinder block when it was removed from the engine stand		
43	crank shaft			

d. Damaged piston by fire

situation of the top surface of piston

There are traces of collision by small metal pieces that was formed by the damage of piston ring due to the abnormal combustion.

A part of the piston was lost at the top

e. Work contracted out to a specialized engine repair factory

We decided to contract out the overhaul to a well equipped factory called Motor de Centro (M/C) which was a specialized engine repair factory. To provide to engineers of M/C, we prepared a finishing criteria of the engine repair manual published by Komatsu and translated the contents of Japanese to Spanish and printed four copies. On November 19, we took out some of the donated spare parts from the parts storage of the central workshop of UPPH in order to supply them to M/C. The breakdown of the parts taken out of the storage is as follows:

a.	set of piston including piston ring	6 sets
b.	cylinder liner (sleeve)	6 pieces
c.	con-rod bearing	12 pieces
d.	main bearing	12 pieces

Loading the cylinder block Assembly on the mobile workshop, we transferred it to M/C together with the spare parts listed above. It took about 15 minutes of vehicle ride. At the factory of M/C, first we did the entrance routine and met an engineer and he introduced us the chief mechanic of machine work. We explained the figures of machining work with the parts to the chief mechanic by showing the finishing criteria written in Spanish. Then we exhibited the parts to be machined to them and measured the outer diameter of the sleeve by a micrometer and confirmed that was

104.0 mm. Based on the measured figure, we decided the finishing value of boring machine to be at 103.90-103.93mm for inner diameter of cylinder block. The outer diameter of piston proved 101.87-88 mm.

The Factory manager joined the meeting on the way and asked a question on the screwing torque of the bolt by referring the finishing criteria given them just before. He then instructed his staff to complete the whole work by Wednesday next week (24th). In addition, the factory manager accepted the lapping of cylinder head and inlet and exhaust valve. Then we took out some donated parts additionally from the parts storage such as cylinder gasket and six pieces of con-rod and transferred to M/C.

On Nov. 22nd, we visited and observed machine work with boring machine and valve lapping work. After that we talked over the use of bushing which would be applied to air inlet and exhaust valve. The factory has a lot of experiences in machining the cylinder blocks with inner diameter of 102 mm because the factory has repaired numbers of China made buses and trucks with the same type of engines as Komatsu bulldozer. On November 23rd, we visited M/C and received the explanation on the manner of honing; inner diameter is finished at 102.02 mm and the grade of plane at the top of the sleeve is ±0.

On November 25th early in the morning, we went to M/C and found the cylinder block assembly completed with cylinder head in normal position. We took back the removed piston, con-rod metal as the reference material of inferior maintenance.

Note: Motor de Centro (M/C), a partner of outsourcing for engine repair
M/C has about 100 employees and 10 engineers at present and they are rich in talents and well experienced. Once it had been repairing 20 to 30 engines of bus and trucks a day, however, the number of order for engine repair has fallen to only 2 to 3 recently. The building of the factory is large enough and the equipment is completely furnished, but the number of employee has drastically reduced to a smaller figure than ever. The reason why the amount of work has reduced lies in the difficulty in acquisition of necessary parts for engine repair due to severe reduction of import. M/C seems to shift to the joint management with Chinese entity.

f. Adjustment of disassembled parts

On November 24th, we went to the laboratory of the central workshop of UPPH in order to test and adjust the fuel pump and fuel injection nozzle accompanied by the master mechanic. We adjusted the fuel pump with the pump test stand. On the other hand we at first disassembled the nozzle and cleaned it, and then adjusted the pressure of valve opening at 220 kg/cm2. The measurement of the pressure proved 180kg/cm2 before disassembly, and therefore we assumed that the low pressure was one of the reasons of incomplete combustion. At the workshop for heavy equipment, we washed inside of D41E bulldozer without engine by ordering water tank lorry to supply water.

g. Total assembly of engine

The procedure of total assembly of engine is shown in the Table 3-11 together with necessary tools (ordinary and special) and equipment.

Table 3-11: Procedure of total assembly of engine and tools or equipment to use

No.	works or removed parts	ordinary tool	special tool, equipment	note
1	machining of inner surface of cylinder		boring machine cylinder dial gauge	finished at the range ø103.93- ø103.90 mm
2	press fitting of sleeve		hydraulic press	sleeve supplied
3	finishing of inner surface		honing machine cylinder dial gauge	finished at ø102.02 mm
4	mounting of crank shaft	○	crane, torque wrench	bearing supplied
5	piston/con-rod assembly (consists of piston, piston ring, con-rod, con-rod bearing)	○	torque wrench	spare parts supplied
note: from 1 to 5 above were contracted out to M/C				
6	rocker lever	○	torque wrench	
7	lapping of inlet and exhaust valve		lapping machine	
8	cylinder head	○	torque wrench	head gasket supplied
9	gear housing	○	torque wrench	
10	oil pump	○		
11	cam shaft	○		
12	balancer	○	torque wrench	
13	rear oil seal	○		oil seal replaced
14	oil pan	○	torque wrench	gasket replaced
15	oil cooler	○	torque wrench	gasket replaced
16	fill opening	○		
17	feed pump	○		O-ring replaced
18	tappet cover	○		
19	fuel injection pump	○	fuel pump test stand in the lab. of central workshop, UPPH	
20	flywheel housing	○	torque wrench	gasket replaced ThreeBond1207 coated
21	flywheel	○	torque wrench	
22	water pump	○	torque wrench	
23	front cover	○	torque wrench	gasket replaced ThreeBond1207 coated
24	adjustment of valve clearance	○	clearance gauge	
25	fuel injection nozzle	○	nozzle tester in the lab. of central workshop, UPPH	adjusted at 200kg/cm2 copper packing replaced
26	cylinder head cover	○	torque wrench	gasket replaced
27	intake manifold	○	torque wrench	gasket replaced
28	exhaust manifold	○	torque wrench	gasket replaced
29	fuel filter head	○		filter replaced
30	Turbo-supercharger	○	torque wrench	
31	thermostat	○		
32	fan hub	○	torque wrench	
33	belt -tensioner	○	torque wrench	spare parts supplied
34	water inlet	○		
35	alternator	○	torque wrench	
36	fan belt	○		
37	oil filter	○	filter wrench	filter replaced
38	starter	○	torque wrench	

Nov. 26 (Fri.) We guided The master mechanic and his subordinate mechanics in adjustment of valve clearance as OJT. Small white boards were used to make the explanation clearer. The boards were given to The master mechanic to use them in similar occasion of instruction. Prior to mounting the fuel injection nozzle, we indicated the proper screwing torque to The master mechanic. A control table of bolt screwing torque written in Spanish would be delivered at the lecture on Dec. 6th. We mounted fuel pump, turbo-supercharger and new fuel and lubricant filter.

Nov. 27 (Sat.) We guide Cuban mechanics in adjustment of timing of fuel injection pump so as to start idling of engine as OJT. The pin-synchronizing[1] method for timing found the first experience even to the master mechanic; this means the total assembly this time was an appropriate opportunity of OJT.

When the mounting work is finished, we start the idling before we mount the engine on the bulldozer. We conducted idling of first round for three minutes and second for five minutes. We did not recognize leak of water or oil, abnormal sound and vibration while idling, so that we judged the engine as normal and mounted it on the bulldozer. On Dec. 2nd, we conducted a test working on the soil surface. For the first week after repair, we recommended the operation should be a shakedown, working for 2 to 3 hours a day. We gave an advice to have operators know the importance of maintenance and keep close contact with the master mechanic while using the bulldozer.

3.2.3 Technical Training

a. Execution of training

A lecture was held for the senior mechanics (workshop staff and 7 senior mechanics) on Dec. 6th from 9:00 to 13:00 at the meeting room in the head office of UPPH. The subjects of the lecture were as follows.

- management of workshop for heavy equipment repair
- maintenance of heavy equipment

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[1] The pin-synchronizing method uses two timing pins. The first timing pin indicates that the piston of the first cylinder lies in the top dead center. At that moment the pin can be inserted to the cam driven gear box from outside the cover. The second timing pin indicates the fuel pump lies in the position of injection, 14 degree angle before the time that the corresponding piston comes to the top dead center. At that moment the pin can be also inserted as well as the first timing pin.

・ fueling system of Cummins engine

b. Provision of training material

We gave the following reference material to raise the quality of maintenance work

- Cummins engine manual & CD (Spanish version)
- Training Aid (Spanish version)
  - Sysema de Combustible del Motor Cummins
  - Injectors
  - PT Pump
- Komatsu 102 series engine shop manual (Japanese basis, partially translated to Spanish for finishing criteria)

3.3 Improvement of heavy equipment maintenance at existing final disposal site

3.3.1 Paving of adjacent area of workshop for heavy equipment

Paving of adjacent area of workshop for heavy equipment was completed in October 2010 and the area covers 1,020 m2. In addition, paving of the parking area for heavy equipment has been implemented for an area of 4,745m2 and has been achieved at about 80 % as of the end of Nov. 2010, and is expected to complete at the end of December.

Workshop for heavy equipment: 12m x 42m = 504 m2 	Paving of adjacent area of workshop for heavy equipment: paved area about 720 m2 

Paving of entrance passage of workshop for heavy equipment: paved area about 300 m2 	Paving of parking area for heavy equipment: paved area 65m x 73m = 4,745 m2 

3.3.2 Improvement of engine repair

The number of overhauled units of bulldozer, which is principal type of heavy equipment, has risen from 2 units last year to 6 units this year. Two positive factors have brought the increase of overhauled units. One is that UPPH was able to acquire necessary parts timely, and another is that UPPH introduced a mobile workshop in late 2009, which resulted in better work environment of the workshop. UPPH owns 17 bulldozers and out of 17, 12 units are in operation and 5 units are out of operation. The working rate is calculated at 71 % this year and exhibits an improvement from 53 % of last year, 2009.
UPPH has a plan to overhaul 3 units of bulldozer out of 5 units which are not functioning now. The remaining 2 units have passed more than 20 years and have a severe damage in the cylinder block. UPPH continues an examination if it should execute the overhaul of engine for these 2 units.

3.3.3 Improvement of maintenance by adoption of mobile workshop

An onboard type mobile workshop was introduced to the workshop at the end of last year and has contributed to the improvement of maintenance work. The vehicle is Dong Feng of China products with the maximum payload of 6 tons. The mobile workshop has the following onboard equipment and functions.

a. Hose reel (to supply water, air, oil and grease)
b. Bench drilling machine, capacity ø20mm
c. Bench grinder 220V 120w
d. Plug outlet 220V x 10A, 380V x 16A
e. Air compressor 5.5 kW
f. Water tank 500L
g. Generator 460 kVA, engine 27.9 kW
h. Oil drum 200L, air pump
i. Electric-powered crane 500 kg

Chief operator of the mobile workshop is the master mechanic and forms a crew with a few mechanics in mobilization. The instruction of mobilization was ordered by the head of the workshop Mr. Quintana, member of C/P. They mobilize the mobile workshop 4 to 5 times a month on average. They conduct maintenance work, welding and repair the malfunctioning with the mobile workshop as in situ service. The mobile workshop is not equipped with those which can meet the major repair, so that the seriously damaged vehicle is brought to the stationary workshop to repair.

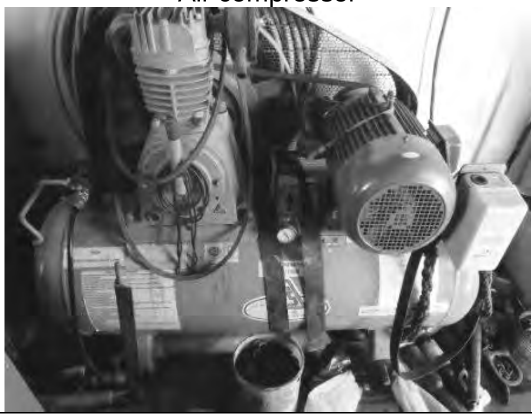
Mobile workshop of China made

Hose reel, for water, air, oil and grease from the left

Drilling machine and electric-powered grinder

Plug outlets and fan switches

Air compressor

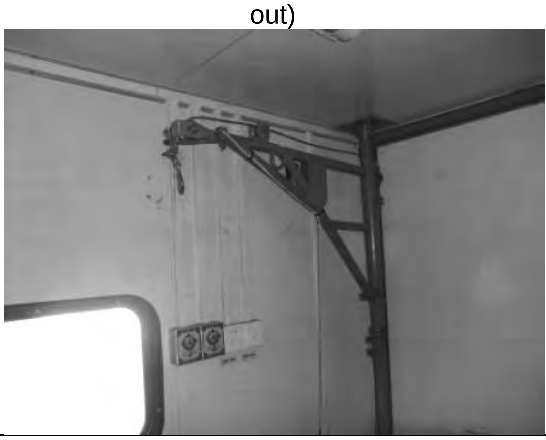


Water tank

Generator, engine of Mitsubishi made

Oil drum＆pump

Electric-powered crane (rotary jib stretches out)

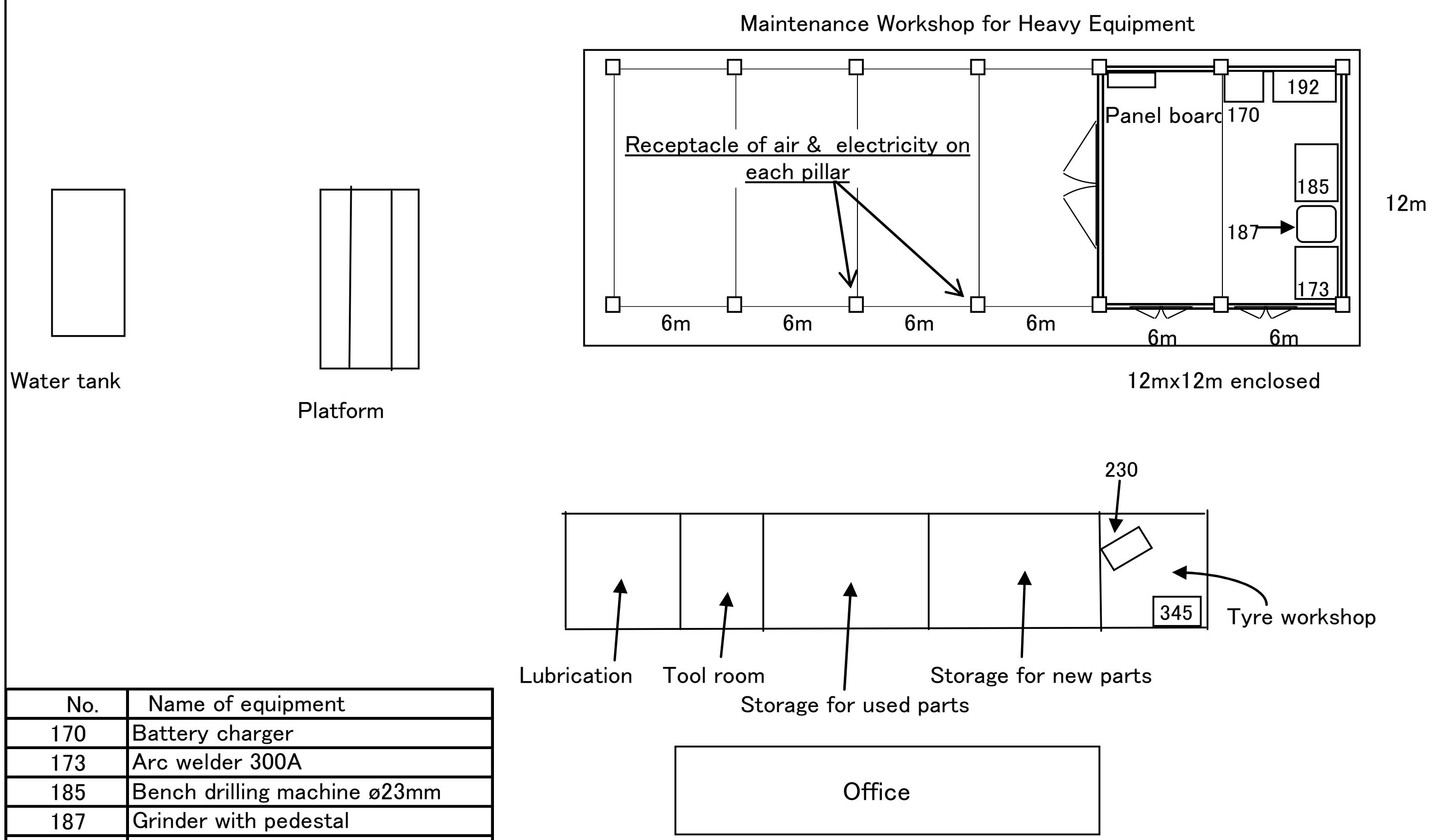


3.3.4 Installation of donated equipment

- Place of installation: Arrangement of main equipment is shown in Figure 3-14.
- Job allocation: Electrical work is outsourced to GEYSEL
- Air delivery piping, drainage, partition is outsourced to UPPA

Cuban side is to implement the preparatory work to install the equipment being donated and to complete by the end of May. The progress of the preparatory work is reported to Japanese side through JICA every month.

Conceptual design of layout plan of workshop for heavy equipment



No.	Name of equipment
170	Battery charger
173	Arc welder 300A
185	Bench drilling machine ø23mm
187	Grinder with pedestal
192	Air compressor 10 kg/cm2
230	Tyre repairing machine
345	Air compressor 5.5kw 14kg/cm2

Note: No. corresponds to the list of equipment in process of purchase

Figure 3-14: Design concept for heavy equipment installation at workshop.

4 Acceleration of Preparatory Works for Installation of Equipment (January – March 2011)

4.1 Significance of Preparatory Works

Among the DPSC project currently on-going with the budget allocated, the group of desarrollo (GTDI: Grupo Técnico de Desarrollo y Inversión、a group headed by the PM of this Project, hereinafter called as ”GTDI”) implements 3 projects which are currently in the construction stage and have close relation with this Project, as shown below:

1. Project for remodeling facilities which accept those equipment and tools donated by JICA (hereinafter referred to as “the Preparatory Work”)
2. Project for installation of weigh-bridges in landfill sites of 8-Vias and Calle100
3. Project for Construction of the new Guanabacoa landfill site

Even among the 3 projects, ①Preparatory work has a significant nature that the project is executed by inter-sectional persons in charge systematically under the periodical check by the head of organization. The team of execution consists of several persons from the UPPH as the executing body and from other departments of DPSC involving 5 C/P members. To execute a project rapidly and surely by promoting the entire process systematically is the viewpoint of what the Action Plan is aiming at. The Preparatory Work is, in this sense, achieving the aim in a short time period. This suggests a good opportunity to try the method of project implementation proposed by the draft Action Plan in practice, not in paper plan. Furthermore the Second JCC decided the time limit of the Preparatory Work should be completed by the end of May in this year. It is expected to verify the effect of adoption of the draft Action Plan, what kind of improvements it brings in quality of project and accuracy of time control, and what kind of modifications are necessary with the draft Action plan after a limited time of execution.

Therefore the Expert Team intended to support the Preparatory Work for its steady realization in view of trial and modification of the draft Action Plan

4.2 Outline of Preparatory Works

The Preparatory Work contains the construction of compost yard in addition to the remodeling of the Central Workshop and the Workshop for Heavy Equipment. Thus the Preparatory Work comprises the following 8 components by counting the compost yard as a component.

i Machine Tool Room
ii Injection Lab
iii Greasing Room
iv Repair Shop & Welding Section
v Car Washing Yard
vi General Activities of Central Workshop
vii Heavy Equipment Workshop
viii Compost Yard

The 8 components are further divided by the type of preparation and the type of work. Up to this feature of the detailed project definition was stated in the Progress Report (2) (hereinafter referred to called as "PR2"). This time the Expert Team proposed an insertion of blank row to each row of detailed sub-work component in order to describe the real situation of execution in comparison to the plan.

As for the 8th component (viii Compost Yard), the first draft of the chronogram was drawn up on condition that it was constructed within the existing compost yard, however, the proposed site was obliged to shift to elsewhere by the notice of the Ministry of Railway ,on Feb. 16, because of areal conflict on the new railway line with the planned site for compost yard. The alternative site was soon decided to be the former tire workshop sandwiched between the Bio-gas Plant and the Central Workshop. At the end of February, the work contents were still under discussion, so that the chronogram was not yet drawn up. In the case the chronogram is completed in the beginning of March, it will be exhibited in the 3rd Chapter of this report.

Detailed sub-component works are classified in the following categories and personnel in charge as show in Table 4-1.

A chronogram describing the detailed sub-component work is effective to examine the minute situation of the project, however, it is not necessarily convenient for the purpose of viewing the transition of the project from the long-term scope. Then a chart describing the summary of chronogram is shown in Figure 4-1 according to the three categories of work which are identified in the Table 4-1 above. A conspicuous nature of the Preparatory Work is considerably long time period allocated for acquisition of materials. The shortest case is V (Car Washing Yard) with one month, on the other hand the other components keep months or more for material acquisition. The extreme case is II (Injection Lab) that assumes 5 months for the same purpose, and plans to buy air conditioner in May and will be in time with the overall limit of completion at the end of the month.

Table 4-1: Classification of Work and Person in Charge

component work		objective facility/equipment	person, belongs to
category	type of work		
prepare	stop of daily operation	machine tool room	Raúl, UPPH
prepare	definition of work	window, skylight, roof, fire protection	Raúl, UPPH
		compressed air system, ventilation fan, ceiling	César, GTDI
		electric wiring, lighting, electric work material	GEYSEL
		water, sewerage, compressed air system	DCH
prepare	facility checking	water, sewerage,	César, GTDI
prepare	design, estimation of material	water, sewerage, office	DCH
prepare	removal	abandoned machines at machine tool room	Raúl, UPPH
purchase	contract of work/material	roof, ceiling	Diego, UPPA
purchase	purchase of material	window, roof, water, sewerage, electric work material, ventilation fan, air conditioner	Diego, UPPA
		window	Roland, UPPA
execute	installation	window, water, sewerage, compressed air system, ventilation fan, ceiling	Roland, UPPA
		distribution panel	GEYSEL
execute	installation/removal	roof	Diego, UPPA
		ceiling	Raúl, UPPH
execute	electric work		GEYSEL
execute	building work	office	Roland, UPPA
execute	concrete cutting for wiring conduit	water, sewerage, electricity	Roland, UPPA
execute	repair	Arreglos de registros eléctricos exteriores	GEYSEL
execute	painting	wall, floor	Roland, UPPA
execute	overall maintenance	remaining equipment	Diego, UPPA

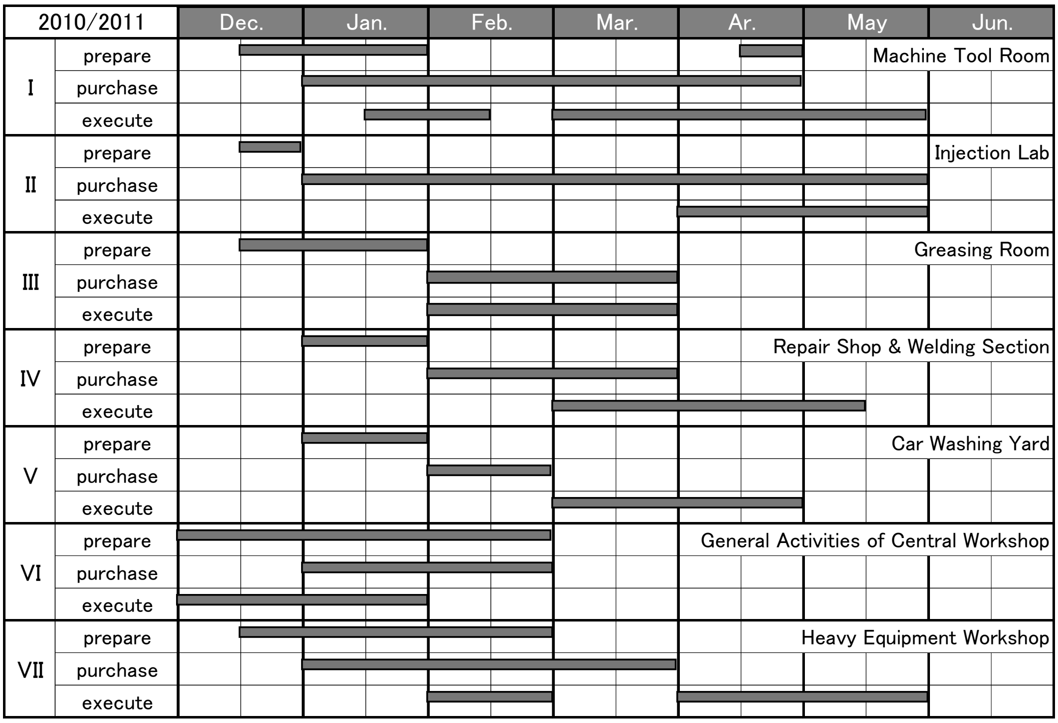


Figure 4-1: Summary Chronogram of Preparatory Work in Workshops

4.3 Description of Progress of Preparatory Works

4.3.1 Achievement at the Middle of February and Preceding Period

a. Report of progress in December (transmitted on Jan. 10, 2011)

The first periodical report was sent to the JICA Technical Cooperation Coordinator in Cuba by way of borrowing a special internet mail that is able to send an e-mail to the foreign recipient. The contents of the mail are itemized below, and are summarized that they have just started the Preparatory Work from the Machine Tool Room which has the largest remodeling plan.

i finish cleaning of the Machine Tool Room
ii define electric works at the Machine Tool Room and the Injection Lab
iii 75-80% of material for the Central and Heavy Eq. Workshop was supplied by GEYSEL
iv ASECOM, in charge of execution, started operation from Jan. 3

b. Report of progress in January (transmitted on Feb. 3, 2011)

The second report noticed that they advanced the remodeling of the Machine Tool Room a step forward and started the remodeling of interiors in the Injection Lab. As for the acquisition of materials, they said they had concluded the purchase contract for doors and windows of the Machine Tool Room and for ceiling material of the Injection Lab and for roofing material of the Greasing Room. They had not entered into construction stage, however, they seems to stay approximately on the scheduled line as the chronogram exhibits that the major tasks in the period from Jan. to Feb. are acquisition of material. The purchase of materials for electrical works from GEYSEL alone shows a favorable progress but the remaining plan of purchase entirely depends on the efforts from now.

c. Progress in February

The regular on-site meeting on Feb. 3 (Wed.) was canceled. On the next day the second periodical report was submitted to the JICA Technical Cooperation Coordinator in Cuba. On the same day of the receipt of report, DPSC noticed that the regular on-site meeting on every Wednesday was moved to every Monday from February 14, in two weeks.

One week before the initiation of the new schedule of on-site meeting, a meeting for the scheduling of the Preparatory Work was held on Mon. Feb.7. In this meeting, the cutting work of concrete floor for making new foundations for the machine and ditch for electric wiring conduit were the hot topic of the discussion. The cutting work was suspended on the midway and needs further expansion of cutting at that time. The work was scheduled to complete in the time period from January to February, however, ASECOM could not resume the work due to the unavailability of air compressor to drive a concrete breaker. The chairman to the meeting, Mr. Sergio, PD of the JICA Project, suggested an emergency solution to escape the critical path that he would arrange an air compressor for ASECOM within this week.

Another hot topic of the meeting was the tight situation in acquisition of construction materials. Even if they had a budget for the purchase, the commodity supply to the market was quite sparse so that it was hard to access whoever had any stock of material they needed. They tried to contact as far as state operated entities which might have the kind of goods they needed, but so far gained little purchase only. It seemed that it seemed quite hard to complete all the purchase soon. ASECOM said that they had not got steel material since last October. The situation has not yet improved even in March and continues the stagnated state as is forecasted in the chronogram with long time period for material acquisition.

On the regular on-site meeting was resumed on Feb. 14 (Mon.). The focused cutting work of concrete floor was left being suspended, however, PD Mr. Sergio stressed at the spot that “The compressor would come tomorrow”. The regular on-site meeting on the next week was cancelled. Two weeks later from the first resumed meeting on-site, the second meeting was held and found the gap for the foundation of machines were apparently expanded and deepened. The ditch for wiring conduit was also apparently expanded and the debris generated by the cutting work was still left just beside.


Before expansion, on Feb. 14


After expansion, on Feb. 28

4.3.2 Issues on Implementation of Project and Engagement of Expert

a. Utilization of meeting for advance

The regular on-site meeting on Monday and the regular meeting for investment on Friday seem to be held on alternate days. The formation gives a strong message that the top of Communal Service Direction stands at the front and takes command over the project execution, however, there is a room of improvement in the use of meeting. Namely the conclusion of meeting has not noticed in writing but the attendants seem to be relied on in dissemination by way of their interpretation and memory instead. Therefore the impact of each meeting is hard to conveyed even to the expert standing just besides the members of the meeting.

On the other hand, Cuban side does not think there is any problem with the manner of meetings. Therefore the expert seeks to find an appropriate time to suggest the following ideas as the hint to make meeting function better.

1. Attendant (entity) should submit the report in writing on progress of its part since the previous meeting
2. Prompter (DTDI) should submit the latest chronogram (or flow chart additionally if possible)
3. To appoint a recorder among attendants to record a memorandum. The president of the meeting verifies the draft memorandum to finalize and deliver at the beginning of the next meeting
4. The memorandum should contain at least the name of attendants, conclusions and notice of next meeting

b. Introduction of managing tools

The Expert proposed to modify the chronogram composed for PR2 by way of trial to the form that allows comparison between the plan and actual situation for each sub-component work. In accordance with the proposal, C/P produced a modified chronogram. The revised chronogram was then edited for fitting to printing and delivered at the meeting for progress on Feb. 7 (Mon.). In that meeting, there was no chance the chronogram is referred to because the focus of discussion came down to the following two points. Among two points, ① was solved by the arrangement of the PD without involving any other project for the arrangement.

1. Suspension of floor cutting work due to the lack of air compressor in the Machine Tool Room
2. Difficulty in acquisition of materials

In spite of the situation stated above, there will happen the change of situation owing to the advance of material acquisition, when the execution of the 8 components will be activated one after another. The chronogram would demonstrate the suitability to that occasion, it must help understand progress of several components in parallel. To meet the need of quicker understanding of the progress, the Expert proposed to introduce a flowchart in addition to the chronogram of bar-chart style. The first version of flow chart was made by C/Ps in charge. The output would be recommended to deliver at the meeting of investment held on every Friday.

5 Equipment Installation and Maintenance Training (April-October 2011)

5.1 Central Workshop Improvement (D12)

At the beginning of the project (by the time of the presentation of the Inception Report), the contents of the main activities for the third year were the following:

- To continue the activities corresponding to the second year.

The activities corresponding to the second year are the following: To acquire and install equipment based on the plan formulated in B.4 in the first year of the project. With regard to equipment acquisition, if they are to be purchased in Cuba the Cuban side will be mainly responsible for acquisition, On the other hand, if they are to be purchased in Japan, the Japanese side will be in charge. The Cuban side will be responsible for equipment installation and, if technical assistance by suppliers is available, training Cuban staff in equipment operation will be given during installation.

However, due to delays in equipment acquisition, delivery in Cuba was postponed for the third year. Consequently, the main activities corresponding to the third year were modified as following:

- Ensure equipment acquisition during the third year, install them and conduct training for equipment operation.
- Conduct training aiming at improving skills and the operation and management of the Central Workshop.

These modifications are shown in Figure 5-1.

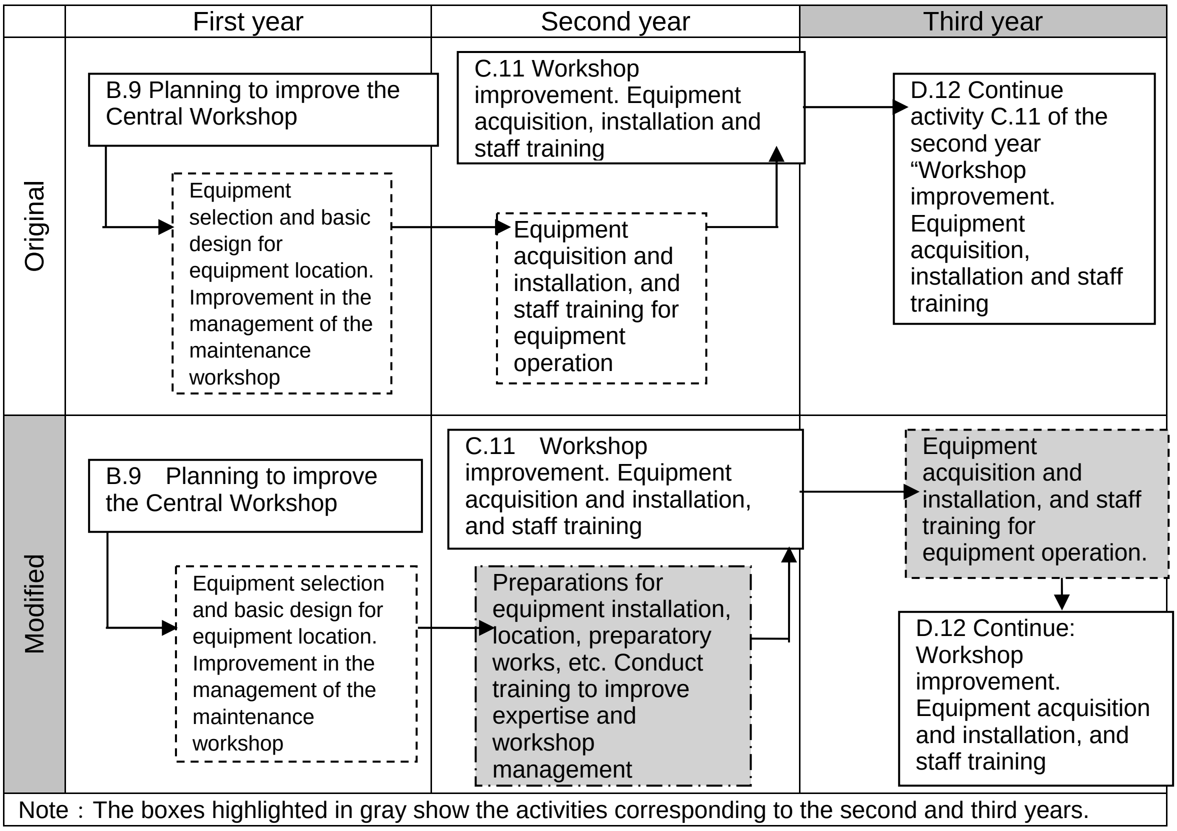
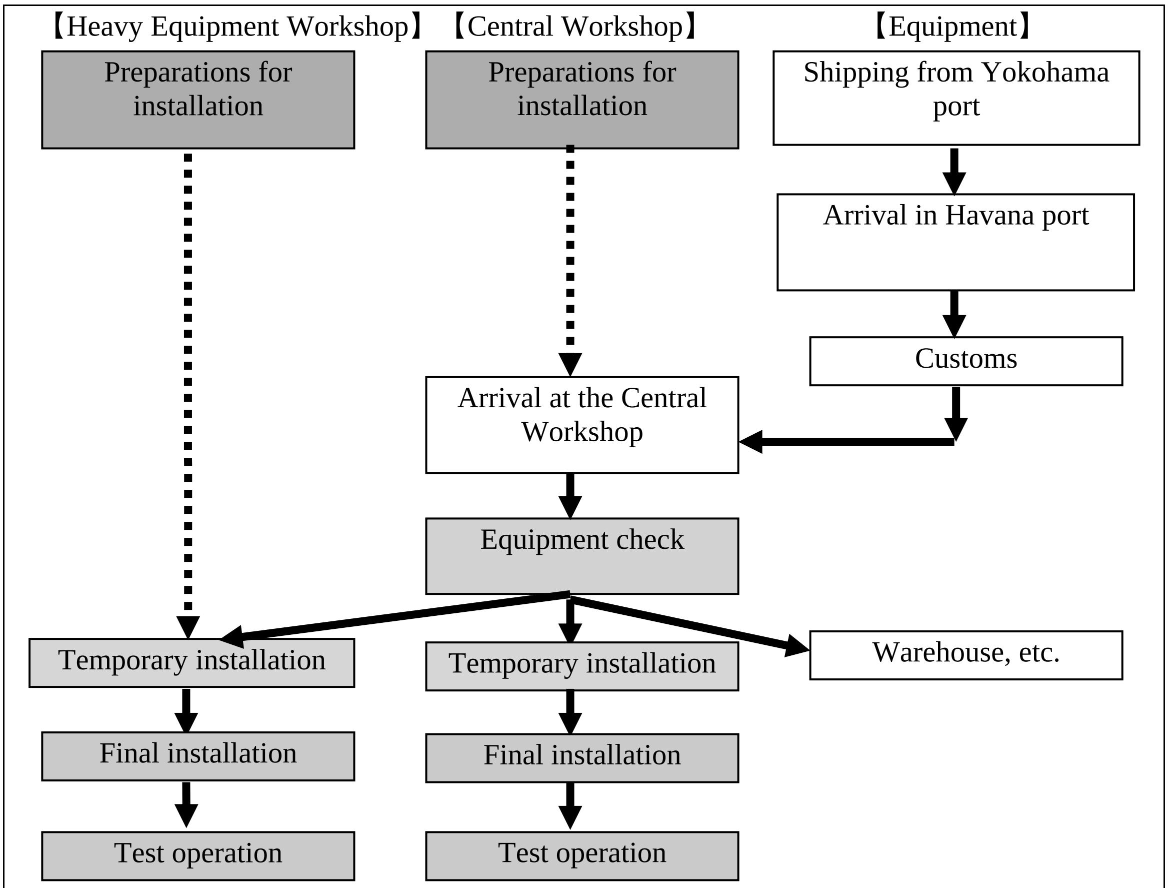


Figure 5-1: Modification of Activities Plan

5.1.1 Flow of equipment acquisition up to the installation of donated equipment

Two batches including equipment for compost production and equipment for the maintenance of collection vehicles and heavy machineries used for landfill operations were offered in open competition on September 14 and November 9, 2010. The equipment was classified according to its final use and packed in 3 lots to be shipped to Cuba. Once in Cuba, the equipment was cleared at customs and both JET and the Cuban side worked together to check the contents of the cases. For machinery requiring special preparations for installation, the Cuban side carried out the necessary works and, with advice provided by two installation experts, together with JET, they installed and tested the equipment.

The flow is shown in Figure 5-2.



Works carried out	People in charge
Preparations for equipment installation	Cuban C/P
Equipment check	Cuban C/P + Hiraga
Temporary installation	Cuban C/P + Hiraga + Dosho
Final installation and operation test	Installation experts + Cuban C/P + Hiraga + Dosho

Figure 5-2: General Flow of Equipment Provision

5.1.2 Equipment Acquisition

The equipment was entirely handed over to the Central Workshop from June to August, 2011. The specific dates of arrival are shown in Table 5-1. It should be noted that the solvents for tire repair were sent separately by air and they passed through customs in Cuba.

Table 5-1: Equipment Arrival Date

Equipment batch	Date of arrival at the Central Workshop	Customs clearance
By air	June 1, 2011	June 1, 2011
By ship-1	June 16, 2011	June 16, 17 and 20, 2011
By ship-2	August 28, 2011	August 28, 2011

Following customs clearance, JET and the Cuban side together opened the wooden cases and checked every piece of equipment in detail. Equipment check was conducted from June 24 to September 30, 2011. Apart from the changes in the dates scheduled for equipment delivery, and the considerable number of boxes, it should be noted that the long time required to rent the forklift used to move the cases from the warehouse, where the cases had been stored to prevent losses (thefts), was one of the factors that prolonged equipment checking. Similarly, due to the limited room in the warehouse, up to three cases had to be piled one on top of the other and the donated forklift was not yet available in Cuba by the time of the first stage of equipment check to help during operations.

The Checklist of donated equipment is shown in Annex-1.

Later, the supply of additional equipment not included in the paragraph above was made possible and the bidding corresponding to September 20 took place. The arrival of the additional equipment in Cuba is estimated for June, 2012. The list of additional equipment is shown in Table 5-2.

Table 5-2: Additional Equipment List

No.	配置	機材名	English	Spanish	Qtty
1	Taller Central	鋸盤	Hack Sawing Machine	Segueta mecánica	1
2	Taller Central	鋸刃	Hacksaw Blade	Pelo de segueta	24
3	Taller Central	クランピングマシン	Crimping Machine	Enboquilladora de manguera	1
4	Makina Pesada	タイヤチェンジャー	Tire Changer	Desmontadora de neumáticos	1
5	Taller Central	ボッシュ製VA/VE型燃料ポンプの分解組立用特殊工具	Service Tools	Herramientas de servicio	1
6	Taller Central	ボッシュ製P型インライン燃料ポンプの分解組立用特殊工具	Service Tools	Herramientas de servicio	1
7	Makina Pesada	ﾍﾞﾝﾁﾊﾞｲｽ	Bench Vise	Mordaza	2
8	Makina Pesada	両頭ｸﾞﾗｲﾝﾀﾞｰ	Bench Electric Grinder	Esmeriladora de banco	1
9	Makina Pesada	ﾄﾙｸﾚﾝﾁ	Torque Multiplier	Multiplicador de torsión	1
10	Makina Pesada	油圧計ｾｯﾄ	Hydraulic Pressure Gauge Set	Juego de indicadores de presión	1
11	Makina Pesada	ﾀｶﾞﾈ＆ﾎﾟﾝﾁｾｯﾄ	Chisel & Punch Set	Juego de cinceles y punzones	1
12	Taller Central	ｽｸﾘｭｰﾋﾟｯﾁｹﾞｰｼﾞ （inch）	Screw Pitch Gauge （in）	Galgas para rosca	1
13	Taller Central	ｽｸﾘｭｰﾋﾟｯﾁｹﾞｰｼﾞ （mm）	Screw Pitch Gauge （mm）	Galgas para rosca	1
14	Taller Central	ﾀｲﾔﾁｪﾝｼﾞｬｰ	Tire Changer	Desmontadora de neumáticos	1
15	Taller Central	ｴｱｰﾀﾝｸ	Air Reservoir	Tanque de aire	1
16	Taller Central	ｴｱｰｲﾝﾊﾟｸﾄﾚﾝﾁ (12.7)	Air Impact Wrench (12.7)	Llave de impacto	2
17	Taller Central	ｴｱｰｲﾝﾊﾟｸﾄﾚﾝﾁ (19)	Air Impact Wrench (19)	Llave de impacto	2
18	Taller Central	ｴｱｰｲﾝﾊﾟｸﾄﾚﾝﾁ (25,4)	Air Impact Wrench (25,4)	Llave de impacto	2
19	Taller Central	ｴｱｰﾄﾞﾘﾙ	Air Drilling Machine	Taladro neumático	2
20	Taller Central	ｴｱｰｻﾝﾀﾞｰ	Air Sander	Pulidora neumática	1
21	Taller Central	ﾊﾝﾄﾞｸﾞﾗｲﾝﾀﾞｰ	Hand Grinder	Esmeriladora manual	1
22	Taller Central	ｶﾞﾚｰｼﾞｼﾞｬｯｷ	Garage Jack	Gato	1
23	Taller Central	燃料噴射ﾎﾟﾝﾌﾟﾃｽﾀｰ	Fuel Injection Pump Tester	Banco de comprobación de bombas	1
24	Makina Pesada	ﾜｲﾔｰﾌﾞﾗｼ	Wire Brush	Cepillo de alambre	10
25	Taller Central	油圧ﾌﾟﾚｽ	Hydraulic Press Machine	Prensa hidráulica	1
26	Taller Central	ｴｱｰｺﾝﾌﾟﾚｯｻｰ	Air Compressor	Compresor de aire	1
27	Taller Central	ﾀｲﾔﾄﾞﾘｰ	Wheel Dolly	Plataforma rodante	1

5.1.3 Preparation Works for Equipment Installation

Preparation works to identify the tools and garage equipment required to properly operate both workshops began in August, 2009. From August, 2009, to March, 2010, all the necessary arrangements to identify the equipment to be acquired were made. As was pointed out in Progress Report 1, tools and equipment selection was carried out based on existing catalogues.

It was agreed from the project start that the Cuban side would be responsible for the preparation works necessary to improve existing workshop conditions. The Japanese side insisted on improving wiring and the ground connections at the specific areas where the donated equipment would be installed as a top priority.

In November and December, 2010, the first list of the tools bidding carried out by JICA was received together with a list of electric protections and cable specifications proposed for the installation of part of the equipment. The plans for the machine tools bases and the diagram of the lubrication system for the greasing facility were also received.

Then, the Cuban side began construction works with several contractors to fully repair workshop wiring. Furthermore, contracts were signed with over 15 entities to acquire the materials required to improve working conditions at the workshops. These materials were gradually purchased as the electricity and construction projects were being completed. The number of projects executed amounts to 12 and they are listed below:



Photo 5-1: Central Workshop Repair Executed by the Cuban Side

a. Electricity Projects (GEYSEL)

- Machine tool room
- Injection lab and warehouses
- Greasing facility and tire repair shop
- Heavy equipment facility
- Greasing facility
- Central Workshop Building 1

The following projects are still pending:

- Central Workshop Building 2 and 3
- Office block
- General lighting

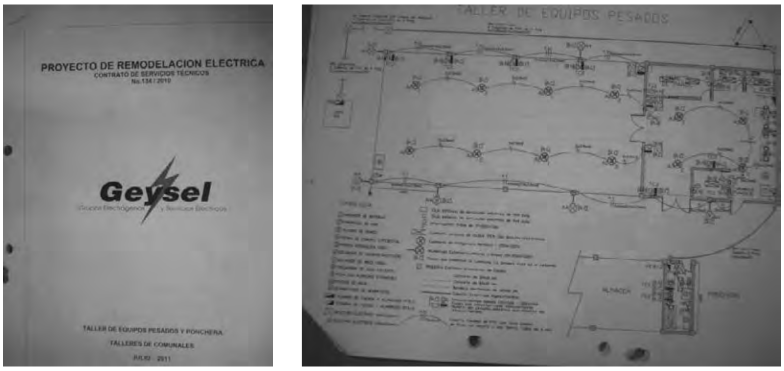


Photo 5-2: Electricity projects (GEYSEL)

b. Civil and Mechanical Projects (EPROYIV)

To build the bases for the tanks, a civil project was formulated, including

- topographical survey
- technological project
- hydraulic and sanitary project
- thermoelectric project
- general project.

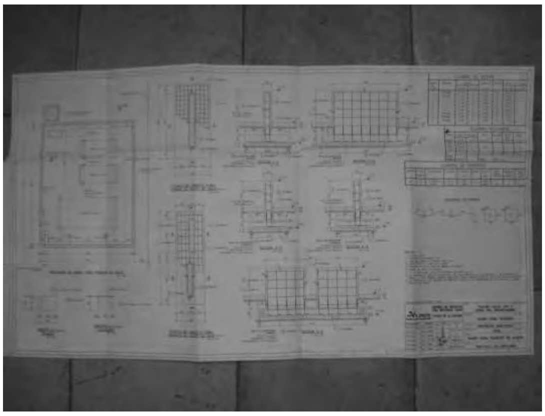


Photo 5-3: Civil and Mechanical Projects (EPROYIV)

The above-mentioned scenario and the existing material shortage in the local market have provoked current delays in the completion of the building stage.

Even though it is true that the reception of tools and equipment was delayed over a year, today (October 24, 2011) the scenario is even more worrying as a second batch of tools, whose specifications are unknown, is not to be received until May, 2012. As their installation will involve project formulation, material acquisition, contract signing, etc., and many of them, e.g., the injection pump test bench and the power hacksaw, are to be installed in facilities whose renovation is almost completed, the delay may be even longer due to existing material shortage in the local market.

The preparation works carried out at the Central Workshop to facilitate equipment installation are summarized as follows:

- Machine tool room – Finished.
- Injection pumb lab – Finished.
- Greasing facility – Finished, except the works necessary to install the oil drums due to lack of an air compressor, steel, and concrete.
- Tire repair shop – It will be finished within the month of October.
- Washing facility – It will be finished by the end of October.
- Tool room – It will be finished by the end of October.

Photo 5-4: Preparation Works

The works listed below will show a slight delay until late 2011. However, the equipment is expected to be installed and the hand tools handed over prior to November 25.

- Central Workshop Buildings 1, 2, and 3.

  Note: The date for the installation of the travelling cranes is still unknown due to lack of materials.

5.1.4 Equipment Installation

The Cuban side carried out the works necessary for the installation of donated equipment, including wiring, foundations, air and water piping, as well as those works required for the general improvement of the working conditions at the workshops, including roof replacement to prevent leakage, lighting, the installation of new electric panels, windows and ventilation shafts, as well as wall and floor painting, among others.

In order to install the machine tools and the lubrication system, two specialists were dispatched to Cuba to provide advice on equipment installation supported by JET. As the specialists' stay in Cuba would be limited, some previous detailed coordination arrangements were made by JET and the C/P to ensure the completion of the installation works. Likewise, Figure 5-3 shows the flow to check the equipment already received in Cuba, the installation of the main pieces of equipment, trial operation and practical training of the staff.

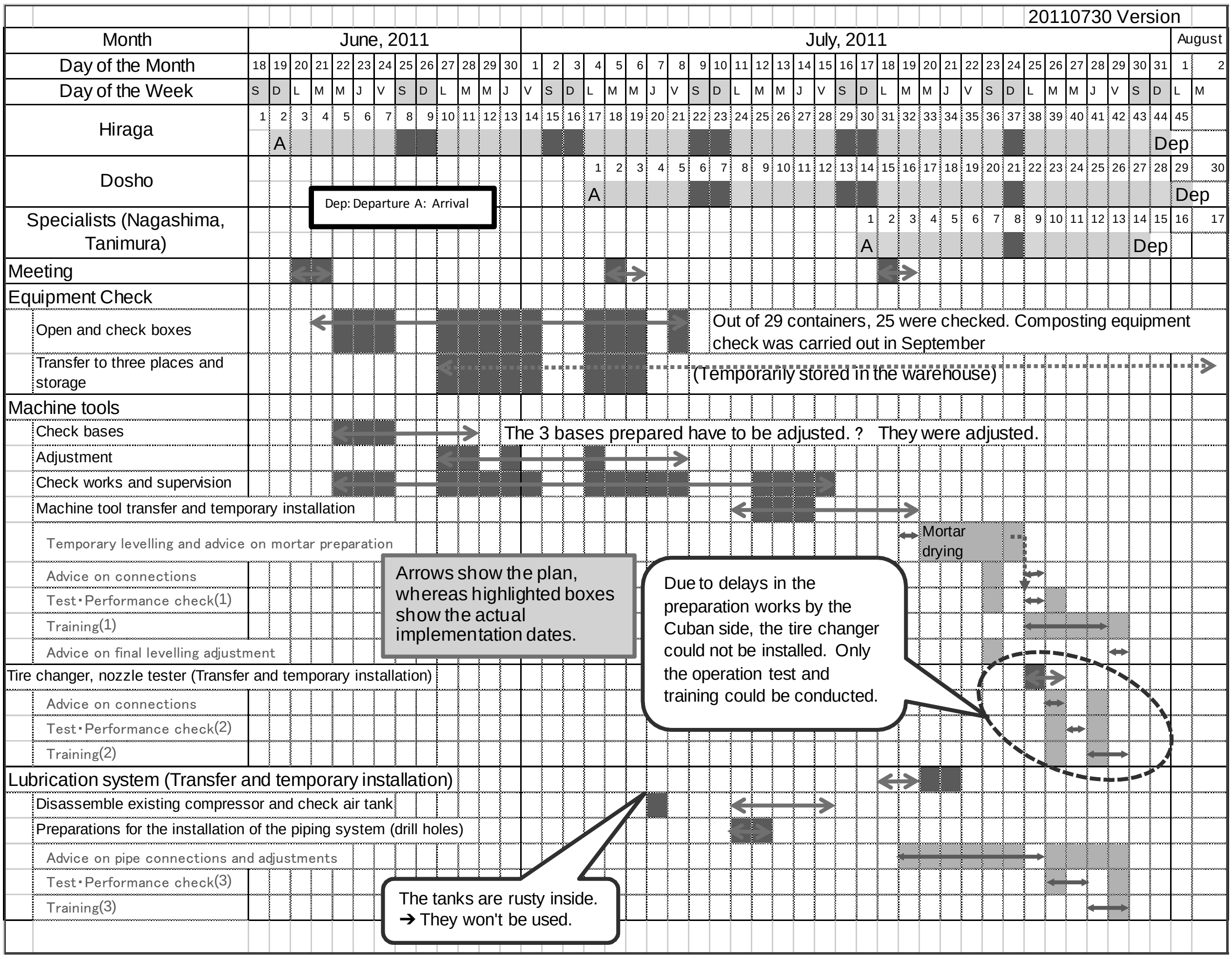


Figure 5-3: Equipment Installation Schedule

Out of the works shown in Figure 5-3, the works carried out by the installation specialists were guidance for equipment installation, test operation, and practical training for the following equipment: lathe, milling machine, upright drilling machine, tire changer, lubrication system and nozzle tester.

a. Problems derived from preparation works and actions taken for equipment installation

The following problems arose and hindered equipment installation.

- Out of the preparation works to anchor both the lathe and the milling machine, the position and dimensions of the holes for the anchoring bolts were not accurate.
- The position of the electric wires for the lathe connection was incorrect.
- Piping works necessary for the lubrication system had not yet begun.
- The existence of limitations for the installation of the outer oil tank (the setting up of the warehouse for flammable materials, etc.) preventing its installation in the short term was also identified.
- Due to lack of materials such as pipes and steel, the deadlines could not be met.

As countermeasures to solve the problems above, JET suggested and advised the following:

- Guidance to adjust the holes for the anchoring bolts required to install the machine tools. Similarly, as the holes for the anchoring bolts to install the lathe, the milling machine and the upright drill machine are bigger than required, made-to-measure leveling plates were brought from Japan in an ad-hoc manner.
- The position of the electric wires for the lathe connection was adjusted.
- The position of the holes on the walls was marked to guide piping work for lubrication system.
- As the pipes required for the lubrication system were lacking, used pipes were employed provided that they were not dirty. Similarly, the pipes packed together with the donated equipment, which were originally planned to be used differently, were also employed.

The following pictures show the scenarios mentioned above.

<table>
<tr><td></td><td></td></tr>
<tr><td>Inappropriate holes to anchor the milling machine</td><td>Adjustment of the anchoring holes for the milling machine</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Incorrect position of the electric wires for the lathe connection</td><td>The position of the holes on the walls was marked to guide pipes for the lubrication system</td></tr>
</table>

Photo 5-5: Preparatory Works for Equipment Installation

b. Equipment installation and piping work

The machine tools (lathe, milling machine, upright drill machine, and grinder) were placed on top of the adjusted anchoring holes. The leveling plates were positioned on the holes and then the machine tools were placed on top. To move the machine tools, a wheel dolly and a chain block were used.

In order to fix the machine tools, after placing the anchor bolts, the holes were filled with mortar. Once the mortar dried up, the leveling bolts and the anchor bolts were adjusted and the electric wire was connected.

With regard to the lubrication system, holes were drilled on the walls to connect the pipes. The air compressor was placed in position. The works for the installation of the air pipes were completed and the greasing and oil pumps and the hose reels were installed. For the compressor installation, wiring was carried out. These works are shown below.

	
Upright drill machine installation	Piping connections for the lubrication system
	
Lathe installation	Milling machine installation

Photo 5-6: Equipment Installation and Piping Work

5.1.5 Advice on equipment operation

Two installation specialists and JET conducted a practical training for the donated equipment, namely, the machine tools, the TIG welding machine, the lubrication system, the tire changer, the nozzle tester, and the car washing machines. A summary of the activities carried out is shown below

a. Practical training for the milling machine

Date	July 25, 2011 9:00 – 15:30 July 26, 2011 9:00 – 12:00
Instructor	Nagashima
Equipment used	VHR-A from Shizuoka
Description	(1) Explanation about the operation of the milling machine (2) Practice: machining using square-shaped bars ● Surface machining 1mm, 2mm ● Groove machining with reamer 1mm, 2 – 3mm ● Bore machining with reamer

Participants：

Name	Age	Years of Experience
Nelson Sánchez Olivera	43	26
Gilberto González Rodríguez	51	35
Carlos Manuel	48	10
Reynaldo Balóy Gómez	61	28
Jesús Kessell	54	30

b. Practical training for TIG welding

Dates	July 25, 2011 9:00 – 15:30 July 26, 2011 9:00 – 15:30
Instructor	Dosho
Equipment used	(1) Panasonic welding machine YC-300WX4T00 (2) Arc welder RJ-0115 (with TIG welding)
Description	(3) Explanation about its structure, functions, and about arc welding (4) Explanation about TIG welding (5) Practice of TIG welding using aluminum

Participants:

Name	Age	Years of Experience
José Luis Hernández	46	15
José Antonio González	31	11
Miguel Calzadilla Hernández	41	7
Reynald Boloy Gómez	61	10
Emilio Zamora	44	20

c. Practical training for the nozzle tester

Date	July 26, 2011 9:30 – 12:30
Instructor	Tanimura
Equipment used	Nozzle tester AB-0511
Description	(1) Explanation about the use of the equipment (2) Practice (pressure adjustment using actual nozzles)

Participants:

Name	Age	Years of Experience
Gilberto Lucena López	71	47
Alejandro Herrera Pérez	45	25

d. Practical training for the upright drill bench

Date	July 26 de 2011 13:30 – 16:00
Instructor	Nagashima
Equipment used	KUD-550FP from Kiwa Machineries
Description	(1) Operation manual (2) Practice (drilling)

Participants:

Name	Age	Years of Experience
Nelson Sánchez Olivera	43	26
Jesús Kessell	54	30

e. Practical training for the lathe

Date	July 27 – 29, 2011 9:30 – 15:30
Instructor	Nagashima
Equipment used	TAL460-1000 Takisawa
Description	(1) Explanation about the operation of the equipment (2) Practice: Morse taper, thread cutting

Participants:

Name	Age	Years of Experience
Nelson Sánchez	43	26

Gilberto González	51	35
Carlos Manuel	48	10
Reynaldo Baloy	61	10
Jesús Kessell	54	30

f. Practical training for the car washing machines

Date	July 27, 2011 13:30 – 15:30
Instructor	Tanimura
Equipment used	CWH-R16V-60 from Banzai and SJM-1030FA from Shinsho
Description	(1) Explanation about the equipment operation (2) Practice

Participants:

Name	Age	Years of Experience
Carlos Pedroso Martínez	46	26
Israel Peig Brito	53	7
Reynaldo Baloy Gómez	61	7
Juan Carlo Díaz Balodo	23	6

g. Practical training for the tire changer

Date	July 28, 2011
Instructor	Tanimura
Equipment used	CG-5424 from Maruma Technica
Description	(1) Explanation about the equipment operation (2) Practice

Participants:

Name	Age	Years of Experience
Jefe: Mario Lueda Dugue		
Julio La Rosa	54	20
Lázaro González	46	20
Alberto Peno	47	20
Alexander Columbie	29	5
Yordanis Valdés	21	3
Esteban Rodríguez	40	1
Albert Valdés	38	8

h. Practical training for the lubrication system

Date	July 29, 2011 12:00 – 13:30
Instructor	Tanimura
Equipment used	5 lines for oil and 1 line for grease
Description	(1) Explanation about the equipment operation (2) Practice

Participants:

Name	Age	Years of Experience
Israel Pérez Brito	53	7
Juan Carlo Díaz	23	6
Fulgencio Barbealdo	55	26
Reynaldo Baloy	61	-

Besides the training sessions implemented, especially those devoted to explain the operation of the machine tools and the TIG welding machine, the installation specialists and JET clarified existing doubts and answered questions asked by the participants. The maintenance staff involved showed great enthusiasm to learn from the experts, so they paid careful attention to their explanations and made the most of the time to grasp the techniques.

With regard to the tire changer, the workshop staff showed they master its operation. Power supply and other preparatory works have not been finished at the tire repair shop. Therefore, tire changer installation could not get started. The practical training for the tire repair shop staff was conducted at the machine tool room where power supply is available.

Even though the practical training for the car washing machines was conducted at the Cuban side’s request, the equipment has not been installed at the planned site as the renovation works there have not been yet completed.

5.1.6 Machine and Equipment Utilization Plan

The first batch of tools and garage equipment donated by JICA was received in July, 2011, and stored in the warehouse. Reception was supervised by an Cuban expert and two warehouse keepers and by two Japanese experts.

They verified the reception of all the items shipped from Japan. The whole batch was recorded using stowage cards to comply with the warehouse reception procedure established in Cuba.

For the installation of the machine tools in the machine tool room and the installation of the garage equipment at the greasing facility, written authorization was granted for the relevant pieces of equipment to leave the warehouse. They were also entered in the accounting books according to established categories.

Hand tools and garage equipment will be made available depending on the completion of renovation works currently being carried out at the Central Workshop and the Heavy Equipment Workshop (tool room, car washing facility, tire repair shop, greasing facility, etc.). These works are expected to be finished before November 25 taking into account what was pointed out in 5.1.3 and 5.3.1.

The procedures planned for the handing over of tools will be established based on current Cuban regulations. The most important issue is tool use control as follows:

a. Request and Handing Over of Tools

- Request for tools by the workshop manager from the Assistant Director for Mechanization.

- Request for tools from the warehouse by producing a voucher.
- Removal of the tools from the warehouse into the tool room by authorized personnel and the accounting expert.
- Reception in the tool room by making an overall tool inventory signed by the workshop manager, the accounting expert, and the tool room clerk.

b. Tool Control

- The tool room clerk is responsible for the tools. He will keep a daily record of operations and will answer for any losses.
- To make an overall tool inventory or one covering 10% of the tools monthly monitored by the accounting expert and signed by the concerned staff. The tool room clerk should be given a copy of the inventory.
- The tool room clerk should possess the document holding him responsible for the tools in his care prepared and signed by the Accounting Department based on the number and value of the tools.
- In case the tool room clerk resigns or is absent for any reason, an inventory of the tools will be made for the substitute clerk appointed by the workshop manager.
- There should be a document listing the staff authorized to use tools for daily operations. This document should be signed by both the workshop manager and the Accounting Department expert.
- The staff authorized to use tools from the tool room will be given a metal identification with a number engraved. When a worker takes away a tool, his identification will be left in its stead to know he has it.
- Tools will be handed over and returned daily. A record of daily operations will be kept.
- In case a tool gets lost or breaks, the tool room clerk must inform the workshop manager about it. The latter will take the disciplinary measures established by the current decree law.
- Tools considered to be basic property will be recorded in the inventory as it is established for such cases.

In the case of garage equipment and machine tools, a person will be appointed in every area to answer for appropriate use and cleaning. He will also be responsible for the quality of planned maintenance.

In the case of machine tools, once laminated material is acquired a program to manufacture and recover spare parts will be carried out.

Photo 5-7: Equipment Installed

5.1.7 Training for Collection Vehicles Maintenance

a. Preparation

At the C/P's request, and based on the consideration of the need to provide advice on the subject, JET prepared some training materials a shown in Table 5-3.

Table 5-3: Training Materials Prepared

No.	Title of the material
1	Manual for LP808 (408) (Japanese compactors)
2	Structure of the injection nozzle
3	Assembly of the injection pump
4	Alarm lights
5	How to use impact sockets/Tire structure
6	Manual for engine maintenance
7	Alternator structure and functions
8	Laws for gas and arc welding
9	Gas welding structure and operation
10	Brake structure and functions
11	Starter motor structure and functions
12	Differential gear structure
13	Transmission structure
14	Camshaft structure and functions
15	Wheel allignment
16	Hydraulic circuit of Dong Feng trucks (The hydraulic diagram of Chinese collection vehicles was drawn)
17	TIG welding
18	Others: Periodic inspection, safety and hygiene, etc.

These training materials are primarily elaborated based on information of vehicle maintenance in Japan. Therefore, it may be unlikely to expect that their direct use for training in Cuba will be useful in practical terms due to the wide gaps of prevailing scenarios existing in Cuba and Japan.

For instance, training focusing on hydraulic and electric circuits for Japanese compactor trucks was implemented for the relevant workshop staff during the first year of the project and the participants seemingly found it difficult to understand the contents of the training conducted. This is due to the fact that most of the trucks repaired at the Central Workshop are Chinese and their hydraulic circuits are extremely simple and manually operated, thus differing dramatically from the ones used by Japanese trucks.

Consequently, this time materials used for training were adapted as much as possible to the Chinese vehicles commonly operated in Cuba.

b. Training Implementation

Special attention was paid this time to conduct training using materials adjusted to the actual situation prevailing in Cuba. Training for hydraulic and electric circuitry was implemented, as well as workshop training at Regla and Habana Vieja municipalities.

b.1. Training for hydraulic circuitry

Due to the lack of hydraulic circuitry plans, which are indispensable to conduct training, the JET member in charge prepared the hydraulic circuitry plans for Dong Feng trucks (made in China), the commonest brand of compactor trucks operated in Cuba, based on pictures taken the year before.

By using these plans as part of the theoretical explanation, “open discussion-type” training was conducted in order to cover such issues as the standardization of terms related to hydraulic parts, the structure of hydraulic parts, the interpretation of hydraulic plans, breakdown diagnosis, etc.

As part of the practical training using actual vehicles, training and instructions were given for such as relief valves adjustment, and flaw position detection using donated tools and equipment such as the hydraulic gauge.

b.2. Training for electric circuitry

JET and the C/P by chance repaired the tailgate of a donated Japanese compactor truck. Based on this experience (the tailgate could not be lowered), a “case study” was prepared to train the workshop staff about hydraulic circuits and electric sequences of a compactor truck. Similarly, some explanation about the structure of the starter motor and the alternator, as well as about different methods for repair and maintenance, was provided.

As part of the practical training using actual vehicles, the starter motor and the alternator of Dong Feng trucks were checked using donated multi-meters. The participants were also trained to identify voltage drops in the ground circuit and to take measures in the case of breakdowns.

Some records of training for hydraulic and electric circuitry are shown in the next pages.

b.2.1 Structure and Functions of the Hydraulic Circuitry (Dong Feng)

Title of the Seminar (Contents)	Structure and Functions of the Hydraulic Circuitry (Dong Feng)	
Date	8:45am 12:30am, 29/09/2011	9 am – 10am, 30/09/ 2011
Place	UPPH's Meeting Room	Central Workshop
Instructor	Tadayuki Yamanaka, Ryo Hiraga (Assistant) (Interpreter: Mitani)	

Participants

No.	Name	Field of Expertise	Years of Experience
1	Nury Cárdenas Véliz	Transport expert	15
2	Isable Tamayo	Transport expert	12
3	Diego Guevara	Mechanic Class A	27
4	Felix Areu Lacalle	Workshop Manager	19
5	Fernando Sauro	Mechanic	7
6	Cecilio L. Alonso Junco	Mechanic	7
7	Bienbenido Humbert Padron	Mechanic Class A	20
8	Emilio Lamora Reus	Mechanic Class A	26
9	Fernando Amil Leal	Head of the Technical Department	27
10	Juan Rodoriguez Martinez	Hydraulic repair expert (Mechanic Class A)	25

Notes：

- The name of each part of the Dong Feng compactor truck was clarified and the hydraulic system and circuitry were explained.
- The seminar was conducted as an open discussion. The participants asked lots of questions and showed their interest in the discussion.
- The participants grasped the issues dealt with at the seminar.
- As part of the practical training with an actual collection vehicle, the instructor showed how to measure oil pressure and explained the measures to be taken in case of breakdown.

b.2.2 Electricity (Electric circuit sequence, starter motor and alternator)

Title of the Seminar (Contents)	Electricity（Electric circuit sequence, starter motor and alternator）	
Date	9:30am 12:30am, 3/10/ 2011	9am – 10am, 4/10/2011
Place	UPPH's Meeting Room	Central Workshop
Instructor	Tadayuki Yamanaka, Ryo Hiraga (Assistance) (Interpreter: Mitani)	

Participants

No.	Name	Field of Expertise	Years of Experience
1	Nury Cárdenas Véliz	Transport expert	12
2	Isable Tamayo Dominguez	Transport expert	12
3	Juan Rodoriguez Martinez	Hydraulic repair expert (Mechanic Class A)	25
4	Sayron Diaz Lopez	Assistant mechanic	1
5	Carlos Manuel Sanz	Electrician	15
6	Froilan Portillo Romero	Transport expert	22

Notas :

- By using the diagrams corresponding to the hydraulic circuitry and the sequence of the electric circuitry, the instructor explained how to identify the location of the breakdown in the Japanese compactor truck that had been repaired before.
- The basics of the starter motor and the alternator, as well as their maintenance, were explained.
- The seminar was conducted as an open discussion. A lot of questions were asked and answered.
- It was difficult to understand the sequence of the electric circuitry for the Japanese compactor truck. However, the remaining issues were easily grasped by the participants.
- The instructor showed how the starter motor and the alternator should be checked.

b.3. Training Implemented at the Compactor Trucks Maintenance Workshop in Regla Municipality

A several used Japanese compactor trucks donated by Japan last year are operated in Regla municipality. Even though some improvised explanation about their operation and management was provided by the time of the donation, the staff did not have enough information about them. This time a follow-up training was implemented (October 11, 2011 9:00 - 12:00). The theoretical explanation covered the following issues: functions of the alarm lights, structure of the brakes, safe operation and maintenance of the compactor truck, the manual for waste collection, especially the actions to be immediately taken in case of emergency, daily inspection, etc.

The seminar was attended by about 20 people, including CAM’s President. A lively exchange of questions and answers took place.

With regard to the 6 donated Japanese compactor trucks, existing problems were identified and the JET members in charge proposed some possible solutions. As part of the training, the “Easy-go” function, the starting of the truck at the D (drive) position due to its considerable weight, and the way to change oil and fuel filters were explained.

It should be noted that the donated compactor trucks are kept extremely clean and operated with utmost care in Regla municipality.

b.4. Training at the Maintenance Workshop in Habana Vieja Municipality

A several used Japanese compactor trucks were also donated to Habana Vieja municipality and JET provided advice on the assembly of the fuel injection pump last year. This time a follow-up training for the safe operation of the compactor truck was conducted (October 11, 2011, 13:00 - 17:00)

As part of the theoretical explanation, the 13 participants (mechanics, drivers and technicians) received some training about safe operation and maintenance of the compactor truck, the manual for waste collection focusing on the actions to be immediately taken in case of emergency, daily inspection, assembly of the fuel injection pump, as well as about timing for fuel injection. A lively exchange of opinions about fuel injection pumps in particular took place.

Later, the reasons for vehicle breakdowns and the suggested measures to be taken were analyzed.

- [HUG829] The truck engine makes a funny noise causing vibrations. The way to check it was explained. As it was noticed that something was wrong about fuel injection timing, they were asked to set the right positions to ensure good timing.
- [HUG830] The truck engine wouldn't start. As it was noticed that the starter motor is not working, they were asked to disassemble it and check it carefully.

b.5. Preparation of Maintenance Manuals

Due to the lack of appropriate measurement equipment and technical training to cope with hydraulic and electric breakdowns, repair in Cuba was carried out based on the empirical knowledge of the staff in charge. Therefore, the main cause of the breakdown took long to be identified and repair and maintenance activities were not always efficient as every mechanic had his own way to solve existing problems.

Now that measurement equipment and donated tools are available, some simple manuals that can be understood and used by the workshop staff began to be prepared to allow implementing the training by JET and sharing the knowledge and information necessary to execute repair and maintenance works in an appropriate, standardized fashion.

The manuals related to hydraulic and electric works would be prepared first by JET (technical guidance) and the Cuban C/P and its staff. Next, a compendium of these manuals is shown.

Hydraulic Parts Maintenance Manual		
No.	Topic	Description
1	Name of hydraulic equipment	There are no standardized terms for them. This may bring about accidents by mistake. The names of hydraulic equipment are defined.
2	Hydraulic equipment mechanism	To grasp the mechanisms of relief valves and cylinders.
3	Hydraulic circuitry diagrams	There are no hydraulic diagrams. JET will draw them and will proceed to explain them so that the staff may interpret them.

4	Maintenance method and measures to cope with breakdowns	To establish maintenance items and the criteria for their execution. Key points of every maintenance work should be indicated. To show how to identify the causes for breakdowns and the measures to cope with them.

Electric Parts Maintenance Manual		
No.	Topic	Description
1	Alternator	Interpretation of electric circuitry diagrams, disassembly procedure, inspection and adjustment, performance check, and high-current fuses.
2	Starter motor	Interpretation of electric circuitry diagrams, disassembly procedure, inspection and adjustments, maintenance criteria, performance check.
3	Compactor truck tailgate circuitry	Interpretation of the electric and hydraulic circuits involved to hoist and lower the tailgate and the electronic parts.
4	Examples of breakdowns	Explanation about the breakdowns related to hoisting and lowering the tailgate.

5.1.8 Effects of Training

Every action taken to improve expertise and facilitate exchange of experiences is beneficial for daily operations. The staff deeply appreciates the various courses taught, as well as the practical training conducted during installation of equipment such as the lathe, the milling machine, the bench drill press, the tire changer, the welding machine, the lubrication system, etc.

The technical level showed by the Japanese experts during training sessions has been extremely high, thus allowing the staff to increase their expertise. However, the true impact of training will be noticeable when donated equipment becomes operational.

5.2 Results of the Intermediate Evaluation and Measures to be Taken

5.2.1 Results of the Intermediate Evaluation

The Intermediate Evaluation of the Project was conducted from October 3rd to 7th, 2011. As a result of the evaluation, the following issues corresponding to Group 3 in charge of collection vehicles maintenance were raised.

[Output 3] Evaluation of the capacity for waste collection and transport: It will be difficult to achieve the goal during the remaining life of the project.

This is the most important area of the Project and the most seriously affected one by the delay in the arrival of the donated equipment during the first half of the project. The delay amounts nearly to one year. The training of the maintenance staff during the second year of the project needs to be sped up so that they may make the most of the donated equipment. However, the achievement of this Output during the remaining life of the project is considered to be unlikely.

The Project Goal and the indicators were also reviewed and the goal was revised as follows: "Vehicle repair and maintenance system upgraded (about 10% reduction of time required for several representative repair/maintenance works in the Workshop) by trained mechanics using equipment donated by the project to be maintained and as indicators: "In the 7 main areas of the Maintenance Workshop (chassis, welding, machine tool, tire repair shop, electricity, hydraulics and injection lab) 20 mechanics are trained, who may operate the equipment donated by the Project" and "7 maintenance manuals are prepared for the main identified areas".

It should be noted that the above-mentioned indicator based on the CDT (Coeficiente de Disponibilidad Técnica), TR (Repair Time) and TE (Waiting Time) remains, but it will be estimated without taking into account the effects of the External Factor such as the difficulties involved for spare parts acquisition.

5.2.2 Measures to be Taken

The reasons for the low mark in the Intermediate Evaluation are the following: (1) the delay of over a year to acquire the donated equipment and (2) the delay in the preparation works by the Cuban side to receive the donated equipment. Similarly, even though the authorization to acquire additional equipment is commendable, they are expected to arrive in Cuba by June, 2012, and the training of the staff is deemed to be more difficult.

As the arrival of the additional equipment cannot be made sooner, the Cuban side was asked to complete the preparation works as soon as possible (improvement works for equipment installation and overall workshop renovation) in order to accelerate the training of the workshop staff. However, it should be noted that for the Cuban side it is extremely difficult to purchase the materials needed for the preparation works, thus raising doubts about the possibility to complete the works on schedule. At present, the completion of the works for the Central Workshop and the Heavy Equipment Workshop is scheduled to be finished by November, 2011.

Next, the four stages of technical training to master donated equipment are shown:

Stage 1	Training by JET, including vehicle principles and mechanisms and special equipment, inspection methods, breakdown diagnosis, and maintenance criteria, etc.
Stage 2	Preparation of maintenance manuals by JET and the Cuban C/P.
Stage 3	Implementation of training based on the maintenance manual.
Stage 4	Tests to prove whether the staff is capable of handling donated equipment and keeping them in good shape.

The efforts to speed up the process may jeopardize quality and they will pose a challenge. Training is expected to be implemented carefully and quickly paying attention to the following:

(1) Prioritize actual maintenance carried out in Cuba. Several types of compactor trucks are operated. Therefore, the staff cannot be expected to master the maintenance works

required for all of them. Training is focused on capacity development to repair and maintain Chinese compactor trucks (Dong Feng) that occupies majority number among all compactors.

(2) Prioritize the improvement of the weaknesses showed by the Cuban side. The staff is qualified for vehicle maintenance. However, they do not master hydraulic and electric circuitry. Therefore, training will be focused on prioritizing already identified needs.

(3) Prioritize practical training. Practical manuals that can be used at the workplace to implement staff training will be prepared.

The above-mentioned priority criteria will be used to achieve a proper and efficient technical training:

With regard to the Overall Goal: "Vehicle repair and maintenance system upgraded (about 10% reduction of time required for several representative repair/maintenance works in the Workshop) by trained mechanics using equipment donated by the project to be maintained", the JET and the C/P together reviewed the contents of the maintenance works and classified them into 15 or more technical fields and decided to select the following 6 as priority areas: (1) Brake maintenance, (2) Leaf spring maintenance, (3) Tire maintenance, (4) Lubrication, (5) Electric maintenance and (6) Welding. The works to be carried out in these areas will help measure time reduction for maintenance, thus comparing the previous maintenance time to the time to be spent for maintenance using donated equipment.

Out of the indicator "In the 7 main areas of the Maintenance Workshop, 20 mechanics are trained, who may operate the equipment donated by the Project", the main areas selected are the following: (1) chassis, (2) welding, (3) machine tools, (4) tires, (5) hydraulic repair (6), electricity, and (7) injection pumps. Similarly, the following staff training actions were selected to ensure the appropriate use of donated equipment: (1) implement training, (2) prepare manuals, (3) implement technical training based on the manuals to assign the right people to the main pieces of equipment, and (4) test the staff for technical proficiency.

The preparation of maintenance manuals corresponding to these 7 priority areas was selected as an indicator.

With regard to CDT, TR, and TE, they were chosen as indicators. However, they will be estimated without taking into account External Factors (difficulties for spare parts acquisition, etc.)

5.2.3 Training during JET's next assignment in Cuba

The Cuban C/P and JET agreed on the following training to be implemented by JET during their next assignment in Cuba: (1) Use of impact sockets, (2) Tires maintenance, (3) Brakes maintenance, as well as training for DMSC's Directors regarding solid waste collection and collection vehicles maintenance.

5.3 Heavy Equipment Maintenance Improvement

5.3.1 Improvement of the Heavy Equipment Workshop Facilities

95% of construction and wiring works at the Heavy Equipment Workshop have been completed. The remaining 5%, including some painting and equipment installation, will be finished by late October.

Photo 5-8: Repair of the Heavy Equipment Workshop by the Cuban Side

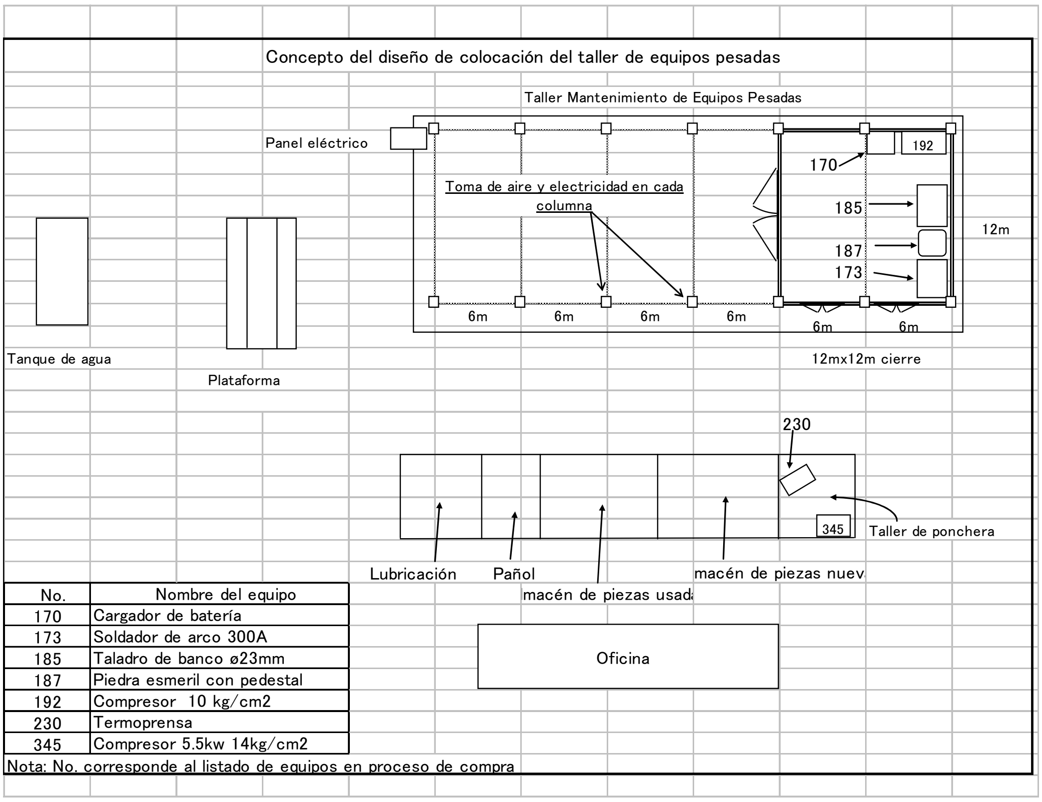


Figure 5-4: Heavy Equipment Workshop Arrangement

5.3.2 Existing Situation in July, 2011

In July, 2011, the Heavy Equipment Workshop lacked the conditions necessary for the installation of donated equipment. The JET's member in charge met his C/P, Mr. Jorge Quintana, and the workshop manager, Mr. Angel Reyes, to discuss in detail the donated equipment earmarked for the workshop.

The areas that need to be renovated for the installation of donated equipment are the following: Additional wall works, tool room and office roof, access gates, wiring, lighting, and floor. The C/P was asked to complete the renovation works as soon as possible (by late November, 2011, at the latest).

The C/P people interviewed said they would meet Mr. Raúl Aguiar to discuss remodeling works. They pointed out that equipment installation by late November was too late. The JET suggested the Cuban side should set up some clear-cut rules to monitor donated equipment.

The JET explained that the current workshop management system should be reviewed to check whether existing control is enough and, if necessary, to introduce some new management regulations. They referred to equipment management (assignment of the responsible person by team, preparation of the inspection list by equipment, etc.), tool room control (prepare the manual for tool room control) and other issues such as spare parts, grease, and oil monitoring, and the monitoring of the actual equipment performance. It was agreed that both sides will tackle in detail the above-mentioned issues during JET's next visit to Cuba.

5.3.3 Basic Stance for Future Activities Related to the Heavy Equipment Workshop

a. Ultimate Goal of Technical Cooperation

- To establish maintenance activities ensuring that heavy equipment are efficiently used.

b. Steps of Activities

- Identify the current condition and performance of heavy equipment
- Analyze equipment downtime and causes using *Pareto* charts.
- Analyze maintenance time and contents.

c. Activities to Improve Maintenance

- To try to reduce downtime of heavy equipment by using donated equipment, training, etc.
- To try to reduce maintenance time by using donated equipment, training, etc.

d. Evaluate Improved Works

- Evaluation will consider the reduction in downtime and maintenance time for heavy equipment.

6 Workshop Improvement, Preparation of Aditional Equipment Installation, and Maintenance Training (November 2011 – February 2012)

The following shows the names, areas and periods of assignment of the Japanese experts in group 3.

Name	Ryo Hiraga
Areas	Maintenance of collection vehicles (operation and management) / Operation of tool machines (selection, acquisition and design of layout)
Period	Nov.25 – Dec. 19, 2011 January 14 – Feb.12, 2012

Name	Tadayuki Yamanaka
Areas	Maintenance of collection trucks (diagnose, maintenance and repair)
Period	Nov.25 – Dec. 19, 2011 January 14 – Feb.12, 2012

Name	Takeshi Dosho
Areas	Operation of tool machines (improvement of heavy equipment maintenance)
Period	January 14 – Feb.12, 2012

As it was mentioned in Progress Report (4), the acquisition of the donation equipment for the Central and Heavy Equipment workshops was delayed, but was carried out on the third year of the Project, thus by modifying the work contents to be done, so the activities schedule was defined as follows:

- To supply the equipment for the third year and make the installation and training activities for its operation.
- To develop courses to strengthen technical, operational and control capacities in the Central Workshop.

Through the Mid-term Evaluation for the Project carried out on October 2011, the Project progress was verified, and the contents and the future implementation framework of the Project were revised.

Besides, taking into consideration the difficulties to fulfill the Project Purpose in the previously established period, caused by the delayed arrival of the donation equipment and other reasons, the appropriate project period was analyzed, reaching the conclusion to extend it for another year and a half.

In this chapter, the Japanese Experts Team will be referred as “JET” and the members of the Cuban Counterpart as “C/P”.

6.1 Implementation plan of the Project activities

With the delay of more than a year, the equipment donated to strengthen the capacity on collection vehicles and heavy equipment maintenance, arrived at the Central Workshop in the following three dates: June 1 and June 16, and August 28, 2011. After the customs inspection, the equipment was kept in the warehouse of the Cuban side. The Cuban side kept on working in the preparatory works planned for the installation of tools and equipment, but due to the difficulties in Cuba to get materials, equipment and spare parts necessary for the works, the first use of donation equipment and tools were delayed. Consequently, the exact conclusion and fulfillment of the activities established to strengthen the capacity on collection vehicles and heavy equipment in the planned periods were hardly carried out.

As described in Progress Report (4), during the Mid-term Evaluation for the Project carried out on October 2011, the aforementioned problem was analyzed, reaching the conclusion to revise and specify the Project Purpose and the verifiable indicators of the Project. (See Table 6-1.)

Table 6-1: Project Purpose and Verifiable Indicators of the Progress after revision

Project Purpose	Vehicle repair and maintenance system upgraded (about 10% reduction of the times required for several representative repair/maintenance works at Calle 100 workshop) to be maintained.
Verifiable Indicators	• In the 7 main areas of the maintenance workshop, over 20 mechanics to be able to operate the equipment donated by the Project appropriately can be developed by trainings. • 7 maintenance manuals for the main areas will be prepared. • Average downtime of collection vehicles is reduced. For the calculations of CDT (Technical Availability Coefficient), the levels of RT (Repair Times) and PT (Pending Times), the effects of external factors (as the difficulty to purchase parts, etc.) should not be reflected.

6.1.1 Implementation plan of the activities

It is worth to praise the levels of technical skills that the Cuban counterpart has for vehicle maintenance. However, as they don’t have enough tools, devices and measurement tools, their works lack precision and it cannot be said that the systematic maintenance techniques are established. Besides, before the Mid-term Evaluation for the Project, the group had not established the neither clear schedule nor activities, and had detail activities like trainings by agreement between the JET and the C/P every time.

To solve these imperfections, the JET agreed to train the C/P and maintenance staffs on the first place, and based on the experiences as a result of the first training, the JET and the C/P will cooperatively elaborate the instruction manuals for maintenance.

Once the manuals are prepared, the C/P will carry out the personnel training in a continuous and systematic way, with the objective of strengthening the capacity on vehicle maintenance staffs.

Regarding this activity to develop the maintenance capacity, the following was defined:

a. Definition of areas and topics

Seven main areas are classified: hydraulic, electricity, tire repair, machinery, welding, chassis and injection laboratory. For each of these areas, the JET and the C/P will agree on the specific topics to be included in the training and in the corresponding manual.

b. Preparation of the training and manuals

The JET will gather the necessary technical information both for the training and for the manuals preparation, taking it from the vehicle maintenance experiences in Japan.

c. Training by JET

Training will be done by the JET for C/P and maintenance staffs.

d. Manuals preparation

The JET and the C/P will cooperatively elaborate maintenance manuals.

e. Training by C/P

The C/P will mainly carry out the training for their maintenance staffs, using the manuals.

f. Exam and evaluation

Evaluations of maintenance staffs will be carried out if each of them acquire certain technical level and can show it in practice.

In the same way, evaluations about the manuals and the training will be carried out with the objective to keep improving them.

Figure 6-1shows the flow of activities

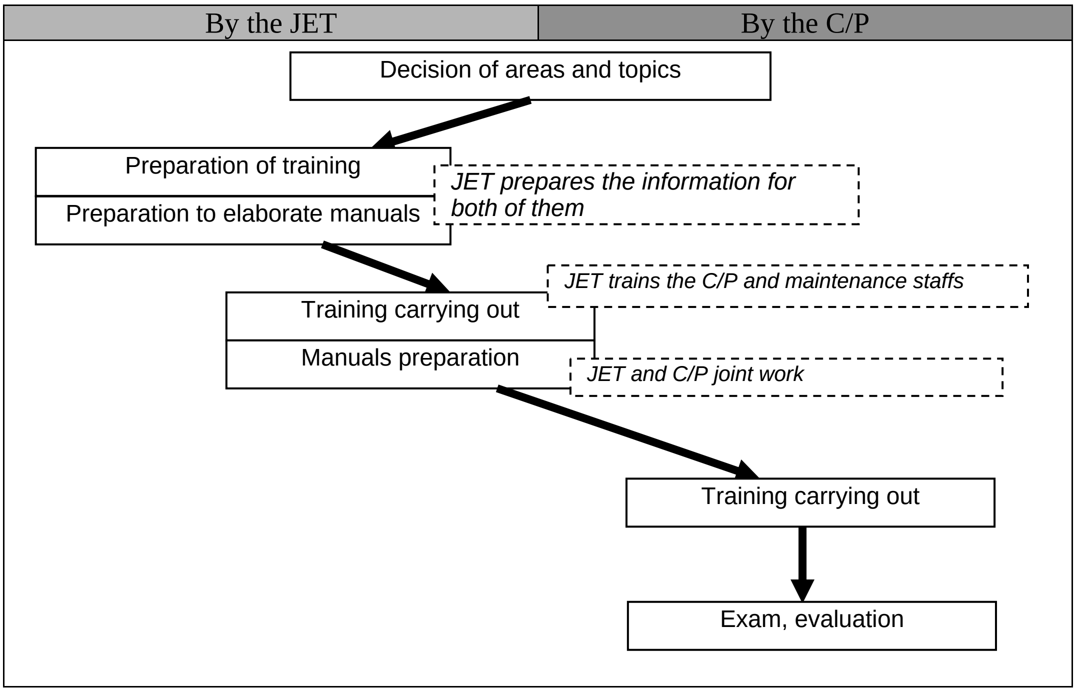


Figure 6-1: Flow of Activities for Capacity Development of Vehicle Maintenance Technique

To carry out the aforementioned activities, the following work lines were defined:

- Contents close to the maintenance reality.

Give priority to the more frequent works for equipment of the most required models in maintenance.

- Overcoming the weak points

Give priority to deficient maintenance techniques.

- Human Resources Development

Give priority to strengthening of C/P and maintenance staffs capacities.

6.1.2 Revision of WBS

As previously mentioned, the delay in the donation equipments arrival, installation and delivery, caused the period of the Project to be extended for a year and half so that the original purpose to train Human Resources can be achieved. At the same time, the information about the specifications of additional donated equipment was defined thus carrying out the elaboration and revision of the WBS (Work Breakdown Structure).

About the activities of Group 3, the general work plan was elaborated for the 7 main topics of maintenance (hydraulic, electricity, tire repair, machinery, welding, chassis and injection laboratory) taking into consideration the flow of activities for capacity development of vehicle maintenance technique in Figure 6-1 as well as the estimated arrival date of the additional donated equipment.

In addition, to respond the strong request by the C/P, the practical training on the operations of the milling machine and the TIG welder was included, inviting the respective Japanese experts to come to Cuba.

6.2 Progress of the installation improvement works and preparatory works for additional donated equipment

6.2.1 Progress of the installation improvement works

On October 2011 as described in the Progress Report (4), the situation of the areas of the Central Workshop and the Heavy Equipment workshop was the following:

- Machinery Area – Concluded
- Injection Laboratory Area – Concluded
- Lubrication Plant Area – Concluded except for the oil tanks elevation works as the lack of steel and reinforced concrete.
- Tire repair Area – Committed to conclude on October 2011.
- Car Washing Area – Committed to conclude on October 2011.
- Tool Room– To be concluded by the ends of October 2011
- Building 1, Building 2, Building 3 of the Central workshop were quite delayed.
- Heavy Equipment workshop – Civil works concluded in a 95%.
- It should also be highlighted that in the period of October 2011, only the machine tools had been installed because the rest of the equipment and manual tools were still in the storehouses as civil works were not concluded.

a. Works progress at the central and heavy equipment workshops up to date

a.1. Lubrication Plant Area

In this area, the Lubricating of equipment is currently being done. This work is completed although the elevation works of oil tanks is pending for the lack of concrete.

Before	After
	
	
	

a.2. Tire repair area

This work is completed and the area is currently working with all the donated equipment already installed. These works included total remodeling of the building (electricity, pneumatic line, roofing, and painting)

Before	After
	
	
	

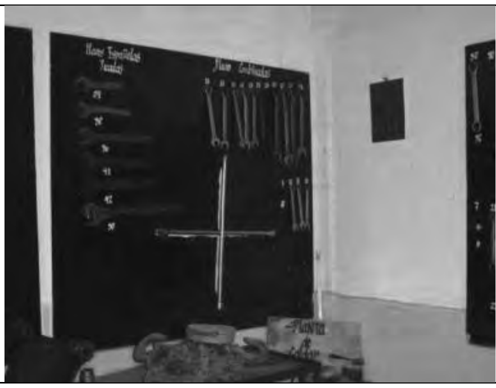
a.3. Car Washing Area

Just as previous area, the total repair of the building was carried out, and an average of 12 trucks is now washed every day.

Before	After
	 

a.4. Tool room

Works completely finished. It was repaired in total and the size of the tool room area was increased. We can now say that 97% of the manual tools in the tool room are being used in the workshop. The remaining 3% is still in the warehouse because they are repeated items.

Before	After
	

Before	After
	

a.5. Building 1, Building 2, Building 3

The 3 buildings were improved in total, mainly concerning electricity, pneumatic lines, roofing and painting details. It needs to be highlighted that regarding electricity, the switch board installation is pending. It is worthwhile to mention that significant improvement is made in the following areas of the buildings.

Before	After
	

a.5.1 Welding area:

This area is completed and has already installed the two electric welding plants and the TIG welder; at the same time works with the gas welding machine donated by JICA have begun.

Before	After
	
	

a.5.2 Electricity and hydraulic room:

This area was improved and made independent by specialty in order to guarantee better work conditions for the workers.

Present

In the case of the 3 buildings in the workshop, the most delayed work is the installation of the traveling cranes, one of which is in assembling phase and is committed to be finished by 15 February 2012.

Remarks: In addition to the mentioned above, in order to install the equipment coming next June, it is necessary to complete the whole construction and electric works beforehand and the works are already started.

a.5.3 Heavy equipment workshop

The construction of the new area of this workshop was concluded with the electric wiring, all equipment installation and the storeroom. This work is fully completed.

Before After

6.2.2 Preparatory works for the reception of the additional donation equipment

The information concerning the selection of the additional donation equipment and its description is stated in a previous chapter. This time, the models and specifications of this donation items were defined. The equipment supplier (in Japan) submitted the utility details table showing such as electric connections, that is the information necessary for the preparatory works for the equipment installation. The utility details table was handed to the C/P, and the JET and the C/P began to elaborate the idea for the modification of the equipment layout. The main changes in layout are mentioned below.

a. Building 1

- Compressor and Air tank

The new compressor and air tank are placed in the same room where the existing compressor is located, so that they both can be used in parallel. In this way, the compressed air will be supplied to Buildings 1 and 2. The installation of air pipes is already concluded.

- Hydraulic press and Grinder

The small grinder that is now in the machinery room and the hydraulic press are installed on Building 1.

b. Building 3

- Crimping machine and Battery chargers

As hydraulic maintenance and electricity works are being carried out in Building 3, the new donation crimping machine and the battery chargers are to be installed in this building

c. Machinery room

- Hacksaw machine

The old hacksaw in use was removed. In its place, the new hacksaw machine will be placed. The electric wiring is concluded.

- Grinder

The grinder installed in the machinery room is small and does not work efficiently for the fulfillment of work demand. It will be replaced with a new donated bigger one and the small one will be installed in Building 1.

Figure 6-2 shows the location of additional equipment.

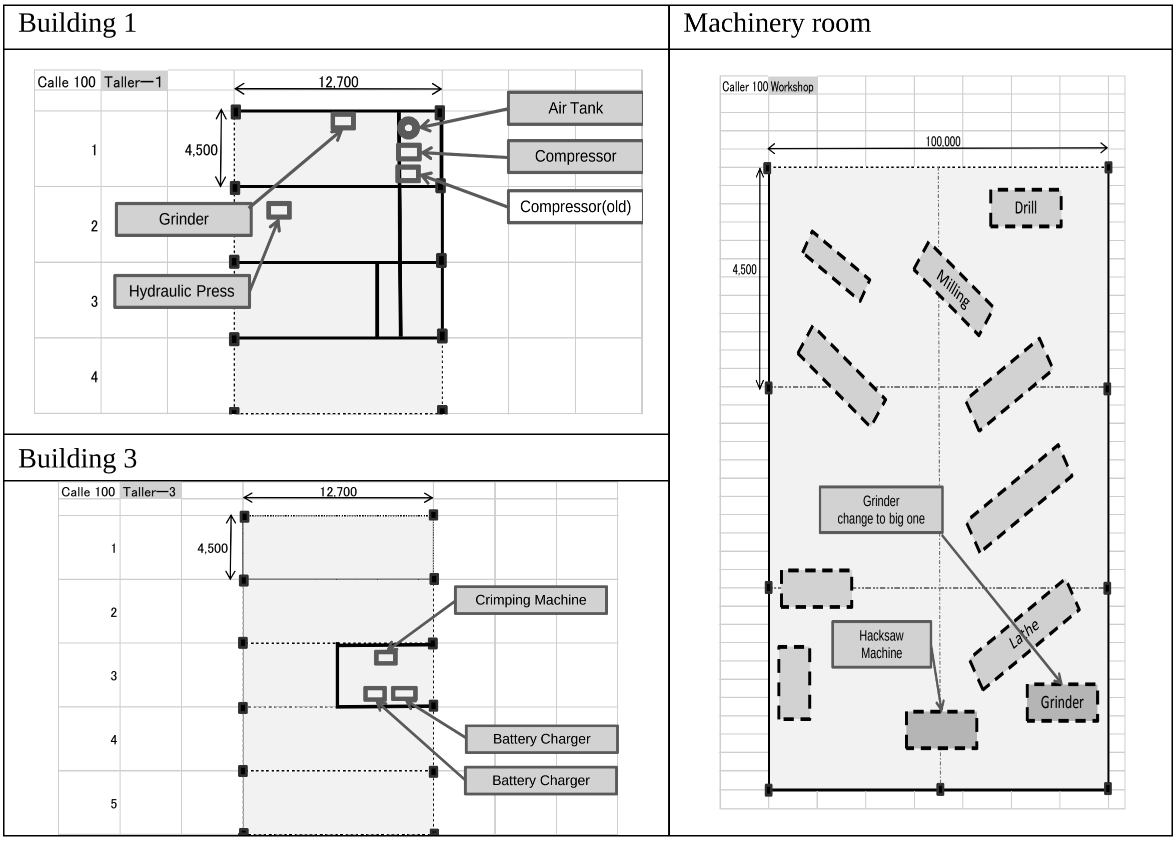


Figure 6-2: Location of additional donation equipment

6.3 Progress of activities to strengthen capacities on vehicle maintenance

6.3.1 Training activities

As shown in the WBS, the JET and the C/P are jointly working on the technical training for maintenance personnel. The training courses carried out afterOctober, 2011 are mentioned below.

a. Training on how to use torque wrenches and tire maintenance.

The most frequent maintenance work at UPPH Central Workshop is the tires repair. With the introduction of the tire changer and impact wrenches, it has been possible to significantly reduce the times for tire maintenance. The torque wrenches enable the precise measurement of the required torque and make it possible the quick and correct mounting of tires as well.

As training course, the structure, mechanism and usage of impact wrenches were explained. The course emphasized the importance of the correct method to mount the tires referring the frequent vehicle accidents occurred in Japan as a result of sudden tire detachment. Likewise, the use of every tire tools was explained.

Also, the use of impact wrenches with the vehicle was put into practice so that participants could experience the actual hands feeling in giving the correct torque. They practiced the safe and correct use of the wrenches, too. Finally, they learnt how to use the test hammer to rapidly identify whether the tire has been appropriately mounted.

b. Training on clutch maintenance

The clutch is a drive transmission mechanism. That's the reason why it wears as a result of the daily trips of the vehicle. It needs to be given appropriate maintenance including parts replacement. Its maintenance also demands precision works so that a training concerning this aspect is worth to be given.

The training consisted of the verification of the parts compounding the clutch, the explanation about the structure, dismounting, checking and mounting, the norms to tighten the torque among other topics.

It also dealt with the structure and the function of the master cylinder and the clutch booster. Besides, an explanation on how to dismount, check and mount the clutch was given.

c. Training for Municipal Directors

The first seminar on Integrated Solid Wastes Management for Municipal Directors was held. As participants do not necessarily deal with the aspects concerning solid waste management, a seminar including the general topics on management was scheduled. The presentation by Group 3 put special emphasis on the necessity and importance of giving an appropriate maintenance to collection vehicles. They referred to the experiences obtained in Japan about the epidemic outbreaks that caused many deaths, to ratify the importance of waste collection as well as the history of collection in Japan and the methods to improve the collection activities. The most effective method to strengthen the collection system is to guarantee collection vehicles backed by a good maintenance system, so it is necessary to have multifaceted approaches on maintenance to achieve it.

Lastly, and taking into consideration the advantages of gathering the municipal leaders in order to learn about waste management and to share information, the Cuban side was recommended to keep on having seminars of the kind.

d. Training on safe operation of machine tool and tools

Due to the frequent cases of injuries caused by the misuse of tools or by the operation of any machine tool, an explanation was given to show how to make a safe use both of machine tool and manual tools donated and already in use.

With the lathe, milling machine, vertical drilling machine and grinding machine installed in the machinery room, accidents are sometimes caused for “getting trapped by or between the machine” or for the spread of filings into the air. Taking this into consideration, the methods of preventive safety were given and lately some of the examples were introduced.

Also the safe and efficient use of tools such as hammer, chisel, wrenches, screwdriver and files was explained, showing specific examples of the unsafe behavior of working with them.

e. Training on welding (gas and arc welding)

Although welding works are practiced everyday at the Central Workshop, the welding equipment is very old and too difficult to adjust the amperage. With the arrival of the gas, arc and TIG welding machines as well as the cutting torch, a course on welding was organized, emphasizing on the main principles of gas and arc welding and safe operations. The course had a theoretical part (welding principles) and a practical part carried out in the welding area at the workshop, where the safe way to work with welding machines was explained with the real equipment. It is worth to mention that in the previous occasion they were explained how to operate TIG welder, so this time was limited to the elaboration of the operation manuals and its distribution. Training on this topic is scheduled for future days aimed at more experienced maintenance staff.

f. Training on Differential

The differential is the transmission mechanism in the drive part and despite is not very frequent to be given maintenance to it, when it has failures it becomes necessary to make a highly precise repair work. Due to collection trucks in particular have special mechanisms as a non-skid differential to prevent tires to get stuck in the rough ways of the landfill sites, it is necessary that the personnel manages how to give maintenance, learning the criteria and correct methods to perform it.

The course included the criteria and key aspects of maintenance, assembling and disassembling, adjustments and inspections: (1) for the correct adjustment between the reduction gear and the reduction pinion, (2) the reduction pinion and (3) the non-skid differential.

g. Compressor checking

A problem of the greasing pump malfunctioning occurred and its cause was identified to be the deficient draining of the compressor. To solve this situation, the participants were explained to make daily checking of the compressor as well as what to do in monthly and annual inspections.

h. Maintenance of machinery equipment

As the specialist sent for the installation of machinery equipment explained that time (July 2011) about their operation in the machinery room through practical lesson, this time, a course on maintenance of machinery equipment was organized, specifically on lubrication method. The training took place in the machinery room to identify in the machines, the lubrication points of the equipment, using the materials translated into Spanish. At the same time, the way how to change the grinding wheel and how to adjust its balance was explained.

i. Record of trainings carried out

The following is the record of the courses afore mentioned:

i.1. Handling of impact wrenches and tires

Title of seminar (Content)	Handling of impact wrenches and tires	
Venue	Meeting room of the white house, UPPH	
Date	9:00 – 12:00 y 13:00 – 15:00, December 7, 2011	
Instructors	Yamanaka, Hiraga, Mitani (interpreter)	
Participants		
	Names and surnames	Specialty
1	Yordani Valdez Castillo	Tire repair facility
2	Juan Luis Boudet	Tire repair facility
3	Felipe Carmona	Tire repair facility
4	Esteban Rodríguez	Tire repair facility
5	Bernardo Peña	Tire repair facility
6	Alfredo Valdés	Tire repair facility
7	Alberto Peña	Tire repair facility
8	Lázaro García	Tire repair facility
9	Emilio Zamora	Mechanic
10	Daniel García	Tire repair facility
11	Alexander Columbie	Tire repair facility
12	Roberto Vázquez	Tire repair facility
13	Gilberto González Rodríguez	Tire repair facility
14	Julio R. Santana Sánchez	Tire repair facility

Remarks:

- The correct use of the impact wrenches was explained, the aspects to take into consideration when using them, the correct way in mounting the tires and the correct way to tight the engine screws.
- The tire types and structures were explained.
- The correct way to use air tools was explained, as well as the aspects to take into account when using them and the way to calculate the capacity necessary for a compressor. The forms of revision and maintenance of tires and the care points of tires were explained in order to avoid sudden fall.
- In the time assigned for the practice with a real truck, after it was explained how to use the impact wrenches, torque wrenches as well as the key care points, all the participants made practical use of them.
- After explaining the form of revision of tires with a test hammer, participants made practices.
- There was a questions and answer session and the discussion was very enthusiastic.
- The correct use of impact and torque wrenches, and hammer was understood through the practices done.

i.2. Function and Structure of the clutch

Title of seminar (Content)	Function and structure of the clutch	
Date	December 9, 2011	
Venue	Meeting room of the White House, UPPH	
Instructor	Yamanaka, Hiraga, Mitani (interpreter)	
Participants		
Nb.	Name and Surname	Specialty
1	Alejandro Herrera Pérez	Mechanic
2	Humberto Fresneda	Mechanic
3	Gilberto González	Mechanic
4	Roberto Vázquez	Mechanic
5	Bienvenido Pumbet	Mechanic
6	José Antonio Hernández Chirino	Mechanic
7	Fernando Amil Real	Head of Department
8	Alexander Columbie Sánchez	Mechanic
9	Asael Cardos	Mechanic

Remarks：

- The structure, function and the form of maintenance of the clutch were explained, as well as the important aspects related to it.
- The Spanish names of the clutch components were defined in order to call them in a unified manner.
- Participants showed interest in the lesson and made questions actively.
- Although participants are used to maintenance works, they did not know some aspects about the clutch functions.

i.3. First Seminar on Integrated Solid Waste Management for Hygiene Workers

First Seminar on Integrated Solid Waste Management for Hygiene Workers
Venue : protocol room, MINCEX
Address : 1ra y 18 Miramar
Date : Wednesday, December 14, 2011
Destined for: municipal directors and heads of hygiene (50 people)

	Person	Contents
8:30		Registration
9:00	Odalys García	Introduction
9:05	Sr. Alejandro Fernández	Solid waste Integrated Management (1)
9:25	Sr. Alejandro Fernández	Solid waste Integrated Management (2)
9:50	Sr. Alejandro Louro Bernal	Solid Waste economical Management
10:10		Break
10:30	Sra. María Eugenia Restroi	Direction Techniques
10:50	Sra. Maritzela Casamayor	Work Hygiene and Safety
11:10	Sr. Raúl Sergio Cuellar	Experience on Solid Waste Management in México City
11:30	Sr. Ryo Hiraga	Importance of Solid Wastes Collection Vehicles Efficient Maintenance
11:50		Questions and answers
12:10	Sr. José Antonio Loyola	Conclusions
12:30		Lunch time

i.4. Precautions for handling machines and tools

Title of seminar (Content)	Precautions for handling machines and tools	
Date	Central workshop	
Venue	9:00 – 10:00, December, 15, 2011	
Instructor	Yamanaka, Hiraga, Mitani (interpreter)	
Participants		
Nb.	Name and surname	Specialty
1	Gilberto	Mechanic (Laboratory)
2	Manuel Figuera	Mechanic
3	Eugenio N. Moret	Assistant
4	Alejandro Herrera	Mechanic (Laboratory)
5	Ernesto Silboza	Assistant
6	Bienvenido Porubet	Mechanic
7	Víctor Pozo	Assistant
8	Roberto Vázquez	Mechanic Assistant
9	Lázaro Martínez León	Mechanic Assistant
10	María Elena Burjes	Store room
11	Humberto Fresnedo	Mechanic
12	Nury Cárdenas	Transport Specialist
13	Fernando Amil	Mechanization Head of Department
14	Daniel Caballeros	Health and safety technician

Remarks：

- The safe ways to use tools (hammer, wrench, files, screwdriver and the bench vise) and equipment (lathe, grinder and drill) were explained.
- Cleaning instructions were given: clean the working area before and after the works in order to preserve the work environment as well as cleaning the tools.
- Participants paid attention to the classes.

i.5. Welding

Title of seminar (Content)	Welding		
Date	9:00 – 12:00, January 24, 2011		
Venue	Meeting room, welding area		
Instructor	Yamanaka, Hiraga, Mitani (interpreter)		
Participants			
Nb.	Name and Surname	Specialty	Years of experience
1	José Luis Hernández Luprrón	Welder	18
2	Conicer Per Pérez	Welder	14
3	Julio Suárez Herrera	Welder	25
4	Mario Arrebato Gonzalez	Welder	18
R	Reepraldo Gezmán Locente	Welder	9
6	Emilio Zamora	Welder	30
7	Nury Cárdenas Véliz	Specialist	15

Remarks

- The names of the parts of the gas welding equipment and arc welding were verified in Spanish.
- The following issues were explained.
  - The principle, mechanism and welding forms
  - The risks of welding works and safety measures
- In the welding area, the security measures were explained.

- Participants paid attention to classes and discussed the topics. A high level of comprehension on the topics was achieved.

i.6. Training on differential

Title of seminar (Content)		Differential	
Date		9:00 – 12:00, January 27, 2011	
Venue		Raúl's office, mechanization area	
Instructor		Yamanaka, Hiraga, Mitani (interpreter)	
Participants			
Nb.	Name and surname	Specialty	Years of experience
1	Roberto Vázquez	Mechanic (Assistant)	2
2	Ernesto Silbloza	Mechanic	2
3	Julio Santana	Mechanic	4
4	Wiliam Chirino	Mechanic	2
5	Emilio Zambora	Mechanic	30
6	Eduardo Jiménez	Mechanic	2
7	Alejandro Herrera	Mechanic	12
8	Nury Cárderas Véliz	Transport Specialist	15

Remarks:
- The Spanish names of the components of the reduction gear, the reduction pinion and the differential were confirmed.
- The important aspects of maintenance and the positions of measurement were explained.
- Maintenance norms and adjustment methods were explained.
- Attendants practiced the use of the indicator and the micrometer.
- Participants asked and discussed about the differential checking methods actively. They could understand very well the contents of the training.

i.7. Training on the Compressor checking

Title of seminar (Content)	Compressor checking
Date	10am – 11am, February 1, 2012
Venue	Compressor room
Instructor	Hiraga, Yamanaka, Mitani (interpreter)
Participants	
Nb.	Name and surname
1	Ramón Acevedo Gomez
2	Yusel Acevedo Padron
3	Antolin Acevedo Cuespo
4	Miguel Angel Aguilar V
5	Fernando Saura
6	Rafael Baracaldo
7	Dagoberto Sierra
8	Emilio Zamora
9	Julio R. Santana

Remarks :
- The ways to make daily, monthly and annual checking were explained.
- The parallel operation of the two compressors and the individual operation were explained.
- Instruction was given mainly on drainage execution.
- People in charge of the compressor checking paid attention to the lesson and understood how to check compressors.
- Due to the amount of time required, the alternative operation of the two compressors

was decided for every week.

i.8. Training of Machinery Tool Maintenance

Title of seminar (Content)	Maintenance of machine tool（Lubrication）
Date	11am – 12am, February 1, 2012
Venue	Machinery workshop
Instructor	Hiraga, Yamanaka, Mitani (interpreter)
Participants	
	Name and surname
1	Nelson Sanchez Oliver
2	Jesús Kesel
3	Gilberto González Raguem
4	Emilio Zamora
5	Julio R. Santana

Remarks：
- The forms of lubricating the lathe, the milling and the drilling machines were explained.
- The precautions to take into consideration while operating the lathe, the milling and the drilling machines were explained.
- The operation of the grinder machine was explained and the way to adjust the balance of the grinding wheel when changing it.
- The mechanics of the machinery workshop understood the contents very well.

6.3.2 Preparation of the manuals

Table 6-2 shows the list of manuals being currently elaborated, and includes the ones already finished.

Table 6-2: Manuals in elaboration

Title
Manual for maintenance of the hydraulic system - of Dong-Feng collection trucks –
Manual for Maintenance with Air Tools
Manual for Tire Maintenance
Manual for Chassis Maintenance
Manual for the Electric System Maintenance
Manual on Gas Welding (Oxygen y Acetylene)
Manual on Arc Welding
Manual on Differential
Manual for Machinery Equipment Maintenance
Manual on TIG Welding Operations

6.3.3 Others

Although activities developed this time mainly involved the training courses held and the elaboration of manuals, the Cuban side requested the JET to advise on the works under way and about the problems related to equipment and failures in collection vehicles during this period. In response to this request, they were given instructions on the following aspects:

- Air pipes (November 28, 2011)

Concerning the air pipe for the use of different air tools, they were instructed to: a) control the pneumatic pressure trough regulators located in the last part of the pipe, b) in order to install the pipe in the columns it should be located in the internal part of the column so as to avoid possible truck contact.

- Failure with the starting motor (December 14, 2011)

The failure with the starting motor of the truck belonging to Habana Vieja municipality was diagnosed. According to the results of the revision, it was recommended to be replaced by a new one.

- Failure of “ESGO” device adjustment (December 14, 2011)

The compactor truck belonging to Regla municipality had problems with the adjustment of “ESGO” device (an auxiliary system for parking braking and starting in sloping grounds). Instructions on adjustment methods were given.

- Failure with greasing pump (January 17 and 18, 2012)

The lubrication and greasing pump reported to have a malfunctioning problem was checked, so that to determine the failure, provoked by the draining water that got into the air of the compressor, which also, when supplying the grease to the tank mixed with air. Recommendations were:

    - to drain the water of the compressor once or twice a day,
    - to name a person in charge of draining and inspection who should elaborate a written record for the equipment checking, and
    - to guarantee a careful supply of grease to the tanks so that it is not mixed with air.

- Preparation of the specifications list for compactor trucks purchase (February 1 and 2, 2012)

As the Cuban part plans to purchase new compactor trucks, they were advised to list their specifications.

6.4 Progress of activities for strengthening the capacities on heavy equipment maintenance

6.4.1 Training carrying out

Civil works at the Heavy Equipment Workshop were finished and both the installation of donation equipment and the delivery of the new tools for the workshop were concluded. In this occasion, the JET emphasized on the appropriate use and correct maintenance of the newly installed equipment by the Cuban side. At the same time, training on maintenance of the heavy equipment engines was given.

The training carried out this time is mentioned below:

a. Cummins engine characteristics

As most of the heavy equipment (bulldozer) existing at the final disposal sites have Cummins engines (for equipment of the TY’220 model, 8 engines, and SR22R model, 2 engines), a training on this specific engine inspection and adjustment was given.

The course involved the personnel training for adjusting the space between the valve and the lid of the suction-exhaust valves, as well as the injector adjustment by using the donated tools and thickness gage.

They were also trained on assembling and disassembling of PT pump (fuel) so that they could learn its structure and functioning and the adjustment methods.

b. Engine checking and adjustment

Although most of the heavy equipment at the final disposal sites have Cummins engines (PT pumps), instructions for the maintenance of other types of motors (BOSH type) were given. Aspects as the valve space adjustment, the method to check the functioning of the fuel injection nozzle (in Japan, the testing method to find the damaged cylinder), the method to measure compressed air pressure, and the practical measuring of the specific gravity of battery liquid, by using the donated hydrometers. There was also a practical training to learn the engine adjustment with the inspection list, using the donated bulldozer D41E.

c. Record of training carried out

The following tables show the record of the afore mentioned courses

c.1. Training on Cummins engine and PT pump/ Engine checking and adjustment

Title of Seminar (Content)	Cummins engine and PT pump/ Engine checking and adjustment		
Date	February 2 and 3, 2012		
Venue	Heavy Equipment workshop		
Instructor	Dosho, Vicente (interpreter)		
Participants			
Nb.	Name and surname	Specialty	Years of experience
1	Rogelio Callado	Mechanic	20
2	Iván Augusto Manrique	Mechanic	4
3	Gilberto Ortega	Mechanic	20
4	Rafael Amedes	Mechanic	37
5	Dioscórides Palmeiro	Mechanic	30
6	Jorge Quintana	Workshop specialist	25
7	Teddy Díaz	Mechanic	22
8	Azahel Cardoso	Assistant	1
9	Manuel Blanco	Mechanic	30
10	Lázaro Montes Martínez	Mechanic	10
11	Gilberto Masa	Grease mechanic	20
12	Rafael Reyes	Assistant	10
Remarks: The use of the material translated into Spanish was highly effective for the training. The explanation through the use of boards was very clear. The previous year the course dealt with operation of the in-line pump and this year it was decided to deal with the operation of the PT pump as many of the heavy equipment have this kind of pump. Likewise, the most complicated parts of the PT pump and the injectors were explained in order to facilitate the participants' understanding. The practical training for assembling and disassembling the PT pump was a very useful for attendees.			

c.2. Training on Engine checking and adjustment

Title of Seminar (Content)	Engine checking and adjustment		
Date	February 3, 2012		
Venue	Heavy Equipment workshop		
Instructor	Dosho, Vicente (interpreter)		
Participants			
Nb.	Name and surname	Specialty	Years of experience
1	Rogelio Callado	Mechanic	20
2	Iván Augusto Manrique	Mechanic	4
3	Gilberto Masa	Grease mechanic	20
4	Rafael Amedes	Mechanic	37
5	Dioscórides Palmeiro	Mechanic	30
6	Jorge Quintana	Workshop specialist	25
7	Teddy Díaz	Mechanic	22
8	Azahel Cardoso	Assistant	1
9	Manuel Blanco	Mechanic	30
10	Lázaro Montes Martínez	Mechanic	10
11	Rafael Reyes	Assistant	10
Remarks: During the course, several aspects related to the oil consumption in the engine were dealt. The way to test the functioning of the cylinders through the discard method, and how to calibrate the valve and injectors clearance in the case of Cummins engine, as well as how to measure the battery liquid density. As a request from participants, the operation of the donation equipment was explained, specifically the drilling machine, the grinding			

machine, the hydraulic press, the air compressor, the battery charger and the tools for the tool room. The topics related in this second class were very interested for the participants.

6.4.2 Preparation of the Manuals

With the objective to appropriately manage, check and maintain the new equipment, the preparation of the corresponding manuals begun.

Table 6-3: Manuals on preparation

Title
Manual for monthly checking (Vertical drilling machine, grinding machine, hydraulic press, compressor, welding machine and battery charger)

6.4.3 Others

Besides the training and the preparation of manuals, the activities mentioned below also took place.

- Instructions for operation and maintenance of the donation equipment (January 17, 18, 25 and 26, 2012)

The good operation of the equipment was checked, indicating the incorrect aspects and suggestions when in use (the drilling machine, the grinder, the hydraulic press, the compressor, the welder, the battery charger and the impact wrenches).

- Instructions for maintenance of the heavy equipment previously donated by JICA (bulldozer KOMATSU, model D41E)（January 19 , 20, 23 and 24, 2012）

- Instructions for a better control of tools (January 17 and 18, 2012).

Attendants were instructed on how to note (directly in the tool shelves) the different sizes of the tools, how to place the torque bolt table and the method to measure the specific battery liquid, among others.

- Visit to Final Disposal sites (February 1, 2012)

In order to identify the activities of the mobile maintenance truck used to assist the heavy equipment at the final disposal sites, a visit to 8 Vias and Tarar'a landfills was done to check the condition of this equipment.

7 Workshop Improvement, Aditional Equipment Installation, and Maintenance Training (March-December 2012)

As supply of donation of additional equipment has been realized at the 4th year, followed by former donation equipment at the 3rd year, an installer for installation of the additional equipment was dispatched and his guidance was carried out. Furthermore, 2 supervisors of milling machine and TIG welding were dispatched and their trainings were conducted by request from Cuban side.

The activities both JET and C/P from February, 2012 to November, 2012 are listed below.

- The trainings by C/P using donated equipments from Japan
- Installation, test operation and training of new equipments on 4th year
- Training of milling machine and TIG welding by 2 specialists
- Training on maintenance of both collection vehicle and heavy equipment by JET

The following shows the names, area and period of assignment of JET, specialists and an installer.

【JET】

Name	Ryo HIRAGA
Area	Maintenance of collection vehicles (operation and management) / Operation of tool machines (selection, acquisition and design of layout)
Period	Jun. 13 – Jul. 12, 2012 and Nov. 10 – Dec. 9, 2012

Name	Tadayuki YAMANAKA
Area	Maintenance of collection trucks (diagnose, maintenance and repair)
Period	Jun. 13 – Jul. 12, 2012 and Nov. 10 – Dec. 9, 2012

Name	Takeshi Dosho
Area	Operation of tool machines (improvement of heavy equipment maintenance)
Period	Jun. 13 – Jul. 12, 2012

【Supervisors】

Name	Yoshikazu KANAZAWA
Area	TIG welding
Period	Jun. 26 – Jul. 12, 2012

Name	Takamitsu NAGASHIMA
Area	Milling machine
Period	Jun. 26 – Jul. 12, 2012

【Installer】

Name	Saburo TANIMURA
Area	Installation guidance of additional donated equipment (Fuel Injection Pump Tester, Service Sets, Crimping Machine)
Period	Jun. 19 to Jul. 15, 2012

The working schedule on June and July, 2012 is listed on Figure 7-1.

And the working schedule on November and December, 2012 is listed on Figure 7-2.

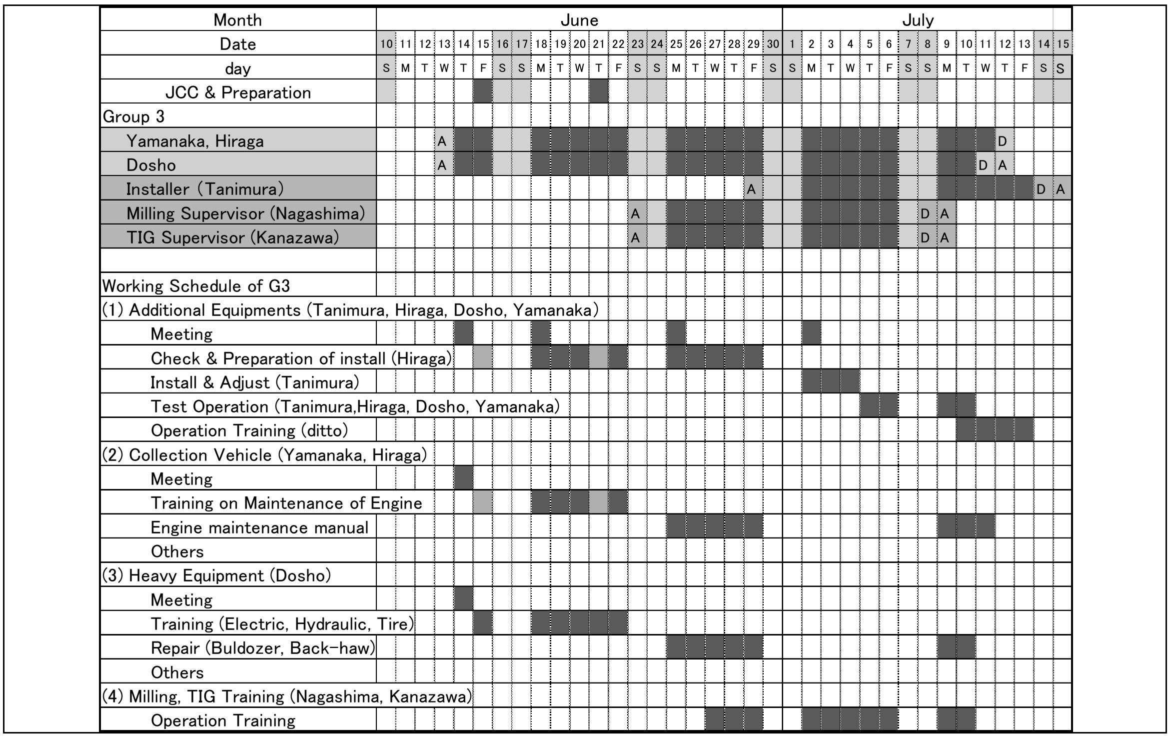


Figure 7-1: Working schedule (Jun. & Jul. 2012)

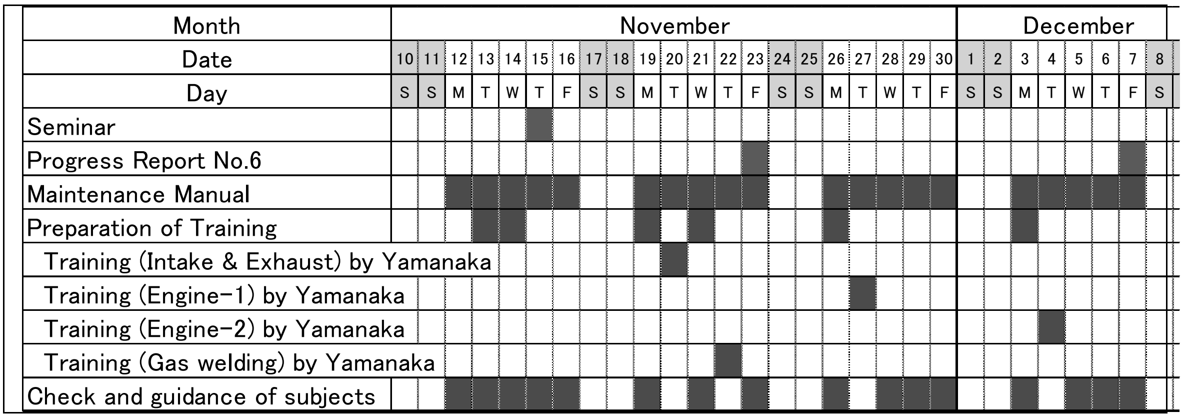


Figure 7-2: Working schedule (Nov. & Dec. 2012)

7.1 Progress of the installation improvement work

7.1.1 Supply of additional equipment

27 kinds of additional equipment were supplied on 4th year and its list is shown in Table 7-1.

Table 7-1: List of additional equipment

no.	Name of Article		
	Japanese	English	Spanish
1	帯鋸盤	Hack Sawing Machine	Segueta mecánica
2	鋸刃	hacksaw Blade	Hoja de segueta
3	クランピング マシン	Crimping Machine	Boquilladora de manguera
4	タイヤ チェンジャー	Tire Changer	Desmontador de neumáticos para camiones y tractores
5	工具ｾｯﾄ VA型／VE型燃料ﾎﾟﾝﾌ用	Service Tools	Herramientas de servicio, para uso de bomba de tipo VA/VE
6	工具ｾｯﾄ P型ｲﾝﾗｲﾝ燃料ﾎﾟﾝﾌ用	Service Tools	Herramientas de servicio, para uso de bomba de tipo P
7	ﾍﾞﾝﾁﾊﾞｲｽ	Bench Vise	Tornillo de banco
8	両頭ｸﾞﾗｲﾝﾀﾞｰ	Bench Electric Grinder	Esmeriladora con pedestal
9	トルクレンチ	Torque Multiplier	Llave de Torque
10	油圧計ｾｯﾄ	Hydraulic Pressure Gauge Set	Juego de equipamiento para el diagnostico del sistema hidráulico
11	タガネ＆ポンチセット	Chisel & Punch Set	Juego de Cinceles & Centra punzones
12	ｽｸﾘｭｰﾋﾟｯﾁｹﾞｰｼﾞ WW標準型	Screw Pitch Gauge	Garga de rosca, tipo WW
13	ｽｸﾘｭｰﾋﾟｯﾁｹﾞｰｼﾞ ﾒﾄﾘｯｸ標準型	Screw Pitch Gauge	Garga de rosca, tipo métrico
14	タイヤ チェンジャー	Tire Changer	Desmontador de neumáticos para camiones y tractores
15	エアータンク	Air Reservoir	Tanque de aire
16	ｴｱｰｲﾝﾊﾟｸﾄﾚﾝﾁ 12.7mm角	Air Impact Wrench	Pistola neumática reversible, 12.7mm x 12.7mm
17	ｴｱｰｲﾝﾊﾟｸﾄﾚﾝﾁ 19mm角	Air Impact Wrench	Pistola neumática reversible, 19mm x 19mm
18	ｴｱｰｲﾝﾊﾟｸﾄﾚﾝﾁ 25.4mm角	Air Impact Wrench	Pistola neumática reversible, 25.4mm x 25.4mm
19	エアードリル	Air Drilling Machine	Taladro neumático no-reversible con Porta-broca & llave
20	ｴｱｰｻﾝﾀﾞｰ	Air Sander	Lijadora neumática
21	ﾊﾝﾄﾞｸﾞﾗｲﾝﾀﾞｰ	Hand Grinder	Esmeliradora con sus puntas
22	ｶﾞﾚｰｼﾞｼﾞｬｯｷ	Garage Jack	Gato de Patín
23	燃料噴射ポンプテスター	Fuel Injection Pump Tester	Banco de comprobación de bomba de inyección
24	ﾜｲﾔｰﾌﾞﾗｼ	Wire Brush	Cepillo de alambre
25	油圧ﾌﾟﾚｽ	Hydraulic Press Machine	Prensa Hidráulica
26	ｴｱｰｺﾝﾌﾟﾚｯｻｰ	Air Compressor	Compresor
27	タイヤドリー	Wheel Dolly	Carro de la rueda

Additional equipment was imported and passed custom by wooden packed boxes; by serial number C-1 to C-8 and M-1 and M-2.

JET and C/P have cooperatively checked all equipment by opening all boxes, by comparing with shipping lists and specification from 15th to 19th June 2012, and all equipment was confirmed to be supplied well without problem.

The layout of the equipment necessary to be installed is shown in Figure 7-3.

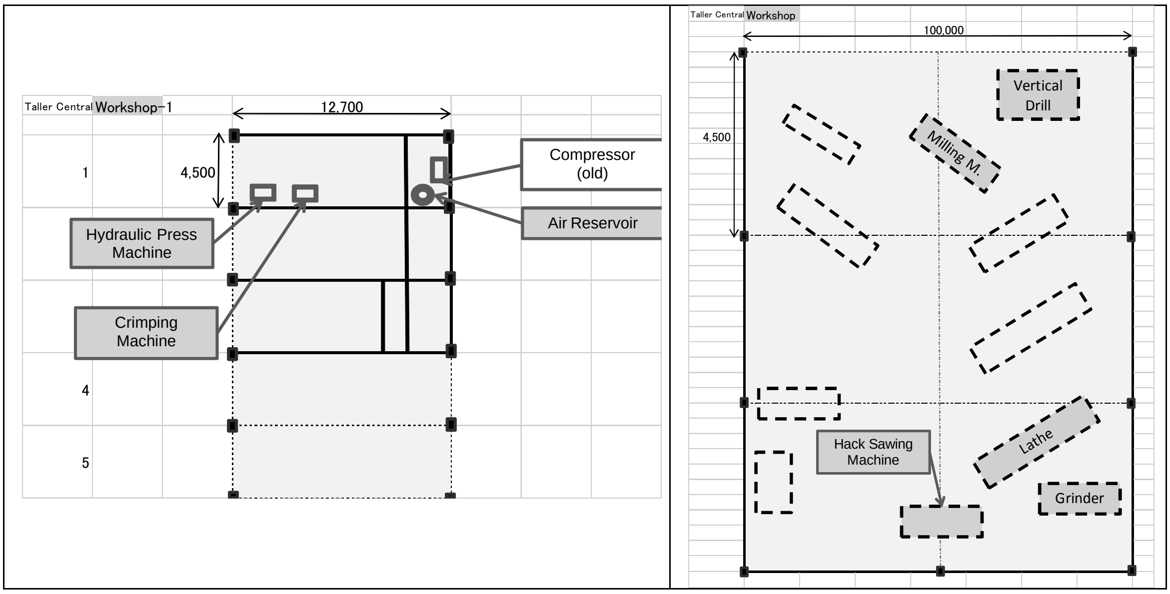


Figure 7-3: Layout of additional equipment

7.1.2 Installation of additional equipment

The donation of additional equipment by JICA was supplied on June, 2012, and the equipment was installed on June and July, 2012, by Cuban side's efforts to conduct electric and civil construction work. Right now, all of them are under operation without problem in good condition, except 1) compressed air pipe layout system and 2) external oil tank installation by EPROYIV at lubrication system area.

To handle tools and equipment appropriately can lead sustainable secure of the equipment. Therefore, both JET and C/P cooperatively conduct preparation of technical manual and training in various fields.

Before	After
	

Photo 7-1: Workshop Improvement

a. Machine workshop

In machine workshop, construction of base and electric wiring for hack saw machine have already prepared. And compressed air piping system with 4 outlets was introduced, and new compressor supplied on June was installed here.

New equipment: Hack saw machine
It was installed on July, and operated without problems, but further adjustment is desirable.

Base preparation for hack saw machine	Installation of hack saw machine
	

Compressed air piping system	Installation of compressor
	

Photo 7-2: Machine Workshop (Hack Saw and Air Piping System)

b. Compressor room

This room is located at No.1 workshop. There was no equipment in this room on last January, and begun preparation work for JICA donation from April and May, to install necessary items. The preparation work contains to set an old Russian compressor (2004), and air piping system covering both No.1 and No. 2 workshop.

New equipment: Hydraulic machine, Crimping machine and Air reservoir
The equipment was under operation already, but it is necessary to adjust air pressure of air piping system at both No. 1 and No.2 workshop having 8 outlets.

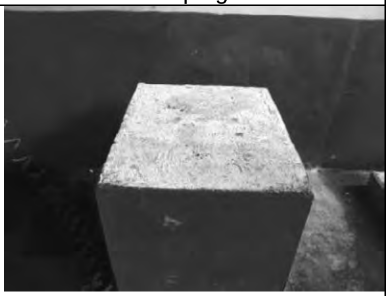
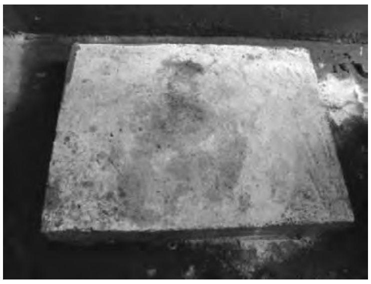
Base of Crimping machine	Base of Hydraulic press	Base of Air reservoir
		

Photo 7-3: Bases for Crimping Machine, Hydraulic Press, and Air Reservoir

Installation of Crimping machine	Installation of Hydraulic press	Installation of Air reservoir
		

Photo 7-4: Installation of Crimping Machine, Hydraulic Press, and Air Reservoir

c. Fuel injection pump test room (Labo)

In this room, preparation of electric source work has finished on January by considering new equipment arrival.

On June, electric wiring and cooling water piping were prepared for new fuel injection pump tester, and air conditioning machine was installed to improve the condition of this room.

Fuel injection pump tester	Water cooling pipe
	

Photo 7-5: Fuel Injection Pump Tester

d. Tire repair shop

Preparation of base and electric wiring was done for new tire changer installation. This preparation work was planned when this room was constructed.

Installation of tire changer (left)


Photo 7-6: Tire Changer

e. Tire repair shop at heavy equipment maintenance yard

Preparation work of base and electric wiring was conducted in this room, to install tire changer, compressor and bench electric grinder with foundation. Those works were planned when this room was constructed.

Tire changer	Bench electric grinder
	

Photo 7-7: Tire repair shop at heavy equipment maintenance yard

f. No.1 and No.2 Workshop

2 Electric chain blocks were installed,
Compressed air piping connecting between No. 1 and No. 2 workshop through underground was buried.

No.1	No.2	Underground piping
		

Photo 7-8: No.1 and No.2 Workshop

All of electric work described in this chapter was done by GEYSEL, construction work like base was done by ASECON, and installation of electric chain block was done by Nuevas Técnicas.

7.2 Progress of activities to strengthen capacities on vehicle and heavy equipment maintenance

The procedure to strengthen capacities on vehicle and heavy equipment maintenance is shown below.

1) Both JET and C/P prepare maintenance manual cooperatively.
2) JET conduct training to mechanics. (During JET is staying in Cuba)
3) C/P conduct training to mechanics. (During JET is absent from Cuba)
4) To bring up over 20 mechanics who can operate donated equipment properly as well as can make appropriate maintenance.

7.2.1 Trainings by C/P

Among above mentioned activities, the outline of 6 trainings by C/P have been carried out from February to October 2012, are listed in Table 7-2 to Table 7-7.

Table 7-2: Training by C/P-1

Title of training		Hydraulic system
Date		28, Feb. 2012
Venue		Meeting room in Taller Central
Instructor		Juan Rodríguez
Participants		
No.	Name	Speciality
1	Osmer Ortega	Assistant
2	Osnier Urrutia	Assistant
3	Humberto Fresnedo	Mechanic A
4	Alex Freddy	Assistant
5	Alexis Méndez	Assistant
6	Elías Pérez	Assistant
7	Carlos Ruiz Dueñas	Assistant
Notes: Hydraulic system, diagram, setting pressure and how to repair hydraulic cylinder were trained.		

Table 7-3: Training by C/P-2

Title of training		Clutch system
Date		7, March, 2012
Venue		Meeting room in Taller Central
Instructor		Alfredo Valdez
Participants		
No.	Name	Speciality
1	Julio Santana	Mechanic B
2	Rubén Ortega	Mechanic A
3	Yoel Gómez	Mechanic B
4	Frank Sorrilla	Mechanic A
5	Roberto Vázquez	Mechanic B
6	Leonardo Rodríguez	Mechanic A
7	Rolando Rodríguez	Mechanic B
8	Geroncio Hernández	Mechanic A
Notes: Repair, setting, replacement and dismantle methods were trained.		

Table 7-4: Training by C/P-3

Title of training		Differencial system
Date		14, March, 2012
Venue		Taller Central
Instructor		Geroncio Hernández
Participants		
No.	Name	Speciality
1	Ernesto Silvosa	Mechanic B
2	Humberto Fresnedo	Mechanic A
3	Alfredo Valdez	Mechanic A
4	Bienvenido Pombet	Mechanic A
5	Amauri García	Mechanic B
6	Esteban García	Mechanic B
7	Juan H. Carrera	Mechanic C
8	Roberto Vázquez	Mechanic A
Notes; Mechanism and repair method was trained.		

Table 7-5: Training by C/P-4

Title of training		Hydraulic system
Date		23, August 2012
Venue		Taller central
Instructor		Bienvenido Pombet
Participants		
No.	Name	Speciality
1	José A. Hernández	Mechanic A
2	Frank Zorrilla	Mechanic
3	Roberto Vázquez	Mechanic B
4	Onelio Despaine	Mechanic C
5	Bienvenido Pombet	Mechanic A
6	Oniel Urrutia	Mechanic C
7	Oniel Ortega	Mechanic C
8	Vladimir Suárez	Assistant
9	Yoel Gómez	Mechanic B
Notes: Mechanism of lubrication system was trained.		

Table 7-6: Training by C/P-5

Title of training		Mechanism of Lathe
Date		12, Sep. 2012
Venue		Workshop
Instructor		Nelson Sánchez
PArticipants		
No.	Name	Speciality

1	Jesús Kesel	Operator B
2	Miguel Díaz	Operator B
3	Bla Díaz	Operator B
4	José Antonio Gustamante	Assistant
5	Gilberto González	Operator B
Notes: Mechanism of lathe was trained.		

Table 7-7: Training by C/P-6

Title of training		Engine cooling system
Date		19, Oct. 2012
Venue		Taller central
Instructor		Alfredo Valdez
Participants		
No.	Name	Speciality
1	José A. Hernández	Mechanic A
2	Frank Zorrilla	Mechanic A
3	Roberto Vázquez	Mechanic B
4	Onelio Despaine	Mechanic C
5	Alfredo Valdez	Mechanic A
6	Oniel Urrutia	Mechanic C
7	Oniel Ortega	Mechanic C
8	Vladimir Suárez	Assistant
9	Carlos Aguiar	Trailer operator
10	Leonardo Rodríguez	Mechanic A
11	Sergio Foncada	Mechanic C
Notes: Cooling system of engine was trained.		

7.2.2 Trainings by JET

8 trainings were carried out by JET from 7, Feb. to 22, Nov. 2012. 6 trainings are targeted to collection vehicle maintenance and 2 trainings are for heavy equipment maintenance. Outline of the training are listed below tables.

Table 7-8: Training by JET-1

Title of training		Operation of grease pump	
Date		10am – 11am, 7, Feb. 2012	
Venue		Lubrication room	
Instructor		Yamanaka, Hiraga, Mitani (interpreter)	
Participants			
No.	Name	Speciality	Years of experience
1	Israle Prerez Brito	Engrasador	5
2	Juan C. Diez Balado	Engrasador	5
3	Enrique Garcia Rodriguez	Transportation specialist	30
Remarks： ● Explained how to handle grease pump ● Explained how to deal when air / drain is mixed ● The participants understood well.			

Table 7-9: Training by JET-2

Title of training	Organization of Taller		
Date	Meeting room of white house, Taller Central		
Venue	9am – 11am, 8, Feb. 2012		
Instructor	Hiraga, Yamanaka, Mitani (interpreter)		
Participants			
No.	Name	Speciality	Years of experience

1	Nury Cárdenas Véliz	Transport specialist	15
2	Enrique Gracia Rodriguez	Transport specialist	30
3	Diego Guevara	Engineer	28
4	Raul Aguilar González	Subdirector of Mecanization	25
5	Felix Abreu Lacalle	Administer of Taller	30

Remarks:

- Explained vehicle maintenance about below items
  - Necessary elements for vehicle maintenance
  - Plan of purchase of vehicles
  - Organization of vehicle maintenance shop
  - Introduction of workshop in Osaka Japan
- Active discussion with C/P was held and all participants understood well about the training

Table 7-10: Training by JET-3

Title of training	Lubrication and cooling system of engine
Date	9:30 – 12:00am, 22, Jun. 2012
Venue	Meeting room, Taller central
Instructor	Yamanaka, Hiraga(assistant), Mitani (interpreter)

Participants

No.	Name	Speciality	Years of experience
1	Yoel Gomez	Mechanic B	18
2	Roberto Yoslai	Mechanic B	2
3	Osnier Orgega	Mechanic C	1
4	Maurice Vignier	Assistant	1
5	Yordani Monecde	Assistant	1
6	Osniel Urrutia Acosta	Assistant	1

Remarks:

- Target participants are young generation (less experiences)
- Active question and answer session was held
- Lack of explanation time for cooling system of engine
- Almost understood

Table 7-11: Training by JET-4

Title of training	Fueling system of engine
Date	9:30 – 12:00am, 12, Jul. 2012
Venue	Raul's office, Taller central
Instructor	Yamanaka, Hiraga(assistant), Mitani (interpreter)

Participants

No.	Name	Speciality	Years of experience
1	Humberto Fresnevo	Mechanic A	30
2	Mario Arebato	Welding B	6
3	Yordemis Moncada	Assistant	1
4	William Navarro	Assistant	6
5	Roberto Vazquez	Mechanic B	2
6	Emilio Zamora	Mechanic A	35
7	Isabel Tamayo	Transport specialist	20

Remarks：

- The participants were eager to listen to and had active questions
- Almost understood
- As they are not familiar about installation of fuel injection pump and adjustment of upper dead point of engine, JET will explain more in detail at next time training of engine.

Table 7-12: Training by JET-5

Title of training	Electric devices and Sequence diagram
Date	9am – 12am, 5, Jul. 2012
Venue	Heavy equipment workshop
Instructor	Dosho, Vicente (interpreter)

Participants

No.	Name	Speciality	Years of experience
1	Ivan Augusto Manrique	Assistant mechanic	4
2	Rafael Amedes	Mechanic	37
3	Dioscorides Palmeiro	Mechanic	30
4	Teddy Diaz Vazquez	Chief mechanic	22
5	Azahel Cardoso	Assistant mechanic	1

Remarks:

- Explained below
  - Electric devices and their mechanism
  - How to read sequence diagram of Bulldozer D41E
  - How to handle digital multi tester
- Understood well about principal of electric device
- Engine start circuit, charging current direction and role of diode were well-understood.
- Repair capacity can be expected improved.

Table 7-13: Training by JET-6

Title of training	Hydraulic devices and how to read hydraulic sequence diagram
Date	9am to 12am, 4, Jul. 2012
Venue	Heavy equipment workshop
Instructor	Dosho, Vicente (interpreter)

Participants

No.	Name	Speciality	Years of experience
1	Ivan Augusto Manrique	Assistant mechanic	4
2	Rafael Amedes	Mechanic	37
3	Dioscorides Palmeiro	Mechanic	30
4	Jorge Quintana	Manager of Taller	25
5	Teddy Diaz Vazquez	Chief mechanic	22
6	Angel Reyes Gassiot	Manager (Mechanization)	20

Remarks:

- Below explanation was conducted
  - Hydraulic devices and their function
  - How to read hydraulic sequence diagram of bulldozer D41E
  - How to use hydraulic gauge
- Basic of hydraulic is understood and repair capacity can be expected improved

Table 7-14: Training by JET-7

Title of training	Air intake and exhaust gas of engine
Date	20, Nov. 2012
Venue	Raul’s room, Taller central
Instructor	Yamanaka, Hiraga(assistant), Shindo (interpreter)

Participants

No.	Name	Speciality	Years of experience
1	Sergio Forcades	Mechanic C	1
2	Eduardo Jimenez	Transportaion expert	1
3	Enrique Garcia	Transportaion expert	30
4	Antonio Octavio Mendez	Assistant	1
5	Osniel Ortega	Assistant	2
6	Yordenis Moncada	Assistant	1
7	Isabel Tamayo	Transportaion expert	18
8	Nury Cárdena	Transportaion expert	16
9	Fernando Amil	Transportaion expert	30
10	Humberto Freinedo	Mechanic A	46

Remarks:

- Explained below;

- Air intake and exhaust gas system of the engine
- Turbo-charger
- Muffler
- Explained maintenance method and standard about above mentioned items
- The participants were very eager and had active discussion
- Well understood

Table 7-15: Training by JET-8

Title of training	Gas welding		
Date	22, Nov. 2012		
Venue	Taller central		
Instructor	Yamanaka, Hiraga(assistant), Shindo (interpreter)		
Participants			
No.	Name	Speciality	Years of experience
1	Mario Arrebato	Welder B	9
2	Yohanclin Damon	Assistant	0.5
3	Luis Mario Torres	Welder B	30
4	Vladimir Suerez	Welder B	1
5	Eduardo Jimenez	Transport specialist	1
6	José Luis Hernandez	Welder B	27
7	Enrique García	Transport specialist	30

Notes:

- Explained of nozzle of gas welding
  - There are cutting and welding nozzles for gas welding device. If confused nozzle will be melted.
  - Should select appropriate size of nozzle as thickness of target steel plate.
  - Nozzle holes should be cleaned by special needle.
- Practice of gas welding
  - Adjust pressure of both oxygen and propane by regulator.
  - Adjust both oxygen & propane speed appropriately, and remember the flare and sound.
  - Proceeding speed of nozzle should be careful.
- Others
  - Nozzle, torch, regulator and hose should be treated carefully.
  - Working place should be cleaned up every day.
- The participants were very eager to listen to and there were active discussion.
- The participants shared their experiences & knowledge.
- The participants understood well about the training.

7.2.3 Preparation of maintenance manual

Prior to the training by JET, maintenance manuals are prepared by cooperation work between JET and C/P, to deliver them at the training to explain, and for appropriate use for practical maintenance.
As of now (23, Nov. 2012), 16 manuals, including under translation, are prepared, and its list is shown at Table 7-16.

Table 7-16: List of maintenance manual

No.	Title of Manual Español	和文	English	Date
1	MANUAL DEL MANTENIMIENTO DEL SISTEMA HIDRÁULICO - de los Camiones colectores de Dong-Feng -	油圧システム整備マニュアル	Hydraulic	2011,10,04
2	MANUAL DEL MANTENIMIENTO DEL CHASIS	クラッチ整備マニュアル	Clutch	2011,12,09
3	MANUAL DEL MANTENIMIENTO DEL SISTEMA ELÉCTRICO	電気システム整備マニュアル	Electric	2011,12,14
4	MANUAL DEL SOLDADURA POR ARCO	アーク溶接機操作マニュアル	Arc welding	2012,01,24
5	MANUAL DE LA SOLDADURA AUTOGENA (Oxigéno y Acetileno)	ガス溶接マニュアル	Gas welding	2012,01,24
6	MANUAL DEL MANTENIMIENTO CON LAS HERRAMIENTAS NEUMÁTIC	エアーツール整備マニュアル	Air-tool	2012,02,09
7	MANUAL DEL MANTENIMIENTO DE LAS RUEDAS	タイヤ整備マニュアル	Tire	2012,02,09
8	MANUAL DE OPERACIÓN DEL DESMONTADOR DENEUMÁTICOS	タイヤチェンジャー操作マニュアル	Tire changer	2012,02,09
9	MANUAL DEL DIFERENCIAL	ディファレンシャル整備マニュアル	Differencial	2012,02,09
10	MANUAL DEL MANTENIMIENTO DE LOS EQUIPOS DE MAQUINADO	工作機械整備マニュアル	Machine tool	2012,06
11	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE REFRIGERACIÓN	エンジン冷却装置整備マニュアル	Cooling system	2012,06,22
12	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE LUBRICACIÓN	エンジン潤滑装置整備マニュアル	Lubrication of engine	2012,06,22
13	MANUAL DE SOLDADURA TIG	TIG 溶接機取扱いマニュアル	TIG welding	2012,07,03
14	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE ALIMENTACIÓN	エンジン燃料装置整備マニュアル	Fuel system of engine	2012,07,10
15	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE ADMISIÓN Y ESCAPE DE AIRE	エンジン吸排気装置整備マニュアル	Air intake & exhaust	2012,11,20
16	MANUAL DEL MANTENIMIENTO DEL MOTOR	エンジン整備マニュアル	Engine	翻訳中

7.2.4 Training by 2 specialists

By Cuban side request, 2 trainings, namely TIG welding and Milling machine, were realized by invited 2 specialists. Outline of the training is shown in Table 7-17 and Table 7-18.

Table 7-17: TIG welding training

Title of training	TIG Welding	
Instructor	Yoshikazu KANAZAWA	
Venue	Welding place, Taller central	
Date	Training	No. of participant
6/25	Preparation of TIG welding training	2
6/26	Explained about TIG torch handling and practice of TIG welding	7
6/27	Explained about TIG welding machine and practice of stainless welding	4
6/28	Practice of stainless welding	8
6/29	Practice of stainless welding	6
7/2	Practice of stainless welding	8
7/3	Practice of aluminum welding	8
7/4	Practice of aluminum welding	5
7/5	Practice of aluminum welding and arc welding	8
7/6	Practice of stainless & aluminum welding	10

Table 7-18: Milling machine training

Title of training	Operation of milling machine	
Instructor	Takamitsu NGASHIMA	
Venue	Workshop, Taller central	
Date	Training	No. of participant
6/25	Test operation of hack saw machine	3
6/26	Preparation of milling machine training (material preparation by hacksaw)	3
6/27	Explained how to handle milling machine (front milling, end mill)	4
6/28	Processing Practice	2
6/29	Processing Practice	4
7/2	Key processing	3

7/3	Adjust center between main axis and push head	2
7/4	Processing Practice	2
7/5	Processing Practice	2
7/6	Processing Practice	5

7.3 Progress in Capacity Building for Vehicle Maintenance

7.3.1 Comparison of maintenance time between before and after of equipment supply

To evaluate donation of equipment from Japan, comparison study of typical maintenance work was carried out by measuring maintenance time between 1) before donation of equipment from Japan and 2) by using donated equipment from Japan, at typical maintenance fields.

The target of maintenance time reduction is 10%, but remarkable results were found after measuring the maintenance time.
Measuring 4 kinds of maintenance time by C/P were listed from Table 7-19 to Table 7-27.

Table 7-19: Welding time measurment-1

Date	8/2/12
Repair work	Container lifting device
Compactor truck	Dong Feng cc59 No.CT4-434
The repair work was carried out using the tools donated by JICA. Only one welding machine was used.	
From	9:00 AM
To	10:45 AM
Total time	1:45
Welder	José Luis Hernández
Person in charge	Fernando Amil Head, Technical Department
Operations carried out: The lifting device was dismounted. The faulty parts were removed. The area was cleaned. The faulty parts were fixed and welded. After the repair work, the lifting device was mounted back in place.	

Table 7-20: welding time measurement-2

Date	25/3/12
Repair work	Container lifting device
Compactor truck	Dong Feng CC94 CT4- No 813
The repair work was carried out using 2 welding machines donated by JICA.	
From	7:05 AM
To	8:10 AM
Total time	1:05
Welders	Miguel Calzadilla José Luis Hernández
Person in charge	Fernando Amil Head, Technical Department
Operations carried out: ● The pins were removed and the lifting device was dismounted. The faulty parts were removed. The area was cleaned. The faulty parts were fixed and welded. The lifting device was mounted back in place. ● Each welder repaired a part of the lifting device, thus speeding up repair works.	

Table 7-21: Welding time measurement-3

Date	4/2/12
Repair work	Container lifting device
Compactor truck	Dong Feng CC29 CT4- No.246
The repair work was carried out using the faulty welding machine.	

From	8:30 AM
To	11:30 AM
Total time	3:00
Welder Assistant welder	Reinaldo Guzmán Mario Arrebato
Person in charge	Fernando Amil Head, Technical Department
Operations carried out: The lifting device was dismounted. The faulty parts were removed. The area was cleaned. The faulty parts were fixed and welded. The lifting device was mounted back in place. Remarks: As the welding machine regulator was faulty, welding strength fluctuated. Therefore, the repair work had to be constantly interrupted to regulate it, thus affecting the quality of the welding.	

Table 7-22: Clutch maintenance time measuring-1

Date	12/3/12
Repair work	Clutch
Compactor truck	Renault CC397 CT4- No. 418
The repair work was carried out using the equipment donated by JICA.	
From	1:55 PM
To	4:05 PM
Total time	2:10
Mechanic Class A	Alfredo Valdés
Person in charge	Fernando Amil Head, Technical Department
Operations carried out: • Remove the transmission bar. • Remove the gearbox. • Remove the plate and the disk. • Line the clutch disk. • Assemble the disk and the plate. • Regulate the plate. • Assemble the collar. • Assemble and adjust the gearbox bolts. • Assemble the transmission. Remarks: There was no waste of time because the mechanic had all the tools and equipment required to carry out the necessary operations.	

Table 7-23: Clutch maintenance time measuring-2

Date	14/2/2012
Repair work	Clutch
Compactor truck	Renault CC388 CT4- No. 683
The repair work was carried out without the required tools.	
From	9:10 PM
To	12:50 PM
Total time	3:45
Mechanic Class A	Alfredo Valdés
Person in charge	Fernando Amil Head, Technical Department
Operations carried out: • Remove the transmission bar. • Remove the gearbox • Remove the plate and the disk. • Line the clutch disk. • Assemble the disk and the plate. • Regulate the plate. • Assemble the collar. • Assemble and adjust the gearbox collar. • Assemble the transmission. Remarks:	

A lot of time was wasted because the jack used was in poor condition. It had to be constantly adjusted to preserve the required height. In addition, as not all the necessary tools were available, the mechanic had to borrow some wrenches to be able to finish the job.

Table 7-24: Tire maintenance time measuring-1

Date	24/3/2012
22.5 Balloon tire puncture	
Compactor truck	Renault CC411
This operation was carried out using a wrench, a lever, stud bolts, etc.	
From	11:00 AM
To	12:20 PM
Total time	1:20
Tire repair shop employee	Alberto Peña
Person in charge	Fernando Amil Head, Technical Department
Operations carried out: • Raise the flat tire lock. • Remove (loosen) the nuts using a wrench. • Dismount the tire and pull the flanges off the rim using stud bolts and a lever. • Repair the flat tire. • Mount the tire on the rim. • Mount the fixed tire on the truck and tighten the nuts with a wrench.	

Table 7-25: Tire maintenance time measuring-2

Date	25/3/2012
22.5 balloon tire puncture	
Compactor truck	Renault CC412
This operation was carried out using the equipment donated by JICA, namely, a tire changer and an impact wrench.	
From	8:15 AM
To	8:45 AM
Total time	0:30
Tire repair shop employee	Lázaro García
Person in charge	Fernando Amil Head, Technical Department
Operations carried out: • Raise the flat tire lock. • Remove the nuts using the impact wrench. • Dismount the tire and disassemble it using the tire changer. • Repair the flat tire. • Mount the tire on the rim with the tire changer. • Mount the tire on the truck and tighten the nuts using the impact wrench. • Lower the lock.	

Table 7-26: Greasing time measurement-1

Date	15/3/2012
Greasing	
Compactor truck	Dong Feng CC43 CT.4 No 616
This operation was carried out using the greasing pump donated by JICA.	
From	12:10 PM
To	12:35 PM
Total time	0:25
Greasing man	Juan Carlos Díaz
Person in charge	Fernando Amil Head, Technical Department

Table 7-27: Greasing time measurement-2

Date	19/3/2012
Greasing	
Compactor truck	Dong Feng CC95 CT.4 No 599
This operation was carried out using a grease cup.	
From	11:05 AM
To	12:15 PM
Total time	1:10
Greasing man	Juan Carlos Díaz
Person in charge	Fernando Amil Head, Technical Department
The brushes had to be removed to clean them during the repair works. The grease cup had to be refilled twice.	

As all compressed air piping system is not completed yet, time measurement of maintenance using air tools is not carried out.

7.3.2 Measurement of project indicators

C/P has carried out to measure project indicators, and their results are shown by Table 7-28. This table shows that it was remarkable improvement between before and after of equipment supply, and recently the project indicators are stable.

Table 7-28: Measurement of project indicators (Indicators of Output-3)

Indicators	Dec. 2010	Mar. 2012	Oct. 2012
CDT-1 (Operation rate: with difficult repair vehicles)	50,7%	82.8%	81.5%
CDT-2 (Operation rate without difficult repair vehicles)	58,6%	85.7%	85.13%
TT	16:20hr	8:10hr	7:57hr
TR	10:40hr	6:30hr	6:23hr
TE	6:22hr	1:40hr	1:34hr

7.4 Subject

The activities of strengthening of capacities on vehicle and heavy equipment maintenance are developing very smoothly now.

At the beginning of the project, it was not smooth for JET to conduct technical transfer, because C/P side has pride about their maintenance ability. But, year by year, capacity of JET has been evaluated, there is no barrier for technical transfer now.

Especially C/P side conducted training by themselves contentiously, and measured project indicators periodically, that means “self development” is proceeding and evaluated very well.

However, below mentioned subject we have as of November 2012.

7.4.1 Operation of donated equipment

(A) Compressed air system
- As old compressor has damage of its case, repair work is necessary soon.
- Layout of outlet of air line is not appropriate and has risk to be plucked out by passing trucks.
- Limited number of regulator creates high risk to give damage to impact wrench when using without regulator.

(B) Lubrication system
- Delay of construction external oil tank facility.

(C) Treatment of equipment and tool
- Rough handling and working place is dirty.

7.4.2 Maintenance capacity

(A) Preparation of manual
- No manual for safety and hygiene is prepared.

(B) Maintenance capacity
- Vehicle maintenance, especially compactor truck maintenance needs various and deep knowledge and experience, but stay of JET is limited.

(C) How to evaluate maintenance capacity of mechanics
- Final project indicator is “create 20 mechanics who can handle donated equipment properly and have capacity of appropriate maintenance”
- How to test / evaluate mechanics should be decided by discussion between JET and C/P.

8 Workshop Improvement and Maintenance Capacity Development (January to June 2013)

The donation of tools and equipment for the maintenance of vehicles and heavy equipment has been accomplished already, and the installation and distribution of them were almost finished by November 2012. Unfinished construction works are the installation of the oil storage facility for the lubrication system, and the air system for the workshop. Out of the 2 unfinished works, the preparations for the oil storage facility need not be rushed because this facility is aiming at a more efficient lubrication work, and the present system can cover lubrication work. With regard to the air system, however, it is deemed necessary to be able to adjust the air pressure to use donated air tools. Some impact wrenches have been damaged by high air pressure; therefore, an appropriate air system should be installed as soon as possible. Nevertheless, it is quite difficult to supply construction materials for the air system in Cuba. As a result, this construction work has been delayed.

On the other hand, the preparation of maintenance manuals and the implementation of training courses by JET (Japanese Expert Team) and by the C/P (Counterpart) have significantly progressed. The final stage to execute exams for maintenance men is just around the corner, so the preparation of exams should be finalized now.

As the donated truck for transport of compost material was seriously damaged by a traffic accident, the procurement of parts from the manufacturer was initially tried. However, this was quite difficult in Cuba. Therefore, the works to repair the damaged truck were finished by using second hand materials

It should be noted that 2 C/P members in Group 3, namely, Mr. Raúl Aguilar and Mr. Diego Guevara left their jobs. As Mr. Raul Aguilar was the leader of C/P Group 3, further progress of the project is currently a matter of concern.

The main activities during the absence of JET from Cuba, from December 24, 2012, to April 25, 2013, are listed below.

- Training by C/P using donated tools and equipment.
- Procurement of materials to build the air system, namely, air regulator, electric magnetic contactor, impact wrench.
- Preparation of maintenance manual by JET.
- Preparation of exams for maintenance men.
- Repair of damaged truck for composting.

The main activities carried out during the presence of JET in Cuba (from April 25 to May 24, 2013) are listed below.

- Construction of the air system.
- Preparation of the maintenance manual.
- Training by JET.
- Preparation of exams for maintenance men.

The following table shows the names, area of expertise, and period of assignment of JET members. The working schedule during April and May, 2013, is shown in Figure 8-1.

【JET】

Name	Ryo HIRAGA
Area of Expertise	Maintenance of collection vehicles (operation and management)
Period	April 25 – May 24, 2013

Name	Tadayuki YAMANAKA
Area of Expertise	Maintenance of collection trucks (diagnosis, maintenance, and repair)
Period	April 25 – May 24, 2013

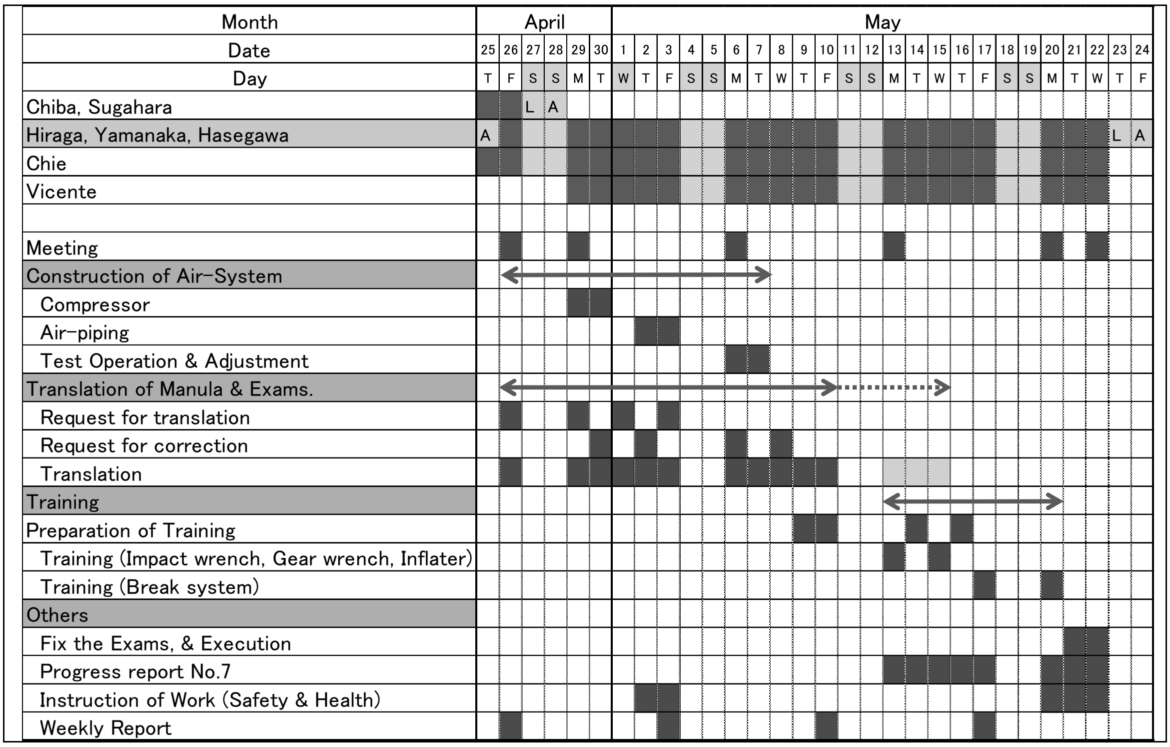


Figure 8-1: Working Schedule (April & May, 2013)

8.1 Improvement of Workshop Facilities

8.1.1 Air System Design

It was decided to adopt the old Russian compressor as air supply, not the donated compressor from Japan, for reusing an old machine. However, as some electric supply devices (electric magnetic contactor and thermal switch), the pressure switch necessary for automatic operation and the V-belt to drive motor power were damaged, they had to be procured in Japan.

To use the air tools at workshop-1 and workshop-2, air-piping works had been completed already. However, as the number of air regulators to adjust air pressure is not enough and they are quite difficult to acquire in Cuba, they were procured in Japan. The layout of the air system was designed by both JET and C/P staff. Refer to Figure 8-2 for details.

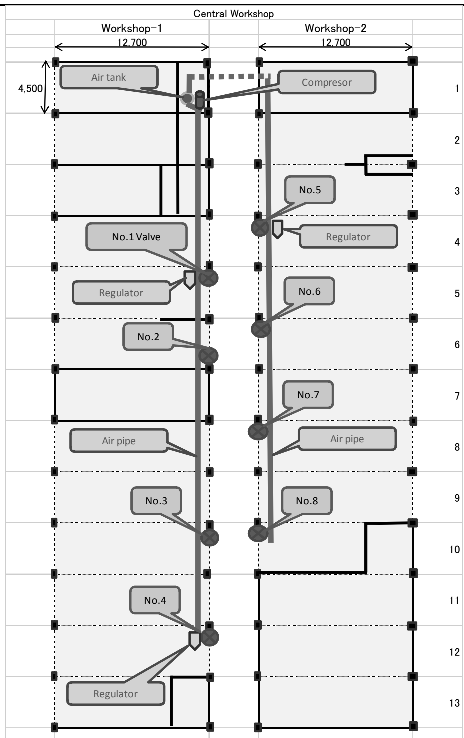


Figure 8-2: Air System Layout (Unit: mm)

There are mainly 2 types of air usage. Air tools need an air regulator to adjust air pressure properly, so it is necessary to install air regulators. On the other hand, it is unnecessary to regulate air pressure when blowing air for cleaning. Those 2 types of air usage are clearly divided by working place, and piping layout of the 2 types, air regulator installation, and no air regulator, are designed as shown in Figure 8-3 and Figure 8-4.

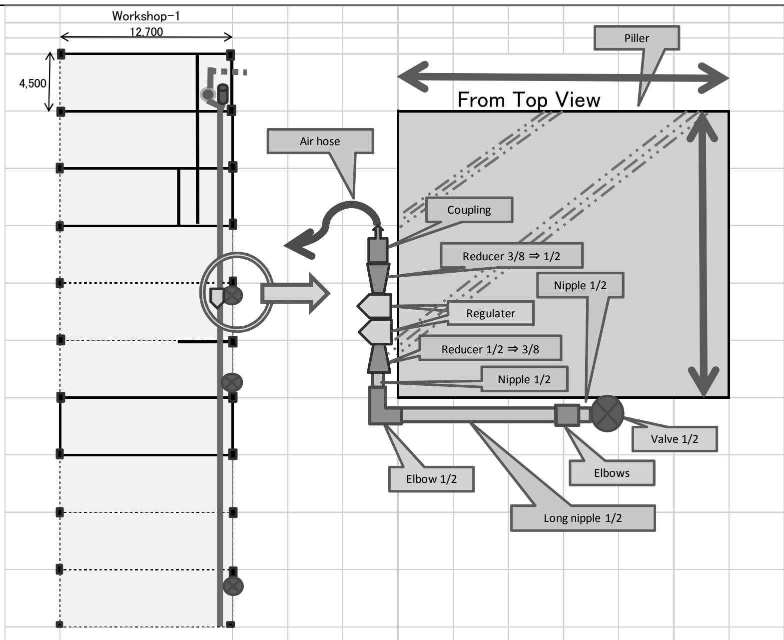


Figure 8-3: Air Piping with Air Regulator (Unit: mm)

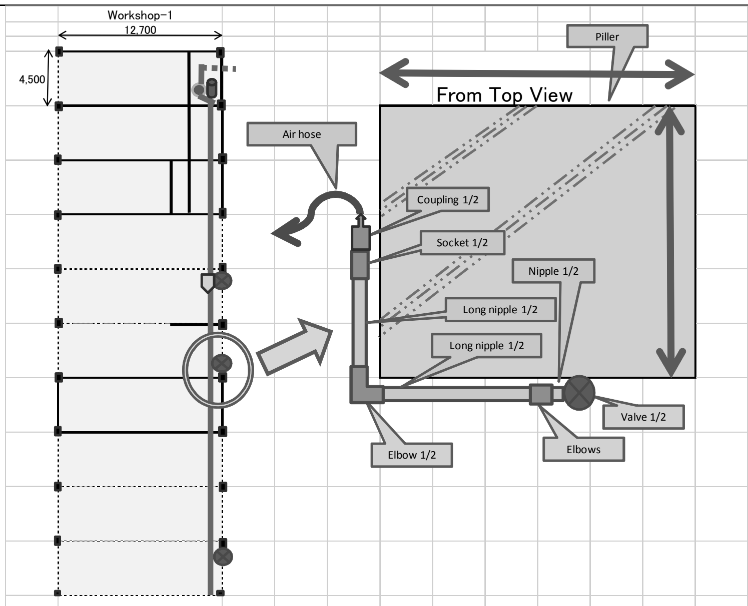


Figure 8-4: Air Piping Without Air Regulator (Unit: mm)

At the tire repair shop, where air tools are used frequently, one air regulator had been already installed. However, as accumulated water cannot be properly drained, a new air regulator is planned to be installed to replace the existing one.

8.1.2 Air System Construction

a. Compressor Installation

As there were some problems with the compressor (made in Russia) for air supply, an electric magnetic contactor, a thermal switch, V-belts, and a pressure switch were procured in Japan and installed.

However, as there is a different voltage between the compressor motor (380V) and the electric source (220V), overcurrent may damage the NFB (no-fuse breaker). Therefore, one of the 2 compressors donated from Japan, which had previously been installed at the compressor room for the use of the tire repair shop, was transferred to the workshop to replace the Russian compressor.

The Japanese compressor motor is for 220V, similar to the electric supply voltage. Therefore, it can operate without any trouble. In addition, a new pressure switch was equipped to operate automatically to maintain 0.8MPa. as the original pressure switch is 1.46MPa and the relief valve of the air tank is only 0.99MPa.

The Japanese compressor was connected to the air tank, whose capacity is 1m^3, and it supplies air to workshop-1 and workshop-2. Refer to Photo 8-1.

Compressor	Replace Pressure Switch
	
Install Inlet Valve of Air Tank	Air Supply Devices
	

Photo 8-1: Preparation of Compressor

b. Air Piping Works for Air Supply

Air piping works were carried out as shown in Photo 8-2. The air regulator is located on the inner side of each pillar to avoid damage by passing vehicles. Each air regulator is adjusted to 0.6MPa for impact wrench operation. During construction of the air piping, JET instructed C/P how to handle the air regulator, namely, how to drain accumulated water, adjust air pressure, supply oil, and adjust lubrication speed.

Welding Work	Air Supply Without Air Regulator
	
Air Supply With Air Regulator	Instructions for Water Discharge
	

Photo 8-2: Air Piping Work

8.2 Progress of Activities to Strengthen Capacities on Vehicle and Heavy Equipment Maintenance

The procedures to strengthen capacities on vehicle and heavy equipment maintenance are shown below.

1) Both JET and C/P staff jointly prepare maintenance manual.
2) JET conduct training for maintenance men (while JET staff is in Cuba)
3) C/P conduct training for maintenance men (while JET staff is not in Cuba)
4) To train over 20 maintenance men so that they can operate donated equipment properly as well as carry out proper maintenance.

8.2.1 Training by C/P

Out of the above-mentioned activities, the outline of the training by the C/P has been carried out as shown in Table 8-1.

Table 8-1: Training by C/P

Title	Engine Maintenance	
Place	Central Workshop	
Date	February 12, 2013	
Lecturer	Frank Zorrilla	
Participants		
No.	Name	Occupation
1	Bienvenido Pornbet	"Class A" Mechanic
2	Alfredo Valdés	"Class A" Mechanic
3	Rubén Ortega	"Class A" Mechanic
4	Emilio Zamora	"Class A" Mechanic
5	Geroncio Hernández	"Class A" Mechanic
6	Leonardo Rodríguez	"Class A" Mechanic
Notes: The following practical training was conducted: -Valve calibration. - Injection pump assembly and timing		

8.2.2 Training by JET

JET conducted 6 training courses, 2 about tire maintenance, 2 about brakes maintenance and 2 about handling of compressor, regulator and impact wrench. The outline of the courses is shown from Table 8-2 to Table 8-7.

JET prioritized tire maintenance due to the following reasons:

- Frequent tire repair
- Impact wrenches were damaged by high air pressure.
- Excessive power is exerted to fasten wheel nuts, which damages bolt threads.
- Torque wrench is not used properly.
- Introduction of a new power gear wrench with new torque wrench.
- Addition of inflator.

Table 8-2: Training by JET-1

Title	How to use the regulator & maintenance of tires of big trucks		
Place	Meeting room, Division of Mechanization		
Date	May 8, 2013		
Lecturers	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of Experience
1	Eduardo Jiménez	Technician	2
2	León Rodríguez	Hydraulic expert	26
3	Orlando Dueñas	Hydraulic expert	2
4	Rafael Reyes	Mechanic	10
5	Luer Luis Boudet	Tire repair man	7

6	Mateo Arrebato	Welder	9
7	Yoel Gomez	"Class B" Mechanic	4
8	Lázaro García	Tire repair man	32
9	Daniel García	Tire repair man	27
10	Bernal de Peña	Tire repair man	23
11	Lázaro Martínez	Assistant	2
12	Roberto Vosleu	Mechanic	2
13	Osriel Ortega	Hydraulic expert	2
14	Nury Cárdenaz Vélez	Transportation specialist	18
15	Isabel Tamayo	Transportation specialist	18

Notes:
The lecture about the 5 themes mentioned below was given successfully.
1) The name of each part and the operation of the impact wrench.
2) The structure and the correct way to use the air regulator.
3) The correct way to use the newly imported torque wrench and power gear wrench.
4) The proper air pressure of truck tires and the presentation of the inflator
5) The structure of tires

The question and answer session was quite active and all the participants understood the contents very well.

Table 8-3: Training by JET-2

Title	Practical Seminar on Tire Maintenance		
Place	Tire repair shop		
Date	May 9, 2013		
Lecturers	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of Experience
1	Eduardo Jiménez	Transportation specialist	1
2	Roberto Vázquez	"Class B" Mechanic	4
3	Sergio Foncada	Assistant	3
4	Lázaro Martínez	"Class C" Mechanic	3
5	Osniel Ortega	"Class C" Mechanic	3
6	Secilio Lázaro	"Class B" Mechanic	10
7	Yadenis Moncada	Assistant	2
8	Juan Rodriguez	"Class A" Mechanic	27
9	Orlando Dueñas	Assistant	1
10	Joel Gómez	"Class B" Mechanic	3
11	Bladimir Penibal	"Class A" Mechanic	1
12	Rafael Reyes	"Class C" Mechanic	10
13	Vernaldo Peña	Tire repair shop man	23
14	Mario Arrebato	"Class B" Welder	9
15	Juan Luis Boudet	Tire repair shop man	7
16	Daniel Garcin	Tire repair shop man	27
17	Lázaro García Valdés	Tire repair shop man	32

Notes:
＊The lecture about the 3 themes mentioned below was given successfully.
➢ How to use the air regulator
➢ How to put nuts and bolts
➢ How to use the newly extended torque wrench and power wrench.
＊The question and answer session was quite active and all the participants understood the contents very well.

A new maintenance manual for brakes was jointly prepared by JET and C/P staff. JET used the manual to conduct two training courses for workshop maintenance employees.

Table 8-4: Training by JET-3

Title	Maintenance of Brakes		
Place	Central Workshop		
Date	May 15, 2013		
Lecturers	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of Experience
1	Yordanis Moncada	Assistant	2
2	Osnier Ortega	"Class C" mechanic	2
3	Carlos Fernández	Mechanic	15
4	Orlando Dueñas	Mechanic	2
5	Antonio Mendoza	Assistant	1
6	Moisé Valdéz	Assistant	1
7	Juan A. Hernández	"Class A" mechanic	20
8	Eduardo Jiménez	Transportation expert	1
9	Sergio Foreada	"Class C" mechanic	3
10	Lázaro Martínez	Assistant	2
11	Rafael Reyes	"Class B" mechanic	10
12	Nury Cárdenas	Transportation expert	18

Notes;

- The lecture about the themes below mentioned was given successfully.
  - Antilock Brake System
  - Various components of the brakes
  - Maintenance and standards of brakes
- The question and answer session was quite active and all the participants understood the contents very well.

Table 8-5: Training by JET-4

Title	Maintenance of Brakes		
Place	Central Workshop		
Date	May17, 2013		
Lecturers	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of Experience
1	Eduardo Gimenez	Engineer	1
2	Rafael Reyes	"Class B" mechanic	10
3	Sergio Forcada	"Class C" mechanic	3
4	Carlos Fernández	Mechanic	10
5	Moisé Valdéz	Assistant	1
6	Juan A. Hernández	"Class A" mechanic	20
7	Nury Cárdenas	Transportation Engineer	8

Notes;

- The explanation on several different brake systems mentioned below was given successfully.
  - Names of parts and their structures
  - Standards and points of maintenance
- The participants repair brakes on a daily basis, so there were heated

discussions on the subject.

Table 8-6: Training by JET-5

Title	Practical training on tire repair		
Place	Central workshop		
Date	20, May 2013		
Lecture	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Ocupation	Year of experienced
1	Bernal de Peña	Tire repair staff	23
2	Eduardo Gimenez	technician	1

Notes;

- Practical training was conducted about below mentioned items;
  - How to remove wheel
  - How to install wheel
  - Appropriate operation of impact wrench
  - Appropriate handling of both power wrench & torque wrench
- Practical training was conducted toward to limited workers.
- The trainees have understood well through practical training.
- The trainees are instructed to conduct training for other members of the workshop on what they have learned through this practical training.

Table 8-7: Training by JET-6

Title	Practical training on appropriate handling of compressor, regulator and impact wrench		
Place	Central workshop		
Date	21, May 2013		
Lecture	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of experience
1	Emilio Zamora	Mechanic A	25
2	Frank Zorrilla	Mechanic A	30
3	Alfredo Valdés Soto	Mechanic A	20
4	Bienvenido Ponvert	Mechanic A	20
5	Eduardo Gimenez	Engineer	1

Notes:

- Practical trainings on the themes below mentioned were conducted toward to limited number of workers to deepen their understanding.

*How to use and maintain the compressor.
*How to use the air regulator.
*How to use the medium & small sized impact wrench.

- The trainees have understood well through practical training.

8.2.3 Preparation of Maintenance Manuals

Prior to the training courses by JET, JET and C/P staff prepared maintenance manuals together. Those manuals were used during the training by JET and by the C/P, as well as for practical maintenance and repair works. The manual on brakes was newly prepared, and totally 20 manuals were prepared from implementation of the project as listed in Table 8-8.

Table 8-8: List of Maintenance Manuals

No.	タイトル Esp.	和文	作成年月日
1	MANUAL DEL MANTENIMIENTO DELSISTEMA HIDRÁULICO - de los Camiones colectores de Dong-Feng -	油圧システム整備マニュアル	2011,10,04
2	MANUAL DEL MANTENIMIENTO DEL CLOCHE	クラッチ整備マニュアル	2011,12,09
3	MANUAL DEL MANTENIMIENTO DEL SISTEMA ELÉCTRICO	電気システム整備マニュアル	2011,12,14
4	MANUAL DEL SOLDADURA POR ARCO	アーク溶接機操作マニュアル	2012,01,24
5	MANUAL DE LA SOLDADURA AUTOGENA (Oxigéno y Acetileno o gás propano) Ver.2	ガス溶接マニュアル Ver.2	2012,11,30
6	MANUAL DEL MANTENIMIENTO CON LAS HERRAMIENTAS NEUMÁTICAS Ver.3	エアーツール整備マニュアル Ver.4	2013,05,16
7	MANUAL DEL MANTENIMIENTO DE LAS RUEDAS Ver. 2	タイヤ整備マニュアル Ver.2	2012,02,09
8	MANUAL DE OPERACIÓN DEL DESMONTADOR DENEUMÁTICOS Ver.2	ﾀｲﾔﾁｪﾝｼﾞｬｰ操作マニュアル Ver.2	2012,11,30
9	MANUAL DEL DIFERENCIAL	ディファレンシャル整備マニュアル	2012,02,09
10	MANUAL DEL MANTENIMIENTO DE LOS EQUIPOS DE MAQUINADO Ver.3	工作機械整備マニュアル Ver.3	2012,11,30
11	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE REFRIGERACIÓN	エンジン冷却装置整備マニュアル	2012,06,22
12	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE LUBRICACIÓN	エンジン潤滑装置整備マニュアル	2012,06,22
13	MANUAL DE SOLDADURA TIG Ver.3	TIG 溶接機取扱いマニュアル Ver.3	2012,11,02
14	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE ALIMENTACIÓN	エンジン燃料装置整備マニュアル	2012,07,10
15	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE ADMISIÓN Y ESCAPE DE AIRE	エンジン吸排気装置整備マニュアル	2012,11,20
16	MANUAL DE LA GESTION DE SEGRIDAD Y HIGIENE	安全衛生作業マニュアル	2012,12,05
17	MANUAL DEL USO DEL BANCO DE PRUEBA DE BOMBAS DE INYECCIÓN	燃料噴射ﾎﾟﾝﾌﾟﾃｽﾀｰ取扱いマニュアル	2012,12,05
18	MANUAL DEL MANTENIMIENTO DEL MOTOR	エンジン整備マニュアル	2012,12,05
19	MANUAL DE LA MANIPULACIÓN DE LA BOMBA DE ENGRASE Ver.2	グリスポンプ操作マニュアル Ver.2	2012,12,05
20	MANUAL DE LA FLENO DE AIRE	ブレーキ整備マニュアル	2013,5,13

8.2.4 Repair of the Damaged Composting Vehicle

The donated truck from Japan for transportation of compost material had an accident, and cabin and other parts listed below were seriously damaged. Initially, although the Cuban side tried to prepare original parts for repair, it proved to be quite difficult, so C/P group 3 members have tried to repair it by using similar parts which are possible to supply in Cuba.

a. Date of the Accident

April 28, 2012

b. Damaged Parts

Cab, air cleaner, air conditioner fan, front springs, steering wheel, emergency brake cable, gear lever, board, and gauges.

c. Repairs carried out

The original cab was replaced with a Dong Feng truck cab. In order to install the new cab, the truck body had to be moved slightly backwards. The front springs were adapted to the truck. A Chinese truck steering wheel was used instead of the original one. The board and gauges from a Chinese truck were adjusted. The brakes cables, including the emergency brake cable, were installed. The new cab was painted white. The air conditioning unit was not installed again as it was out of order and some parts necessary for repair were lacking.

d. Test driving

The repaired truck was successfully tested.

e. Present condition / Existing problems

The truck is in a perfect condition. A new driver is expected to be hired soon.

Damaged Vehicle	Repaired Vehicle
	

Photo 8-3: Repair of Damaged Vehicle

8.3 Evaluation of Capacity Building for Vehicle Maintenance

8.3.1 Preparation of Exams

JET prepared questions for exams targeting maintenance men to evaluate capacity building for vehicle maintenance, and finalized them through discussions with the C/P staff.

This evaluation originates from “Verifiable Indicator 3-3.1; At the 7 main areas of the maintenance workshop, 20 maintenance men are trained to correctly operate the equipment donated by the project”, and the number of fields is decided as 8 as shown in Table 8-9.

Table 8-9: Fields for Examination

No.	Fields of Examination		
	Español	日本語	English
1	Mantenimiento	整備	Maintenance
2	Eléctrico	電気	Electricity
3	Hidráulico	油圧	Hydraulic
4	Soldadura	溶接	Welding
5	Neumáticos	タイヤ	Tires
6	Máquinas herramientas	工作機械	Machine tools
7	Bomba de inyección	燃料噴射ポンプ	Injection pump
8	Engrase	油脂	Greasing

8.3.2 Discussions to Conduct Exams

Based on the written exams prepared by JET, both JET and C/P staff finalized questions for the exams and decided how to conduct the exams as shown below:

- C/P will conduct written exams prepared by JET.
- C/P will allot points for each question and will decide the passing grade.
- Examination will be conducted in one day.
- C/P will mark the exams.
- For maintenance men who fail the exams (or for all people), training will be conducted by using the explanations formulated and attached to the exams by JET.
- Extend certificates for those who pass the exams.
- C/P will prepare practical exams.
- C/P will report to JET about the progress of the exams and the preparation of practical exams.

8.4 Subject

The activities designed for capacity development of maintenance of vehicles and heavy equipment are progressing very smoothly. Almost all maintenance manuals are prepared already and training by JET is approaching its final stage. The training by C/P is firmly established and evaluation through exams will be conducted soon.

However, some C/P members left their office recently and lack of materials affects maintenance ability.

8.4.1 C/P Members’ Resignation

Mr. Diego Guevara resigned in January 2013, and Mr. Raúl Aguilar in March 2013. As Mr. Raúl was a key C/P member, his resignation may affect the project. Resignation of C/P members is increasing recently, which may deteriorate working atmosphere and motivation.
As far as Group 3 is concerned, Mr. Raúl Aguilar’s men were working together during his tenure, and young Eduardo was working always with JET team. Moreover, many maintenance men are working very closely JET members, so there is no big problem for the project.
However, it is necessary to have long continuous studies and experiences to master maintenance ability of vehicles, so a long-term plan for capacity development of maintenance men and personnel changes should be concerned, and it is very much desirable to adopt people who have enough technical ability.

8.4.2 Lack of materials

Although the donation of necessary tools and equipment for the maintenance of vehicles and heavy equipment has been accomplished already, there still exists some lack of materials. For example, electric cables, steel materials, and cement, fundamental materials for maintenance and construction work, are difficult to procure in Cuba, thus delaying construction and maintenance works.

Even if capacity of maintenance is developed successfully, it may be difficult and/or take a long time to carry out maintenance and repair works due to the difficulties related to supply of parts and materials. Two examples, namely, limited operation of the injection pump tester, and abrasion of caterpillar of bulldozer are shown below.

The injection pump for testing should be fixed to the injection pump tester to rotate to check the amount of injected fuel. This injection pump tester was donated and facilitated last June, 2012.

As there is a variety of sizes of injection pumps due to different types of vehicles, several kinds of attachments should be prepared to fit them to the injection pump tester, but only one set was donated from Japan. Recently, Chinese vehicles are most popular in Cuba, and donated attachment for injection pump tester is too high to fit their pump to the tester. Therefore, it is impossible to check Chinese injection pumps at present. As the attachment has not a complicated shape to process, as shown in Photo 8-4, JET advised them that it is possible to prepare the attachment by themselves by using machine tools donated from Japan, if the steel material can be obtained, but they say it is difficult to get raw materials to be processed.

The other example is the donated bulldozer from Japan for the final disposal site. Its pins and bushes are extremely worn out to operate, and parts supply is difficult due to the present high prices.

In this case it is also possible to process steel material to prepare pins and bushes instead of preparing original parts, but they say it is also difficult to supply raw steel material, especially anti-abrasion material.

It seems there is a limitation of maintenance and repair works due to difficulties with material supply. However, we should make sure whether it is possible to supply them or it is simply impossible altogether, as there may be lack of communication/information about materials finding, and we should study more effective budget allocation for material procurement.

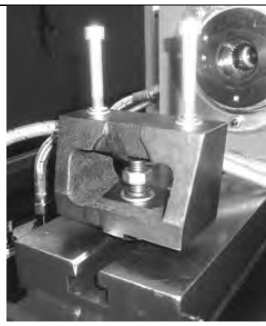
Injection pump tester	Too high attachment for Chinese trucks
	
Komatsu bulldozer	Abrasion of pins & bushes of caterpillar
	

Photo 8-4: Difficulties for maintenance due to lack of materials

9 Workshop Improvement and Maintenance Capacity Development (July 2013 – May 2014)

The supply of equipments and tools for maintenance of collection vehicles and heavy equipments has finished by June 2011. The construction works to realize effective operation of the donated equipments have also completed by May 2013, as installation of compressed air system has finished, and thus all donated equipment are now operatable. By the utilization of the donated equipments, maintenance works can be faster, more easily and accurately done than before.

It is necessary to increase number of air tools to make maintenance work even more effectively in the future. To do this, it is essential to increase number of air regulator which can maintain air pressure at every value. Nonetheless, as it is difficult to purchase air regulator in Cuba, JET prepared 4 air regulators in Japan to bring in to Cuba, as well as other air tools to improve the maintenance works further.

As for capacity development of maintenance men, many maintenance manuals has been prepared and numerous trainings has been carried out by using those maintenance manuals. Since almost all trainings about vehicles maintenance have finished, written examinations covering 8 fields were carried out with outstanding results.

Resignation and change of C/P personnel were anticipated to be an issue during JET's last visit to Cuba; however, qualified successors are brought onboard and/or some are returned to former positions, so no problem raised after all. It is evaluated that capacity development of human resources are well on going.

During absence of JET in Cuba, C/P are continuing self-training alongside their daily work, it is expected that capacity development of improvement of maintenance techniques may be possible by themselves.

Main activities for the period beginning from May 23 and ending November 23, 2013 (while JET left Cuba) are described below.

- The examinations covering 8 fields were carried out. (by C/P)
- Operational rate of collection vehicles was studied. (by C/P)
- Extension of air and water pipe at workshop. (by C/P)
- Training on safety and hygiene (by C/P)
- Supply of additional air regulators necessary for air system. (by JET)
- Supply of air tools for improvement of maintenance ability. (by JET)
- Preparation of new maintenance manual. (by JET)

Main activities during stay of JET in Cuba (21st November, 2013 to 19th December, 2013) are listed below.

- Change of air regulator of grease pump
- Fix of air regulators at workshop
- Preparation of maintenance manual
- Trainings by JET
- Participation to the 5th (final) seminar
- Others

The following table shows the names, area of expertise, and period of assignment of JET members. The working schedule during November and December, 2013, is shown in Figure 7-1.

【JET】

Name	Ryo HIRAGA
Area of Expertise	Maintenance of collection vehicles (operation and management)
Period	November 21 – December 20, 2013

Name	Tadayuki YAMANAKA
Area of Expertise	Maintenance of collection trucks (diagnosis, maintenance, and repair)
Period	November 21 – December 20, 2013

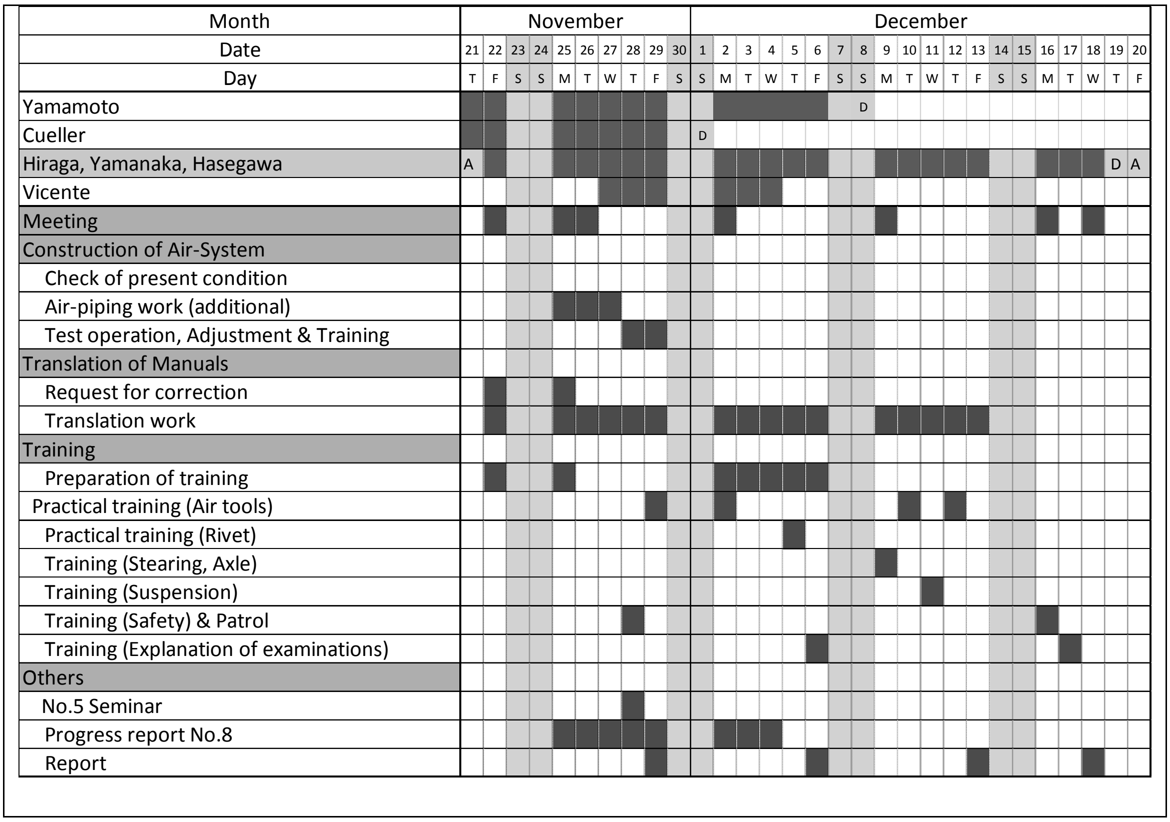


Figure 9-1: Working Schedule (November & December, 2013)

9.1 Improvement of Workshop Facilities

9.1.1 Improvement of air system at workshop and tire repair workshop

Construction work has been done to drive air tools at workshop-1 and workshop-2. As of May 2013, the compressor donated from Japan was installed and connected to air tank and delivered to air pipe system having 8 terminals. Within 8 terminal system, 3 air regulators were installed to use air tools while valves were installed for the rest of the5 terminals.

At this time (November, 2013), 2 types of air tool were brought to Cuba for efficient maintenance of brake system. One is a “rivet gun” to drive rivets to stick brake lining to brake shoe, and the other one is a “belt drive grinder” to grind rough surface of brake lining to be smooth. Furthermore, 4 air regulators were brought to Cuba. By using those items, dramatic reduction of maintenance time is expected. Moreover, “concrete drill” was brought to Cuba and fixed existing air regulators to concrete pillars. On the other hand, Cuban side extended air pipe and installed a valve at the workshop. As for tire repair workshop, both air and water pipes were extended for efficient maintenance work. See Photo 9-1 and Figure 9-2.

<table>
<tr><td>Fix air regulator</td><td>Fix air regulator by concrete drill</td><td colspan="2">Extension of air pipe at workshop (1)</td></tr>
<tr><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Extension of air pipe at workshop (2)</td><td>Extension of air pipe at tire repair workshop (1)</td><td colspan="2">Extension of air pipe at tire repair workshop (2)</td></tr>
<tr><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">Extension of water pipe at tire repair workshop</td><td colspan="2">Water tank at tire repair workshop</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
</table>

Photo 9-1: Improvement of air and water piping system

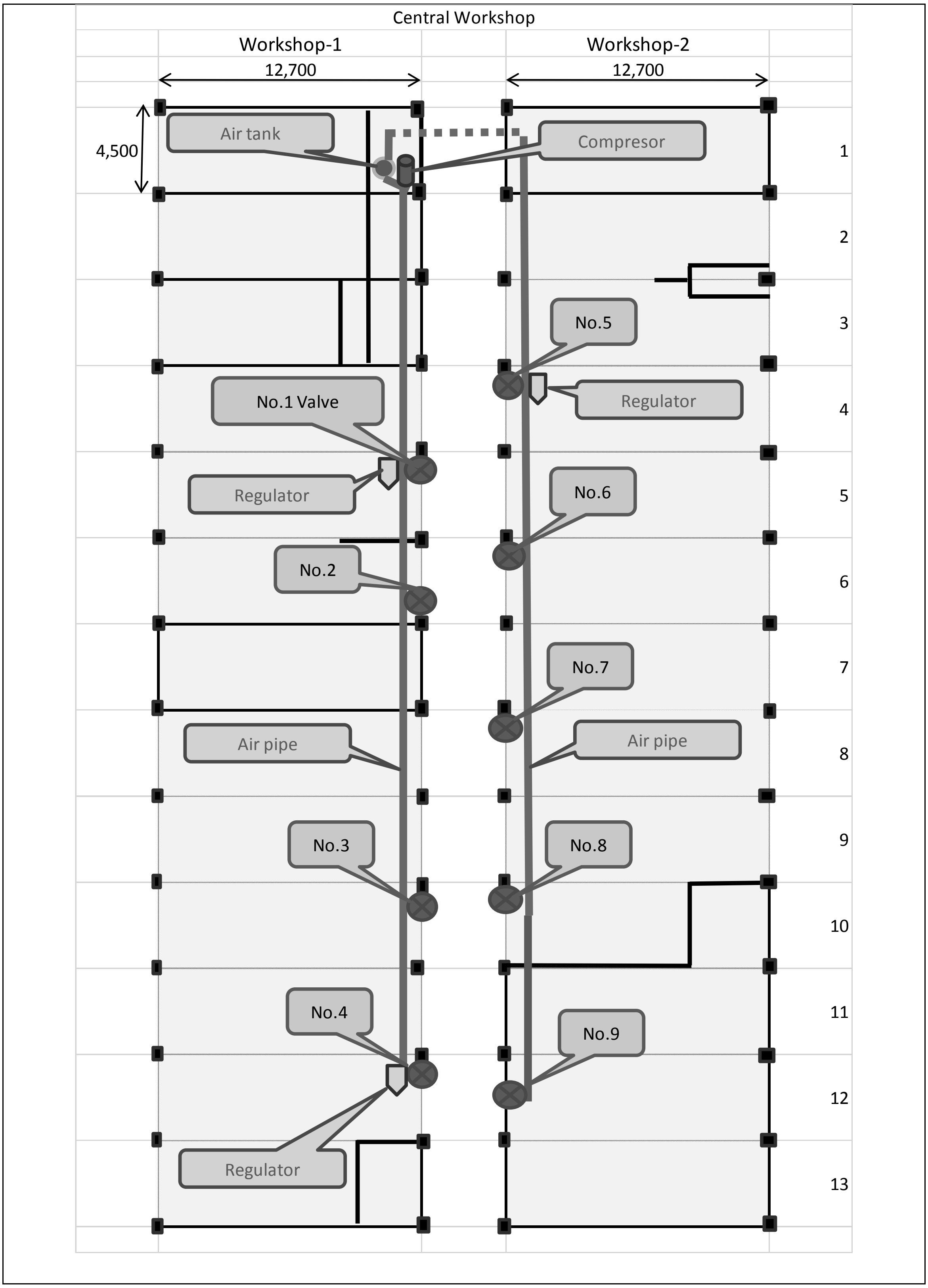


Figure 9-2: Layout of air system (Unit: mm)

9.1.2 Exchange air regulator of grease pump

Since air regulator in greasing room was not good condition, it was replaced to a new air regulator which was brought from Japan. JET instructed C/P how to operate it and caution points, and guided to C/P to train the person in charge of greasing work. See Photo 9-2.

Instruction of air regulator exchange	Install cups to air regulator
	

Photo 9-2: Exchange of air regulator

9.2 Progress of Activities to Strengthen Capacities on Vehicle and Heavy Equipment Maintenance

The procedures to strengthen capacities on vehicle and heavy equipment maintenance are shown below.

1) Both JET and C/P staff jointly prepare maintenance manual.
2) JET conduct training for maintenance men (while JET staff is in Cuba)
3) C/P conduct training for maintenance men (while JET staff is not in Cuba)
4) To train over 20 maintenance men so that they can operate donated equipment properly as well as carry out proper maintenance.

Activities to strengthen capacities after progress report No. 7 are mentioned below.

9.2.1 Training by C/P

C/P has conducted “safety and hygiene training at workshop” on August, 2013, and the outline is listed at Table 9-1.

Table 9-1: Training by C/P

Title		Safety and hygiene at workshop
Place		13th August, 2013
Date		Office of Fernando
Lecture		Fernando Amil and Eduardo Jimenez
Participants		
No.	Name	
1	Juan Rodrigez	
2	Osniel Urrutia	
3	Yordenis Moncada	

4	Leonardo Rodrigez
5	Felix Abreu
6	Jose Luis
7	Ernesto Silbosa
8	Reinier Diaz Rojas
9	Nelson Sanchez
10	Frank Mendosa
11	Carlos Pedroso Martinez
Notes; The lecture was conducted along manual on safety and hygiene. Various safety manner at each workshop was explained to mechanics.	

9.2.2 Training by JET

During replacing damaged air regulator at greasing workshop, JET instructed C/P by "on-the-job training" how to operate air regulator, and suggested C/P to conduct training to the person in charge of greasing work again.

A new manual was prepared this time and JET held some training sessions based on the manual contents. JET conducted some practical training about the proper operation of the new hydraulic tools provided. In addition, some other practical training was carried to improve flat tire repair.

The training outcomes are shown from Table 9-2 to Table 9-11.

Table 9-2: Training on the Proper Operation of Hydraulic Tools (1)

Title	How to use new air tools		
Place	Machine room of the Central Workshop		
Date	December 5th, 2013		
Lecture	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of experience
1	Nelson Sanchez	Lathe worker	27
2	Felix Abreu Beguerí	Mechanical worker	9
3	Leonardo Rodriguez	Mechanical worker	23
4	Andres Gonzalez	Mechanical worker	42
5	Yoel Oviol Asujega	Assistant worker	2
6	Alejandro Huerrera Perez	Mechanical worker of injection bomb	27
Notes; Participant had a practical training of the cleaning tool (of air & water) and received explanations on the important notes. Each participant practiced to rivet and take them off with new rivet machine. Each participant received explanations on how to use the new polishing machine and practiced the operation. The Cuban counterpart, Eduardo, made some complementary and appropriate explanations and all the participants understood it sufficiently.			

Table 9-3: Training on Tire Repair (1)

Title	Adequate use of socket box and power wrench		
Place	Tire repair section in the Central Workshop		
Date	Decenmber 5th, 2013		
Lecture	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of experience
1	Yordanis Valdes Castillo	Tire repairman	8
2	Daniel Garcia Alarcón	Tire repairman	30
3	Lázaro García Valdez	Tire repairman	30
4	Alberto Peña Rigal	Tire repairman	30
5	Leonardo Rodriguez	Mechanical worker class A	25
6	Osbaldo Fiss	Mechanical worker class C	20
7	Eduardo Morales	Mechanical worker class C	2
Notes; The adequate way to remove and screw wheel nuts was explained and participants practiced it. The adequate way to use power wrench and impact wrench was explained and participants practiced it. In Cuba, workers used to screw wheel nuts too much, so instructors gave severe warnings not to screw them excessively, instead to do it with certain torque as is instructed in notes ‘1’ and ‘2’.			

Table 9-4: Training on the Proper Operation of Hydraulic Tools (2)

Title	How to use new air tools		
Place	Machine room of the Central Workshop		
Date	December 6th, 2013		
Lecture	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of experience
1	Jesus Queser	Lathe & mechanical worker	33
2	Emilio Bustamente	Lathe worker A	6 months
3	Leonardo Rodriguez	Mechanical & maintenance worker	23
4	Renier Díaz Rojas	Engineer	2
5	Yordenis Moncada	Mechanical worker	3
6	Orlando Dueñas	Mechanical worker	2
Notes; Participant had a practical training of the cleaning tool (of air & water) and received explanations on the important notes. Each participant practiced to rivet and take them off with new rivet machine. Each participant received explanations on how to use the new polishing machine and practiced the operation. The Cuban counterpart, Eduardo, made some complementary and appropriate explanations and all the participants understood it sufficiently.			

Table 9-5: Training on Tire Repair (2)

Title	Adequate use of socket box and power wrench		
Place	Tire repair section in the Central Workshop		
Date	December 6th, 2013		
Lecture	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of experience
1	Alberto Valdes	Tire repairman	11
2	Julio Ramos	Tire repairman	18
3	Daniel Mendosa	Tire repairman	20
4	Bernardo Peña	Tire repairman	23
5	Alberto Peña	Tire repairman	33
6	Esteban Lazo	Tire repairman	10
7	Leonardo Rodriguez	Mechanical maintenanceman	23
Notes; The adequate way to remove and screw wheel nuts was explained and participants practiced it. The adequate way to use power wrench and impact wrench was explained and participants practiced it. In Cuba, workers used to screw wheel nuts too much, so instructors gave severe warnings not to screw them excessively, instead to do it with certain torque as is instructed in notes ‘1’ and ‘2’.			

Table 9-6: Training on the Steering System (1)

Title	Power steering system		
Place	Machinery office in the Central Workshop		
Date	Decenmber 9th, 2013		
Lecture	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of experience
1	Eduardo Morales	Mechanical worker C	2
2	Maidel López	Mechanical worker C	5
3	Osniel Ortega	Mechanical C	5
4	Juan Rodriguez	Mechanical A	25
5	Yoel Oviol	Mechanical C	3
6	Marcos Navarro	Mechanical B	4
7	Moisés Roberto Valdez	Mechanical A	6
8	Yordenis Moncada	Mechanical C	5
9	Isabel Tamayo	Especialist of Transportation	28
Notes; The name of each part, its structure and way of maintenance was explained successfully. The participants have attended the workshop attentively and have obtained a good understanding.			

Table 9-7: Training on the Steering System (2)

Title	Power steering system		
Place	Machinery office in the Central Workshop		
Date	Decenmber 10th, 2013		
Lecture	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of experience
1	Andies Gonzalez	Mecánico A	25
2	Orlando Dueñas	Mecánico B	6
3	Gaviel Paez	Ayudante	1
4	Carlos Baruda	Mecánico B	4
5	Lázalo Basnoeva	Mecánico B	6
6	Mario Avievato	Mecánico B	7
7	Eugenio Move	Mecánico A	6
Notes; The name of each part, its structure and way of maintenance was explained successfully. The participants have attended the workshop attentively and have obtained a good understanding.			

Table 9-8: Training on Front Alignment, Shafts, Suspension, and Shock Absorbers (1)

Title	Front Alignment, axle, suspension and shock absorber		
Place	Machinery office in the Central Workshop		
Date	Decenmber 11th, 2013		
Lecture	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of experience
1	Moisés Valdez	Mechanical A	4
2	Marcoss Navarro	Mechanical B	5
3	Lázaro Basnueva	Mechanical C	7
4	Lázaro Martinez	Mechanical C	5
5	Juan Rodriguez	Mechanical A	26
6	Frank de Mendosa	Mechanical B	2
7	Moisés Valdez	Mechanical A	4
Notes; The participants had explanations on the structures, way of inspection and maintenance of front alignment, axle, suspension and shock absorber. The participants had good and active discussions, exchanging their experiences.			

Table 9-9: Training on Front Alignment, Shafts, Suspension, and Shock Absorbers (2)

Title	Front Alignment, axle and suspension		
Place	Machinery office in the Central Workshop		
Date	December 12th, 2013		
Lecture	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of experience
1	Lázalo Basnueva	Mechanical C	4
2	Andrés Gonales	Mechanical A	25
3	Gabriel Paez	Mechanical C	2
4	Isabel Tamallo	Transpotation specialist	26

5	Eugenio More	Mechanical A	23
Notes; The participants had explanations on the structures, way of inspection and maintenance of front alignment, axle, suspension and shock absorber. The participants have attended the workshop attentively and have obtained a good understanding.			

Table 9-10: Risk Control Activities

Title	Introduction of risk control activity		
Place	10am to 12am, 16th December 2013		
Date	Office of Fernando and welding workshop		
Lecture	Hiraga, Yamanaka, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Years of experience
1	Diego Moises Guevara	Director of Central Workshop	32
2	Yamirén Mesa Samuel	Occupational health and safety engineer	0.5
3	Eduardo Jimenez Proenza	Engineer	3
Notes; Explained about “risk control activity” Checked risks at welding workshop at central workshop Discussed causes and countermeasures of risks Well understood about how to play “risk control activity” and discussed with each other with eager manner.			

Table 9-11: Adequate procedure of tire change

Title	Adequate procedure of tire change		
Place	From 10:00 am to 11:00 am of December 17th, 2013		
Date	The Central Workshop		
Lecture	Yamanaka, Hiraga, Hasegawa (Interpreter)		
Participants			
No.	Name	Occupation	Year of experienced
1	Yoldenis Moncada	Tire repairman	8
2	Lázaro Valdes	Tire repairman	24
3	Eduardo Jimenez	Engineer	3
Notes: The instructor explained the adequate way to use regulator, impact wrench and power wrench. The instructor explained the adequate way to loosen and fasten nuts of truck tires. Three participants understood well the contents.			

9.2.3 Preparation of Maintenance Manuals

Prior to the training courses by JET, JET and C/P staff prepared maintenance manuals together. Those manuals were used during the training by JET and by the C/P, as well as for practical maintenance and repair works. The new manual on “direction, axle and suspension system” was prepared, and totally 21 manuals were prepared that are listed in Table 9-12.

Manual 6 on hydraulic tools and Manual 10 on machine tools were also updated. See Table 9-12.

Table 9-12: Maintenance manuals

No.	タイトル		作成年月日
	Esp.	和文	
1	MANUAL DEL MANTENIMIENTO DELSISTEMA HIDRÁULICO - de los Camiones colectores de Dong-Feng -	油圧システム整備マニュアル	2011,10,04
2	MANUAL DEL MANTENIMIENTO DEL CLOCHE	クラッチ整備マニュアル	2011,12,09
3	MANUAL DEL MANTENIMIENTO DEL SISTEMA ELÉCTRICO	電気システム整備マニュアル	2011,12,14
4	MANUAL DEL SOLDADURA POR ARCO	アーク溶接機操作マニュアル	2012,01,24
5	MANUAL DE LA SOLDADURA AUTOGENA (Oxigéno y Acetileno o gás propano) Ver.2	ガス溶接マニュアル Ver.2	2012,11,30
6	MANUAL DEL MANTENIMIENTO CON LAS HERRAMIENTAS NEUMÁTICAS Ver.3	エアーツール整備マニュアル Ver.3	2012,11,30
7	MANUAL DEL MANTENIMIENTO DE LAS RUEDAS Ver. 2	タイヤ整備マニュアル Ver.2	2012,02,09
8	MANUAL DE OPERACIÓN DEL DESMONTADOR DENEUMÁTICOS Ver.2	ﾀｲﾔﾁｪﾝｼﾞｬｰ操作マニュアル Ver.2	2012,11,30
9	MANUAL DEL DIFERENCIAL	ディファレンシャル整備マニュアル	2012,02,09
10	MANUAL DEL MANTENIMIENTO DE LOS EQUIPOS DE MAQUINADO Ver.3	工作機械整備マニュアル Ver.3	2012,11,30
11	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE REFRIGERACIÓN	エンジン冷却装置整備マニュアル	2012,06,22
12	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE LUBRICACIÓN	エンジン潤滑装置整備マニュアル	2012,06,22
13	MANUAL DE SOLDADURA TIG Ver.3	TIG 溶接機取扱いマニュアル Ver.3	2012,11,02
14	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE ALIMENTACIÓN	エンジン燃料装置整備マニュアル	2012,07,10
15	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE ADMISIÓN Y ESCAPE DE AIRE	エンジン吸排気装置整備マニュアル	2012,11,20
16	MANUAL DE LA GESTION DE SEGRIDAD Y HIGIENE	安全衛生作業マニュアル	2012,12,05
17	MANUAL DEL USO DEL BANCO DE PRUEBA DE BOMBAS DE INYECCIÓN	燃料噴射ﾎﾟﾝﾌﾟﾃｽﾀｰ取扱いマニュアル	2012,12,05
18	MANUAL DEL MANTENIMIENTO DEL MOTOR	エンジン整備マニュアル	2012,12,05
19	MANUAL DE LA MANIPULACIÓN DE LA BOMBA DE ENGRASE Ver.2	グリスポンプ操作マニュアル Ver.2	2012,12,05
20	MANUAL DE LA FLENOS	ブレーキ整備マニュアル	2013,5,13
21	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE LA DIRECCIÓN, TRANSEJES Y SUSPENSIÓN	ステアリング、アクスル、サスペンション整備マニュアル	2013,11,30

9.3 Evaluation of Capacity Building for Vehicle Maintenance

9.3.1 Execution of Exams and the results

JET prepared questions for exams targeting maintenance men to evaluate capacity development of vehicle maintenance men, and finalized them through discussions with the C/P staff.

This evaluation is originated from “Verifiable Indicator 3-3.1; At the 7 main areas of the maintenance workshop, 20 maintenance men are trained to correctly operate the equipment donated by the project”, and the number of the fields was expanded to 8 fields and the exams were executed from August to November, 2013. The results of the exams are shown in Table 9-13. Perfect score of the exams is 100, and passing score was decided to be over 60. 55 maintenance men took the exams and all of them passed it successfully.

Table 9-13: Result of the Exams.

No.	Field of Exams			No. of examinee	No. of successful candidate
	Español	日本語	English		
1	Mantenimiento	整備	Maintenance	14	14
2	Eléctrico	電気	Electricity	5	5
3	Hidráulico	油圧	Hydraulic	8	8
4	Soldadura	溶接	Welding	5	5
5	Neumáticos	タイヤ	Air tool	8	8
6	Máquina herramienta	工作機械	Machine tool	7	7
7	Bomba de inyección	燃料噴射ポンプ	Injection pump	3	3
8	Engrase	油脂	Greasing	5	5
Total				55	55

At the beginning, number of successful candidate is expected to be over 20 only; however, over double of that number of maintenance men passed the exams. It may be a result from overwhelming number of maintenance men have joined to the training sessions than expected. As questions of the exams are originated from the training, and the maintenance men tackled with eager manner to master the training; moreover, trainings by C/P were conducted continuously. Nonetheless, some of the maintenance men could not challenge the exams by some reasons. Therefore additional exams will be executed for them, so number of successful candidate might be increased.

Exams questions were prepared based on prepared maintenance manuals and trained items, so if the mechanics understood them well, they could answer correctly.

About No.1 Maintenance exam., Scores of 2 mechanics were low than others. Because, it is estimated that their experiences of maintenance works were limited and their basic knowledges are inferior than veteran mechanics.

Regarding to No.2 Electricity and No.3 Hydraulic exams, scores are high, over 80, and wrong answers were almost caluculation questions.

No.4 Welding exams are high score also, and wrong answers were concentrated to TIG welding questions, that are not yet got used to.

No.5 air tool, No.6 machine tool, No. 7 injection pump and No.8 greasing exams had good scores, and it is estimated that they understand them very well, because the mechanics in charge are well get used to handle them always.

To the successful candidates, JET provided certifications expecting them to tackle to maintenance work more eagerly. See Photo 9-3. As JET prepared answers and explanation of exams, JET requested to C/P to explain to the maintenance men, and not only written exams, but also practical exams to execute in the future. See Annex-1.

Award of certification	Group photo
	

Photo 9-3: Award of certification

9.3.2 Measurement of project indicators

C/P has carried out to measure project indicators, and their results are shown by Table 7-28. This table shows that it was remarkable improvement between before and after of equipment supply, and recently the project indicators are stable.

Table 9-14: Measurement of project indicators (Indicators of Output 3)

Indicators	Dec. 2010 Before the project	Mar. 2012	Oct. 2012	Nov. 2013
CDT-1 (Operation rate: with difficult repair vehicles)	50.7%	82.8%	81.5%	64.9%
CDT-2 (Operation rate: without difficult repair vehicles)	58.6%	85.7%	85.13%	78.7%
TT (Time at taller)	16:20hr	8:10hr	7:57hr	7:57hr
TR (Time for repair)	10:40hr	6:30hr	6:23hr	6:23hr
TE (Time for waiting for repair)	6:22hr	1:40hr	1:34hr	1:34hr

9.4 Challenges

The activities designed for capacity development of maintenance of vehicles and heavy equipment are progressing very smoothly. Almost all maintenance manuals are prepared already and training by JET is approaching its final stage. The training by C/P is firmly established and results of exams to evaluate the activities were much successful than expectation.

However, there are still barrier for maintenance work by lack of material, which is most serious challenges for vehicle maintenance.

Next challenge is a manner of maintenance man which is little bit rough and with all their strength in many occasion. JET instructed them frequently, but it might be necessary long time and continuous instruction and activities to let them handle equipment and tools by careful, safe and sanitary manner.

9.5 Others

9.5.1 Seminar

No. 5 seminar was conducted on 28th November, 2013. As from C/P side, Fernando Amil presented the progress of the project, subjects and the prospects titled "Advance in the improvement of works at the workshop and the personnel training". As for JET side, Ryo Hiraga presented about importance of vehicle maintenance and future prospect titled "Corrective improvement and preventive maintenance of collection vehicle."

9.5.2 Breakdown and Repair of Two Machine Tools

(1) Bench Drill Breakdown

After JET's arrival in Havana, it was informed that the bench drill motor was making some funny noises and generating some fumes. When trying to get it started, the motor would not move and no reading could be obtained from the ampere meter due to the existing high current.

JET consulted the manufacturer and it was assumed that there was something wrong with the magnetic brake of the motor. It was disassembled and the electric circuit was checked.

It was found that the electric circuit was damaged, so no current passed to the motor brake. As it was impossible to repair the electric circuit, the springs and the rotary disk of the motor brake were removed, thus allowing the drill to get started. (See Photo 9-4）

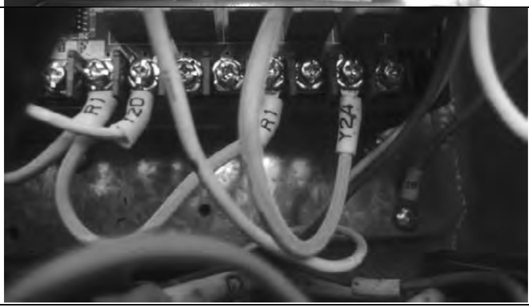
Photo	Explanation
	Magnetic brake disassembly
	As the disk and other parts of the brake were rusty, they were polished using the newly donated grinding machine.
	Both primary and secondary brake rectifiers showed 0 voltages.
	The yellow wire of "Y24" of the primary brake rectifier showed 0 voltage.

Photo 9-4: Bench Drill Repair

(2) Hacksaw Repair

The C/P informed JET about the breakdown of the power hacksaw, namely, the hacksaw arm could not be lowered. JET consulted the manufacturer about the way to solve this problem and they sent the hacksaw plan.

After its arrival in Havana, JET together with the C/P checked the hacksaw and detected lack of oil and presence of air. After supplying enough oil and removing the air, the hacksaw arm began to move down. However, the arm went down only when the control dial was in the rabbit position.

JET consulted the manufacturer again about this condition. The manufacturer replied that the oil being used might be too viscous and that the air had to be removed. JET then removed all the oil (Cubalub No. 100), replaced it with less viscous oil (Cubalub No. 22), and removed the air.

As a result, the hacksaw began to operate when the dial was in the middle position (between maximum and minimum levels). Therefore, the gauge was fixed to that position to operate the hacksaw. JET prepared the manuals, including photographs, about the proper way to supply the oil and remove the air, and added this information to the manual previously prepared for the machine tools.

9.6 Complementary activities for the capacity improvement

During the JET's last stay at Habana, from April 24 to May 23 of 2014, the team has finished all the activities which were left undone until the last visit, and also has conducted some complementary activities as is mentioned below for the autonomous and continuous improvement activities by the Cuban counterparts.

- Confirmation of measurement of maintenance time.
- Elaboration of another maintenance manual.
- Seminars.
- Maintenance of donated equipment and supply of parts.

The detail of each activity goes as follows.

9.6.1 Confirmation of measurement of maintenance time

The project objective of group 3 is; achieve a 10% reduction of maintenance time in main sections, using donated equipment and improving workers' abilities. The measurement of maintenance time without donated equipment and with donated equipment was already conducted in four sections; (1) welding, (2) clutch, (3) tire and (4) grease. The result was excellent.

The JET's team had not yet received the report of time measurement of (5) leaf spring maintenance and (6) transmission maintenance, so this time, the team has confirmed the mentioned maintenance time.

The result of maintenance time is showed from the Table 9-15 to the Table 9-18.

Table 9-15: Maintenance time measurement（Leaf spring）

Date	May 3, 2011
Repair work	Maintenance of leaf spring without donated equipment
Collection truck	CC-359
Starting time	7:40 a.m.
Finishing time	7:10 p.m.
Total time	11hours 30minutes

Name of worker	Ernesto Silbosa
Timekeeper	E duardo Jimenés
Conducted operation: Dismantle backside springs. Repairs. Assemble springs and fasten joint parts.	

Table 9-16: Maintenance time measurement（Leaf spring）

Date	January 20, 2013
Repair work	Maintenance of leaf spring with donated equipment
Collection truck	CC-80
Starting time	7:40 a.m.
Finishing time	2:25 p.m.
Total time	6hours 45minutes
Name of worker	Ernesto Silbosa
Timekeeper	Eduardo Gimenés
Conducted operation: Dismantle springs. Assemble springs. Fasten the joint parts.	

Table 9-17: Maintenance time measurement（transmission）

Date	July 30, 2011
Repair work	Maintenance of transmission without donated equipment
Collection truck	CC 29
Starting time	7:50 a.m.
Finishing time	4:15 p.m.
Total time	8hours 25minutes
Name of worker	Rolando Rodriguéz
Timekeeper	Eduardo Jimenéz
Conducted operation: Dismantle transmission, box, plate, disk, bearings, and crank shaft. Assemble bearings, handle, plate, disk, transmission, and servo clutch.	

Table 9-18: Maintenance time measurement（transmission）

Date	September 25, 2012
Repair work	Maintenance of transmission with donated equipment
Collection truck	CC-50
Starting time	1:05 p.m.
Finishing time	6:40 p.m.
Total time	5hours 35minutes
Name of worker	Alfredo Valdéz
Timekeeper	Eduardo Jimenéz
Conducted operation: Dismantle transmission, servo clutch, box, plate, disk, and fork shaft. Assemble plate, disk, fork shaft, transmission and servo clutch.	

In all maintenance sections, the maintenance time with donated equipment in a large way falls below the one without donated equipment, so the time-reduction rate widely surpasses 10 %.

9.6.2 Completion of maintenance manuals

The JET team has made maintenance manuals to improve technical capabilities of counterparts and mechanical workers and this time has accomplished the last manual, “transmission manual”. With this, 22 manuals, which are showed in the Table 9-19, were prepared.

The JET team expects these manuals will be used by the Cuban counterparts in the seminars targeted for mechanical workers hereafter and also revise and add in some words according to the actual situations.

Table 9-19: List of maintenance manuals

No.	タイトル		作成年月日
	Esp.	和文	
01	MANUAL DEL MANTENIMIENTO DELSISTEMA HIDRÁULICO - de los Camiones colectores de Dong-Feng -	油圧システム整備マニュアル	2011,10,04
02	MANUAL DEL MANTENIMIENTO DEL CLOCHE	クラッチ整備マニュアル	2011,12,09
03	MANUAL DEL MANTENIMIENTO DEL SISTEMA ELÉCTRICO	電気システム整備マニュアル	2011,12,14
04	MANUAL DEL SOLDADURA POR ARCO	アーク溶接機操作マニュアル	2012,01,24
05	MANUAL DE LA SOLDADURA AUTOGENA (Oxigéno y Acetileno o gás propano) Ver.2	ガス溶接マニュアル Ver.2	2012,11,30
06	MANUAL DEL MANTENIMIENTO CON LAS HERRAMIENTAS NEUMÁTICAS Ver.5	エアーツール整備マニュアル Ver.5	2013,12,11
07	MANUAL DEL MANTENIMIENTO DE LAS RUEDAS Ver. 2	タイヤ整備マニュアル Ver.2	2012,02,09
08	MANUAL DE OPERACIÓN DEL DESMONTADOR DENEUMÁTICOS Ver.2	ﾀｲﾔﾁｪﾝｼﾞｬｰ操作マニュアル Ver.2	2012,11,30
09	MANUAL DEL DIFERENCIAL	ディファレンシャル整備マニュアル	2012,02,09
10	MANUAL DEL MANTENIMIENTO DE LOS EQUIPOS DE MAQUINADO Ver.5	工作機械整備マニュアル Ver.5	2014,05,19
11	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE REFRIGERACIÓN	エンジン冷却装置整備マニュアル	2012,06,22
12	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE LUBRICACIÓN	エンジン潤滑装置整備マニュアル	2012,06,22
13	MANUAL DE SOLDADURA TIG Ver.4	TIG 溶接機取扱いマニュアル Ver.3	2014,05,06
14	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE ALIMENTACIÓN	エンジン燃料装置整備マニュアル	2012,07,10
15	MANUAL DEL MANTENIMIENTO DEL SISTEMA DE ADMISIÓN Y ESCAPE DE AIRE	エンジン吸排気装置整備マニュアル	2012,11,20
16	MANUAL DE LA GESTION DE SEGRIDAD Y HIGIENE	安全衛生作業マニュアル	2012,12,05
17	MANUAL DEL USO DEL BANCO DE PRUEBA DE BOMBAS DE INYECCIÓN	燃料噴射ﾎﾟﾝﾌﾟﾃｽﾀｰ取扱いマニュアル	2012,12,05
18	MANUAL DEL MANTENIMIENTO DEL MOTOR	エンジン整備マニュアル	2012,12,05
19	MANUAL DE LA MANIPULACIÓN DE LA BOMBA DE ENGRASE Ver.3	グリスポンプ操作マニュアル Ver.3	2014,05,14
20	MANUAL DE LA FLENOS	ブレーキ整備マニュアル	2013,5,13
21	MANUAL DEL MANTENIMIENTO DE SISTEMA DE DIRECCION, ALINEAMIENTO DELANTERO, EJES Y SUSPENSION	ｽﾃｱﾘﾝｸﾞ、ﾌﾛﾝﾄｱﾗｲﾒﾝﾄ、ｱｸｽﾙ、ｻｽﾍﾟﾝｼｮﾝ整備マニュアル	2013,12,04
22	MANUAL DEL MANTENIMIENTO DEL TRANSMISIÓN	トランスミッション整備マニュアル	2014,5,12

9.6.3 Seminars

After the completion of transmission manual, the JET team has conducted seminars based on this manual for mechanical workers.

9.6.4 Maintenance of donated equipment

This time 3 pieces of equipment had problem.

(1) Motor failure of tire changer

The tire changer motor of the Central workshop had burnt down and the Cuban counterparts had already sent it out to other workshop to repair cables. They say the failure was caused by the variation of voltage.

(2) Lighting of red alarm of the TIG welder

The TIG welder had stopped with the red alarm light on. The JET team measured the power-supply voltage and found it 230 V. The selector switch of input voltage of TIG welder was for 200 V, so the JET team changed it for 220 V. With this change, the problem was solved. This trouble-shooting method was already included in the manual, but for the better understanding, the team has modified the expression.

(3) Missing cogs of automated gear of the lathe

Three cogs of automated gear of the lathe were missing and also badly worn so the JET team is trying to take contact with the manufacturer. The Cuban counterpart explained the accident happened when a novice was using it. The worker had already left the workshop so the team could not get more detailed information.

During the previous visits, the team had already heard several troubles of donated equipment, so to do the proper maintenance, the JET team took the following measures for the appropriate maintenance.

(1) Manual revision

The JET team added the trouble-shooting method of machine tools and equipment to the manuals.

(2) Clarification of responsible person of each machine tool

The JET team strongly recommended to restrict the machine operation only to the responsible persons and to train beginners under the supervise of persons in charge for the proper machine operation.

(3) Adequate handling of accidents

The JET team asked the Cuban counterpart to take contact with the team before trying to solve problems by themselves, because the best way to resolve troubles is to make inquiries to the manufacturers. The JET team promised to cooperate in this point even after the project completion.

(4) Control record book and creation of maintenance section

The JET team strongly recommended recording all troubles of equipment, those causes and handlings. The team proposed a format of record book so the Cuban counterpart could keep record on an ongoing basis.

Moreover the team reconfirmed the creation of equipment maintenance section.

9.6.5 Obtain necessary parts of donated equipment

In Cuba, obtainment of equipment and parts is extremely difficult. Most of the donated equipment by this project is made in Japan so the purchase of necessary parts like consumables is highly difficult.

As far as tools and repairable items are concerned, the Cuban side should make efforts to solve problems like getting purchase budget.

On the other hand, as regarding tool machines and equipment, the JET team would work as go-between to inquire of manufactures necessary parts and to decide items to purchase. The Cuban side should request the supply to some dealers specialized in the import of Japanese goods.

10 Evaluations and suggestions

Activities of capacity development on maintenance of both waste collection vehicles and heavy equipment have been carried out for 5 years. The contents of activities are donation of equipment for vehicle maintenance, preparation of maintenance manuals, implementation of training and evaluations, and these activities were carried out by both JET and C/P cooperatively and good results are realized. The results, evaluation, and subjects & suggestions are listed below.

10.1 Results

10.1.1 Donation of maintenance equipment

The most serious problem of maintenance of collection vehicles in Cuba is lack of maintenance equipment, so necessary equipment, from machine tools to hand tools, were donated by JICA. Some change and delay of equipment were happened, but donation equipment can meet to demand of Cuban side.

10.1.2 Preparation of equipment installation and improvement of working environment by Cuban side

Preparation of installation of equipment, electric wiring and piping works have done by Cuban side. Although, some problems were happened, but all equipment were installed and accommodated appropriately.

Moreover, Cuban side has improved environment of workshop, by lighting, ventilating and painting works.

10.1.3 Preparation of maintenance manuals

As before the project implementation, maintenance work has done by maintenance man’s intuition and / or experience individually, 22 maintenance manuals were prepared by JET and C/P cooperatively. By the maintenance manuals, standards of maintenance and maintenance methods are clarified.

All prepared maintenance manuals are attached to Annex-1.

10.1.4 Implementation of training

JET carried out series of trainings to develop capacity of maintenance men by using prepared manuals and C/P conducted also the training.

10.1.5 Implementation of examination

The examinations were carried out to check whether enough capacity development of maintenance skills of the maintenance men has achieved or not by the series of capacity development activities, and good results were gained.

10.2 Evaluations

3 items of evaluations of capacity development project for maintenance of both collection vehicles and heavy equipment are listed below, that are (1) Project Purpose and Verifiable Indicators of the Progress, (2) selection of maintenance equipment and (3) capacity development of mechanics.

10.2.1 Project Purpose and Verifiable Indicators of the Progress

Project purpose and verifiable indicators of the progress are listed at Table 10-1, and all are gained good results.

Table 10-1: Project Purpose and Verifiable Indicators of the Progress

(Indicators of Output 3)

Project Purpose	Vehicle repair and maintenance system upgraded (about 10% reduction of the times required for several representative repair/maintenance works at Central workshop) to be maintained.
Verifiable Indicators	• In the 7 main areas of the maintenance workshop, over 20 mechanics to be able to operate the equipment donated by the Project appropriately can be developed by trainings. • 7 maintenance manuals for the main areas will be prepared. • Average downtime of working collection vehiucles is reduced. For the calculations of CDT (Technical Availability Coefficient), the levels of TR (Repair Times) and TE (Pending Times), the effects of external factors (as the difficulty to purchase parts, etc.) should not be reflected.

a. Project purpose

To evaluate project purpose (time reduction rate of maintenance time), 6 representative maintenance works were selected, and both maintenance time without donated equipment and maintenance time by using donated equipment were measured and finally maintenance time reduction rates were calculated. See Table 10-2.

All maintenance time reduction rates of all maintenance works, have been achieved significantly above 10% which are the target of maintenance time reduction rate.

Table 10-2: Results of maintenance time measuring (Indicators of Output 3)

Maintenance work	Maintenance time before the Project (hour)	Maintenance time after the Project (hour)	Maintenance time reduction rate
Welding	3.0	1.05	65%
Clutch	3.45	2.1	39%
Tire	1.2	0.3	75%
Greasing	1.1	0.25	77%
Spring	11.5	6.75	41%
Transmission	8.42	5.58	34%

b. Verifiable Indicators of the progress

As far 1st verifiable indicator of the progress "In the 7 main areas of the maintenance workshop, over 20 mechanics to be able to operate the equipment donated by the Project appropriately can be developed by trainings", written examinations were carried out to evaluate whether mechanics gained appropriate maintenance capacity or not, after preparation of maintenance manuals and series of trainings.

The examinations were carried out in the 8 main areas, and extreme results were gained shown at Table 10-3.

Table 10-3: Result of Examination targeted to mechanics (Indicators of Output 3)

No.	Area of Exams.			No. of candidates	No. of successful candidates
	Español	日本語	English		
1	Mantenimiento	整備	Maintenance	14	14
2	Eléctrico	電気	Electricity	5	5
3	Hidráulico	油圧	Hydraulic	8	8
4	Soldadura	溶接	Welding	4	4
5	Neumáticos	タイヤ	Air tool	7	7
6	Máquina herramienta	工作機械	Machine tool	6	6
7	Bomba de inyección	燃料噴射ポンプ	Injection pump	2	2
8	Engrase	油脂	Greasing	4	4
Total				50	50
If one candidate takes plural examinations and get successful result, only one area can be counted.					

As far 2nd verifiable indicator of the progress "7 maintenance manuals for the main areas will be prepared", 22 maintenance manuals were prepared by cooperation between JET and C/P, that are extremely beyond the target.

There were no maintenance manual in central workshop in Havana before the project implementation, maintenance work was done by the maintenance man's intuition. As many equipment and measuring instruments were donated by this project, maintenance manuals were prepared by covering maintenance and changing standards. The preparation of the maintenance manuals are well evaluated to develop quality of maintenance capacity. Moreover, these maintenance manuals can be expected of far-reaching effects to be used in other countries where Spanish are spoken.

The 3rd verifiable indicator of the progress "operational rate of collection vehicles" has been measured from before implementation of the project. These operational rates are defined as CDT (Technical Availability Coefficient), TR (Repair Times) and TE (Pending Times), and the effects of external factors (as the difficulty to purchase parts, etc.) should not be reflected. The results are shown at Table 10-4.

Table 10-4: Measurement of project indicators (Indicators of Output 3)

Indicators	Dec. 2010 (Before project)	Mar. 2012	Oct. 2012	Oct. 2013
CDT-1 (Operation rate: with difficult repair vehicles)	50.7%	82.8%	81.5%	64.9%*
CDT-2 (Operation rate without difficult repair vehicles)	58.6%	85.7%	85.13%	78.7%
TT	16:20hr	8:10hr	7:57hr	7:57hr
TR	10:40hr	6:30hr	6:23hr	6:23hr
TE	6:22hr	1:40hr	1:34hr	1.34hr
*Drop of CDT from 2012 to 2013 is caused limited parts to be supplied.				

These results show that there are big difference between before project, December 2012 (before donation of the equipment), and after implementation of the project (after donation of the equipment), that shows clear effectiveness of the equipment supply.

The recent drop (October, 2013) of CDT is mainly caused by delay of supply parts of China trucks which are introduced recently.

Above mentioned both project purpose and verifiable indicators of the progress are evaluated to be well achieved.

10.2.2 Selection of maintenance equipment

Selection of maintenance equipment was carried out among Japanese products (partly foreign products) by request of C/P basically, and necessary items were added by JET's check of workshop and maintenance works. Although specification of the equipment was changed by limitation of the budget, all requested equipment was donated, and used and / or operated at each section of the workshop. As donated equipment has enabled improvement of maintenance quality and speed up of the maintenance, therefore selection of equipment is evaluated as appropriate.

10.2.3 Capacity development of C/P and mechanics

Before the implementation of the project, maintenance works were done by intuition and experience of each mechanic, because they had no maintenance manuals and no trainings at central workshop and workshop for heavy equipment.

In this project, as new maintenance equipment were donated, maintenance manuals were prepared to explain how to handle new equipment, as well as clarify maintenance standard and procedure, and as maintenance trainings were carried out by using these maintenance manuals, quality of maintenance of vehicles was improved. Moreover, C/P implemented training by themselves by using the maintenance manuals, continuous capacity development can be expected.

10.3 Subjects and suggestions

10.3.1 Acomplished level of capacity development of maintenance technique and subjects to ensure the sustainability

The project perpose and indicators set by the project are all achieved as mentioned above. After the project is terminated, C/P and mechanics should maintain attained maintenance ability and develop it by theirselves, but as pointed out by the joint terminal evaluation report, aspect of sustainability has little bit weak.

As maintenance capacity of collection vehicles has various view points, main evaluation points are classified into (1) Maintenance capacity, (2) Preventive maintenance, (3) Management of maintenance equipment, and (4) Comprehensive countermeasure to avoid damage of vehicle, and each evaluation point is broken down more in details respectively, to evaluate accomplished level of maintenance capacity as well as further subject shown in Table 10-5.

Table 10-1：Achievement level of maintenance capacity of collection vehicles and subjects to ensure the sustainability

Maintenence capacity		Achievement level of the project （2009 – 2014）		Subjects to be attained to ensure sustainability after the project
Main items	Detail items	Early period	Latter period	
Basic theory	Understand name of parts	○	○	Maintenence & development of achievement of project
	Understand structure & function	○	○	Maintenence & development of achievement of project
	Repair standard and limt for use	△	○	Maintenence & development of achievement of project
	Attention points for maintenance	×	△	Understood by all mechanics
	Measuring method	×	△	Understood by all mechanics
Maintenance work	Appropriate handling of equipment	×	○	Maintenence & development of achievement of project
	Measurement	×	△	All mechanics can measure accurately
	Production & utilization of appropriate jigs	×	△	More production & usage of jigs
	Order & quality of maintenance	×	△	Instruction of model maintenance work, training to be spread & check method of maintenance
	Maintenance time	×	○	Maintenence of achievement of project, & try more speed up of maintenance work
	Environment of workshop	×	△	Perfect Put in order, cleanliness & careful handling of equipment activities
Field of maintenance	Field / area of maintenance work for mechanic in charge	×	△	Expansion of maintenance field (3 to 4 fields) of each mechanic
Maintenance capacity developing activities	Set up post for technical capacity training	×	×	up post / organization to conduct various training / study
	Implementation of training	×	△	Set up annual plan & continuous execution of trainings
Health & safe activities	Risk finding activities	×	△	Periodical (monthly) implementation of risk finding activity
	Comprehensive activities	×	△	Set up of health & safety commission & implementation of activities

Maintenence capacity		Achievement level of the project (2009 – 2014)		Subjects to be attained to ensure sustainability after the project
Main items	Detail items	Early period	Latter period	
Preventive Maintenance		Achievement level of the project (2009 – 2014)		Subjects to be attained to ensure sustainability after the project
Main items	Detail items	Early period	Latter period	
Inspection	Check of vehicle prior to operation	△	△	Amendmend of check lists, preparation of record book, implementation of check, record and report. Implementation by drivers & collection workers
	Check of loading device prior to operation	×	×	
	Check & cleaning after operation	×	△	Regular check & vehicle cleasing
	Regular ocular check	×	△	Plan & implementation of regular check by mechanics (monthly, every 3, 6, 12 months check, etc.) Preparation of check items & standard, record book & space for check. Implementation of check, report of the results & maintenance by results of check. Improvement of check judgement & risk finding ability
	Regular dismantle check	×	×	
	Fill out record book & report	×	×	
	Check judgement ability	×	△	
	Preparation of space for check	×	×	
Periodical maintenance	Maintenance by mileage	△	△	Secure parts & change parts regularly
	Maintenance by check	×	△	Setting of maintenance standard, implementation & checkof maintenance work
	Preparation of space for maintenance	×	×	Preparation of check & maintenance space
Management of maintenance equipment		Achievement level of the project (2009 – 2014)		Subjects to be attained to ensure sustainability after the project
Main items	Detail items	Early period	Latter period	
➢ Inventory management ➢ Operation	Inventory slip	○	○	Maintenence of achievement of project
	History book of equipment	×	○	Maintenence & development of achievement of project
	Maintenance & trouble shooting	×	○	More revision of manuals & training implementation

Maintenence capacity		Achievement level of the project (2009 – 2014)		Subjects to be attained to ensure sustainability after the project
Main items	Detail items	Early period	Latter period	
management	Cause finding & repair of damaged portion	×	△	Future damege cause analysis, countermeasure setup & dissemination
	Information sharing & training about countermeasure of damage	×	△	Amendment of manuals & trainings Crefull handling & prohibit
	Countermesures to prolong life	×	△	Careful handling & prohibit to handle equipment by beginer without the person in charge
Comprehensive countermeasure to avoid damage of vehicle		Achievement level of the project (2009 – 2014)		Subjects to be attained to ensure sustainability after the project
Main items	Detail items	Early period	Latter period	
Data collection & analysis	Book-log	△	△	Record book of each vehicle was not prepared & only person in charge grasped damage frequency, causes & tendancy by vehicle model. From now on, record book of each vehicle should be prepared, recorded & used for maintenace by appropriate analysis.
	History book of vehicle	△	△	
	Data analysis	△	△	
	Feedback to maitenance work	△	△	
Regular check & maintenance	Implementation of preventive maintenance	△	△	(details are listed at Preventive Maintenance clause)
Operation of collection vehicles	Appropriate driving	×	△	Implementation of training about safe drive & check prior to operation to drivers
	Easy repair (flat tire, etc.)	△	△	Implementation of training about easy repair
	Appropriate collection work	△	△	Implementation of training about safe & appropriate collection work
Access road condition	Access road in dump site	×	×	Suggestion to responsible burau to rehabilitate access road at dump sites
Appropriate supply of vehicles	Grasp data analysis results	△	△	Preparation of specification of vehicle supply by above data collection/anaysis, & difficult maintenance
	Preparation of specification	×	△	
Remarks:				

Maintenence capacity		Achievement level of the project （2009 – 2014）		Subjects to be attained to ensure sustainability after the project
Main items	Detail items	Early period	Latter period	

Discription	Evaluation by JET
○	Already achieved appropriately
△	Already achieved but not enough
×	Not yet achieved

11.1.1 Selection of maintenance equipment

Although the selection of maintenance equipment is well evaluated, but there are some subjects listed below.

(1) Difficulties of air-system construction

It is necessary to install air-regulator to control air pressure to use air-tools, but as acquisition of air-regulators in Cuba was difficult, some donated air-tools were destroyed by high air pressure.

(2) Damage of vehicles by rough roads in final disposal sites

Frequent maintenance of tires, clutch and break-linings are necessary due to rough road of final disposal site, could not be considered at selection stage of maintenance equipment, therefore such maintenance equipment have lack of kinds and quantity.

(3) Difficult acquisition of materials in Cuba

Electric cables, pipes and joints were supposed to be possible to get in Cuba, but it was very difficult to prepare them, and some of them could not be obtained and the others took long time to prepare.

Appropriate selection of necessary maintenance equipment should be checked and considered very carefully about (1) what kind of maintenance are done at workshop, (2) possible or impossible about maintenance by outsourcing, (3) kinds and manufacturer of collection vehicle and (4) how the maintenance are done, as well as (5) Cuban side’s ability of system design and construction work and (6) possible or impossible to supply materials for construction works.

Moreover about machine tools and operational equipment, not only changing of spare parts but also periodical maintenance by specialist are very necessary.

Such a comprehensive consideration, both participant of expert of collection vehicle maintenance and enough time are very much needed.

11.1.2 Maintenance and management of donated equipment

Many donated equipment have greatly contributed for capacity development of maintenance of both collection vehicles and heavy equipment. Almost all equipment are used effectively now, but some of them were damaged or troubled like below.

(1) Damages of air-tools

As air pressure is so high, that impact wrenches were damaged.

(2) Trouble of machine tools

Hack saw machine, upright drilling machine and lathe had troubles. Trouble of hack saw machine was happened by different oil use, although the cause of upright drilling machine was not clarified, but removal of breaking system enabled it to be operational, and the lathe’s trouble was happened by inappropriate operation.

(3) Abrasion of operational equipment

Car washing machine’s operation time is so frequent that the performance of the car washing machine is getting worse due to abrasion of the parts.

(4) Others

Garage jacks and electric wire cables of welding machine are damaged by inappropriate handling.

Whenever damage and / or trouble was happened like above mentioned examples, both JET and C/P have carried out study to find the causes, and in case of improper handling, manuals have been revised and trainings have been conducted to let the mechanics handle the equipment properly. In case of lack of air-regulators which are difficult to get in Cuba, JET got them in Japan and brought them to Cuba.

In case of trouble of machine tool, it is necessary to consult with the manufacturer. JET strictly advised mechanics not to dismantle troubled parts of machine tool by themselves, and after get the advice by manufacturer through JET, check and / or repair it. Even after the project is over, communication between JET and C/P should be maintained as before. But, as Cuban side mail transmission is quite difficult, JICA's assistance is appreciated.

Although maintenance manuals were prepared and series of trainings were conducted, still it is not enough, so, check procedures when troubles happened (trouble shooting) were included into the manuals. Moreover, proper operation and check should be done, in case of machine tools and special equipment, operator should be fixed and other mechanics are prohibited to operate such machines.

11.1.3 Supply of equipment and parts after the project

During the project, JET could get and bring necessary equipment to Cuba, but after the project, Cuban side should supply them by themselves. Although it is quite difficult to supply materials, equipment and tools in Cuba, but in the case of tools, acquisition is possible, so Cuban side's effort is expected. In the case of Japanese goods, JET introduced C/P an agency to import Japanese goods, as well as advised to maintain continuous communication between JET and C/P.

11.1.4 Improvement of capacity development of maintenance

C/P and mechanics have mastered basic theories and maintenance method by fulfillment of equipment, preparation of maintenance manuals and series of trainings, but practically, still difficult to process materials to produce repair parts and jigs accurately and there are uneven abilities among the mechanics.

Although it is understandable that mechanics are very busy by daily repair works, but, C/P should have leadership to conduct study and training periodically among the mechanics, because such activities enable to improve capacity development of all mechanics.

Right now, mechanics are separated to work at each area, but it is necessary to train the mechanics to cover plural areas as many as possible. If so, reduction time of maintenance and capacity of mechanics can be improved dramatically.

For reduction time of repair, preparation of "re-built of machine" is one of the method. For example, primarily new engine is supplied, and if one of the vehicle's engine is troubled, then change to new engine, and removed troubled engine will be repaired and stocked to install next vehicle which engine will be troubled. Such stock of repaired machine is called "re-built of machine" that can reduce repair as well as improve operation time of collection vehicles dramatically.

11.1.5 Working environment

During installation of donated equipment, Cuban side made great improvement of working environment, however, working places are not clean nor well organized. For example, as spilled oil is not clean up soon, working place is not clean as well as unsafe, and there are rough handling of tools, so, JET conducted risk prediction activities, but not yet done periodically.

As such activities to improve working environment needs awareness of mechanics, it is necessary to introduce “5S” (Tidiness, Orderliness, Cleanliness, Standardization, Discipline) by leadership of C/P and improvement activities by mechanics by themselves, although it is difficult to realize.

11.1.6 Preventive maintenance

3 steps of preventive maintenance by mileage of vehicle is done right now. But, comprehensive preventive maintenance activities are not done, like regular check of vehicle and appropriate driving and operation of collection vehicle.

Preventive maintenance activities including daily check by driver prior to operation work, periodic check and regular overhaul check by mechanics, are very effective to prevent trouble and damage to the vehicles, so checking system and its implementation are very much expected to be realized. For the check activities, the mechanics should master diagnostic ability to forecast future trouble of vehicles.

11.1.7 Comprehensive approach to prevent vehicle trouble

For improvement of capacity development of maintenance of vehicles, not only improvement of maintenance skill, but also comprehensive approach is necessary like (1) appropriate driving and operation not to prevent damage to the vehicles, (2) improvement of access road which damages to the vehicles in the final disposal sites, (3) preparation of appropriate specification to purchase new collection vehicles to meet Cuban condition.

Right now, operation and maintenance record of collection vehicles are recorded by paper basis, but preparation of book-log of each vehicle and history record of damage, repair and maintenance should be done, and C/P should grasp causes and tendencies of the trouble by data analysis, and should take action for comprehensive and effective maintenance work as well as to prepare appropriate specification for acquisition of new collection vehicles.

11.1.8 Approach to C/P and mechanics

As Cuban C/P and mechanics have their prides about their skill and method of vehicle maintenance, they did not listen to JET’s advice, and technical transfer was difficult at the beginning of the project.

Points to be careful when JET tries technical transfer, never force Japanese way to Cuban side and it is necessary for JET to make their efforts to understand / respect Cuban maintenance methods at first. Such efforts need enough time to create good relationship between JET and Cuban mechanics.

If JET tries steady cooperation, for example, JET provides proper advice when Cuban side has hard time to repair, then, Cuban side understand JET’s technical ability, and technical transfer can be conducted smoothly. Most important point is the efforts to understand with each other.

Project Completion Report

Section 5: Report on Output 4

～Report on Capacity Development of Final Disposal Site Operation ～

1 Introduction

The JICA Expert for the final disposal site has made nine trips to Havana during the Project, and made evaluations and gave advices for final disposal sites design, operation, and managements.

In designing of the final disposal site, evaluations and advices were given for the New Guanabacoa landfill site which include leachate treatment facility, and recycling plant which is to be built next to the final disposal site.

For operation of the final disposal site, various advices were given to how to improve landfilling works and operational management for existing Calle 100 landfill, Ocho Vías landfill, Tarará landfill and Campo Florido landfill site through examining the site operation with the counterpart. Advices on operational management were also given to the future head of the New Guanabacoa landfill site.

Names of JICA Expert and DPSC/UPPH C/P members are as follows:

Name	Assignment Period
JICA Expert	
• Mr. Toshihiko Chiba	September 2009 to June 2014
Counterparts	
• Mr. Gianni Ponce	September 2009 to May 2011
• Mr. Pedro V. Pérez	September 2009 to September 2011
• Mr. Ernesto Domínguez	June 2011 to present
• Mr. Lazaro Sotolongo	June 2012 to present
• Ms. Grettel Gutierrez	June 2012 to October 2012
• Mr. Alberto Figueras	November 2012 to January 2013
• Ms. Harilyn Tamayo	November 2012 to present
• Mr. Antonio Blanco	November 2012 to February 2013
• Mr. Alexis Vazquez	April 2013 to August 2013
• Mr. Hermes del Toro	June 2013 to present
• Mr. Camilo Rodríguez	September 2013 to present

2 Activities carried out during the first fiscal year period

2.1 Capacity Assessment of Counterpart Group on "Landfill Design and Final Disposal Site Operation"

Calle 100 landfill, Ocho Vías landfill, Micro Cuatro landfill and Tarará landfill were studied onsite. All of the site had insufficient number of equipments and their operations have a lot of shortcomings in terms of soil covering, compaction, access roads, vehicle saturation at the entrance, and scavengers controls (which officially do not exist but in practice they enter the sites despite the security measures, and causing disturbances).

The New Guanabacoa sanitary landfill site needs to overcome these shortcomings. However, the Expert could not confirm if there are plans to end operations and close existing landfills, since the unit in charge of landfill operation has not played a necessary role neither in the design of the new site nor in the overall planning of the final disposal site system.

The lack of communication and planning arises among DPSC entities in charge of the new sanitary landfill design or landfill operation. It may pose some problems that the enterprise currently designing the new site does not belong to DPSC and appears to have no experience on this matter.

Since final disposal for the City of Havana is closely related to the M/P review as well as the "New Final Disposal Site Construction Plan Recommendations," some comments are given as follows:

a) Taking into account about the start of New Guanabacoa sanitary landfill site operation and the expected remaining service life of the existing landfills, it is necessary for the existing landfills to consider the problems related to waste collection vehicles shortage, the size of the new sanitary landfill entrance, and the arrival schedule of collection vehicles, and closure plan and project.

b) The Waste Laboratory analysis results should be taken into consideration in establishing the most suitable leachate treatment system. Also, at the new sanitary landfill, the entrance of wastes containing heavy metals, like car batteries, or hydrocarbons like residuals from vehicle repair works should be forbidden since they may hamper leachate treatment or make the treatment of sludge difficult due to their hazardous contents.

c) According to the counterpart comments, the new sanitary landfill design is limited to the civil works, but the waste cells construction and the site operation plan are not sufficiently considered. This may cause operation problems later, particularly those related to inner roads, slopes, cells height, and rain drainage project, etc.

d) It seems that the new sanitary landfill includes a composting plant and a recycling plant but further information or plans about this matter could not be obtained. This may cause difficulties, because CITMA included those plants as a requirement to authorize site construction.

e) Regarding the slopes, they have considered a 4:1 angle but it does not appear to be based on waste composition analysis, the rain pattern at the area, or the cover soil particle size.

2.2 Advices for the project of designing and construction of the New Final Disposal Landfill in Guanabacoa

Period: February 14, 2010 – March 15, 2010

2.2.1 Project Concept and Progress

a. Confirmation of project concept and progress

The budget for the project of the New Landfill in Guanabacoa for 2010, including the construction cost, has not been secured yet because its budget request for this fiscal year had eliminated by mistake from the list submitted by DPSC in the annual budget approval process in MEP.

The designing has been suspended because of this problem, though the overall layout plan has been revised since December 2009.

EIPPH (Empresa de Investigaciones y Proyectos Hidráulicos Habana, Dependencia de Institute Nacional de Recursos Hidráulicos) in charge of designing the leachate treatment facility has submitted a report, presenting 3 types of the facilities with description of merits and demerits of each one as well as cost comparison so that DPSC could make a decision to choose one of them. DPSC, however, doesn't fully understand the contents of the report nor to have specific evaluation criteria to make the decision.

While EIPHH studied the area dimensions needed for the leachate treatment facility, DCH responsible for the landfill layout didn't receive this information, which suggests that the overall coordination for the project is insufficient.

Besides, though it was informed that a recycle plant and a landfill gas plant were also to be constructed, those plants are not identified in the overall layout drawing by the DCH.

DCH refuses to provide the latest drawings to DPSC and JET because no agreement has been made with DPSC for the payment in this year. Therefore, the JET has not been able to find out the current situation of its design.

It was found that the first phase construction of the landfill would start at the old quarry located in the west of the site because the farmland (mango farms) which lies in the east would have environmental impact, while the farmer's resettlement schedule has not been informed.

If the construction of the leachate treatment facility requires larger area, more land must be acquired. No arrangement, however, have been made for this purpose.

DPSC is incapable of preparing an annual plan for the project, because the basic information, including the landfill capacity required and the annual waste disposal volume, is not shared among DPSC and the other concerned parties.

b. Requirements of the environmental license

Though the leachate treatment method had been required to be modified as a precondition for the environmental license when the environmental impact assessment had been screened, it became evident that the project passed the screening and the construction could start immediately after the construction permission was given (It is explained that it is not difficult to obtain the construction permission).

It should be noted that the license was given only for the construction done in this fiscal year (the first stage of construction), and that it is necessary to obtain a new environmental license per stage.

The design values of influent to be treated in the leachate treatment facility have been set up based on the data shown in the JICA Development Study report, that was the average values of the leachate quality analyzed in the Calle 100 landfill at the time of the study. It is necessary to revise those design values and verify that the revised values can comply with the requirements imposed through the screening of the environmental impact assessment, because the design influent pollution concentration is considerably lower than that estimated for a landfill that has a structure to collect methane through anaerobic digestion, which is planned to be adopted for the New Landfill.

Moreover, various requirements detailed below are imposed for the landfill development permission. It is necessary to examine whether they are compulsory requirements or not, as well as if the design can meet the conditions.

Specifically concerning the impermeability, even though double layers using an earth liner and a HDPE sheet are required, it may be difficult to adopt the double liners due to the budget limitation and therefore it is necessary to examine whether the plan can be changed or not.

b.1 Impermeable liner

The landfill bottom will be first covered with a 1.0 meter thick soil layer such as clay, sandy clay or bentonite. Then, it will be covered with a 2mm thick HDPE sheet and over this impermeable sheet a 30 cm thick geotextile will be place to prevent the sheet from being damaged.

Later, a 30 cm thick layer of coarse gravel (30/90mm) and a 20 cm thick layer of fine gravel (8/32) will be placed. Finally, it will be covered with a geotextile sheet and another 20 cm thick layer of fine gravel.

b.2 Leachate treatment

The slopes of the trenches bottom will be 2% in the direction of the gas collection pipes and the leachate collection pipes. The drainage network will have a slope of 4% in the direction of the treatment facility. Gas and leachate will be collected through the perforated collection pipes to be installed along the center line of each cell. The leachate will be treated in a leachate treatment facility which has capacity enough to comply with the NC 27/99 “Residual waste discharge into the terrestrial water and the sewerage system”.

It is necessary to take it into account that the site is located near “Las Palmas” dam, whose water is in good quality.

“Cojimar” river, whose downstream forms part of one of the protected areas in the province, should not be affected by the development of the Landfill.

The minero-medical water vein of “Santa Maria del Rosario” is also near the site. According to the Cantera Habana experts, a part of the site lies within the radius of protection #III of the vein.

b.3 Solid waste covering and compaction

The weight per volume of waste collected is estimated to be 0.2 to 0.4t/m^3.

The weight per volume of waste disposed of is estimated to increase to 1.0 to 1.2t/m^3 through compaction.

The coefficients of compaction that are recommended to be used for the calculation for organic waste and debris are 3 and 1.5 respectively, for the reason that estimation of the weight per volume for the waste disposed in the landfill may cause serious mistakes, besides the heterogeneous nature of the waste.

Regarding covering, daily, intermediate and final coverings are required. Moreover, covering with clay is required to prevent gas leakage and rain water infiltration, considering the gas collection.

b.4 Gas collection system

The gas collection system is included in the project, though the details depend on the generated gas volume.

The plan include the gas collection system after completion of filling up the site, just like how Calle 100 site has installed gas collection wells and collection networks after the completion of the area; however, the same plan also has designs to install leachate collection pipes which will be also used as gas extraction piping. These idea completely conflicts each other.

- Installation of gas collection wells
- Installation of gas collection network
- Installation of gas collection and combustion equipments

b.5 Reforestation buffer zone

It is necessary to provide the 100m width reforestation as buffer zone in all the perimeter of the Landfill.

b.6 Requirements for the exploration

Sanitary landfill operation, leachate treatment, and types of waste to be received are stipulated in the landfill micro-localization process and required to be satisfied.

c. Construction commenced

Even thought the construction of the road to reach the landfill site has started, the Japanese Expert recognizes that the actual condition of the road is similar to a temporary access road for the landfill construction work, not ensuring an easy access to the site for collection vehicles.

It was explained that the access road construction was behind schedule due to problems on contractor’s side but would be completed soon or later because that the construction had been already ordered except the pavement.

d. Section to be constructed, budget, drawing, schedule for this fiscal year

It was informed that the 2009 budget request for the New Landfill had been missed in the process of reviewing in MEP, not enabling the construction schedule to be prepared.

Even though a first landfill trench is planned to be constructed in this fiscal year 2009, the disbursement of the construction cost has not been guaranteed yet due to the above mentioned circumstances, nor does the design firm seem to have completed the design, while the firm refused to disclose all the design information that has been elaborated in this fiscal year.

The access road construction started but it is behind schedule because the constructor is not conducting this job in a full scale. Whether the detailed working drawings have been already elaborated is not confirmed as of the 3rd of March 2010.

e. Organizations and persons concerned

- DPSC (Provincial Direction of Communal Services)
  - ✓ Ms. Odalys Garcia: Project Manager

- ✓ Mr. Gianne Ponce: Engineer in charge of coordination

- UPPH
  - ✓ Mr. Pedro V. Pérez: Chief of Technical Department, Final Disposal
- DCH in charge of comprehensive designing for the New Final Disposal Landfill
  - ✓ Mr. José Daniel Lugo Miranda: Project leader
  - ✓ Mr. Basilio del Vallín Marcheco: Designer
  - ✓ Mr. Raúl R. González- Longoria Graña: Supervisor for designing
  - ✓ Mr. Raymundo Calixto Hidalgo Roselló: In charge of Earthwork
- EIPPH in charge of designing of the leachate treatment facility (lagoons)
  - ✓ Mr. José Francisco Santiago: Specialist in water resource
  - ✓ The contract was made with EIPPH covering all the works of the facility construction.
- Proambiente de la ENIA (consultant)
  - ✓ Mr. Arístedes Zayas Aranzola (Engineer) : in charge of geological investigation
- CITMA
  - ✓ It deals with all the issues related to the environmental protection.

2.2.2 Technical Observations

The Japanese Expert cannot obtain all the design documents to comprehend the technical problems in designing and constructing the New Landfill, but he recognizes that it is clear that the fundamental advices are necessary for the project. The following are the contents of the advices which are considered as necessary.

a. Concept of the New Final Disposal Landfill

A semi-aerobic landfill structure is applied for the New Landfill design, while the methane gas collection is planned in the same design. Since the methane gas collection can be achieved through anaerobic fermentation, it functionally contradicts the semi-aerobic structure.

Moreover, the influent quality of raw leachate varies widely depending on what type of structure the landfill has. Therefore, it is essential to clarify the design concept of the New Landfill.

b. Standards and regulations related to final disposal landfills

UPPH prepared some guidelines related to waste, including the “Methodological Rule for Final Disposal Landfill Operation in Habana City,” and the “General Guideline for Projects related to Urban Solid Waste” both of which are concerning landfills.

These guidelines describe the landfill methods, areas where the construction of landfill is prohibited, distance to be maintained from residential areas and potable water resource, impermeable structure, leachate treatment and landfill gas control.

When asked about the existence of regulations and guidelines related to final disposal landfills and their compliance requirements to Mr. Gianne Ponce of DPSC and Mr. Basilio del Vallín

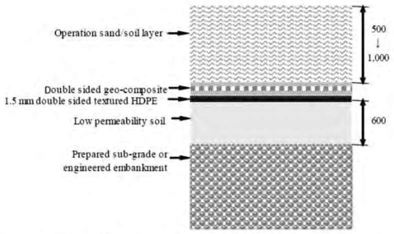
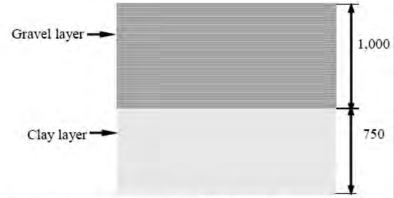
Marcheco of DHC answered that there were no laws or regulations related to structures of final disposal landfills in Cuba, and that the guidelines described some standards in other countries that could be adopted and were not compulsory requirements. They explained that the laws and regulations related to structures of final disposal landfills were being elaborated and would be completed soon, but it is not clear when such regulations will be established.

Additionally, they refer to the report prepared by the JICA Development Study (The Study on Integrated Management Plan of Municipal Solid Waste in Habana City, Final report) to plan and design the structure of the Landfill. It is reviewed that those three types of standards are referred for the landfill planning and designing in Cuba.

The following table shows the comparison of the three references.

Table 2-1: Comparison of the Three References for Landfill Planning and Designing

Subject	The Study on Integrated Management Plan of Municipal Solid Waste in Habana City, Final report	Methodological Rule for Final Disposal Landfill Operation in Habana City	General Guideline for Project Related to Unban Solid Waste
Buffer distance Prohibited zone	There is a description in the report that although the site location is regulated to be at least 500m away from houses it should be mitigated for the sanitary landfill cases.	It is required that the site should be located at least 300m away from houses and habitable areas, and at least 600m away from urban area, residential area, institutes related to medicine and education, jails, food manufactures, potable water resource. The site should be at least 3km and 1.5km away from the airports with jet and propeller airplane landings respectively. It should not be constructed in a swampy place, including spring area, salt water marshes, swampy coasts, and beaches. It is not permitted to construct landfill in areas where flood may occur with a probability of less than 100 years, or on active faults, or areas where landslide or land subsidence by underground vein excavation occurred. No landfill is allowed in areas whose stability and/or durability are questioned.	The site should be located at least 300m away from the nearest houses, wells, potable water resource, hotels, restaurants, food-processing plants, schools, churches and parks. At least 8km away from the nearest airport (Bird strike is concerned). At least 100m away from surface water channels. At least 100m from unstable areas, for example, areas where landslide can occur. No construction is allowed in the exceptional areas specified by the government.
Landfill structure	Semi-aerobic (It is not markedly specified but the structure is semi-aerobic.)	Anaerobic landfill Daily covering: more than 15cm	Anaerobic landfill Trench method, Area method
Leachate treatment System	Alternative 1: Aerated lagoon → Maturation pond Alternative 2: Aerated lagoon → Sedimentation pond → Wetland Alternative 3: Anaerobic pond → Facultative pond → Maturation pond Alternative 4: Anaerobic pond → Facultative pond → Wetland Alternative 5: Anaerobic pond → Aerated lagoon → Sedimentation pond →Wetland Alternative 6: Anaerobic pond → Aerated lagoon → Maturation pond	There is a description which permits leachate injection (Circulation).	Only the necessity of leachate treatment is mentioned. Biological and chemical treatment.

Impermeability	 Figure 5.10.5 Composition of HDPE Sheet Liner System (Bottom)  Figure 5.10.6 Composition of Clay Liner System (Bottom)	1) HDPE sheet of at least 0.76mm thick on the top the 60cm-thick clay soil whose permeability coefficient is 10-7cm/s or less 2) 60cm-thick clay layer whose permeability coefficient is 10-7cm/s or less, or membrane whose impermeability is similar or superior to the clay layer. 3) Above the maximum level of underground water, 5m-thick natural soil whose permeability coefficient is 10-5cm/s or less. Regarding the types 1) and 2), there should be a natural soil layer whose permeability coefficient is equivalent to 10-5cm/s or less and the distance between the landfill bottom and the maximum groundwater level should be 3m or more.	Clay liner is presented as a common method in Latin American countries. From the bottom; 60cm-thick homogeneous clay soil 1 to 2mm-thick HDPE sheet 20 to 30cm-thick clay
Landfill slope angle	The installation of an earth embankment on each waste layer enables the landfill slope angle to be 1 : 2.	Equal to or less than 1 : 3 The safety factor should be more than 1.5 in normal conditions and 1.3 in the time of earthquake, if the slope is steeper than the above mentioned required value.	No description.
Final covering	30cm-thick clay liner 30cm-thick protection layer (for reforestation) Gas collection pipe	From the surface; 15cm-thick vegetation topsoil layer 60cm-thick clay layer with permeability coefficient of 10-7cm/s 0.5mm-thick geo-membrane 30cm-thick layer of draining material with permeability coefficient of 10-3cm/s 60cm-thick clay layer with permeability coefficient of 10-7cm/s 100cm-thick soil layer with permeability coefficient of 10-5cm/s	No description.
Post-closure maintenance period	5 to 10 years are required for the landfill stabilization.	At least 20 years after completing the final covering.	No description.

c. Revision of the site layout plan

The actual layout plan is found to be elaboration of precedence on utilizing the existing roads in the site. The priority should be given to establish essential objectives of the New Landfill since revising the site layout plan is required as the layout plan is the detrimental factor for the landfill capacity and thus.

d. Leachate collection method

In the actual plan, the leachate entering the leachate collection pits located in each trench is to be sent to the treatment facility (lagoons) through pumps, which means that the leachate will keep being pumped up even when the landfill waste are stabilized and the leachate treatment become unnecessary. Thus revising the plan is required.

e. Land for the leachate treatment facility

While an area of 1.5 ha is prepared for the leachate treatment facility in the project, the designer in charge of the facility argues that an area of 6.0 ha is necessary for the system. As the area secured is insufficient, whether reducing the area for the landfill or obtaining more land for the treatment facility should be considered.

f. Impermeability

Although impermeable structure using high density polyethylene sheets was proposed in the Master Plan, the adoption of other structure is being studied because of the budget limitation.

Advices are needed for building a structure to satisfy the required impermeability.

g. Advices for the Calle 100 lagoons (leachate treatment facility) to be constructed

Lagoons are planned to be constructed in the exiting Calle 100 landfill site.

The site where the lagoons are to be constructed is full of waste already disposed, and therefore the waste must be moved to other site in order to build the lagoons. Advices must be given for the economical method to transport the disposed waste and designing and construction the lagoons itself.

In 2002 the lagoons were originally planned to be constructed in the third area (ZONA III), where wastes were not disposed at that time. Though some elements such as layout were revised afterwards, the basic design specifications seem to remain the same as the original plan.

It was originally planned to construct lagoons for two sites in the Calle 100 landfill site, but now only one unit is planned to be constructed at the upstream side of the site. There is concern that the unit's treatment capacity to receive and treat the leachate is insufficient and pumping up the leachate is required to collect and send it to the unit. Besides, the design values of influent were based on the leachate quality analyzed in 2002. Total review of the plan should be carried out.

It is the first time for Cuba to build lagoons for leachate treatment, and there is concern that distrust would be raised to the New Landfill project if the unit of lagoons in Calle 100 doesn't work sufficiently.

The Expert considers that the advice for designing and constructing the lagoons in Calle 100 site is highly important.

h. Mini-Seminar

Through interviews to the persons concerned, the Japanese Expert has recognized that the framework to design and construct the Landfill is indecisive because the functions required for landfills are not fully understood and they have not perceived physical facilities and equipments to fulfill such functions in the limited experiences in Cuba.

The Japanese Expert explained to his C/P the objectives and the functions of landfills so that he could understand their functions and structures. The structures were explained using videos where landfills in Japan.

The explanation with the videos was highly effective because they enabled him to understand visually each type of equipments and impermeable structures used in the sites.

Subsequently, the Project Manager requested the Japanese Expert to hold seminars on landfills for the other staffs related to the subject. The Japanese Expert held two mini-seminars and explained mainly the purposes and the functions of landfills, through showing Photo and videos.

Photo 2-1: First Mini-Seminar

(It was held prior to a meeting on the design of the New Landfill)

Photo 2-2: Second Mini-Seminar

(with the participation of the persons in charge of the project in DCH and UPPH)

3 Activities carried out during the second fiscal year period

Period: May 4th, 2010 – June 18th, 2010 and October 11th – December 5th, 2010

3.1 Improvement of the entrances of the final disposal landfills

The M/P had mentioned that it is an issue to be resolved that the traffic congestions at the entrances of the existing final disposal site caused by the waste collection vehicles entering the sites. However, later baseline study revealed that such traffic congestions happened only when some unusual circumstances occurred such as urgent cleanup operations required after the hurricane struck the city.

On the other hand, the Japanese Expert observed that a number of vehicles entered and left the Calle 100 landfill without passing through the entrance reception where the waste transportation was controlled because of the undefined traffic line. The traffic line around the entrance should be properly determined.

At the dumping area, the vehicles were not well guided and there were cases where drivers decide themselves where and how they drive within the site. The raw material collecting staffs were walking around at the area where the waste collection vehicles were running to dump the waste. There was a great risk of injury to the landfill staff. Also such operation prolong the roundtrip time of a vehicle inside of the landfill -- from the entrance through the dumping site to the exit -- which made the waste collection efficiency lower.

The Japanese Expert, therefore, gave advices about guiding the waste collection vehicles at the dumping site in more effective way, and discussed how to reduce the roundtrip time inside of the site, instead of discussing how to mitigate the traffic congestions at the entrances.

3.1.1 Observation concerning landfill operations

a. Access road

Since February 2009, nighttime waste collection has been implemented in which the waste is brought into the landfills in not only daytime but the nighttime. Through this practice, the number of the vehicles entering in the landfills in the daytime has been reduced as the entry times of waste collection vehicles in the landfills is divided by daytime and nighttime. It has become easier to guide the waste collection vehicles at the dumping stage.

On the other hand, there was no lighting system in the landfills. This makes the drivers to be reluctant to go to the proper dumping point, especially when the weather is bad, and dump the waste along the access road.

In this respect, a vicious circle was observed; the access road was not well maintained, and the waste was dumped along the margins of the access road, the driving conditions became deteriorated, elevating the possibility of puncturing or blasting tires, which made the drivers prefer dumping the waste along the margins.

Although the C/P recognized that the access road repair was essential, its priority was low due to the unavailability of the heavy machines and the lack of fuel.

Photo 3-1: Situation of the 8 Vías access road

b. Ways of guiding waste collection vehicles

The UPPH guiding staffs were verbally instructing the waste collection vehicle drivers where to go to dump the waste.

According to the C/P personnel, the dumping areas were differed according to the types of vehicles. However, it was observed that no guidance was given to some experienced drivers or when multiple vehicles were arriving at the same time.

Although the recovery of raw materials was being carried out in the most of the landfill, collectors were concentrated near the dumping stage, probably because higher recovery efficiency can be expected immediately after truck dumps the waste.

Their working condition was very dangerous. If the guidance was appropriately done, they would be warned about the approaching vehicle, but if there was no guiding staff at the stage, accidents could occur causing bodily injuries.

ZONA-I In front of the trench

ZONA-IV

Photo 3-2: The guidance conducted at the dumping yard in the Calle100 final disposal landfill

c. Dumping stage

The waste is usually dumped at the dumping area, and it pushed and leveled with bulldozer(s) after the collection of the raw materials.

Although the dumping stage was arranged using bulldozer(s), the majority of the area was uneven and the waste was not sufficiently covered, which made the driving conditions for waste collection vehicles worse.

The Japanese Expert observed that there were stuck vehicles in the waste. The guiding staffs and the collectors were pushing it and later a bulldozer was pulling it up.

Photo 3-3: Dumping stage at Calle100

Many UPPH staffs were working to collect the raw materials near the dumping stage. The Expert were concerned about the safety of them. When plural vehicles were moving around at the dumping site, they would not notice an approaching vehicle from loud noise.

The guiding staffs and the raw material collecting staffs didn’t wear any masks or gloves. They were working under the scorching sun without shady area in the dumping site which reeked of foul odors. Their working conditions were very poor.

The preparation of some rest area and the supply of protectors are necessary.

Photo 3-4: Raw material collection near the dumping stage

3.1.2 Advices for the improvement

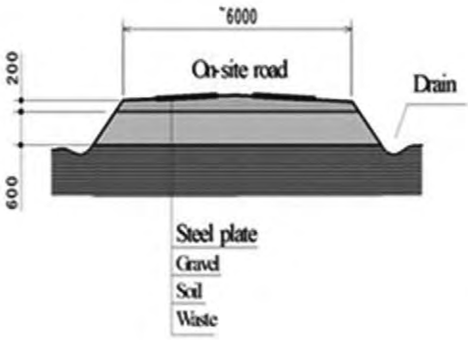
a. Arrangement of the access road

The road in the landfill should be continuously arranged through providing plane and linear modifications which are required along the landfill development.

The condition of the access road from the landfill entrance to the zone under usage was comparatively good due to its fixed linear form, while the driving conditions through the temporal road to the dumping stage was quite bad due to the insufficient covering and compaction.

Therefore, the Expert presented some examples of the modifications conducted in other countries, such as a road arrangement with an iron plate and a preparation of small enclosing bank to guide vehicles, preventing them from dumping on the way to the proper dumping site.

The Expert expected it can give them some hints as to proper ways to improve the condition of access road even though those examples can not be applied directly and immediately in Cuba for shortage of resources.



Construction of Main Road

Photo

Before After
Secondary Road

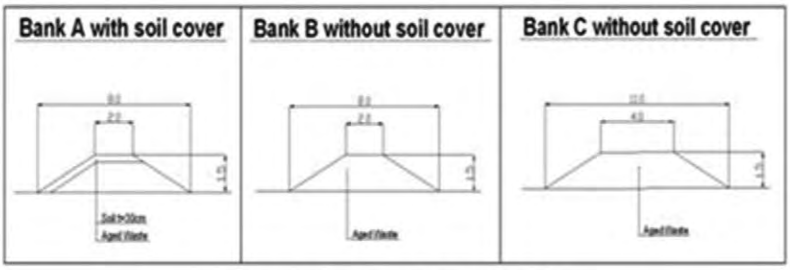


Figure 8-17: Structure of the Enclosing Bank

Photo

Before After
Enclosing Bank

Figure 3-1: Access road construction within the landfill

b. Modified way of guiding waste collection vehicles

The Expert advised that it was important to fix the access road to the dumping stage and clarify the dumping stage and the work area.

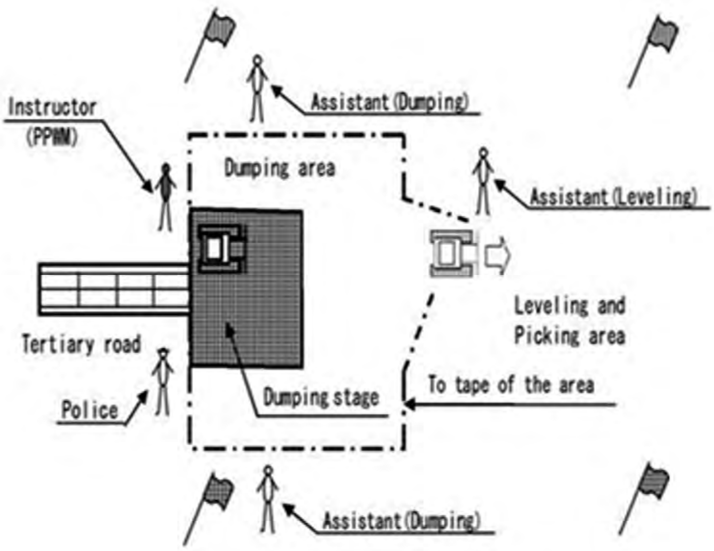


Figure 3-2: Concept of the Dumping area

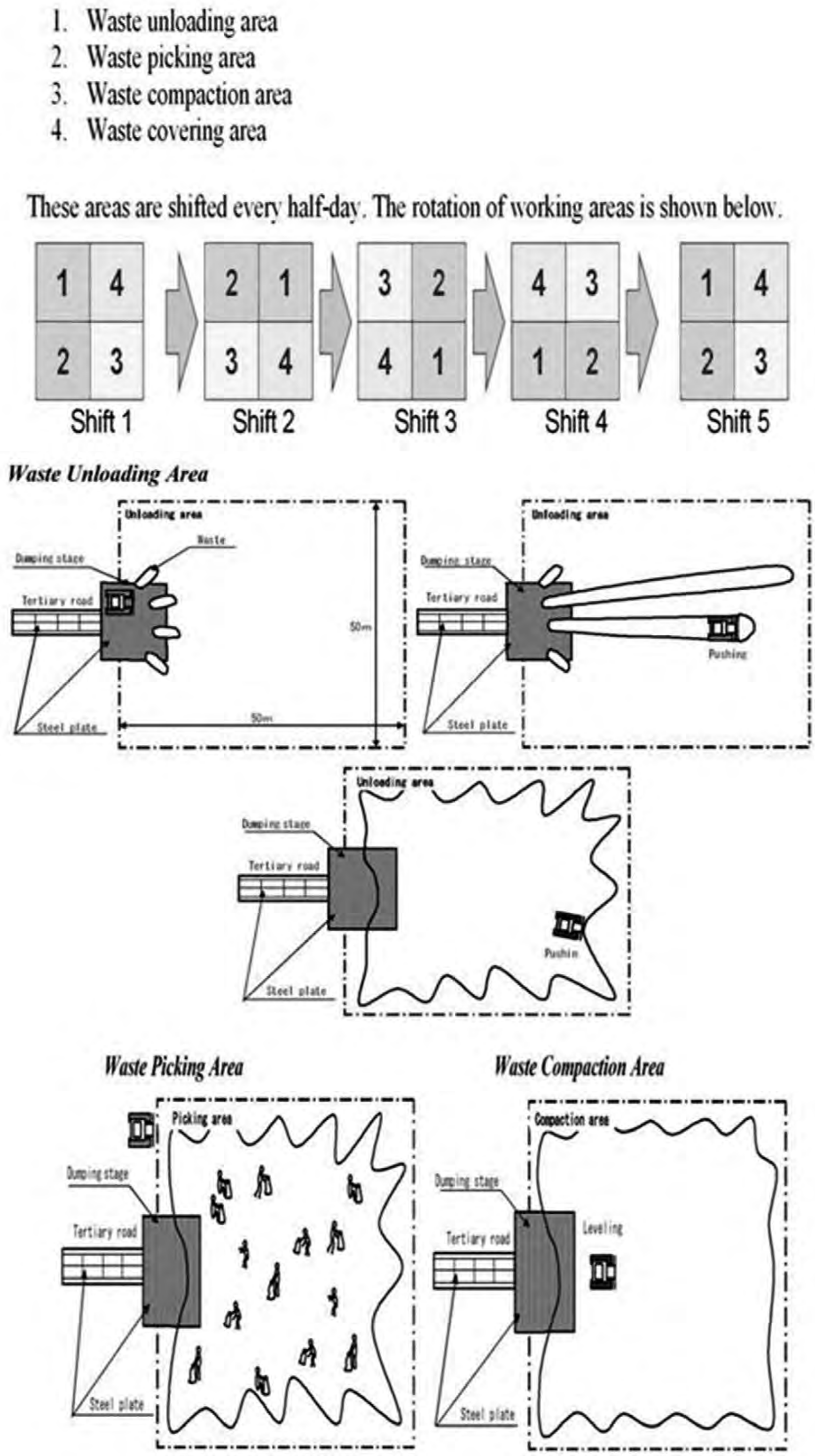
Figure 3-3: Concept of the Entrance of landfill

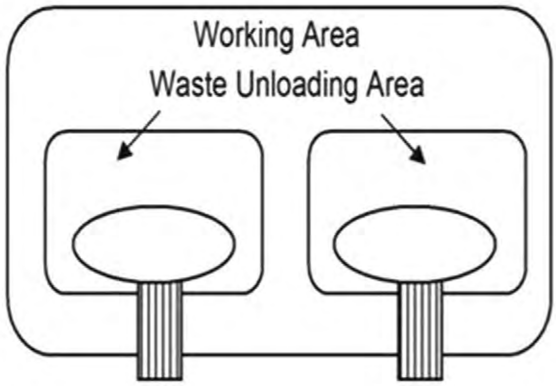
c. Modified dumping stage

As the operations of dumping, raw material collection and compaction were carried out in the same area. As a result, the dumping area became extensive.

The Expert explained that the raw material collection efficiency and the staff's safety would improve when the area was divided in compact dumping area, raw material collection area, compaction area and covering area, which were to be rotated, because that the site could be controlled more precisely when the dumping area was compact.

The Expert advised also to separate the dumping stage for horse cars from the dumping stage for waste collection vehicles.





Working Area Separation
(Waste Picking Area)

3.1.3 Improvements found related to landfill operation

a. Clear definition of the traffic line at the entrance

In the Calle 100 final disposal landfill, the waste collection vehicle drivers give a control sheet to the administration office staff when entering, and left it through the exit road without making procedures at the office (the entering vehicles should be principally weighted on the truck scale. The truck scale was, however, out of order during the expert's activity development).

However, because there were cases that vehicles headed for the dumping area without stopping at the office and/or left the landfill for another collection trip without dumping all the waste that they had carried, a gate was installed at the exit for stricter control.

The emergency access road and the exit road were paved so that the vehicles could pass swiftly.

Through these improvements, the traffic line around the entrance became clear.

June 10, 2010 December 2, 2010

b. Preparation of a waiting area for waste collectors

A waste collection crew is composed of a waste collection vehicle driver and some waste collectors.

It was found that the waste collectors started collecting the raw materials when the vehicles arrived at the dumping site to dump the waste.

The drivers had to wait for the collectors to finish collecting the raw materials at the dumping site, which contributed to the prolongation of the waste collection vehicle roundtrip time in the landfill. UPPH determined to prohibit the waste collectors from entering the landfill, preparing a rest area near the landfill entrance so that they could wait there for their vehicles to come back to pick them up.

As a result, the roundtrip time inside of the landfill was considerably reduced.

Photo 3-5: Rest area for waste collectors

c. Application of the trench method (for nighttime waste dumping)

As the nighttime collection has started, the waste is now brought to the landfill also in the nighttime.

In the nighttime it is very difficult to collect the raw materials and level the landfill using heavy machines. Therefore the nighttime landfill operation is limited to dumping the waste at the dumping yard. The raw material recovery, leveling and compaction of the waste accumulated through a night are conducted in the following morning.

As these operations should be completed in a short time, UPPH introduced the trench method as an experiment.

The method has been also applied in the oldest landfill zone or ZONA Ⅰ, where the organic waste has been converted into the soil. It can be used for covering. As a lot of plastic materials of low decomposability are found mixed in such soil, UPPH has a plan to sieve the soil using the trommel in the compost yard in future.

Although the trench method requires excavation with backhoe, leveling and compaction can be effectively carried out with one heavy machine, resulting in the prolongation of the landfill life.

Photo 3-6: Trench at Calle100

Photo 3-7: Dumping stage in front of the trench

d. Access road widening (8 vías)

The repair of the access road not only improves the driving conditions for waste collection vehicle but also serves to prevent the drivers from dumping the waste onto the margins of the road in the nighttime. The construction work to widen and level out the access road has started in 8 vías landfill with the installation of a truck scale.

In the other landfills, the access roads are being repaired when heavy machines and fuel are available.

Photo 3-8: Access road widening (8 vías)

Photo 3-9: After widening the entrance road (8 vías)

e. Thorough guidance for waste collection vehicle

When visiting the Calle 100 final disposal landfill in June 2010, the expert found the guidance for waste collection vehicles insufficient. However, when he revisited the landfill in December 2010, he could observe some UPPH staffs guiding each driver according to the type of vehicles, indicating where to go for dumping.

The raw material collectors were staying close together to collect the material. The expert found the conditions improved for the half year.

No person except UPPH staff is allowed to collect the raw materials, but it seemed that unauthorized persons actually were entering the site to collect them.

However, when the expert visited the site on 2 December 2010, two policemen were patrolling to control the entry. Even the C/P who accompanied the expert was asked to show them his ID card, which gave the expert an impression that the site was under strict surveillance.

Photo 3-10: Vehicle guidance

Photo 3-11:Patrol by the police against waste pickers

3.2 Training concerning final disposal landfill operation

Before providing some training for the staff who actually work in the landfills, the expert considered it essential that the C/P, or Chief of Technical Department of Landfill Unit would raise his consciousness about the improvement of the landfill operation, understanding well that the existing landfills were being operated only based on the experiences.

He didn't have the basic data, including the correct volume of the waste transported to the landfill each day, the final form of the landfill and the height of the actual landfill. They were all necessary for the landfill management.

Therefore, the expert intended instructing him in the basic landfill management during this period.

3.2.1 Actual conditions and problems related to the existing final disposal landfills

a. Breakdown of track scale

Although the Calle 100 Landfill has a truck scale installed at the entrance, it has been almost always out of order without serving to control the waste volume during the expert's activities development.

The installation of a new track scales has started in the 8 vías and the scale is to start functioning in January 2011, but the installation work tends to be delayed.

b. Lack of control of landfill form and height

In the existing landfills, the landfill operations were carried out without determination of the final form and height of each landfill.

There was no criterion for determining until when the landfill operation could continue even about the Calle 100 landfill whose closure was drawing near,

It was necessary to clarify the final form of each landfill and calculate properly its remaining capacity and time so that new final landfills could be premeditatedly projected.

c. Insuffcinet comaction

In the existing landfills, the bulldozer(s) were only pushing and leveling the dumped waste and the compaction was not sufficiently conducted.

d. Insuffcinet coverage

In the Calle100 final disposal landfill, while the gas extraction area (about 20ha) was well covered with viscose soil, the other areas had a lot of discovered portions. The expert found the covering insufficient.

It was informed that the soil for the coverage was transported from a place 32 km away from the Calle 100 landfill. The amount of the supplied soil was not enough for covering.

3.2.2 Training plan

a. Actual status of training about final disposal landfill operation

The landfill operation was conducted based on each staff's accumulated experiences.

While DPSC in charge of investment didn't grasp the actual state of the landfill operation, the UPPH managers didn't have systematic knowledge about the functions of the landfills and the desirable operation method, which made it difficult to provide training to the staff.

b. Training material

There is a manual called "Methodological norms for the operation of the final disposal site in the Havana City."

This manual regulates:

- Requirements for the construction of final disposal sites (Issues to be determined, required documentation, location factor, structural standard, etc.)
- The final disposal site management method (Control of the waste transportation, control of landfilling operation, underground water monitoring, etc.)

The manual presents ideal conditions of the final disposal site to be projected and operated in future. However, the staff who worked at the actual sites didn't know even the existence of the manual. The contents should be amended to be more realistic and feasible so that they can utilize for the practical operations.

c. Training plan

It was essential that the persons in charge of final disposal site operation firstly understand the actual problematic situations and then learn how to improve them, so that they could provide practical and effective training to their workers.

The expert found their consciousness about the existing problems low. They seemed not to be so motivated to improve the situations.

The expert considered that such unawareness was produced by their ignorance of the desirable conditions of final disposal landfills, and on starting his activities he presented the C/P in charge of final disposal site operation the functions and control method of the final disposal landfills in Japan so that they could find practical ways to improve the actual situations by themselves.

As a result, the C/P took into account how to operate the final disposal landfill and how to improve the problematic conditions, and some workshops on these themes were planned to be held for the workers from the next visit.

The expert especially notes here that the C/P came to recognize that some of the presented operation methods should be implemented and some of the pointed items should be improved, and that these subjects were being practiced.

3.2.3 Training contents

a. Functions and structures of final disposal landfills

The expert explained the functions and structures of final disposal landfills to the C/P according to necessity.

b. How to control the landfill height

The experts explained that the landfill height could be controlled easily, using water hose or wooden post in form of dragonfly.

Photo 3-12: Height control with a wooden post

Photo 3-13: Level measurement with a water hose

c. Compaction

Compaction couldn't be sufficiently conducted by their conventional compaction method where the waste was only leveled out. The expert explained that the waste should be pushed against the slope to ensure sufficient compaction.

d. Waste leveling and compaction

Figure 3-4: Method of dropping down the waste

Figure 3-5: Method of pushing the waste upwards

There are two alternative ways for leveling and compaction of dumped waste, using bulldozer(s); method of dropping the waste towards the bottom of the slope and method of pushing the waste upwards against the slope.

When applying the method of dropping the waste towards the bottom of the slope, the waste layer can hardly be uniform with the thickness greater at the lower portion, where the waste cannot be compacted enough. Meanwhile, the application of the method of pushing the waste upwards allows the waste layer to be made uniform and easily compacted.

The important points on leveling and compaction are as follows:

- The thickness of the leveled waste must not be too great. For example, a heavy machine commonly used for land leveling can duly compact the earth when its thickness is around 30-50 cm.
- When leveling and compacting the waste, operate the machine as if it were slightly pushing up the slope so that the thickness of waste layer can be uniform as much as possible. It is desirable for the slope gradient to be 3:1 (about 20º).

- The thickness of a layer should be determined with the waste characteristics, the landfill form and how to use the closed landfill taken into account. In general, a thickness of less than 3 m is recommended.

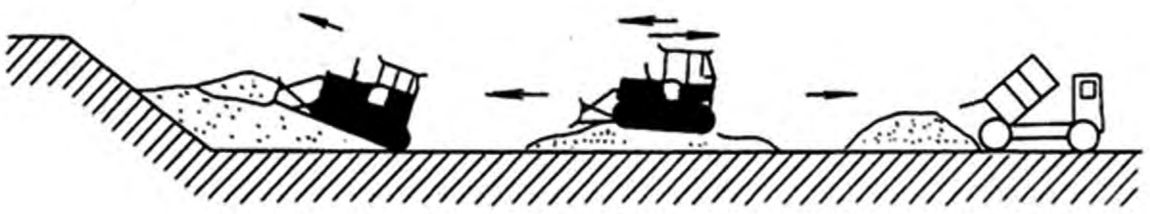


Figure 3-6: Concept of waste leveling and compaction

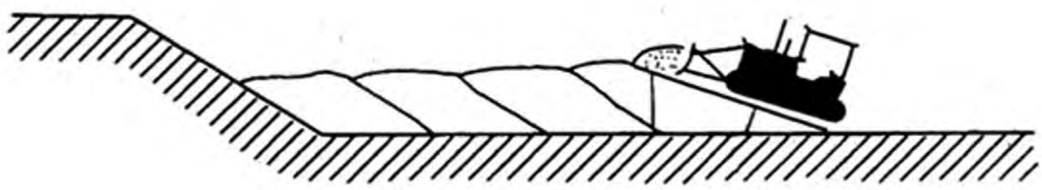


Figure 3-7: Concept of waste compaction while pushing it upwards

e. Lagoon location in the Calle 100 final disposal landfill

When the construction of the lagoon started in the Calle100 final disposal landfill, the waste accumulation at the area where the lagoon was projected had already reached 9 meters in height and its transportation was required.

Originally two lagoons were projected in the upstream site and the downstream site, but later the construction at the downstream was renounced due to a fuel pipe lying near the site.

Even though the actual site conditions were different from the original ones considered when the project plan had been prepared, the Cuban side was going to construct the lagoon at the upstream site, following the original plan.

The expert advised that the project should be revised before newly placing an order, in case of the prior conditions were changed.

f. Cause of fires at the Tatará final disposal landfill and countermeasures

Tatará final landfill is an old quarry where mainly organic waste is dumped.

Therefore, fermentation heat and methane gas generation are constantly observed.

A fire occurred during the development of the Project. The expert explained the cause of the fire and how to take countermeasure.

Photo 3-14: Smoke from the underground portion of the landfill

Cause of fires at the Tatará final disposal landfill and countermeasures

In the Tatará final disposal landfill organic waste such as pruned trunks and branches is disposed of. When huge amount of organic waste is accumulated, the waste can ignite spontaneously due to heat storage through fermentation or methane gas generated through organic waste decomposition process under anaerobic condition.

In the Tatará landfill where the waste is dropped towards the bottom of the old quarry and bulldozed, Oxygen is supplied into the waste layer through excavation. The spontaneous ignition was supposed to be caused by this air circulation in the waste deeper layer whose temperature has become quite high.

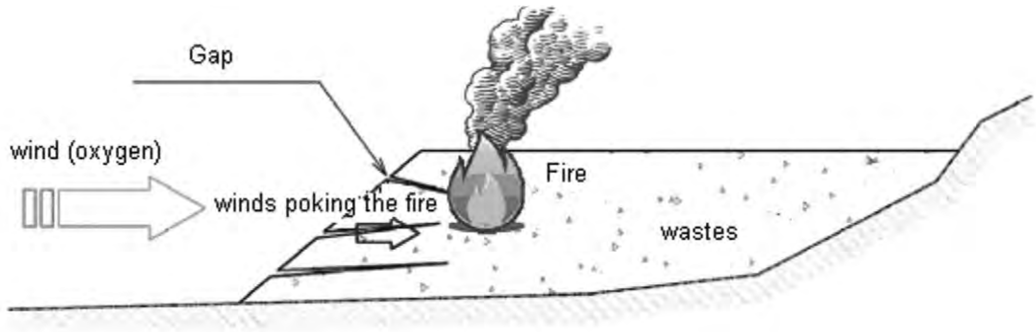
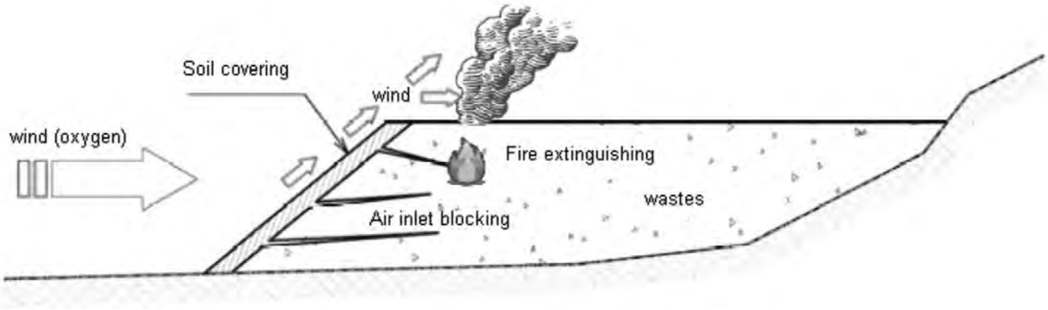


Image of glowing fire

It is effective to infill with the earth airspaces and fissures which are supposed to be air supply source in order to extinguish the fire.

As the combustion with little oxygen for a long time might have generated hollow portions in the layer, it is necessary to take measures, such as vigilance by guards and preparation of some escape routes, in order to ensure the safety for the operators and workers while they are working to cover the waste with the earth.



Example to extinguish a fire by covering with the earth

According to the experiences obtained at compost installations, organic waste is fermented with its temperature rising when the accumulation reaches 4 meters in height.

It is informed that the temperature inside of the landfill where organic waste is mainly disposed of rises above 80º. It is indispensable to conduct waste covering sufficiently, including intermediate covering, in order to prevent occurrence of fire.

3.2.4 Implemented and improved issues

a. Height measurement using GPS

It was told that the there was a regulation about the maximum height permitted for the Calle100 final disposal landfill, concretely 25 meters from the level of the highway, but nobody knew whether the height was practically regulated or not. Therefore, the expert asked the C/P to clarify the following points.

- The reason why the landfill height is regulated (from esthetic viewpoint or others?)
- Is the maximum height measured from the land level of the landfill or from the top of the highway?
- How long is the service period of the Calle100 landfill? (When does the new final disposal landfill start to serve?)

It is known that no more usage is allowed in the Zone 1 of the Calle 100 landfill, but it is not clear how the remaining capacities of the other zones are or how low the other zones are compared with the Zone 1.

As it was difficult to investigate topographically on all the vast are of the Calle 100 landfill, the C/P proposed the expert to conduct measurement of the heights at selected points from the sea level using a simple, which could be used to control daily operations also. The expert joined the measurement activity and advised about how to summarize the obtained data.

The persons in charge of the landfill operation had not recognized the importance of measuring the landfill heights and controlling the landfill amount until then, but the C/P came to spontaneously recognize the necessity to understand the actual conditions of the landfill and carry out the measurement, finding a measuring method by himself, which should be evaluated as a progress.

While the expert had accompanied to the C/P to measure the heights for 4 days, he indicated to the C/P what he had found concerning the dumping and compacting methods.

The expert considers the purpose of the measurement with simple GPS and its expected effect as follows.

Purpose of the measurement with simple GPS and its expected effect

In the existing landfills, the landfill operation is practically being conducted according to the easiness order in landfilling without information on the final form or the actual heights of each landfill.

While the operation is conducted based on the experiences of the site staffs, an ineffective control is observed, concretely, exceptional waste-dumping along the access road margins and the removal of such waste to proper area with heavy machine(s) in the following days, originated by the implementation of nighttime waste collection, urgent transportation of voluminous waste after the attack of a hurricane, access road inundation due to heavy rain.

The remaining area to be used in the Calle 100 landfill is being gradually reduced according to the extension of the gas extraction area promoted by the CDM project.

It is essential to understand the actual status of the Calle 100 landfill and to elaborate its usage plan in order to prolong its lifetime as long as possible, at least until new landfill(s) starts to serve.

The height at each measurement point with its coordinates is obtained through using simple GPS. However, the result of the measurement carried out in last June had not been utilized because no other information than the heights were not linked to the contour map.

Even though the persons responsible for the landfill management were insisting that the lifetime of the Calle 100 landfill was finishing, but they couldn't provide objective and numerical explanations for the condition that they had faced, for example, how many meters or how many cubic meters were left to close the landfill. Therefore, they delayed in responding to the urgent necessity in securing new landfill(s) and the possibility of raising the allowable maximum height of the landfill.

It is necessary to understand precisely the actual status of the landfill for better control which can facilitate projecting new landfill(s) and effective operation of the landfill.

On going back to Japan in last June, the expert was told that the C/P would present an operation plan elaborated based on the obtained data. However, the activity didn't develop because they couldn't get the geographically referred map as information base where all the data could be coordinated.

In this visit, when the expert was asked whether such map could be procured in Japan, he explained, knowing that such topological data were available in GEO-CUBA, that they themselves should make efforts to get the map because it was a map indispensable for the landfill control in Cuba, not required by us, Japanese side. Then, the C/P started to take action to obtain the map.

The expert considers it remarkable in Cuba where things tend to stagnate that they voluntarily took actions to obtain the data, recognizing its necessity.

Photo 3-15: Height measurement using simple GPS

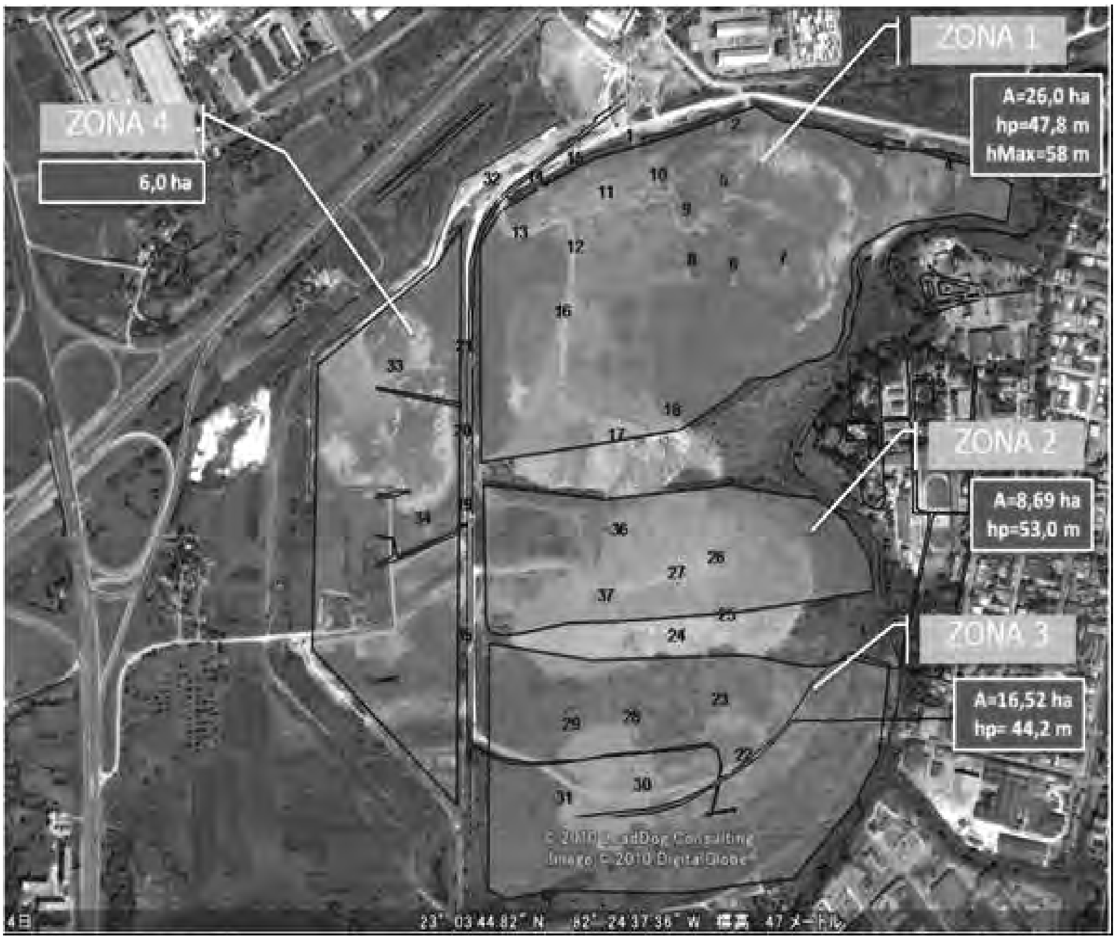


Figure 3-8: Result of the measurement of the heights from the sea level with simple GPS

b. Repair and arrangement of truck scale

The exert had heard that the truck scale installed in the Calle100 landfill had been repaired some times and even that the repair had been completed, but he could never confirmed that it was functioning during his stay.

A truck scale is being installed in the 8 vías final disposal landfill. The basement concrete was prepared as of 2 December 2012.

Photo 3-16: Indicator of the truck scale out of order, Calle100

Photo 3-17: Basement for truck scale, 8 vías

c. Relocation of lagoons in the Calle100 final disposal landfill

Originally two lagoons were planned to be constructed at the upstream and the downstream areas in the Calle100 final disposal landfill. However, the lagoon construction plan at the downstream was renounced, because a fuel pipe for the airport lies near the area, and a lagoon was to be constructed at the upstream area.

When the expert visited the site in February 2010 soon after the construction work had started, he saw the waste filling the area with height of more than 9 meters. Some old-type bulldozers were transporting the compacted waste of which excavation efficiency was low. The technical capacity was quite poor and the waste removal was going delayed.

The expert proposed to weight the advantages and disadvantages both of the cases, or the one of forwarding the construction plan at the upstream area and the other of changing the construction site to the downstream area, confirming the reason why the lagoon construction at the downstream area had been renounced.

When the expert visited the city in June 2010, the C/P side was intending to prepare alternative proposals to be presented to the government in two months while the construction work was suspended.

When visiting it again in October 2010, the expert was informed that the lagoon was to be constructed definitely at the downstream area and that the geological and land surveys had started.

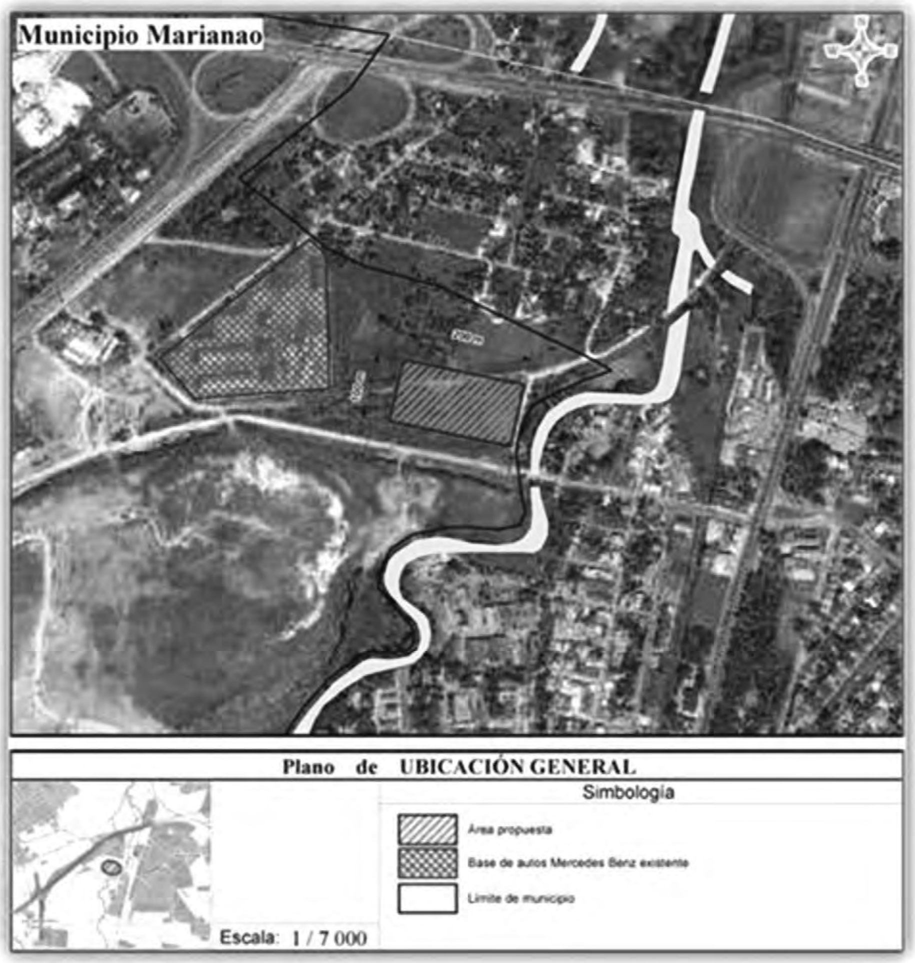


Photo 3-18: Revised construction site of lagoon in the Calle100 landfill

d. Project progress recognized by the C/P

Concerning the project progress related to 3.1 and 3.2, the following report was prepared by the C/P Mr. Pédro V. Péres.

Activities for the outcome of Group 4 on sanitary landfill design and final disposal site operation

In this period, we visited again the landfills Calle 100, 8 vías and Tarará.

The progress made in the Calle 100 landfill is as follows:

- Pavement of Heavy Machine Workshop
- Pavement of emergency access road
- Planning of oxidation lagoon
- Improvement on the truck scale
- Waiting area for staffs who participate in waste collection in the city
- Extension of degasification area

Survey on the used area of the final disposal landfill

Because of the new landfills in the city under study and construction, besides the overusage in the Calle 100 landfill, aiming at extend the lifetime of this landfill, it became necessary to survey the heights in the four zones. The purpose of this study was to understand the heights in the 36 points.

1. To know the current status of the land using a GPS.
2. To clarify the contour differences among the zones and to calculate the remaining service time until the landfill finally becomes a large plateau.

The following issues were confirmed through the visit with Expert Chiba to the Calle 100 landfill.

1. The access road leading to the usage area has considerably improved.
2. The usage area has been divided by area. The dumping areas for the specialized vehicles, dumping cars, and hose cars. They are guided by the persons who work in the landfill.
3. The distance of operation of bulldozer(s) (waste pushing and compaction) has been decreased approximately among 50 to 80 meters in line.
4. At the end of the shift, the daily waste covering is conducted with debris and soil.
5. When closing the used area, it is covered with soil.
6. We have no official data, but consider that these measures have reduced the entry and the exit of the vehicles approximately in 15 to 20 minutes per each.
7. The improvement of the roads has contributed to the reduction of the level of tire puncture in the landfill and breakage of leaf springs.
8. The inspectors of the DJP (provincial government) and the DNR (national police) stay permanently each day to reduce the level of presence of waste-pickers en the landfill.
9. 20 new degasifications wells were additionally constructed and installed, responding to starting of final covering of Zone 1 and of boring in Zone 2.
10. The construction work of oxidation lagoon will be carried out in the next year (beginning).1

    In the other landfills, namely 8 vías and Tarará, the work has been progressing. We expect that better results can be obtained in the next year.

3.3 Advices about project of new final disposal landfill

The design of a new final disposal landfill in Guanabacoa and its access road construction work had been suspended due to a mistake made during the budget approval process.

When visiting the city in October 2010, the expert was informed that the budget had been officially approved but its practical meaning was that it had been approved to divert the budget for the Calle 100 lagoon construction for the above-mentioned purposes.

DCH is in charge of designing the new landfill in Guanabacoa. As it took a long time for the budget to be approved, to determine the contents of the work and to conclude a contract, the expert's activities on this subject were limited to some discussions about what they had done during his absence and how the design concept should be and he couldn't give concrete advices about their designs.

3.3.1 Actual status of the new final disposal landfill project

a. Status of the access road construction

The access road construction has hardly progressed since February 2010 when the expert visited the site.

The expert was explained that explosives necessary to explode the exposed rock area had not been permitted to be used because of consecutive visits of important persons to Havana City. There has been no progress over the several months after such consecutive visits of important persons.

It was informed that the rock area was explored once during his absence and the crashed rocks flew to drop on the roof of a neighbor's house, damaging it. The capacity of the constructor seems no to be so high.

Then, the construction work was suspended and when visiting the site again in November 2010 the expert found the condition of the access road deteriorated compared with the condition observed in last February 2010 due to the erosion caused by the precipitation during these several months.

Photo 3-19: 10 May 2010

Photo 3-20: 2 December 2010

b. Concerns about the project scheme

The new final disposal landfill was being designed, through projecting a receptacle for landfill in the determined area.

The DCH engineers in charge of designing the new landfill thought that UPPH in charge of the landfill operation should determine the final form of the landfill and how to use the constructed landfill.

Therefore, they didn't take into account the landfill capacity, the final form and the order of landfilling, which were the most fundamental to landfill design.

Besides, the coordination with a lagoon, a recycle plant and an administration office to be constructed in the same area was not sufficiently conducted.

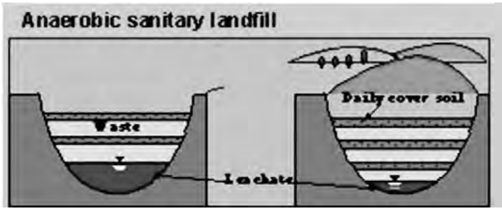
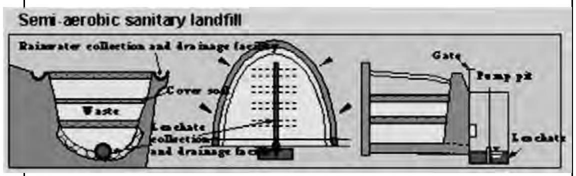
3.3.2 Advices provided

a. Determination of the concept

For the new final disposal landfill, the semi-aerobic structure with pipes used for degasification as well as for leachate collection and drainage lying was applied. However, an installation for methane gas collection related to anaerobic system was also planned in the project, which conflicted with the concept of the semi-aerobic landfill structure because this is the system to reduce methane gas generation.

Besides explaining the above-mentioned issues, the expert advised to confirm the possibility of extending the construction area because the lagoon would require more area.

Table 3-1: Semi-aerobic landfill and anaerobic landfill

	Semi-aerobic landfill	Anaerobic landfill
Image		
Characteristic of leachate	The concentrations of BOD and COD are kept high for a long time.	The concentrations of BOD and COD reduce more promptly than in the anaerobic landfill.

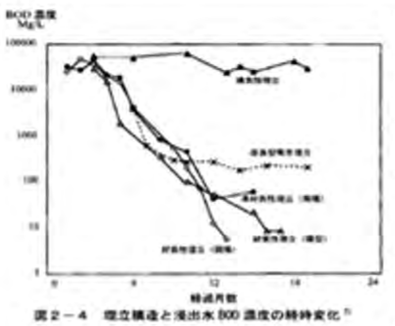


図2−4 埋立構造と浸出水BOD濃度の経時変化


表2−2 埋立構造と浸出水の水質

項目		埋立継続時	埋立終了6ヶ月後	埋立終了1年後	埋立終了2年後
嫌気性埋立	BOD (mg/L)	40,000 ~ 50,000	40,000 ~ 50,000	30,000 ~ 40,000	10,000 ~ 20,000
	COD* (mg/L)	40,000 ~ 50,000	40,000 ~ 50,000	30,000 ~ 40,000	20,000 ~ 30,000
	NH_3−N (mg/L)	800 ~ 1,000	1,000	800	600
	pH	6.0前後	6.0前後	6.0前後	6.0前後
	透視度	0.9 ~ 1.0	1 ~ 2	2 ~ 3	2 ~ 3
改良型衛生埋立	BOD (mg/L)	40,000 ~ 55,000	7,000 ~ 8,000	300	200 ~ 33
	COD* (mg/L)	40,000 ~ 50,000	10,000 ~ 20,000	1,000 ~ 2,000	1,000 ~ 2,000
	NH_3−N (mg/L)	800 ~ 1,000	800	500 ~ 600	500 ~ 600
	pH	6.0前後	7.0前後	7.0 ~ 7.5	7.0 ~ 7.5
	透視度	0.9 ~ 1.0	1 ~ 2	1.5 ~ 2.0	1 ~ 2
準好気性埋立	BOD (mg/L)	40,000 ~ 50,000	5,000 ~ 6,000	100 ~ 200	50
	COD* (mg/L)	40,000 ~ 50,000	10,000	1,000 ~ 2,000	1,000
	NH_3−N (mg/L)	800 ~ 1,000	500	100 ~ 200	100
	pH	6.0前後	8.0前後	7.5前後	7.0 ~ 8.0
	透視度	0.9 ~ 1.0	1 ~ 2	3 ~ 4	5 ~ 6
好気性埋立	BOD (mg/L)	40,000 ~ 50,000	200 ~ 300	50	10
	COD* (mg/L)	40,000 ~ 50,000	2,000	1,000	**
	NH_3−N (mg/L)	800 ~ 1,000	50	10	1 ~ 2
	pH	6.0前後	8.5前後	7 ~ 8	8.5前後
	透視度	0.9 ~ 1.0	6 ~ 7	2 ~ 3	2 ~ 5

*$K_2Cr_2O_7$法で分析

Leachate treatment in oxidation lagoon	The lagoon requires larger area to treat leachate because of the bad quality of leachate.	Leachate can be treated in a smaller lagoon, compared with a lagoon in anaerobic landfill.
Waste stabilization	It takes time to decompose organic waste.	Decomposition of organic waste is comparatively rapid.
Methane gas generation	Much methane gas is generated.	The amount of methane gas generated is small.
Possibility of fire	The degasification plant should be kept controlled because the concentration of methane gas generated is high enough for combustion or explosion.	When operating the landfill appropriately, the possibility of fire is low.

b. Determination of the final form of the landfill

While the required capacity of the new landfill in Guanabacoa is for 25 years, its final form wasn't presented in the design. What they designed was a landfill before starting operation. Considering the daily amount of the waste transported informed by UPPH, the expert explained that the height would reach above 100 meters and that a landfill should be designed with the landfill order as well as the final form determined.

c. Basic knowledge of landfill

The expert intended to give the basic knowledge about landfills, as a part of the activities being developed from last February. He presented various Photo of the sanitary landfills in Japan and explained what points we should take into account to respond to each topographical condition and to protect the impermeable sheets in designing a landfill.

d. Recycle plant capacity

A recycle plant where raw materials are to be manually selected is projected inside of the new landfill site. Checking the planned number of the staff in charge of manual selection, the expert worried about that they might have overestimated the capacities of the staff.

Therefore, he made a comment as follows.

Recycle plant planned in the sanitary landfill in Guanabacoa

In the recycle plant planned in the new landfill in Guanabacoa, the raw materials are selected by picking them up manually from the unclassified waste which flows through a conveyor.

The efficiency of the selection of the raw material with conveyor is better than the selection conducted in the landfill site, but the capacity is limited, compared with the mechanical selection.

In the plan projected by DCH, there are 22 posts in total for picking up the materials on both the sides of a conveyor installed in the center of the floor.

La capacity of manual selection varies depending on the types of raw materials as well as on the accuracy required in the selection. In case of Japan, the capacity of a recycle plant where 24 selectors classify manually raw materials is about 26 tons per day (working for 5 hours).

What they do in this plant is to remove any foreign materials from the raw materials brought to the plant, already classified according to the type of materials such as glass, cans and pet bottles. The capacity of the plant in Guanabacoa is considered less than the capacity of this plant.

According to the given information, the plant is to receive 200 tons of waste unclassified per shift of 8 hours for the raw material selection, in other word, 600 tons per day with 3 shifts. Taking into account the data of the plant capacity in Japan above-mentioned, the expert worries about that the capacity of the plant in Guanabacoa may have been overestimated.

He understands that the plant is projected at a limited land and that it is difficult to increase the number of selectors and of operation lines. Taking them into account, he still would like to advice to study the plan again, checking if it is feasible to pick up raw materials from 600 tons of waste per day.

e. Participation in meetings with the design company

The expert confirmed the progress of the landfill design, listening to the designers of DHC in charge of the landfill project.

Although the designers firstly insisted that they were in charge of the design to construct the landfill before starting service and that DPSC and UPPH were responsible for the landfill operation, the expert explained the necessity to determine its final form at the time of designing the landfill.

Additionally the expert advised and explained concerning the following issues.

- Construction site of the leachate treatment plant
- Traffic line on the access road
- How to ensure the impermeability of the enclosing banks
- Earth impermeable structure using clay
- Examples of sanitary landfill constructions and structures

Figure 3-9: Discussion with designers at the construction site

f. Participation in meetings with access road constructors

The access road construction started but was suspended because of the difficulty in excavating the exposed rock area.

The constructor insisted that they had planned to explode the rock area but the usage of explosives was not permitted because of some foreign important persons visiting to Cuba. However, even when there was no such visit, the construction hardly progressed. Their technical capacity was low and when they exploded the area once, they damaged the roof of a neighbor's house with crashed stones.

The exposed rock area is being eroded. The expert considers that a heavy machine such as concrete breaker can work handling the hardness of the area.

As it is necessary to excavate the old quarry when constructing the landfill itself, the designers should design the project, taking in account the constructor's technical capacity and availability of heavy machines in Cuba.

Figure 3-10: Meeting with access road constructor on the site

3.3.3 Design modifications conducted during this period

The followings are the design modifications confirmed during this period.

a. Decrease of the number of cells to elevate efficiency

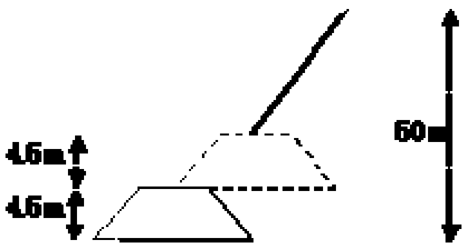
As the number of trenches was decreased from 6 to 4, the amount of the earth to be removed to construct enclosing bank was reduced, resulting in the increase of the total capacity of the landfill and the construction cost reduction.

b. Revision of the function of inner roads

Although some inner roads were originally planned to be prepared for a cell, the modification was conducted to prepare inner road(s) that could respond to the functions of the peripheral road used to control the site as well as the access road.

c. Enclosing bank

It was originally planned to construct a high enclosing bank at the first stage of the construction, but the construction was divided in two stages to reduce the amount of the earth: an enclosing bank is to be constructed at the first stage and another bank at the second stage after the waste height reaches the top of the first bank.



d. Consideration for the final form of the landfill

Although any concrete plan was presented during this period, the designers said that they were designing the landfill, taking in account its final form.

e. Coordination with recycle plant

Although two access roads were originally projected for the landfill and for the recycle plant, a connecting road between them and the revision of the plant distribution are now under study, responding to an operational requirement, concretely the common use of a truck scale.

4 Activities for the 3rd phase

Activity period: May 15th– June 21st, 2011 and October 2nd – October 28th, 2011

4.1 Improvements of the final disposal sites

4.1.1 Improvements observed

a. Calle 100

An entry/exit control of collection vehicles has been improved at Calle 100 landfill and the measure has been firmly established.

Separation of entry and exit of collection vehicles (October, 2011)

Resting place for collectors (October, 2011)

Photo 4-1: Control of entry and exit

In this landfill, the separation of entry and exit path of the collection vehicles has been firmly established after the installation of a control barrier and the expansion of the paved surface in the exit path. It is also observed that the collectors use the resting area.

Inspectors check solid waste transported by vehicles (October 2010)

Inspection of solid waste in damping area (October 2010)

Photo 4-2: Waste Inspection

Standing around the weighbridges, which are inoperable, the inspectors check collection vehicles and talk with their drivers to verify the type of waste transported and the same inspection is also done in the damping area.

b. Expansion of methane gas extraction area (Clean Development Mechanism (CDM) Project in collaboration between France, Chile and Cuba)

Soil coverage around the wells to extract methane gas in the CDM project (May, 2011)

Photo 4-3 Expansion of methane gas extraction area

Due to increase in methane gas extracting area where wells have been installed and surface covered by clay soil, the area occupied by the waste without soil covering has been reduced, however, the potential damping area has been reduced, too.

It is necessary to keep operating the Calle 100 landfill until the new one of Guanabacoa will put into operation. Therefore, it is necessary to make an effective coordination between the CDM project and waste disposal operation at the Calle 100 Landfill.

c. Strengthening a communication network and fire control measures

Previously, it was not possible control the fire occurred during the night until the next day, however, a communication mechanism was established with the existing landfill managers and their staff, and they were also instructed to give priority to use a cover material and fuel in case of fire. However, concrete measures to control fire have not yet been verified by the Japanese expert.

d. Increase of road width of access route to the Ocho Vias Landfill (paving, drainage near the entrance and the weighbridge foundation)

Image of access route to Ocho Vias landfill (May, 2011)

Image of access route after raining (October, 2011)

Photo 4-4 Access route to Ocho Vias

The access route to Ocho Vias landfill has been widened and paved, but due to constant rainfalls in October 2011, the water accumulation did not allow collection vehicles to enter into a damping area. Consequently there were few days an entry of collection vehicles was not permitted completely. We were explained that this measure had been notified to the competent authorities, but not to the collector vehicles. Since they were not allowed to enter, neither could take the waste to other landfills, some trucks got to discharge its waste around the landfill entrance, violating the rules and the accumulation of solid waste was very high.

A fuel is provided to operate heavy machineries, but not in an enough quantity and they cannot clean the area immediately. Seeing the waste accumulated, the collection vehicles continue discharging at an access road to the landfill, letting the area remains messy, thus falling into a vicious cycle.

Base for weighbridge (May, 2011)

Office for control of weighbridge (October, 2011)

Photo 4-5 Wastes disposed of near the base for weighbridge to be constructed

There is waste dumped around the base of weighbridges under construction, so there is a risk that it would be damaged by cleaning with heavy equipment.

e. Improvement of dumping methods at Tarara landfill

Situation of damping area (October, 2011)

Situation of damping area slope (October, 2011)

Photo 4-6 Situation of damping area (October, 2011)

After the expert pointed out the need to use heavy machineries to extinguish fires, they began to be sent periodically to the landfill. This also helped to improve the damping area conditions, reducing its slope.

When we visited the landfill in October 2011, despite unfavorable conditions after raining constantly nearly for a week, it was observed that the damping area has been maintained in acceptable conditions and had advanced the process of forming a gentle slope. The volume of waste disposal has increased temporarily due to the arrival of vehicles that discharge normally at Ocho Vias landfill where it had banned the reception of wastes because of bad weather. It was also observed the presence of non-compacted waste. It is hoped that the situation will be improved if they have an enough fuel distribution.

4.1.2 Improvements observed (by Cuban counterpart)

Although efforts are made to improve the final disposal sites of Calle 100, Ocho Vias and Tarara, they have not been reflected in a real situation. It was verified during the visits made by the Japanese expert and Cuban counterpart, being identified the following situations:

- The pathways to final disposal sites are impaired.
- In the Ocho Vias landfill, it has not yet been organized a rotation system to separate a operation of damping process, collection of raw materials, waste compacting and soil covering. The expert also suggested introducing the same method for the disposal of animal-drawn carts, and neither has been achieved. We believe that this method should be implemented in Calle 100 landfill, too. These existing final disposal sites currently show the deficiency in compaction and soil covering because of the following reasons:
  - Rupture of heavy machineries periodically.
  - Lack of fuel. When we visited on October 18th, Ocho Vias and Tarara landfills, these machineries were stopped due to lack of fuel.

It is important to mention that the Ocho Vias landfill had to be closed temporarily at 10 am on the day we visited because collection vehicles discharged wastes on the road leading to the damping area. There were wastes accumulated around the ground foundation of weighbridge and there is a danger to be damaged when they begin to clean the area with heavy equipment.

The access routes to the existing final disposal sites are very deteriorated.
Soil compaction is not sufficient because the bulldozer is necessary for soil leveling and only works when the operator has some spare time.

There is a Chinese compaction machine at Ocho Vias landfill, which has worked only few times and has been considered useless.

Soil covering is also insufficient and there is no material stocked on site for this purpose.
Countermeasures:

- Guarantee that all of the heavy machineries of Ocho Vias landfill will be repaired or substituted by the others transferred from other landfills.
- Procure a stable supply of fuel for proper operation of the landfills.
- Provide protection equipment for the landfill workers.
- Prepare rotation system for damping, raw materials collection, compaction and soil covering, both for Compactor Garbage Truck and for and collection for animal-drawn carts rotation as indicated in the previous report.

4.2 Mid-term evaluation and countermeasures

4.2.1 Results of mid-term evaluation

Mid-term evaluation of the project was conducted from 3rd to 7th of October, 2011 and the degree of achievement of the Output 4 was qualified as "there is some difficulty to improve the capacity of the design and management of final disposal sites during a project period as determined ".

In the first half of the project, the activities related to Output 4 have been implemented successfully as planned, however, a certain weakness has been noticed in term of human resources sustainability because some Cuban counterparts have quitted their job and had left the project. To achieve the desired results, one of the main challenges is the training of new counterparts.

On the other hand, the Cuban side requested an extension of Japanese expert in order to continue technical assistance related to design and management of final disposal sites.

4.2.2 Countermeasures (by Japanese expert)

One of the reasons to qualify as mentioned above is a weakness in human resource sustainability due to resignation of the previous counterparts.

The new counterpart assigned to the expert has few knowledge or experience of management of final disposal, however, he has an extensive working record and capacity to manage development projects in other fields and shows a high willingness and responsibility to work in this new field for him. We expect he will obtain rapidly all specific knowledge needed in each field and understand the needs of final disposal sites, in order to overcome a loss of previous counterparts over a relatively short period of time.

a. Management of final disposal sites

Replacing Mr. Pedro Pérez who resigned, Mr. Lazaro Sotolongo was assigned as a counterpart to be in charge of waste final disposal management at the Project. Mr. Sotolongo has been involved in construction works of the new landfill project and will be its administrator. He lives around the entrance to the landfill and therefore, as a local resident, more than anybody else, he wishes that the new landfill would be handled properly. He can follow an entire process of construction works and can understand the structure of the landfill from the beginning. However, in-depth training would be required before attempting to manage the new landfill and to complete lack of practical experience.

b. Guidance on the new landfill project

Replacing Mr.Gianni Ponce, Mr. Ernesto Dominguez was assigned as a counterpart to Group 4. Recently Ms. Gretel Gutiérrez (hydraulic engineering) was assigned to strengthen the area of leachate treatment which had been delayed. The Cuban side assigned two skilled technicians to complete a loss caused by the resignation of Mr. Gianne, a young technician who worked as a local counterpart.

Since construction began on the new landfill, the Cuban side hired IPROYAZ to supervise and to manage the project by their own efforts, as well as to follow design changes and other modifications during a construction process. IPROYAZ has extensive experience in the design and supervision of large-scale construction projects.

The design has been completed almost entirely, except for the leachate treatment system. From now on, it is important to follow design changes according to the needs of the project.

Mr. Ernesto Dominguez and Ms. Gretel Gutierrez joined the Group 4 after almost all design modifications have been completed. As they have not been involved from the beginning, perhaps the experience they could gain through this new landfill project may not be utilized efficiently, more training will be required to elevate their capacity so that they could supervise this kind of project by themselves.

4.2.3 Countermeasures (by Cuban counterpart)

The mid-term evaluation signed and approved on October 5th by the joint evaluation team determines that the activities related to the Output # 4 has been implemented under the plan, although it raises concerns regarding the sustainability of human resources due to the resignation of 2 of the 3 counterparts who had been working with Japanese expert to achieve this output; the fact lead to consider that a technical transfer from Japanese expert to them became a loss for the project.

Concerning the 2 indicators to assess an achievement of the Output # 4, in case of the indicator 4-1, an increase to 14 points to evaluate landfill operation will ensure more clarity in the guideline and the operation thereof. In case of the indicator 4-2, during this period 7 changes have been made to the design of the East Landfill. To ensure the objectives of the Expected Output # 4, it is proposed to implement the following countermeasures:

- Indicator 4-1
  - Release drastic control or limitation of the entry of collection vehicles to the landfill.
  - Complete the installation of equipment for heavy equipment workshop and provide staff training on effective use of these facilities.
- Indicator 4-2
  - Assign 2 counterparts to replace those who quit the project. This measure was fulfilled when Mr. Lazaro Sotolongo was assigned for Mr. Pedro Perez and Ms. Gutierrez Grettel, for Mr. Gianni Ponce.
  - Increase a number of the counterparts of this Group to 4 in total, in order to assign 2 counterparts for each indicator.
  - Request the extension of Japanese expert with the objectives of continuing training and technical assistance to the Cuban counterparts, guidance on the construction of the East Landfill and a design of other planned disposal site in West Havana projected from next year.

4.3 Training on the operations of disposal sites

4.3.1 Summary of the activities implemented from May 15 to June 21, 2011

- The expert gave technical guidance to the Cuban counterparts about a control of the entry of collection vehicles to the final disposal sites, soil compaction and covering, methods of control of the height of the landfilling layers, construction of internal access roads, etc.
- The biggest problem is the chronic shortage of all types of resources such as personnel, fuel, heavy machineries, measuring equipments, etc.
- The provision of these resources can be improved if they could persuade the Investment Department about the effects or benefits to be obtained by providing them timely.
- Japanese expert tried to provide technical materials describing the most important aspects of each operation. (For example, Why soil compaction is necessary for landfilling? What are the effects of compaction?)
- One of the counterparts (Mr. Pedro Perez) took a long vacation in the second half of this period to take care of his mother who had come from Costa Rica, for this reason it was not possible to provide a technical training satisfactorily.

4.3.2 Summary of the activities implemented from 2nd al 28th of October, 2011

The expert gave an intensive orientation to Mr. Lazaro Sotolongo, who replaced Mr. Pedro Perez, in relation with basic landfill structure and management concepts, using the technical materials that developed or used in training seminars and guidance for previous counterparts. It was intended to spend as much time as possible for this type of training to the new counterpart, who was very interested in acquiring the necessary knowledge and came almost every day to the project office in the DPSC project for advice and training.

Japanese expert and Sotolongo visited the existing landfills to verify a situation of operation and management of each landfill and identify problems and pending tasks.

4.3.3 Manual on waste final disposal sites.

The expert asked the Cuban counterparts to develop a manual about basic landfill operation and to be used for training workers in the existing landfills, for which the counterparts would be instructors.

One of the counterparts prepared by himself, a simple manual, providing his own technical views and information extracted from the "Manual of Calle 100 Landfill" prepared by a short-term expert of JICA in 2007.

As the beginning, the expert instructed that the manual should reflect the current operation of existing landfills and should serve as a tool for workers training, having the counterparts as instructors. It was also asked to focus on the aspects that could be improved by training local workers.

4.4 Guidance on new landfill Project

4.4.1 Progress

A construction of access road to new landfill had begun before the project started and there have been delays, but it is almost entirely completed.

Image of May, 2010

Image of May, 2011

Photo 4-7 Access route to New Landfill

General plan of works was completed, except the electrical plan and drawings of weighbridges and the leachate treatment plant.

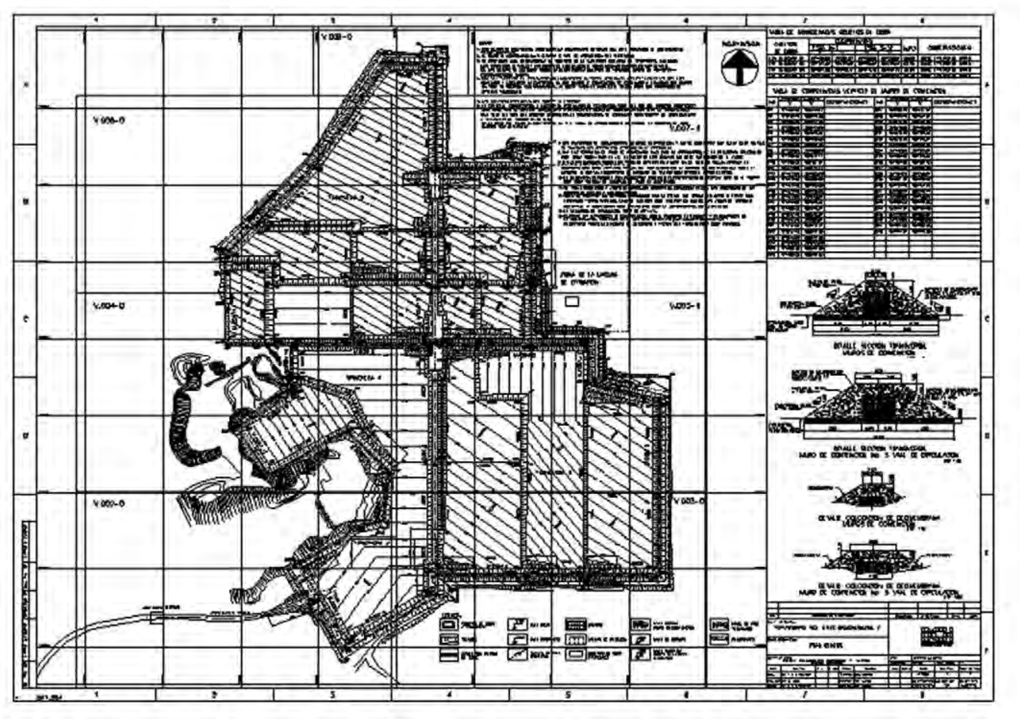


Figure 4-1 General plan of the Project

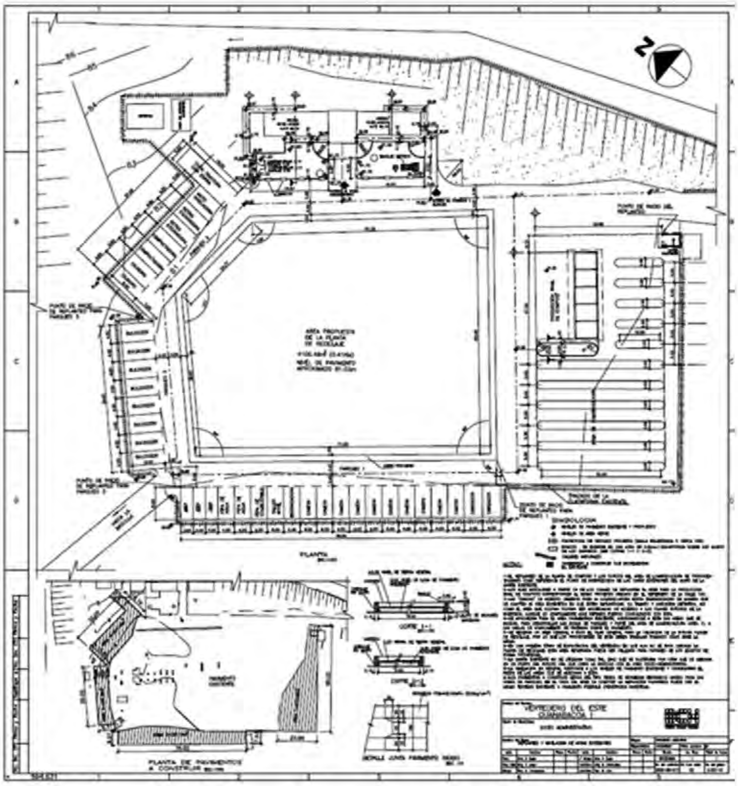


Figure 4-2 Drawing of recycle plant, administrative office and compost yard

Block drawings were also completed.

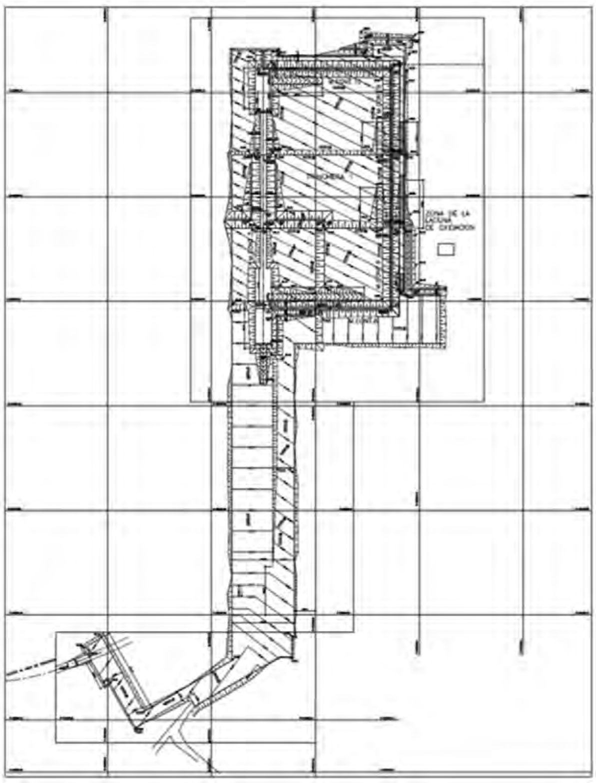


Figure 4-3 General drawing of block

A constructor was hired to carry out a works for block No.1 and they began the works. The construction was suspended for the modification of the coordinates and the study of trees located in the zone and was re-initiated by the retaining walls foundation works.

Landfill access route works explanation (October, 2011)

Retaining wall construction explanation (October, 2011)

Photo 4-8 Nueva Guanabacoa works in progress

For the supervision of works, the DPSC hired a local company that has experience in landfill design.

This year the budget was allocated for the construction of the leachate treatment plant and it was expected that since April 2011, EIPHH (water resources), which is responsible for the design, would begin to work on the detailed design, however, they didn't do it because they have been so busy with other works. When the expert was in Cuba in June 2011, the EIPHH committed to have the design ready until September 2011, it was not confirmed the product neither the progress of the design.

With respect to the construction of the oxidation pond at Calle 100 landfill, it was found that the ground for this work interfered railway project, therefore, the necessary procedures have been taken to modify the original design. EIPHH is also responsible for this process and has not advanced nothing like the design of the oxidation pond.

4.4.2 Instructions during the time that the expert was out of Cuba

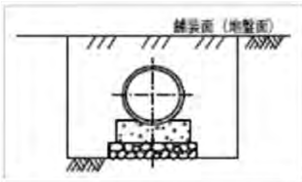
After the expert returned to Japan, through JICA coordinator for cooperation with Cuba, via Email, Japanese expert received in January 2011, the conceptual design of the new landfill project developed by the DCH for the purpose of technical review. The expert checked and emailed the results of the review as shown below.

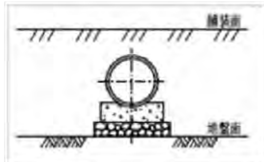
When the expert returned to Cuba in May 2011, he had to explain again to the Cuban side, the points described in the technical instruction mentioned above. It was verified that the Cuban side had not implemented any specific change in the plans during the time that the expert was out of the country. This experience implied how difficult is to give guidance only by mail or otherwise in writing. It requires more personal guidance through dialogue in which the expert can answer the concerns of the Cuban side one by one.

Calculation of the Structure for the Leachate Collection and Drainage Pipe

With regard to the calculation of the structure for the buried pipe, there are some calculation methods established depending on the conditions in which the pipe is buried (ditch type, elevation type, etc.)

A condition in between the ditch type and the elevation type is used to design the installation of the leachate pipe, taking into account collection efficiency and air access into the waste layers.





Ditch Type Elevation Type

The ditch type is used to prevent soil settlement due to friction generated between the pipe wall and the surrounding soil. The pressure exerted on the pipe by the soil is reduced. The elevation type, on the contrary, is affected by friction caused by soil settlement on both sides of the pipe. Consequently, it undergoes a greater pressure than just the pressure exerted by the weight of the solid wastes dumped on the upper side of the pipe.

In order to prevent the leachate pipe holes from closing and to increase collection efficiency and air supply, paving stones or other filtering materials should be used. By covering the area surrounding the pipe with a high-compaction filtering material, to counteract the pipe deformation a horizontal force and a perpendicular force in relation to the pipe position will be generated to help preserve the balance of the forces and to withstand the pipe deformation.

The conventional design of buried pipes in Japan is not the most suitable one when the waste layer height reaches 50 m. According to the calculation, the standard synthetic resin pipe (high-density polyethylene pipe) will not withstand the load.

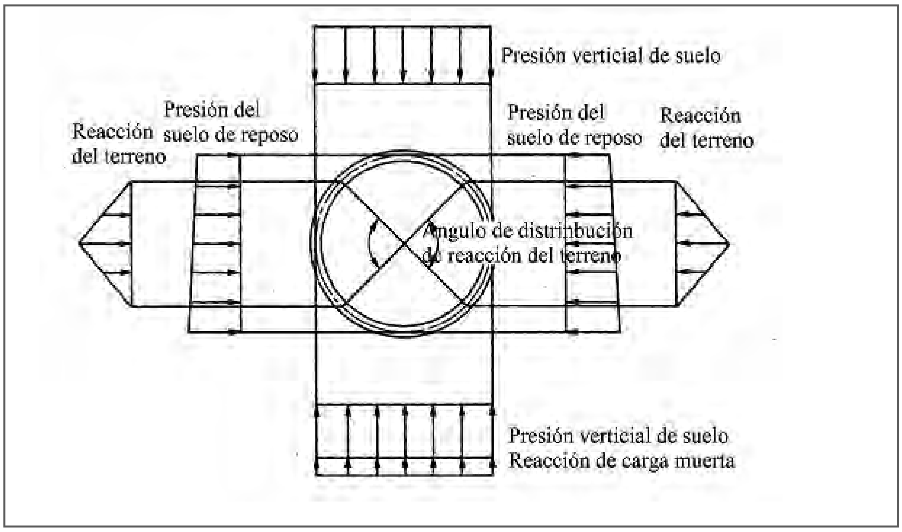
However, in practice there are certainly many sanitary landfill sites whose height exceeds 50 m. Even with a conventional design, if a pipe resistant enough to withstand the pressure exerted by waste layers exceeding 15 m is used, it is possible to keep the buried pipe despite its bending.

Nevertheless, in this case some filterable materials such as paving stones and macadam, which are resistant to compaction, are required to avoid too high a load provoked by the pressure exerted by the wastes on only one of the sides of the buried pipe.

Lateral Pressure (Pressure exerted by the solid wastes)

If the pipe is buried in a ditch by appropriately compacting the cover soil, the pipe will withstand not only the lateral pressure exerted by the soil, but also two horizontal forces, namely, the pressure exerted by the settling soil, and the ground reaction generated by the pipe deformation, as shown in Figure II-20. These two external forces prevent the pipe deformation caused by the lateral pressure exerted by the soil by reducing the bending moment exerted over the pipe.

Regarding rigid pipes buried not so deeply, when calculating their resistance a method to calculate the bending moment taking into account the lateral pressure and the supporting conditions is generally used. However, it does not take into consideration the horizontal external force. In the case of leachate collection and drainage pipes usually buried deeply, if the horizontal force is ignored, the calculated bending moment is often extremely big, thus rendering the design excessive. Consequently, the horizontal load should be taken into account to calculate pipe resistance under actual conditions.



Modelo de la carga que actúa a la tubería enterrada

Example of Pressure Exerted over the Buried Pipe

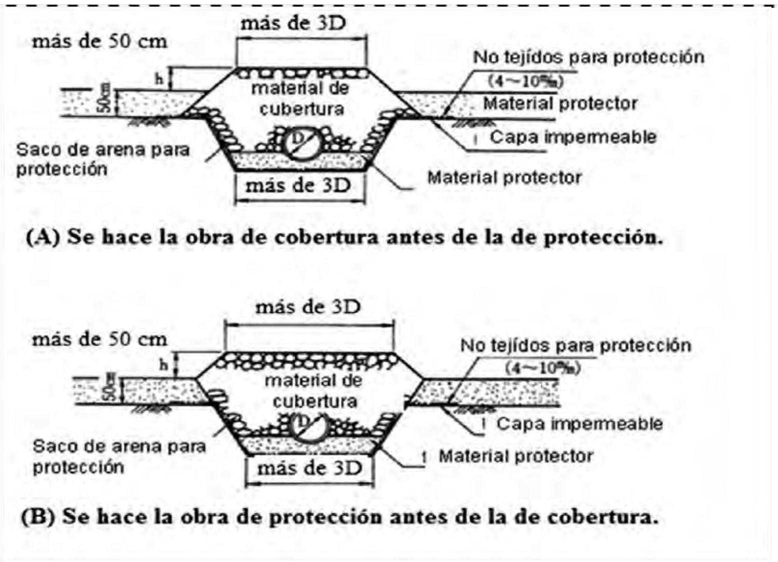


Figure 4-4 Example of Structure of Leachate Collection and Drainage Pipe Installed at the Landfill Bottom

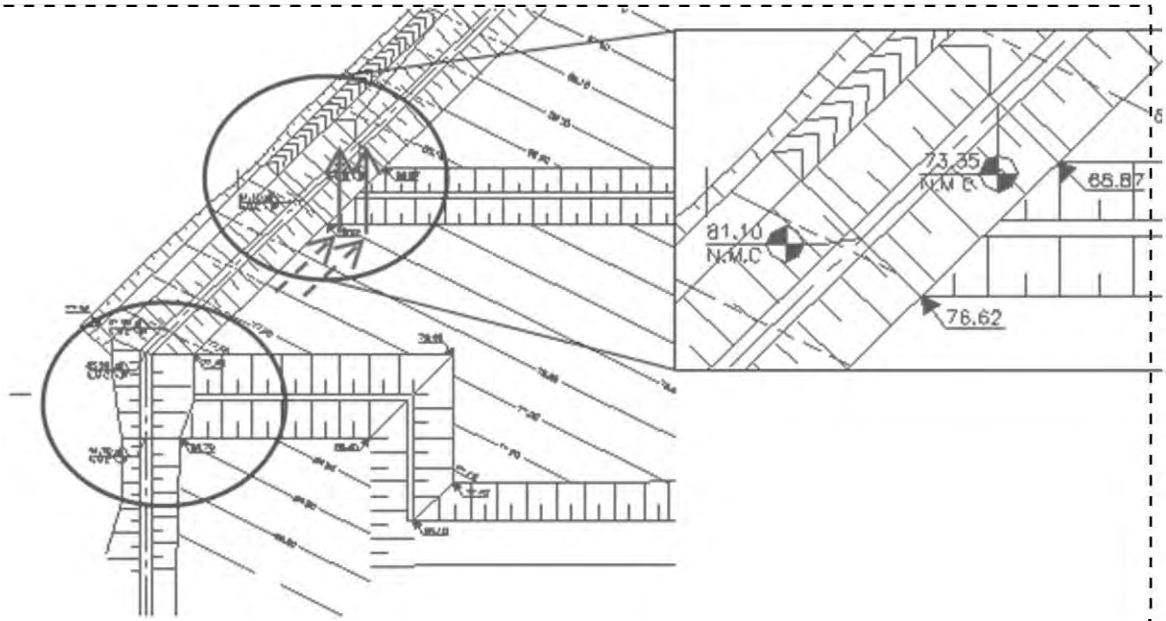
Comments on the Plans for Guanabacoa Landfill Site drawn by DCH

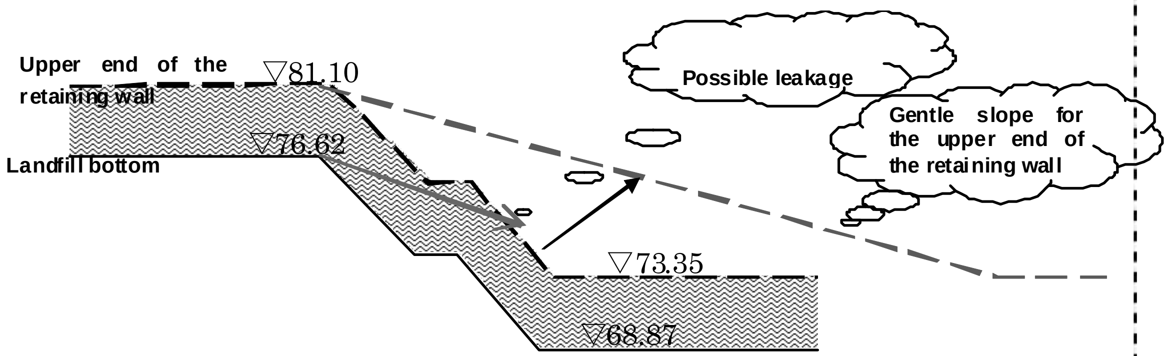
- The final shape of the landfill site is not clear. (It is impossible to tell whether the necessary capacity is ensured or not.)
- Was the order for landfilling works in all the trenches considered? How are the internal access roads managed to fill the trenches up to the ultimate level? Can wastes continue to be transported to reach the design height? ※For trucks to be able to climb the waste layer height of 50 m, a linear distance of around 420 m with a slope of 12% is required.
- The shape of the retaining wall in the area where there is a difference in level.

As shown in the figure below, in some areas there is a difference in level. The upper end of the retaining wall of the lower step is lower than the bottom of the upper step.

Water flowing down the surface may be stopped by the retaining wall prior to the beginning of landfill site operations. However, when the trench is being filled with wastes, the water level may exceed the retaining wall.

As a countermeasure, the wall height will be modified to make it higher than the leachate infiltration level.





Recycling plant and composting yard

By checking existing plans, it is evident that designers wanted to make the most of the flat area according to the ground conditions. However, the scale and the necessary area for every facility should be considered to confirm whether they may all be located on the site available.

Pumping Stations

Regarding the pumping station for leachate, the design includes a facility built on top of the pump. I imagine that it was intended to watch over and check the pump. However, I believe it to be excessive. As toxic gases such as methane, carbon monoxide and sulphuric hydrogen are generated in the leachate collection pit, the risks will increase if the work is carried out in an enclosed space.

4.4.3 Activities implemented from May 15 to June 21, 2011.

- Gianni Ponce, one of the counterparts of the DPSC, resigned for personal reasons and Ernesto Dominguez (thermodynamic and nuclear engineer) was assigned as the new counterpart for Group 4.

- The expert gave technical guidance to Mr. Dominguez.
- It was explained that the material to be used as core of the retaining wall (Rajón) only could be obtained in a quarry located about 70 km from the construction site. Reducing the cost of construction is the biggest challenge we face today.
- No method is defined to design leachate collection pipes that could resist the load of the filling layers that will reach a height of 50 m. This was indicated as critical concern on the general plan of the new landfill. The expert asked to meet with DCH to confirm the parameters used in the design, but it was not possible to coordinate the meeting during the stay of the expert.
- The methods of acquisition and placement of geomembrane liners still is pending. (This work is not included in the contracted works so far.)
- The design of the leachate treatment plant was considered the most high priority to receive technical assistance from the Japanese expert, but due to delays in the delivery of the design by the responsible water company, it have not been possible to provide concrete technical guidance during his stay in Cuba.

4.4.4 Summary of the activities implemented from 2nd to 28th of October, 2011

- Mr. Pedro Perez was the counterpart of the operation and management of landfills, but he quit his job at UPPH and Mr. Lazaro Sotolongo joined the team as a new counterpart. He will be manager of the new landfill of Guanabacoa after getting into operation.
- There were meetings with Cuban counterparts every Tuesday.
- The expert attended the meetings held every Wednesday to discuss the progress of the new landfill project.
- IPYOYAZ proposed using local soil obtained as product of excavation works at the project site for construction of retaining wall and tried to verify if the soil meet the technical requirements by the CBR test, which is normally used to assess the level of resistance of the subgrade material for a road project.

The expert suggested a triaxial compaction test in order to obtain an angle of internal friction (φ) and cohesion (C) to calculate soil stability against circular slip.

Discussion on the design with the assistance of representatives of YPROYAZ, DCH and DPSC.

Photo 4-9 Discussion on the design

- A technical guidance was provided by the Japanese expert to the engineers of IPROYAZ in relation with a design and construction of final disposal sites.
- A technical guidance also was provided to Sotolongo based on the management of existing landfills and controlled landfill with environmental concerns.

4.4.5 Training on the operation and management of final disposal sites (By counterpart)

In order to ensure necessary training to Cuban counterpart, it is indispensable to implement a series of measures in order to obtain optimum results from their training.

- Prepare a manual on the main activities of landfill works for the training of local staff. The manual has been already prepared.
- Coordinate training courses to be implemented at the first quarter of next year (2012) for local staff of the existing landfills.
- Coordinate training courses on abroad for the Cuban counterparts for their specialization on the landfill operation.

4.5 Manual for Sanitary Landfill Operations (Draft)(by C/P)

The main items to be included in the plan for the operation of a sanitary landfill site should at least cover the following activities:

- Access control and weighbridge operation.
- Waste dumping methods.
- Waste covering.
- Compaction.
- Fire control.

4.5.1 Access Control and Weighbridge Operation

The checkpoint and the weighbridge are the first stage of sanitary landfill operations to:

- Detect prohibited solid wastes.
- Control traffic.
- Communicate with the driver.
- Determine the amount of waste transported to the landfill site
- Keep records of the vehicles going in and out of the landfill site and any other relevant data.

Sanitary landfill sites should be equipped with a weighbridge to know the amount of solid wastes entering the site aiming at setting up certain parameters necessary for operation monitoring and it is indispensable that sanitary landfills should be equipped with weighing system, because it is necessary to know incoming solid waste quantity in order to establish operation control parameters, as well as to fix tariff and charges.

The weighbridge operator will record relevant vehicle data, weigh the truck, enter its tare (if known), provide receipts and/or weighing documents, and weigh the truck again after waste unloading to know the amount of waste transported.

a. Forbidden Solid Waste Detection

As it is impossible to segregate the solid wastes being transported by collection vehicles at the landfill site entrance, they should then be checked at the dumping area. Other vehicles, especially those whose origin is unknown, should be inspected at the entrance as they are likely to bring prohibited solid wastes.

It is recommended that the lists of prohibited wastes are updated periodically. The staff at the checkpoint and at the dumping areas, as well as truck drivers, should be provided with updated lists so that they may be aware of the wastes that must not enter the site. Direct waste inspection helps the truck driver be more careful about the wastes he carries, thus minimizing the chances of unauthorized wastes from entering the landfill site.

b. Traffic Control

Landfill sites have several operation areas. The areas occasionally depend on the type of vehicles, whether they are equipped with automatic unloading or not. At some landfill sites, the kind of waste, e.g. garden wastes, determines the dumping area. It is a common operation practice at most landfill sites to frequently change the dumping areas based on weather conditions and other factors. Moreover, the staff deployed at the access gate or the weighbridge operator should guide the truck drivers in order to facilitate operations and prevent confusions.

c. Communication with the Truck Driver

The majority of the operations at the checkpoint and the weighbridge depend on the communication with the truck drivers. The drivers coming for the first time will need some help to get to the dumping area and to know existing regulations, landfill operations, payment systems, etc. Unknown vehicles should be checked to avoid regulation infringement. Their drivers should provide information related to the kind of wastes they carry. The cargo should be checked here to approve access. The same applies for hospital wastes.

The checkpoint is the place where direct communication with the site users takes place. Relations should be kind and polite. However, the driver should be made aware of the fact that there are regulations and procedures he must comply with. They should know that their only right is the dumping of previously authorized wastes and that they should absolutely comply with existing requirements and regulations.

d. Determine the amount of waste transported to the landfill site

Monitoring of plans, budgets, and costs requires detailed and accurate records. The weight of the solid wastes transported to the landfill site is the most important statistics. All the estimation related to costs and efficiency is based on recorded weight. The nominal volume of the collection vehicle is negligible to estimate relevant costs, operation efficiency, expected service life, and other important parameters. The control staff in charge should generally record information related to the following:

e. Vehicles going in and out of the landfill site

All landfill site records are kept either at the checkpoint or in the weighing area. This may vary depending on the landfill site. The first duty of the checkpoint is to record vehicle entrance and departure. If possible, the time of arrival and the time of departure should be recorded.

In large landfill sites such as the one in Calle 100, it is particularly important to know that there are no vehicles inside the landfill site by closing time. Keeping records about the time spent to check each vehicle may be useful to improve operation efficiency.

The weight of the vehicles accessing the landfill site is the most important statistic. All estimation related to costs and efficiency such as operation efficiency, expected service life, and other important parameters, is based on recorded weight.

The control staff should generally record the following:

- Vehicle identification.
- Gross weight of the vehicle.
- Tare (either by weighing the vehicle or based on existing records).
- Time and date of arrival and departure.
- Kind of waste (household, industrial, hospital wastes, etc.).
- Weight of the covering material brought.
- Any other special information.

These data should be summarized on a daily basis. Weekly, monthly, or yearly reports are required. The routine review of these records statistically may help landfill operators improve planning and implement any necessary adjustments.

4.5.2 Disposal Methods

The daily cell is the primary constructive element in any sanitary landfill site. Solid wastes are spread and compacted in layers within a perfectly defined area and up to a certain volume. By the end of every operation day, the area filled with compacted wastes is covered using a thin layer of soil, which is later compacted. Thus, a cell is shaped with the wastes compacted and covered daily with soil.

When the wastes are confined into a cell, the chances that they catch fire are minimized. In case a fire breaks out anyway, it does not spread easily. Harmful animals such as mice and flies find it hard to access the wastes for food or shelter. Moreover, the amount of materials exposed to the elements is reduced, thus minimizing the scattering of wastes, microorganisms and dust, mitigating foul odors and leachate generation, and facilitating gas emission control.

a. Cell Construction

A cell is built by compacting the wastes along a slope in successive layers having the same thickness. Wastes are dumped at the foot of the working face and pushed over the slope. The appropriate steps for cell construction are listed below:

- Dump solid wastes over the area to be used as the working face for the day.
- Use leveling stakes to control the height of the cell and to shape the appropriate slope to facilitate drainage by gravity. The upper surface sloping of the cell should be 2 to 5%, whereas the height of the cell is commonly about 2.4 to 3.5 meters.
- The cell dimensions can be consulted in the landfill plan. These dimensions should correspond to the volume of the wastes compacted by the end of a work day. However, if for some reason the dimensions for the cell are not known, or if they need to be modified, some useful recommendations are the following:
    - The width of the working area depends on the number of collection vehicles carrying wastes to the operation area and the number of heavy equipment available to spread and compact them. For safety reasons, the width of the working face will not be reduced to less than three times the width of the shovel of the heavy machinery used and it should not exceed 45 meters as a wider working face is more difficult to handle unless the equipment available is enough and the operations are strictly supervised. With regard to the appropriate height for the cell, there are no rules. However, some designers prefer a height of 2.5 meters or less, presumably because with such a height no serious settlement problems will occur.
- Density recommended for solid wastes in a finished cell is around 800 Kg/m^3.
- Spread the solid wastes along the working face in layers 0.30 to 0.60 m thick.
- Compact the solid wastes by compacting the wastes over the slope at least 4 times.
- Once the wastes dumped for the day are compacted, the soil for daily covering is dumped over them.
- Spread and compact covering material by keeping a minimum thickness of 15 cm. Depending on the type of soil from which the material was taken, its thickness may be increased. For example, loose materials such as sand may get into the empty spaces of the wastes. So, if wastes are not correctly compacted, more covering material will be needed.

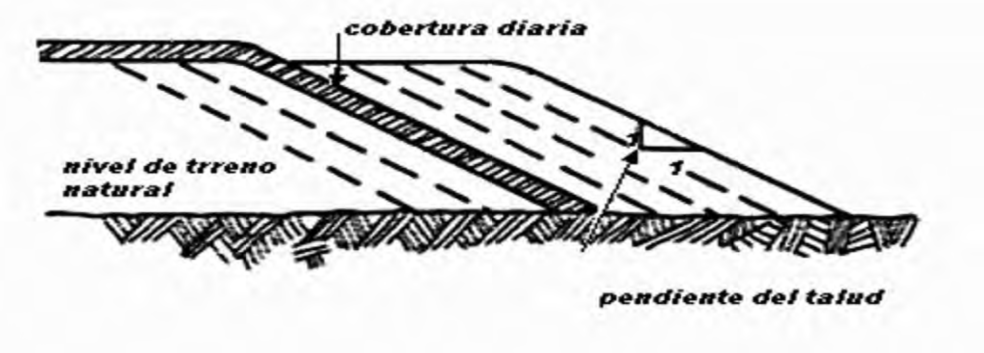
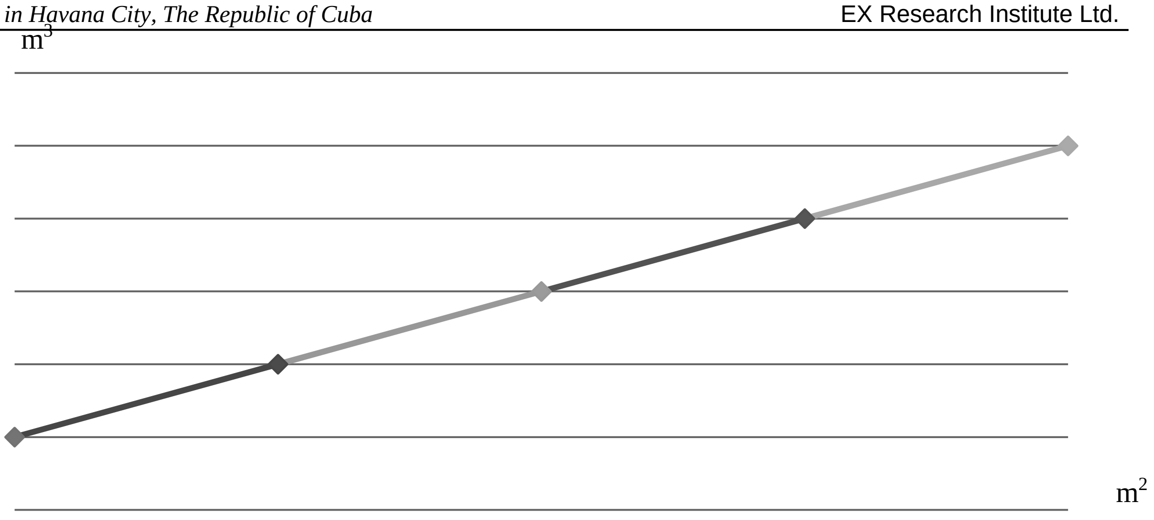


Figure 4-5 Daily Covering



Note: The Y axis shows the covering material required (in m^3), whereas the X axis shows the area covered (in m^2) using the amounts corresponding to the Y axis.

Figure 4-6 Amount of Daily Covering

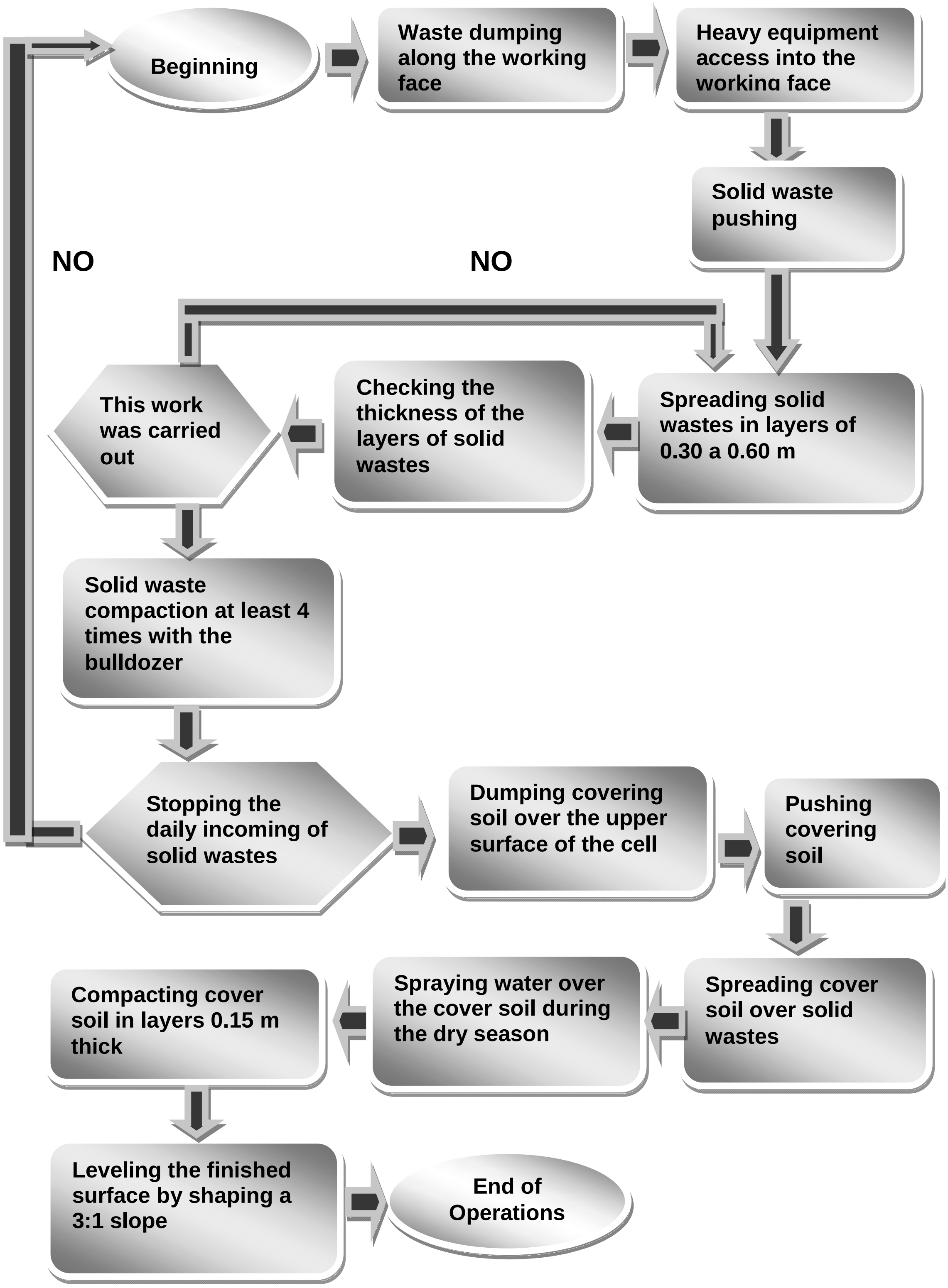


Figure 4-7 Daily Cell Construction

4.5.3 Covering

The surface surrounding the finished daily cell, which will be exposed to the elements for over a week until a new cell is built on top, will be impacted by weather conditions and possibly by vehicles going through. These surfaces are normally covered with a layer of compacted soil 0.30 m thick. This layer is known as the intermediate cover and it is used to protect the daily cover and to prevent water infiltration into the landfill for an extended period.

To shape the intermediate cover, the following should be carried out:

- Once a surface has been filled, over which solid wastes are not expected to be dumped for a long time, the material to shape the intermediate cover will be dumped over the daily cover.
- Covering material is spread and compacted by keeping a minimum thickness of 30 cm.

When the landfill has reached the desired level, a final cover at least 60 cm thick should be used to allow some light traffic and to help prevent rain from infiltrating into the confined wastes.

Once an area or the whole landfill area is finished, the material to be used as final cover will be dumped over the area in question. Later, the cover material will be spread and compacted by keeping a minimum thickness of 30 cm. Later, the cover material will be spread and compacted to get a minimum thickness of 60 cm.

4.5.4 Compaction

Compaction requires full attention due to its impact in the short and long terms on the landfill operation, the speed and extension of settlements, and mainly on the landfill capacity.

The number of times the bulldozer has to be used to achieve proper compaction depends on several factors, the most important ones being the weight and type of the heavy equipment, the moisture content and the waste composition.

The degree of waste compaction depends on the pressure exerted upon them. The thinner the waste layer, the more waste compaction is achieved.

4.5.5 Fire Control

Fires bring about safety problems, affect air quality, and damage property. In a landfill site, a fire may be difficult to locate as they sometimes break out inside the cells and the smoke follows the easiest way out, not precisely above its location.

Fires can be controlled as follows:

- Effective waste compaction to reduce empty spaces and air access.
- Daily waste covering.
- Appropriate cover soil compaction.
- In case a fire breaks out, attempt to put it out by restricting oxygen access. This may generally be achieved by covering the area with enough soil. Water is not recommended.

Biogas generation may also provoke fires and explosions. Therefore, it should be extracted by means of the following techniques:

- Containment: Waterproof barriers are installed around the landfill site to facilitate preparation for biogas extraction and collection.
- Passive ventilation: Trenches filled with granulated material such as gravel are dug around the landfill site. The cells are thus surrounded by a high-permeability area allowing gas to be collected.

4.5.6 Recommended Operation Procedures

A number of recommendations to be implemented for appropriate landfill site operations are shown below:

- The working face should be as narrow as possible.
- Keep a separation of 2.5 to 3.0 m between the compaction equipment and the collection or transfer vehicles.
- All the wastes received at the landfill site should be disposed of within 48 hours.
- The wastes should be treated immediately after being dumped in the working face. They must not be left to pile up or shaped only once or twice a day.
- In order to make good use of the landfill capacity, the wastes should be dumped at the base of the cell or disposal ramp and be treated there to help reduce the chances of paper scattering due to the wind, achieve maximum compaction, and improve waste control. Another advantage is that when wastes are dumped in a limited area, the amount of cover soil required is also reduced.
- Wastes should be spread along the surface of the working face in layers of 30 to 60 cm thick.
- Wastes must never be dumped in the working face of those areas where digging is being carried out.
- The wastes spread along the working face should be compacted according to the compaction requirements established in the operation plan. Generally, heavy equipment should move at least 4 times over the wastes to achieve enough compaction if some equipment of steel rollers or caterpillars is used.
- Wastes are handled efficiently if they are spread over a 3:1 slope using crawler-type equipment. However, some excellent results can be achieved on flat surfaces if some wheel-type equipment is used. By shaping a slope having a certain gradient, cover soil to be used is reduced, as well as the time spent for waste spreading and compaction. However, if there is an excessive gradient in the slopes (slopes over 3:1), compaction is reduced.
- Cover soil should be moistened only during the dry season to achieve appropriate compaction and to prevent the material from being spread by the wind. Water used should not be excessive to avoid clogging and/or trickling affecting the cover soil, thus generating some operational problems.
- Storm water should be removed from the filled surfaces within 72 hours.

- When it rains hard over the working face, accumulated storm water should be pumped out prior to waste dumping.
- Any holes emerging on the finished areas should be filled as soon as possible to prevent storm water from accumulating there, thus minimizing the chances of rain infiltration into the lower layers.
- In case hospital and industrial wastes are received at the landfill site, they should be separately disposed of. They must never be disposed of together with the rest of the wastes.

5 Activities of the 4th phase

Activity period: April 6 to April 27, 2013

5.1 Plan of Activities of the Japanese Expert

5.1.1 Plan of Activities during the Expert's Assignment in Cuba (Prepared by the C/P and the Japanese Expert)

As the plan of activities and the advice requested by the Cuban side during the Japanese expert's previous assignment in Cuba had been uncertain, and owing to the fact that only a few days had been planned, before leaving the country I asked the C/P members to decide the plan for my following assignment.

Consequently, the C/P staff prepared the plan of activities to cover the Japanese expert's three-week stay in Havana and we discussed it during our first meeting.

Even though they assured me that the planned meetings had been confirmed, they had certainly not made the necessary arrangements with the parties concerned as shown in the Plan of Activities. Therefore, they modified the plan a few days before and the meetings were eventually held. Regarding the issues to be discussed and the agencies to be visited, however, it should be noted that they tried to stick to the existing plan at all costs, so I can figure out that it worked as a way to somehow have control over the working process.

It is desirable that this way to monitor the working process should be used to compare the plan with the actual situation, as well as to eventually realize the planned assignment in case of delays. However, it should be taken into account the fact that in Cuba some external factors such as an unexpected meeting, the weather conditions, or the lack of transportation may dramatically affect the planned activities. The Cuban side feels powerless to have control over the working process, so some efforts need to be constantly made to improve the current situation.

SUB DIRECCIÓN PROVINCIAL DE INVERSIONES Y DESARROLLO
SERVICIOS COMUNALES LA HABANA
Calle 180 No. 116 e/ 1ra y 5ta, Playa
Teléfonos: Pizarra 2720694 y 2720695

ELABORADO POR: ERNESTO DOMINGUEZ GLEZ
ESPECIALISTA

PLAN DE TRABAJO MENSUAL **ABRIL - 2013**

LUNES 1	MARTES 2	MIERCOLES 3	JUEVES 4	VIERNES 5	SABADO 6	DOMINGO 7
					Llegada a Cuba	
LUNES 8	**MARTES 9**	**MIERCOLES 10**	**JUEVES 11**	**VIERNES 12**	**SABADO 13**	**DOMINGO 14**
>Análisis individual del estudio de factibilidad de Guanabacoa	>Análisis individual del estudio de factibilidad de Guanabacoa	>11,00am, Análisis colectivo con especialistas de la VDID sobre el estudio de factibilidad de Guanabacoa	>Revisión del proyecto de explotación de Guanabacoa	>Revisión del proyecto de explotación >11,00am, Análisis con proyectistas de DCH sobre proyecto de explotación		
LUNES 15	**MARTES 16**	**MIERCOLES 17**	**JUEVES 18**	**VIERNES 19**	**SABADO 20**	**DOMINGO 21**
>Visita a Calle 100. >Encuentro con autoridades e inversionistas de la DPPH.	>Revisión de la modificación de la 1ra etapa de Guanabacoa, Área de tricheras	> Revisión de la modificación de la 1ra etapa de Guanabacoa, Área de sistema de lagunas tratamiento de aguas residuales	> Análisis con proyectistas de DCH y INRH sobre la modificación de la 1ra etapa de Guanabacoa	>Recorrido por 8 Vias, Guanabacoa, yTarará		
LUNES 22	**MARTES 23**	**MIERCOLES 24**	**JUEVES 25**	**VIERNES 26**	**SABADO 27**	**DOMINGO 28**
>Revisión del proyecto de drenaje pluvial de Guanabacoa	>Revisión del proyecto de drenaje pluvial de Guanabacoa	>Encuentro con proyectistas de DCH sobre proyecto de drenaje pluvial de Guanabacoa	>Recorrido por 8 Vias, Guanabacoa, Tarará y Calle 100	>Reunión con el grupo IV del proyecto para intercambio y dar orientaciones para la próxima visita del experto.	Regreso al Japón	

Figure 5-1: Work Plan

5.2 Improvement of Final Disposal Sites

5.2.1 Improved Situation during the Japanese Expert's Assignment (Prepared by the Expert)

a. Calle 100 landfill site

With regard to Calle 100 landfill site, the weighbridge became operational as from November, 2012, using some of the parts previously planned to be installed at Ocho Vías landfill site, and it has remained so up to the present (April, 2013).

Compactor trucks have been identified, including license and registration. Some data such as the weight per vehicle and truck arrival and departure times have also been recorded.

Photo 5-1: Calle 100 Weighbridge

The landfill site has a new manager now. However, the way to monitor the access roads and the dumping area has remained unaltered.

On March 31, 2013, prior to the arrival of the Japanese expert, a rather large fire broke out at the site due to the strong winds. It was put out on April 6, 2013. The site staff are well aware of the need for slope shaping, waste covering with soil, and a fire extinction system.

For methane gas extraction, filled trenches continue to be dug out. Decomposed sandy wastes are used as surrogate for soil and organic wastes are dumped into the dug trenches. It has been reported that the areas currently used for methane extraction have not increased.

Waste dumping area

Re-excavation of trenches

Photo 5-2: Calle 100

b. Ocho Vías landfill site

The manager of Ocho Vías landfill site was replaced six months ago. The new manager, Mr. Luis Chang, was involved in the closure of the so-called Special Period Landfill Sites in the year 2011, so he is well aware of the need for waste compaction and covering with soil. He pointed out that the site has dramatically polluted ground water, so it has to be closed. However, the actual situation is unknown.

There has been some progress regarding the works required to install the weighbridge. The foundations have been already laid. However, due to the use of some of its parts for the installation of the weighbridge at Calle 100 landfill site, it is not known when the works will be resumed. The works are likely to become worthless as Ocho Vías site is expected to be closed eventually.

A new final disposal site to be used once the site is closed down has not been secured yet. Consequently, I pointed out that the covering of currently exposed wastes, the shaping of slopes, and the compaction and covering of wastes using soil may help reduce the pollutant load.

Uncovered wastes

Ramón (center), Luis Chang (right)

Photo 5-3: Ocho Vias

c. Tarará landfill site

Mr. Omar has been the manager of both Campo Florido and Tarará landfill sites since the beginning of the Project. During my visit to the site, I could verify that waste compaction and covering with soil is being carried out satisfactorily.

With regard to the construction of the fence to prevent trespassing, a 12-meter stretch out of the pending 30 meters has been completed at the back of the site where open dumping was carried out at the beginning of the project.

Landfill operations extend up to the point where the land is level after the slope gradient was reduced to make it accessible for heavy equipment.

The life service of the landfill site is expected to be 2-3 years judging from the height of the access roads and the nearby houses.

Fence to prevent trespassing

Current situation

Photo 5-4: Tarara

d. Campo Florido landfill site

After the staff forbade scavengers from entering the site, they destroyed the entrance hut, thus making it useless.

The wastes piled up around the hut. It was difficult for the compactor trucks to access the site as the wastes were dumped along the access road. Waste compaction and covering with soil is carried out once a month using the heavy equipment owned by Tarará landfill site. Therefore, it is difficult to tackle any contingencies that may arise.

Most wastes are taken to the site using horse-driven carts. Waste volume has decreased. The site condition has not changed significantly since the beginning of the project.

Destroyed hut and wastes dumped near the site entrance

Current site condition

Photo 5-5: Campo Florido

5.3 Capacity Building on Management of Final Disposal Sites

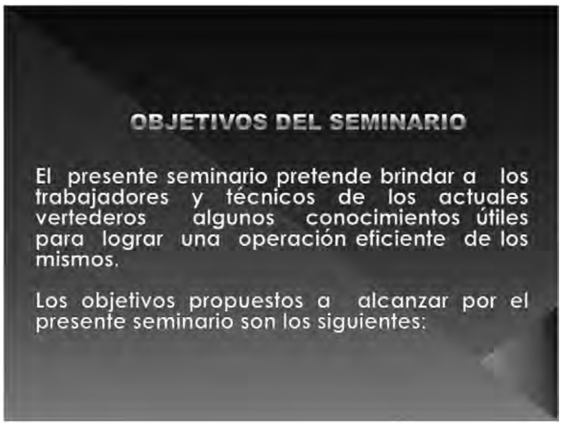
5.3.1 Training of Landfill Site Staff

The implementation of training on management and monitoring of final disposal sites was a pending issue. A week before the arrival of the Japanese expert, on 4 April 2013 a seminar on the subject was held at Calle 100 landfill site for the relevant staff. The seminar was planned and carried out by the C/P staff. Ernesto Domínguez, a C/P member, organized the seminar and acted as lecturer. It was attended by managers and workers from the final disposal sites and it dealt with the operation of landfill sites. A PowerPoint presentation was prepared to be used at the seminar. As the participants found it instructive, it is recommended that it should be held again in the future.

Mr. Ernesto Domínguez, a C/P member, lecturing at the seminar

Participants at the seminar

Photo 5-6: Training of Landfill Site Staff



Some of the PowerPoint files used at the Seminar

Figure 5-2: Seminar Presentation

5.3.2 6.3.2 Landfill Site Operation Manual

The existing operation manual is lacking in specific information. Therefore, it should be improved by including practical knowledge. The present manual does not include specific information about the landfill operation. Consequently, we have prepared a more basic, practical manual.

5.4 Landfill Site Operation Manual (by the Japanese expert)

Landfill Site Operation Manual

Landfill Plan

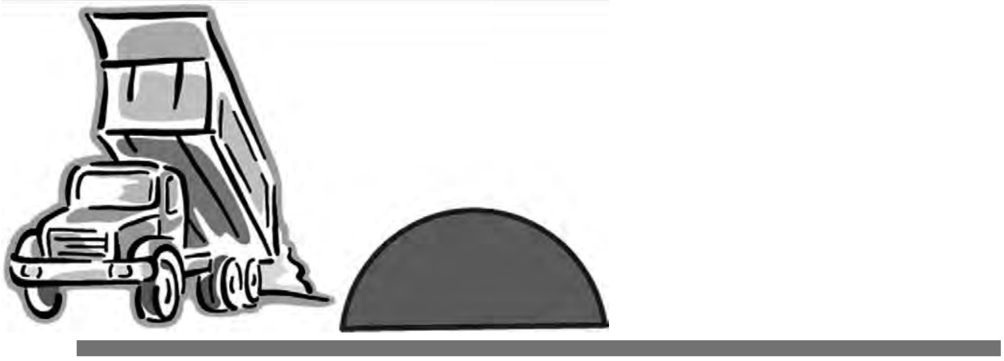
- Data collection
  - Identification of yearly waste volume and composition.
  - Daily waste volume, number of waste collection vehicles, number (volume) of collection vehicles entering the site every hour.
  - Assumed landfill volume.
  - Assumed volume of cover soil depending on waste volume.
  - Working hours for heavy equipment ⇒Assumed fuel consumption
- Landfill Method Selection
  - Select (i) Pushing down the wastes, (ii) Pushing up the wastes depending on land characteristics.
  - Pushing down the wastes is a widely accepted method. For waste compaction, the push-up method is better. Fuel consumption is higher however. In addition, drivers dislike it as the working face is filled with wastes and it may crumble sometime near them.
  - Plan for waste covering with soil.
- Landfill Site Plan
  - Show landfill site area (and height) on the plan by months and years.
  - Circulation lines along the access roads.
  - Location of the cover soil deposit.
- Construction Work Plan
  - Construction of access roads
  - Gas extraction pipes
  - Measures to deal with leachate
- Daily Work Plan
  - Guides
  - Heavy equipment operators
  - Recording and monitoring
- Others

Landfill Site Operation

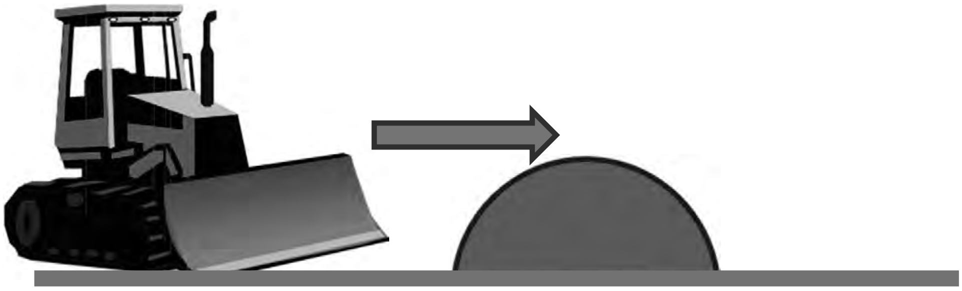
In order to increase density, the wastes are not tipped using the controlled open dumping method. A pre-treatment process is required before dumping.

Prior to reaching the dumping area, the wastes should be tipped in a nearby place.

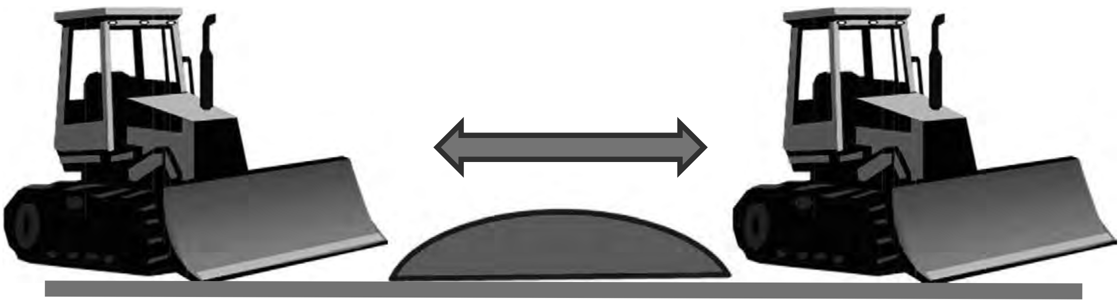
They should be spread and compacted several times using a bulldozer to crush and contract them, thus reducing the empty spaces and increasing waste density



- Dump the wastes before reaching the landfill area.

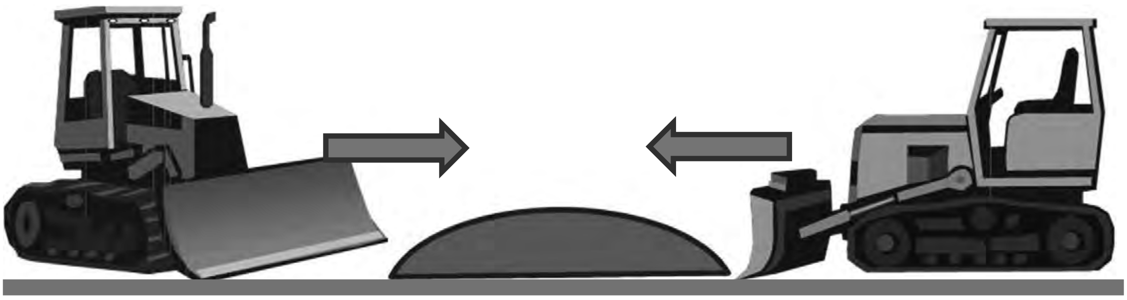


- Spread the piled-up wastes using the bulldozer blade.

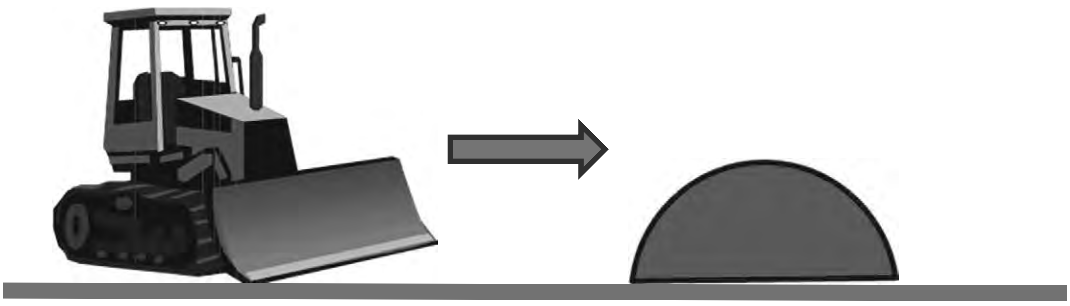


- The wastes are compacted several times using the weight of the bulldozer so that they can be crushed, contracted, thus reducing the empty spaces and increasing waste density.

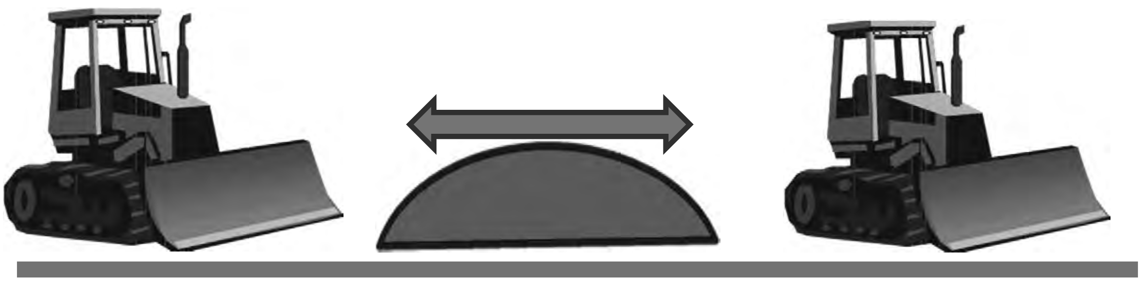
Gather the compacted wastes again using the bulldozer blade. If this process is repeated several times, waste density may increase.



- Gather the compacted wastes using the bulldozer blade.

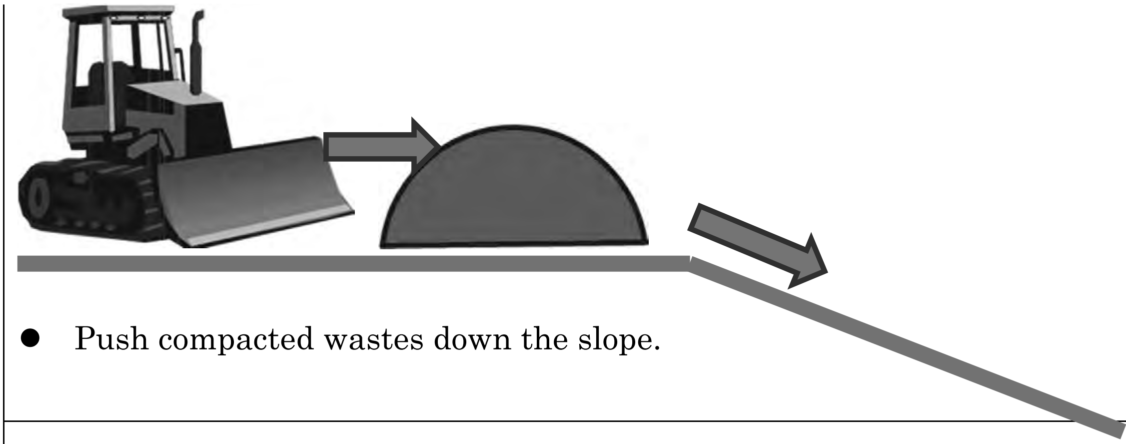


- Spread the piled-up wastes again using the bulldozer.

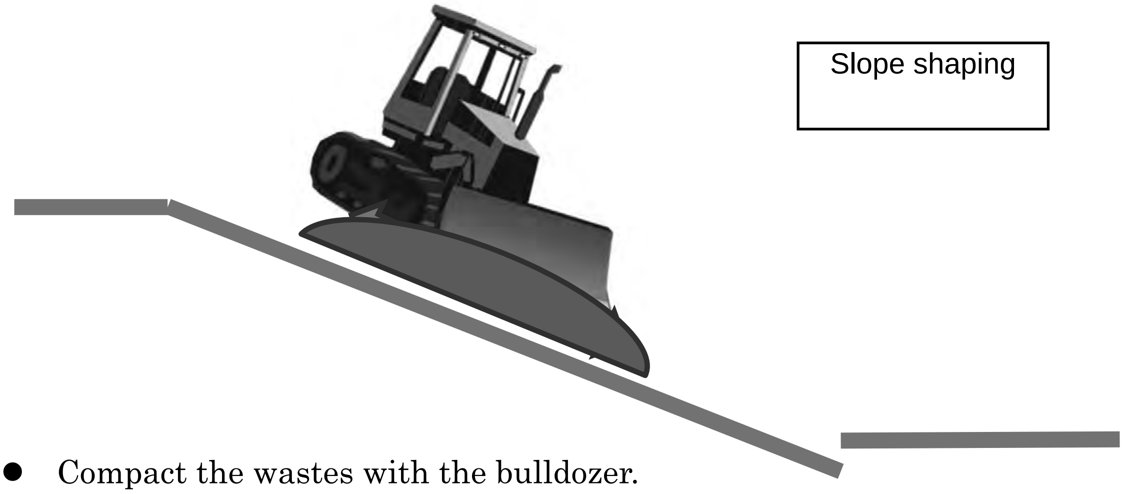


- Compactar varias veces los residuos por el propio peso del bulldozer.

Después sin verter los residuos compactados en la parte bajo de talud, haciendo pendiente de talud de aproximadamente 1: 3 hacia abajo de frente de trabajo, verter utilizando el propio peso del bulldozer pasando repetidamente.

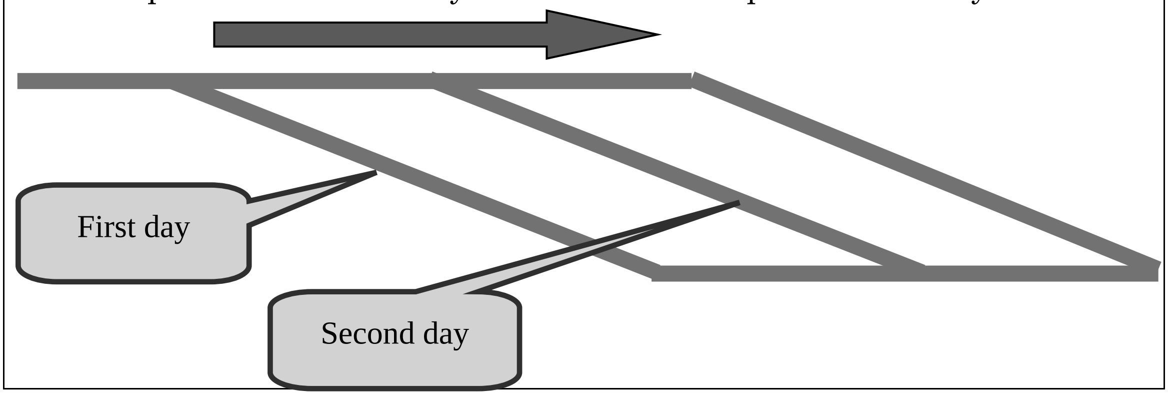


- Push compacted wastes down the slope.



- Compact the wastes with the bulldozer.

- Dump the wastes this way and extend the slope forward daily.



Remarks

1. Slope shaping (compact the wastes along the slope using the bulldozer) is most important because:
   - Compacting the slope drastically reduces fire generation.
   - Generation of flies is reduced.
   - Waste scattering and generation of foul odors are reduced.
   - Leachate generation is reduced.

- Waste pile collapse as a result of heavy rains is prevented.
- The cover soil volume is minimized (as the wastes are compacted, the volume of cover soil required is reduced).

Unlike the controlled open dumping method, the compacted waste layers are denser, thus helping improve the soil, prevent fires and waste scattering, and reduce the volume of cover soil required. Moreover, as the waste surface is less rugged and more compacted, it is more exposed to sunlight, its temperature thus rising at a level that prevents the generation of flies and other harmful animals.

- The worst method is to dump uncompacted wastes from the slope using the bulldozer.
- The fire extension rate is high (human walking speed).

2. Vectors, waste scattering, foul odors.
3. Slope gradient
   - 1: 3～1: 4
   - Extreme accuracy is not necessary.
4. Waste thickness
   - Decide by the time of the plan formulation.
5. Dumping areas
   - It is recommended that the wastes should be dumped before reaching the slope and that they should be compacted two or three times using heavy machinery.
6. It is recommended that the wastes should be gathered using the bulldozer and that they should be compacted one more time. In case of fuel limitations, just dump the wastes into the slope.
7. Access roads
   - As the slope extends, the distance to the dumping area to be covered by the trucks increases. As they move over the wastes, there occur flat tires and other related truck damage. There may also be landslides during the rainy season.
   - Waste covering with soil is thus necessary. If the access roads are not secured, there usually occurs waste dumping elsewhere.
   - The access roads can be maintained in good condition by using rocks, soil, sand, logs, etc.
8. The guides show the truck drivers the dumping areas. They also deal with any possible problem that may arise involving trucks and heavy equipment. At least they prevent them from dumping the wastes in unauthorized areas.
9. The guards check that municipal solid wastes are not mixed with hazardous and forbidden wastes.
10. There exist some safety rules for the collection of recyclable materials by scavengers. Under the guide's supervision, accidents involving scavengers and vehicles are prevented.

Step 1: Slope shaping

⬇

Step 2: Waste covering with soil

Waste covering with soil

- It is recommended that waste covering materials should be obtained within the landfill site area.
- Sandy soil is preferred to clayey soil.
- The thickness of the soil cover should be around 30 cm for the wastes along the horizontal surface and the slope (in case of daily cover and cover during the weekend).
- In case cover soil acquisition and operation turns out to be difficult, the single shaping of the slope (compaction of the waste layers along the slope) is considered much better than open dumping.
- In case cover soil acquisition becomes difficult, debris, soil and sand, bricks, tiles, and other materials used to build roads are transported separately from domestic wastes and stored for later use.
    - Excavated wastes are only used exceptionally.
    - Food wastes decompose rapidly. However, trees, branches, and paper take longer to decompose.
    - Excavators and vehicles are required.
- Advantages and disadvantages should be considered.
- Others

Measures to prevent fires

- Cause of fire
    - Medicines, lime (its temperature rises when in contact with water), phosphoric acid, phosphorous, cigarette lighters.
    - Methane gas
- Arson by scavengers to facilitate collection of scrap metals, as well as to remove steel wires from tires).
- A fire spreads quickly along the slope.
- When the wind blows, the fire spreads rapidly. In Japan, they usually break out in the winter.
- Fires are more easily noticeable at nighttime.
- Slope shaping and waste covering with soil are the best measures to prevent fires.
- Fires provoked by arson are difficult to put out, as the source of the fire is hidden among the wastes. The wastes act as screens preventing water from reaching the fire source.
- In order to put out a fire completely, the wastes are dug out, spread and covered using heavy equipment. Water is finally added.

Others

- It is difficult to cover tires with soil. They can be cut into smaller pieces if the equipment is available.
- In order to exterminate vectors, the following operations are effective: (i) slope shaping (waste compaction using heavy equipment), (ii) waste covering with soil.
  - In Osaka there was a time when the authorities tried to exterminate flies by using DDVP insecticide. However, after some time the flies grew resistant to it. They finally decided to cover the wastes with soil (the temperature inside the wastes reaches 60-70 ºC).

5.5 Recommendations for the Plan of the New Final Disposal Site

5.5.1 Progress Report

a. Formulation of the Feasibility Study

The feasibility study was conducted in order to obtain the budget for the construction of the new final disposal site.

The feasibility study was carried out by CIH, a consulting company under Havana University, in July, 2012.

The study was discussed and approved by the Ministry of Economy and Planning in November, 2012.

The feasibility study includes the final disposal site and the leachate recirculation plant. Yearly construction and management costs are analyzed. The budget is usually executed once the feasibility study has been approved. However, in February, 2013, the minister of Economy and Planning asked to reduce the budget by half. Therefore, the concerned agencies have already begun to devise the measures that need to be taken to reduce the budget.

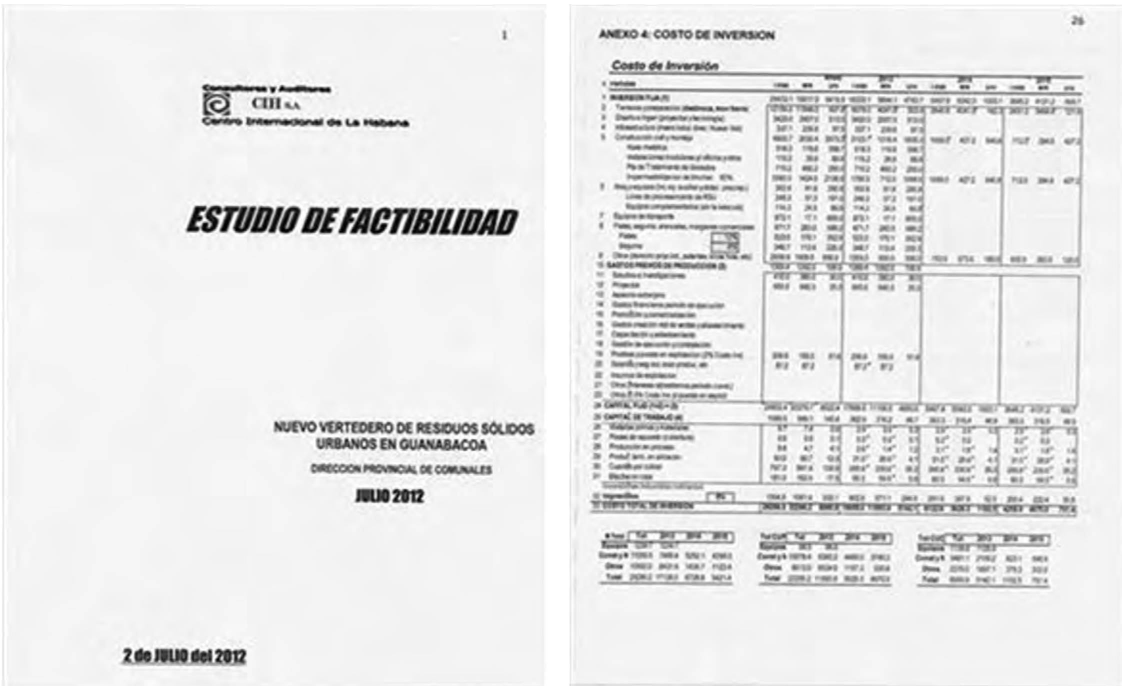


Figure 5-3: A Part of the Feasibility Study

b. Measures to reduce the budget

In response to the indications by the minister of Economy and Planning to reduce the costs, the following measures were agreed upon:

-Reduce the landfill site extension in the first stage.

-Use clay instead of the proposed geo-membrane for waterproofing.

-Stop using imported materials and use domestic materials instead (collection and drainage pipes).

-Reduce the width of the access road.

-Divide the leachate treatment pond in two parts and modify the treatment system.

In addition, CITMA requires that treated water should be discharged in a place other than into La Palma dam in case the quality standard for water discharge into said dam corresponds to that of Class A water bodies.

Consequently, almost half of the costs for the construction of the first stage of the leachate treatment pond corresponds to the construction of the outfall pipe.

c. Discussion of the measures proposed to reduce costs.

A meeting was held at Calle 30 on 23 April 2013 attended by the designers from DCH and INRH, and by CITMA’s environmental experts (Center for Environmental Inspection and Monitoring) to discuss the measures proposed to reduce costs, especially for the construction of the leachate treatment plant.

One of the proposed alternatives was to divert and discharge treated water into La Palma dam to meet existing standards, and not to prolong retention time or try to comply with the standards by implementing an advanced treatment system, notwithstanding the fact that water quality standards may be strict.

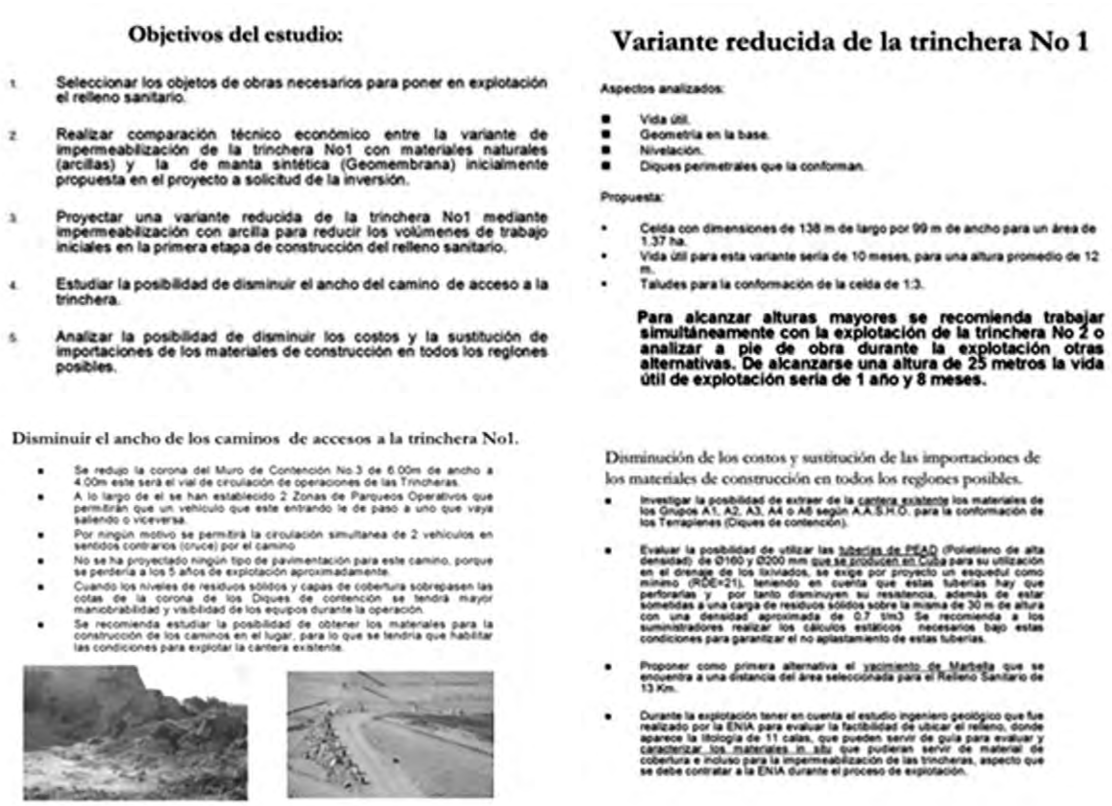
I have pointed out that diverting the water into the dam is not the main solution, or cost-effective.

The measures vary depending on whether the water quality standards of La Palma dam are defined as Class A or Class B. The discussion is still ongoing as it is the National Institute of Water Resources the agency that is supposed to finally define the class of the water body in question.

Photo 5-7: Discussions

5.5.2 Specific Measures to Reduce Construction Costs of the Landfill Site

Some of the measures proposed to the minister of Economy and Planning by Mr. Basilio from DCH to reduce construction costs are shown below.



Objetivos del estudio:

1. Seleccionar los objetos de obras necesarios para poner en explotación el relleno sanitario.
2. Realizar comparación técnico económico entre la variante de impermeabilización de la trinchera No1 con materiales naturales (arcillas) y la de manta sintética (Geomembrana) inicialmente propuesta en el proyecto a solicitud de la inversión.
3. Proyectar una variante reducida de la trinchera No1 mediante impermeabilización con arcilla para reducir los volúmenes de trabajo iniciales en la primera etapa de construcción del relleno sanitario.
4. Estudiar la posibilidad de disminuir el ancho del camino de acceso a la trinchera.
5. Analizar la posibilidad de disminuir los costos y la sustitución de importaciones de los materiales de construcción en todos los regiones posibles.

Disminuir el ancho de los caminos de accesos a la trinchera No1.

- Se redujo la corona del Muro de Contención No.3 de 6.00m de ancho a 4.00m este será el vial de circulación de operaciones de las Trincheras.
- A lo largo de el se han establecido 2 Zonas de Parqueos Operativos que permitirán que un vehículo que este entrando le de paso a uno que vaya saliendo o viceversa.
- Por ningún motivo se permitirá la circulación simultanea de 2 vehículos en sentidos contrarios (cruce) por el camino
- No se ha proyectado ningún tipo de pavimentación para este camino, porque se perdería a los 5 años de explotación aproximadamente.
- Cuando los niveles de residuos sólidos y capas de cobertura sobrepasen las cotas de la corona de los Diques de contención se tendrá mayor maniobrabilidad y visibilidad de los equipos durante la operación.
- Se recomienda estudiar la posibilidad de obtener los materiales para la construcción de los caminos en el lugar, para lo que se tendría que habilitar las condiciones para explotar la cantera existente.

Variante reducida de la trinchera No 1

Aspectos analizados:

- Vida útil.
- Geometría en la base.
- Nivelación.
- Diques perimetrales que la conforman.

Propuesta:

- Celda con dimensiones de 138 m de largo por 99 m de ancho para un área de 1.37 ha.
- Vida útil para esta variante sería de 10 meses, para una altura promedio de 12 m.
- Taludes para la conformación de la celda de 1:3.

Para alcanzar alturas mayores se recomienda trabajar simultáneamente con la explotación de la trinchera No 2 o analizar a pie de obra durante la explotación otras alternativas. De alcanzarse una altura de 25 metros la vida útil de explotación sería de 1 año y 8 meses.

Disminución de los costos y sustitución de las importaciones de los materiales de construcción en todos los regiones posibles.

- Investigar la posibilidad de extraer de la cantera existente los materiales de los Grupos A1, A2, A3, A4 o A6 según A.A.S.H.O. para la conformación de los Terraplenes (Diques de contención).
- Evaluar la posibilidad de utilizar las tuberías de PEAD (Polietileno de alta densidad) de Ø160 y Ø200 mm que se producen en Cuba para su utilización en el drenaje de los lixiviados, se exige por proyecto un esquedul como mínimo (RDE=21), teniendo en cuenta que estas tuberías hay que perforarlas y por tanto disminuyen su resistencia, además de estar sometidas a una carga de residuos sólidos sobre la misma de 30 m de altura con una densidad aproximada de 0.7 t/m3 Se recomienda a los suministradores realizar los cálculos estáticos necesarios bajo estas condiciones para garantizar el no aplastamiento de estas tuberías.
- Proponer como primera alternativa el yacimiento de Marbella que se encuentra a una distancia del área seleccionada para el Relleno Sanitario de 13 Km.
- Durante la explotación tener en cuenta el estudio ingeniero geológico que fue realizado por la ENIA para evaluar la factibilidad de ubicar el relleno, donde aparece la litología de 11 calas, que pueden servir de guía para evaluar y caracterizar los materiales in situ que pudieran servir de material de cobertura e incluso para la impermeabilización de las trincheras, aspecto que se debe contratar a la ENIA durante el proceso de explotación.

Figure 5-4: Proposal by DCH

Some of the measures proposed to the minister of Economy and Planning by DCH in order to reduce construction costs.

The measures to reduce construction costs include the use of domestic materials and a reduced scale. Taking into account the current budget limitations, it is extremely difficult to find a better solution than this one.

The service life of the new site is expected to be just 10 months for trench 1 according to the estimated volume of transported wastes. Therefore, the construction of trench 2 has to begin immediately.

Even though the construction of the landfill site is finished, its capacity will not suffice to accept the wastes once the existing sites are closed.

As this will be the first environmentally-friendly sanitary landfill site to be built in Cuba, it is important to control the volume of wastes initially accepted.

5.5.3 Measures Proposed to Reduce the Construction Cost of the Leachate Treatment Plant

The summaries (executive summary and summary) presented by Mr. Santiago from INRH are shown below.

EXECUTIVE SUMMARY

CONCLUSIONS

1. Based on the estimated costs and on the effluent quality to be obtained, the best alternative is "<u>Construction of a wetland considering La Palma dam as a Class B water body</u>", which has the following advantages:
   a. Lower initial investment cost.
   b. Complex equipment need not be imported.
   c. Simple construction.
   d. Simple operation.
   e. Simple maintenance.
   f. Lower energy cost.
2. The planned treatment system will ensure compliance with the Cuban Standard "Discharge of Wastewater into Terrestrial Water Bodies and the Sewer System. Specifications".
3. In order to optimize the investment, we propose to execute it in two stages, each of them designed to treat 185m^3/day.
4. During the construction stage and for a period of 1-2 years, as the flow of leachate generated will not reach its peak, the system should be monitored to decide whether an outfall pipe needs to be built enabling to discharge the effluent outside the sub-basin of La Palma dam.

RECOMMENDATIONS

1. Discuss the current feasibility study at the meeting of the Technical Advisory Board and approve the proposed alternative, being the most advantageous one.
2. Determine equipment requirements and request quotations for equipment acquisition.
3. Implement the proposed alternative by taking advantage of the fact that the flow of leachate generated will not peak, and the system can be monitored to decide whether an outfall pipe needs to be built to discharge the effluent outside the sub-basin of La Palma dam.

SUMMARY

The current updating of the alternatives for the treatment of the leachate to be generated in the trenches of the new Guanabacoa sanitary landfill site is conducted at the request of the investor to implement the best treatment solution in the light of the decisions made during 2013, and it is based on the draft plan completed and handed over in April, 2012 (Santiago, 2012), which was in turn formulated based upon the study of alternatives prepared in 2010 (Santiago, 2010) aiming at preventing the pollution of the water in the basin.

The following approaches were taken into account:

1. La Palma dam is considered as a Class B water body, just as its basin. Two alternatives are proposed:

A) Construction of a wetland considering La Palma dam as a Class B water body.
B) Recirculation of 50% of the effluent considering La Palma dam as a Class B water body.

2. La Palma dam is considered as a Class A water body, as it is a reservoir of drinking water for the city. Two alternatives are proposed:

A) Construction of a wetland considering La Palma dam as a Class A water body.
B) Recirculation of 50% of the effluent considering La Palma dam as a Class A water body.

An evaluation of these two alternatives in terms of construction cost is shown in the Table below.

Table: Summary of Construction Costs for the Various Alternatives

No.	Alternative	Construction Cost
1.	Construction of a wetland considering La Palma dam as a Class B water body.	$240,000.00
2.	Recirculation of 50% of the effluent considering La Palma dam as a Class B water body.	$398,803.00
3.	Construction of a wetland considering La Palma dam as a Class A water body.	$506,569.00
4.	Recirculation of 50% of the effluent considering La Palma dam as a Class A water body.	$663,802.00

Based on the estimated costs and on the quality of the effluent, the best alternative is "Construction of a wetland considering La Palma dam as a Class B water body".

The alternative selected has the following advantages:

1. Lower initial investment cost.
2. Complex equipment need not be imported.
3. Simple construction.
4. Simple operation.
5. Simple maintenance.
6. Lower energy cost.

This alternative can be executed in the first stage without building the outfall pipe. The preparations to later build it, if considered necessary not to discharge the effluent into La Palma dam, can be set up in advance.

In order to optimize the investment, this alternative is proposed to be executed in two stages, each one capable to treat 185m^3/day.

1. The following will be included in the first stage:
   a. Entrance records
   b. Anaerobic pond
   c. Aerated pond
   d. Wetland
   e. System records
   f. By-pass
   g. Outfall pipe

During the first stage and for a period of 1 or 2 years, and taking into account the fact that the flow of leachate generated will not peak, the system should be monitored in order to decide whether an outfall pipe needs to be built enabling to discharge the effluent outside the sub-basin of La Palma dam.

The second stage will be executed when the flow of leachate generated increases.

6 Activity for the 5th phase

Period of Activities: 19 October 2013 to 9 November 2013

6.1 Expert's Plan of Activities

6.1.1 Plan of Activities during the Expert's Assignment in Cuba (formulated by C/P and Japanese Expert)

Since last assignment, JET has asked C/P to arrange the Program of Activities during the expert's stay in Cuba. In the period covered by PR8, Mr. Ernesto, Group 4 C/P leader, formulated the Program of Activities for the expert's three-week assignment.

Although the number of visits to the relevant organizations and discussions with the C/P has been limited, the Cuban side actually made well coordinated arrangements in advance. In addition, the Cuban side asked the expert for some advice on several issues raised while he was away.

As the construction of the New Guanabacoa landfill site (Group 4's top priority) has not been resumed yet, and the expert could not provide his input for the revised site design as introduced, the Cuban side submitted it as an alternative activity.

I have noticed they are increasingly interested in making the most of the expert's relatively short stay in the country. Last time the C/P pointed out the need for a civil engineer to join the project during the expert's absence. This time, Mr. Hermes, who is a civil engineer, joined the project as a new C/P member.

The Program of Activities as submitted to the Japanese expert by the C/P is shown below.

SUB DIRECCIÓN PROVINCIAL DE INVERSIONES Y DESARROLLO
SERVICIOS COMUNALES LA HABANA
Calle 180 No. 116 e/ 1ra y 5ta. Playa
Teléfonos: Pizarra 2720694 y 2720695

ELABORADO POR: ERNESTO DOMINGUEZ GLEZ
ESPECIALISTA

PLAN DE TRABAJO DEL EXPERTO JAPONES **OCT - 2013**

					SABADO 19	DOMINGO 20
					Llegada a Cuba	
LUNES 21	**MARTES 22**	**MIERCOLES 23**	**JUEVES 24**	**VIERNES 25**	**SABADO 26**	**DOMINGO 27**
>Análisis individual del experto del Proy. Ejec. de la 1ra etapa del Relleno Sanitario del Este	> Análisis individual del experto del Proy. Ejec. de la 1ra etapa del Relleno Sanitario del Este	> Exposición de las consideraciones a esp. de la VDID sobre el Proy. Ejec. de la 1ra etapa del Relleno Sanitario del Este	> Análisis individual del experto del experto del proyecto ejecutivo del nuevo vial de acceso al Vertedero de calle 100	> Análisis individual del experto del proyecto ejecutivo del nuevo vial de acceso al Vertedero de calle 100		
LUNES 28	**MARTES 29**	**MIERCOLES 30**	**JUEVES 31**	**VIERNES 1**	**SABADO 2**	**DOMINGO 3**
>Visita al Vertedero de Calle 100, 8 Vías, Guanabacoa	> Análisis individual del experto del Proy. Ejec. de la Planta de Reciclaje del Relleno Sanitario del Este	> Análisis individual del experto del proyecto ejecutivo de la Planta de Reciclaje del Relleno Sanitario del Este	> Exposición de las consideraciones a esp. de la VDID sobre el Proy. Ejec. del Nuevo Vial de acceso a Calle 100 y de la Planta de Reciclaje del Este	> Análisis individual del experto del proyecto ejecutivo de la Recirculación de Lixiviados del Vertedero de Calle 100		
LUNES 4	**MARTES 5**	**MIERCOLES 6**	**JUEVES 7**	**VIERNES 8**	**SABADO 9**	**DOMINGO 10**
> Análisis individual del experto del proyecto ejecutivo del cierre de 8 Vías	> Análisis individual del experto del proyecto ejecutivo del cierre de 8 Vías	> Análisis individual del experto de los avances en el proyecto para el tratamiento de los Lixiiados en el Este	>Reunión con proyectistas de DCH,INRH y ISDE para dar recomendaciones a los proyectos elaborados por ellos	>Reunión con esp. de la VDID para intercambio y dar orientaciones para la próxima visita	Regreso al Japón	

The following 7 projects the Cuban side is currently planning are included in the program.

① Contraction of the trench for the New East sanitary landfill site

② Contraction of the access road to the New East sanitary landfill site.
③ Construction of the recycling plant for the New East sanitary landfill site.
④ Construction of the leachate treatment facility for the New East sanitary landfill site.
⑤ Construction of the new access road to Calle 100 landfill site.
⑥ Contraction of the leachate recirculation system for Calle 100 landfill site.
⑦ Closure of 8 Vías landfill site.

With regards to the projects listed above, the data were submitted for revision, except for ② and ④. The activities were carried out as scheduled. I offered the C/P some advice every time an issue was raised and discussed with them at the meetings held.

Moreover, as an alternative to ④, I visited the site of the oxidation pond currently being built as part of another project.

6.2 Improvement of Final Disposal Sites

6.2.1 Existing Conditions during the Expert's Assignment in Cuba (formulated by the expert)

a. Calle 100 Landfill Site

The weighbridge in operation during my previous stay in April 2013 has been out of service for some time now. I was told that it broke down only a few days before my arrival and it is not planned to be repaired during my assignment.

Photo 6-1: Broken Weighbridge

Photo 6-2: Access Road Sprinkled with Water

Mr. Domingo is still the landfill site manager. With regards to the inner road, the condition of the sloping access road to the site has changed. Its width has increased. It has been kept in relatively good condition. At the waste dumping area, where it is difficult for collection vehicles to pass by the recyclable material segregation place, truck circulation has improved by using a whistle, a generally uncommon way in Cuba I had previously recommended.

According to Mr. Domingo, no fire broke out during the expert's absence as the wastes are being covered with soil, and the first aid system to prevent a fire from breaking out has been implemented as recommended by the expert.

During my first visit to the site, some wrongly dumped wastes were noticeable at the heavy equipment parking area. However, they were moved away the second time I went there.

Photo 6-3: Present Condition of the Sloping Access Road to the Landfill Site

Photo 6-4: Present Truck Traffic Control at the Waste Dumping Area

b. Ocho Vías Landfill Site

Mr. Luis Chan has been the site manager for a year.

On both sides of the road leading to the site, there are lots of wastes dumped there during rainy days when the access of collection vehicles to the dumping area at the back of the site proves to be impossible, thus making it even harder for vehicles to get to the dumping area.

As they use the limited fuel and equipment available to move the misplaced wastes, they fail to properly carry out normal operations such as waste compaction and covering with soil.

According to both Mr. Camilo, who has been reinstated in his old position, and is responsible for all final disposal sites, and Mrs. Odalys from DPSC, constant management staff changes have brought about some confusion at the site. Also, Mr. Chan’s long absence has significantly affected site operations.

I was informed that the Ministry of Science, Technology, and the Environment (CITMA) gave some instructions to improve the site environment.

The Cuban side explained that the site must be closed as soon as possible due to its serious environmental pollution. However, as an alternative sanitary landfill site has not been yet ensured, the closure of Ocho Vías site might increase fuel consumption as the wastes will then have to be dumped in a site farther away, or might lead to the introduction of a makeshift site. Therefore, I insist that any final decision should be carefully discussed.

Ocho Vías site should continue to be used until an alternative landfill site is made available. The present condition of the site may get better by improving the access road, reducing uncovered waste area, and introducing the leachate recirculation system planned for Calle 100 landfill site.


Photo 6-5: Near the weighbridge base

Photo 6-6: Near the access road

c. Tarará Landfill Site

The site manager has from the project onset been Mr. Omar, who is also the manager of Campo Florido landfill site. Site operations such as waste covering with soil and traffic control at the dumping area are being properly carried out as I could notice when I visited the site.

The fence to prevent unauthorized people from trespassing is near completion.

As this is a relatively compact site, it can be easily managed. The present condition is expected not to change in the future.

By the time of our visit, some trucks supposed to carry the wastes to Calle 100 gained access to the site.

Tarará is a site mainly accepting tree waste. However, as it is easy for compactor trucks to gain access there, they say that the volume of household wastes, which were previously carried to other final disposal sites, has recently increased.

Although we were informed that there is still some room for waste dumping in the area shown in the photo below, the remaining site area is not enough to allow intensive waste dumping. Therefore, the site should only be used for its original purpose.

Photo 6-7 Fence to prevent unauthorized people from trespassing

Photo 6-8: Present site condition

d. Campo Florido Landfill Site

This site was not visited this time.

6.3 Training on Management of Final Disposal Sites

6.3.1 Training for Site Workers

No training was carried out while the expert was away. As the sites are currently understaffed to recover the areas used to dump the wastes during the rainy season, training was not conducted during the expert's assignment this time.

6.3.2 Operation Manual Revision

Mr. Alexis, who was the director of all final disposal sites during my previous assignment, left UPPH August 2013. Mr. Camilo, who was the director of all the final disposal sites when the project began, was reinstated in his old position.

Mr. Camilo had not received the operation manual submitted to Mr. Alexis during my previous assignment.

I have repeatedly pointed out the need to hand over the documents in case of staff changes. However, this time neither the revised operation manual nor the original operation manual itself have been handed over to Mr. Alexis's successor, thus affecting the project sustainability and continuity.

Heavy equipment operators and site workers continue landfilling operations. However, every time the site director is replaced, some confusion arises due to wrong instructions. Therefore, a system should be implemented enabling the outgoing director to inform the new appointee about the details of his new position.

6.3.3 Construction of a New Access Road to Calle 100 Landfill Site

The existing access road lies in the way of the new railway line currently being built from Havana Port to Mariel Port. Therefore, a new access road not interfering with the new railway line needs to be built.

Significant progress has been made in terms of the construction of the new railway line scheduled to be completed by February, 2014. Therefore, the construction of the new access road is a prioritized issue for Calle 100 to operate.

During my previous assignment in April, I was informed of the need to build the new access road. However, no executive project had then been formulated. Now, six months later, the survey and design have already been completed, and construction works have relatively progressed compared to previous years, thus proving this is top priority.

The works had already begun despite the discrepancy existing between the investors and the contractor in terms of the sub-base material to be used. However, the works have now come to a halt. Its duration is said to be two and a half months. As the railway line is expected to be finished in less than three months, the works should be resumed as soon as possible.

In the vicinity of the building site lies the temporary access road previously used. If expanded, it can be used for collection vehicles to access the landfill site.

Initially, the new access road was being built by expanding the temporary access road. At present, however, due to the existence of houses on both sides of the road, the design has been revised in order not to affect them. Therefore, they should refrain from using the temporary access road. Nevertheless, in case the deadline cannot be met, I am afraid the temporary access road will have to be gradually used.

The wetland is included in the building site. I was informed that the soil is expected to be not very solid there. Therefore, some time is required to select the subbase material. However, the road to exclusively carry the wastes to the landfill site can be used by repairing it with heavy equipment in case any land subsidence occurs. That is why I recommended that meeting the deadline should have top priority.

Photo 6-9: Railway line

Photo 6-10: Confirmation of the site to build the new access road

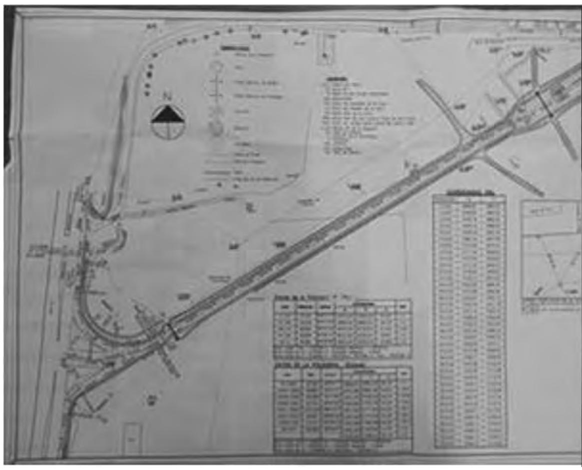


Photo 6-11: Plans

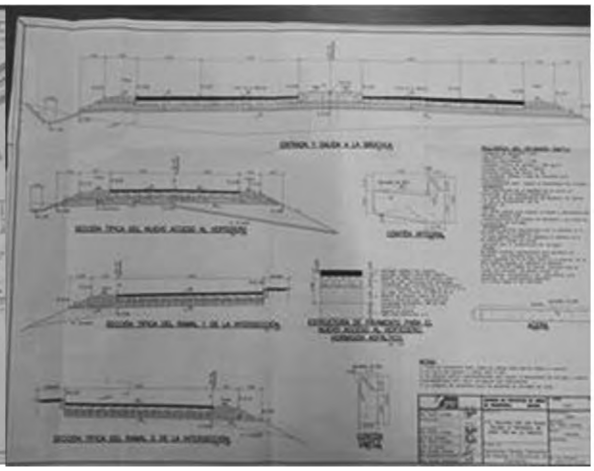


Photo 6-12: Standard section plan

EPOT

Executive Project: New Solution to the Access Road to Calle 100 Landfill Site in Havana.

Contract Number: 10412 S1/ 13-01

April, 2013

Table of Contents

1.**General Information**

1.1 Project name

Executive Project: New Solution to the Access Road to Calle 100 Landfill Site in Havana.

Code: 10412 S1/ 13-01

1.2 Purpose

It is intended to find a solution to the problem posed by the changed location of the entrance to Calle 100 landfill site as a consequence of the construction of the new railway line.

1.3 Type of project

Executive.

1.4 Microlocation

The building site is located in Marianao municipality, Havana.

1.5 Name of the investor

Provincial Unit for Waste Collection and Disposal.

1.6 Name of the person responsible for the investment

Osvaldo Navarro Granado, B.Sc.

1.7 Name of the project company

Empresa de Proyectos de Obras de Transporte(EPOT)

1.8 Name of the person in charge of the road project

Engineer Yenira Condes Molleda

1.9 Cost

$502.614,80

2 Work Description

2.1 Background

The Empresa de Proyectos de Obras de Transporte(EPOT) has submitted the Executive Project "New Solution to the Access Road to Calle 100 Landfill Site" for its review and approval by the investor and the relevant organizations.

2.2 Benefits

The new entrance to Calle 100 landfill site enables trucks to enter the site through 114th Avenue after the old access road is closed as a consequence of the construction of the railway line running parallel to A-4 Highway.

2.3 Technical standards

-NC 53-131: 84 Formulation of building projects. Geometric road design. Geometric characteristics of level crossings.

-NC52-42: 78 Embankments. Construction specifications.

-NC53-115: 84 Formulation of building projects. Obras de fábrica. Calculation method.

-NC160: 02 Highways. Hot asphalt concrete. Placing on site.

-NC161: 02 Highways. Bases and sub bases made of soft limestone.

-NC293: 05 Best practice code for concrete frame.

-NC334: 04 Highways. Flexible road surfaces. Calculation method.

-NC250: 05 Durability requirements for the design and construction of buildings and civil works using structural concrete.

-NC259: 05 Highways. Hydraulic concrete road surfaces. Tiles

Best practice code.

-NC120: 07 Hydraulic concrete. Specifications.

-NC207: 03 General requirements for the design and construction of concrete structures.

-NC853-2012 Rural highways. Technical categories and geometric characteristics of the direct layout.

-Hydrological Calculations in Small Basins. Dorticós, Pedro Luis, 1986.

- Hec-Ras Software: used to determine hydraulic parameters in river courses and channels.

-Topographical survey.

-Report on geometric research.

-DT-27: Project scope and content procedures for the formulation of the Executive Project of rural and urban expressways, avenues, and streets. April 2003.EPOT

-DT-32: Technical document on the scope and content of level crossings. April 2003.

Road category・・・・ IV

Design speed・・・・ 50km/ hour

Lane width ・・・・ 3.00m

Carriageway width ・・・・ 6.00m

Lane pumping・・・・ 2.0%

Sidewalk・・・・・ 1.50m in the layout and 1.20m at the crossing with 114th Avenue

Sidewalk slope・・・・ 8%

Minimum radius at the intersection turns・・・25.00m

Slope gradient・・・・ 2% a 5%

2.4 Design criteria

2.4.1 Ground-profile design criteria

The ground is flat with accumulated solid and liquid wastes in several areas. The road layout is along a planted field, to which the projected road leading to the inner access road to the site will be adapted.

The new access begins on 114th Avenue with an intersection. The access road is 729.42m long. It was designed over private planted fields, which are affected by it, with a curve having a radius of 90.00 m and a length of 57.71m. It runs straight until curve 12 having a radius of 90.00m and being 85.64 long. At the end of the curve, the projected road joins the existing road. At the intersection with 114th Avenue, traffic islands and openings along the divider on 114th Avenue to enable trucks moving along this road to turn in every direction will be implemented. See plans 3 and 7 /10.

The cross section is composed of a carriageway 6.00m wide with 2 lanes 3.00m wide each, with walks on both sides 1.50m wide at the access road and 1.20m wide at the intersection with 114th Avenue. The access road will be wider at the entrance of the intersection and at the weighbridge to facilitate traffic. At the entrance to the weighbridge there will be a lane 3.00m wide for free access and another lane 4.70m where the weighbridge will be installed. The new access road will finish at the existing inner road with an extremely simple intersection. See plans 2 and 3/ 10.

For the road surface, asphaltic concrete 0.08m thick will be used. See plans 2/ 10.

The design of the road gradient is intented to reduce earth moving and to comply with all the compulsory points such as the initial point located at the intersection with 114th Avenue and the end point at the intersection with the existing inner road. The maximum longitudinal slope is 2.91% and the minimum longitudinal slope is 1.75%, excluding the weighbridge area where the longitudinal and transverse slopes will be 0.00%. The profile is composed of four vertical curves. Curves 1 and 2 are 120m long and have an ev value of 0.64 and 0.55m respectively. Curves 3 and 4 are 40m long and and have an ev value of 0.09 and 0.15m respectively. See plan 4/ 10.

2.4.2 Earth moving

Excavations will be carried out practically throughout the entire access road. There will be mainly an enbankment at the intersection. Excavation is required as the ground is filled by wastes in the areas to be used to build the road. See plans 2 and 5/10.

2.4.3 Road surface design

The design of the road surface structure was based on the calculations made according to NC-334, 2004: Flexible highways-road surfaces. Calculation method for flexible road surfaces.

The new access road has the following surface structure:

-Asphaltic concrete: 0.08m thick in two layers, one 0.04m wide of intermediate hot asphaltic concrete, and another 0.04m of hot fine asphalt concrete.

-Base material: 0.20m wide of a mix of gravel, sand, and whitish and yellowish fine-grained material. Average CBR=45%, Classification A-2-4. It should be stabilized qith cement at a rate of 5 to 9% of the weight to obtain a CBR of 60 to 80%.

-Subbase material: 0.30m wide of a mix of gravel, sand, and whitish and yellowish fine-grained materials.CBR= 45%, Classification A-2-4. See plan 2/10.

The quarry to be used is the one nearest to the building site, which yields quality materials as required for the works to be carried out. It is the “Rubén Martínez Villena” quarry located near Rancho Boyeros Avenue 10 km from the building site.

This quarry is practically depleted. However, it has two working faces at the bottom, the rocks of which are a mix of gravel, sand, and whitish fine-grained material.

2.4.4 Drainage

Rainwater will be collected using canals and discharged through sewers 1x1m in size to existing and projected ditches to prevent it from accumulating around the new access road and to keep the enbankment in good condition. See plans 9 and 10/10.

The areas should be cleaned and the existing facilities should be properly maintained.

In order to remove rainwater, the following elements were taken into consideration:

-2 ditches along both sides of the trapezial access road with a slope 2: 1

-3 box culverts of 1 row 1X1 in size. See plans 8 and y 9/9.

2.5 Environmental considerations

Moving the smallest amount of earth as possible in order to use only indispensable materials, thus minimizing environmental impact, was a prioritized issue in the project. However, this will not be possible altogether as the wastes dumped at the site pollute the ground, so a rather significant amount of material from the quarry will have to be used to fill the area.

6.3.4 Leachate Recirculation System for Calle 100 Landfill Site

Methane gas is extracted at Calle 100 landfill site by covering part of the site area with sand as the gas is in an anaerobic state. To this effect, leachate must be treated. However, leachate recirculation has not yet being introduced.

Several projects to build an oxidation pond have been planned so far. However, construction plans have been dropped as the wastes had already been dumped in the contruction site area, and not enough space was available when it was found that it interfered with the railway line.

The leachate recirculation system has been proposed instead of the oxidation pond as an easy way to reduce ground water polluted by leachate.

The existing leachate recirculation program is limited to collect and carry the leachate. The specific way to pour the leachate into the methane extraction area covered with clay is yet to be defined.

I pointed out that methane could leak from the wells once they are installed in the area covered with clay, so the way to pour the leachate should be carefully analyzed.

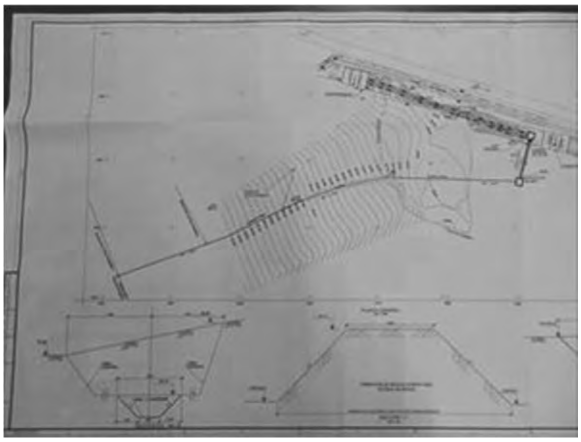


Photo 6-13: Plans

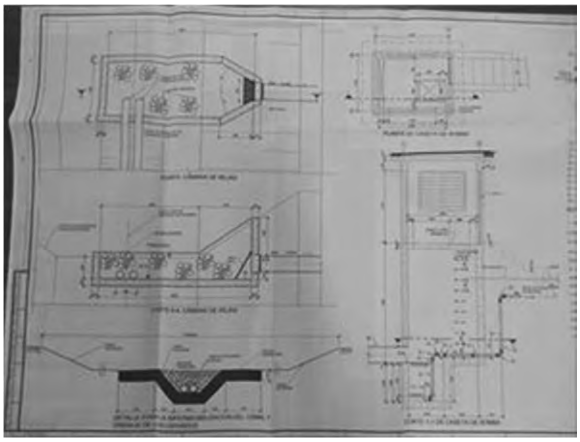


Photo 6-14: Pumping facility

The Se indica la memoría descriptiba del sistema de recirculación de lixiviado elaborada por DCH.

PROJECT NAME **Calle 100 landfill site**	Contract Number	Work Item Number	Plan Number
	2012-6011	**01**	**H.000-0**

WORK ITEM	Location
Perimeter channel	**Autopista Este-Oeste e/100 y 114**

GENERAL DESIGNER	UEB	GROUP	STAGE
Architect Daniel Lugo.	**D.Esp.**	**5E**	**PE**

HYDRAULIC AND SANITARY WORKS

Table of Contents:

1- Introduction

Calle 100 landfill site is currently scheduled to be closed. However, part of the site still receives solid wastes, whereas another area is expected to be expanded. The original site plan did not include a system to treat the leachate generated by solid wastes, thus posing a serious environmental threat over the years.

Our company has formulated several projects to treat the leachate generated at the landfill site. They have mainly consisted of oxidation ponds, which have not been built for several reasons though. The latest project could not be carried out as the location selected interfered with the new railway line currently being built to join Havana Port and Mariel Port.

The request made by the investor to formulate this projects reads: "Based on the limited area available and taking into account the new theories in terms of the use of leachate to promote microbian activity at the landfill sites by recirculating it back into the waste dumping area in order to increase the activity of anaerobic gas-producing bacteria, a pond is expected to be built at Calle 100 landfill site to collect and recirculate leachate back into the area where the wells and trenches have been installed as part of the International Degasification Project, thus preventing leachate from polluting Almendares river". The construction of the oxidation ponds was originally intended to avoid this precisely.

According to the investors, the Physical Planning Authority and the rest of the organizations concerned agreed with this solution. Therefore, they asked our company to formulate a project for leachate recirculation.

The liquid generated by the organic wastes found in Municipal Solid Wastes (MSW), and rainwater fallen all over them during the landfill site operation, which eventually seeps into the ground, causes the various compounds found in the wastes to dissolve. This liquid carrying a high polutant load is known as leachate. It poses a serious environmental threat as it may pollute the underlying aquifers. Therefore, it should be prevented from reaching the subsoil by designing a collection and recirculation system.

2- Drainage system for leachate collection and recirculation

The cleaning of a 70m-long stretch of the channel surrounding the landfill site on the North, along which leachate circulates during the rainy season, is included in the project. After cleaning it, another canal will be built at the bottom of it, which will be used as a drain to collect and carry the leachate. This channel will have a trapezial section 0.60m wide with a slope 1:1. Its perimeter will be waterproofed using a compacted clay layer to obtain a permeability coefficient of 1×10^{-7} m/sec. Inside it 2 HDPE perforated pipes 200 mm in diameter will be placed, which will be covered by a 50 to 100 mm gravel filter. This material should have a permeability coefficient higher than or equal to 10^{-3} m/sec to allow leachate to flow into the pipes. The pipes will be equipped with a screen chamber, from which leachate will be deflected to a pumping station, where a submergible pump will be installed to pump leachate into the area occupied by the wells and trenches of the International Degasification Project.

The drainage channel will be built after the existing one is cleaned and leveled. This should be done during the dry season when there is little or no leachate flowing. However, the project includes a temporary channel to run parallel to the existing one to be used to deflect the leachate. Two clay enbankments will be built at the beginning and at the end of the selected stretch in order to cut off the flow along the channel. These enbankments will be removed once the drainage channel works are completed.

The leachate drainage channel will have a slope of 0.005. The HDPE pipes will have an SDR-21 and will be perforated using ½" bits 20 centimeters apart.

3-Leachate pumping

General

The leachate daily generated by the wastes dumped at the landfill site will be collected using a drainage system and will be carried to a pumping station.

Leachate from 25 ha is assumed to be discharged into the existing channel. The leachate flowrate was claculated by assuming the following parameter: 0.2 L/s/ha=17.20 m^3/day/ha, as the investor failed to provide the data concerning leachate flowrate as requested.

Pumping station

The design includes a pumping station having a load H=31 m measured from the beginning of the leachate pipe to the highest site elevation and adding the system load loss.

The pumping station is composed of the following:

- 2 submergible pumps for wastewater carrying solid particles not exceeding 80 mm.
- A device to automate the system enabling to start the pumps alternately in every pumping cycle.
- Wet well having a capacity of 1.275 m^3
- Inspection well enabling to maintain the equipment and drain the leachate accumulated in the pipe when pumping stops.
- Opening 600 x 600 mm in size with frame, cast iron lid, and ladder.
- Opening150 x1500mm in size enabling well ventilation and the installation of electric wires and probes used for automated control.

- Hut with windows and an iron gate at the entrance.

Characteristics of the pumps used for leachate extraction

- Pumping rate: 5.32 l/s
- Pumping height: 30.9 m
- Maximum height: 36 m
- Actual impeller diameter: 159 mm
- Type of impeller: SUPERVORTEX
- Maximum diameter of particles: 80 mm
- Suction: 100 mm
- Discharge: 80 mm
- Pressure: PN 10
- Input power - P1:13 kW
- Nominal power - P2:,10.4 kW
- Frequency: 60 Hz

We have no information about whether or not portable pumps having these specifications are actually manufactured. If they are and the investor can procure them, then some necessary adjustments are to be made in order to simplify the pumping station by building a sump in the vicinity of the drainage cannel.

To lay the foundations of the pumping station, a soil study including the characteristics of the materials for the base should be conducted. The size of the base might change once this information is available.

4- Line pipes

A line pipe Ø80 in diameter to stretch from the pumping station to the well area was designed. It will run over the ground along an existing trail. At the pipe end, a flow-control valve will be installed. Some hoses or pipes Ø50 mm will be connected to it. They will be divided into sections using shutoff valves. The position of the pipes will be modified depending on the well location and operation requirements. Besides complying with all existing standards and regulations, the materials will have to meet the requirements stipulated by the Ministry of Construction (MICONS) regarding the Technical Suitability (DITEC) of the products and materials to be used in the country..

6.3.5 Executive Program for the Closure of Ocho Vías Landfill Site

Ocho Vías landiff site is reportedly scheduled to be shut down as it is a major source of pollution for the Almendares-Vento river basin.

At the beginning of the project, some works for the installation of a new eighbridge and the improvement of drainage along the access road entrance began to be undertaken. However, the works were suspended, and apparently they will not be resumed.

So far no data justifying the site closure, such as the results of a water quality survey upstream and downstream the site proving it to be a major threat for the basin, have been provided. However, the decision to close the site is seemingly final.

Under these circumstances, DCH has submitted the executive program for the closure of Ocho Vías landfill site.

Prior to beginning the formulation of the site closure program, DCH has requested that some relevant surveys such as a topographic survey, a soil survey, and a hydrological survey should be conducted. However, they have not been carried out so far. There is simply a report showing how to cover the area using clay.

I hope that after these relevant surveys are conducted, a most specific executive program is formulated and gradually implemented. However, as an alternative site has not been found yet, Ocho Vías should continue to operate by reducing its environmental load until a new site becomes available.

WORK ITEM **Ocho Vías landfill site**		LOCATION **Autopista de Melena y Primer anillo, Municipio Cotorro.**	
GENERAL DESIGNER **Ing. Basilio del Vallín**	UEB **D. Esp.**	GROUP **5E**	STAGE **-**

HYDRAULIC WORKS. SOIL RESEARCH

Table of Contents

1. Introduction

Ocho Vías landfill site, located on Autopista Melena y Primer anillo, Cotorro Municipality, having a total area of 30 ha, was originally used to dispose of industrial wastes. At present, it has exceded its service life and it is scheduled to be shut down as it poses an imminent serious threat for the Almendares-Vento basin. The project will formulate a solution to the site closure by complying with international standards and regulations, as there are no local standards and regulations in Cuba for such facilities.

The final covering of the landfill site with soil is extremely important for the site closure. Waste covering with soil should achieve the following: Minimize the presence and proliferation of flies and birds; keep rodents away; prevent fires; reduce unpleasant odors and rainwater infiltration into the wastes; channel gas to the drains to remove it from the saitary landfill site; help improve the landscape; be the base for the inner access roads; enable vegetation to grow. The ground of a closed sanitary landfill site can be improved to become a park, a sports field, or a green area. So far we have not been informed by the investor about the final use of the facility.

A solution to the final closure of this landfill site is herein proposed.

2. Technical instructions for the site closure

Fort he final covering both of the outer slopes and the horizontal area, we recommend to use the following (from bottom upwards in this order):

- **A base layer of compacted material at least 60 cm thick** to homogenize and shape the ground. Two layers 30 cm thick may be used to facilitate compaction. This layer is placed on top of the solid wastes. To this effect, the soil of the site may be used provided it has been previously **selected and tested**.
- **Waterproof barrier**: Soil having a permeability of at least $1x10^{-7}$ cm/sec such as motmorilonithical clays or the like to prevent or minimize rainwater infiltration (materials available near the site are recommended). If they are not available, look for clays as near the site as possible. A layer 30 cm thick will be used.
- **A layer of soil 20 cm thick:** Pasture with roots not going too deep into the ground, but which can hold on to it. The soil to be used should be fit to control erosion and should consume little water.
- Except for the soil, all layers will be compacted to 95% of the standard proctor. The tolerance range for optimum humidity will be ± 2% compared to that found at the lab.

Remarks:

The investor will make the necessary arrangements to locate these materials to meet the demand. Some geotechnical tests will be required for these materials.

For the calculation of the work volume, the solid wastes are initially assumed to cover an area of 10 ha. This should be verified after the topographic survey is conducted.

Denomination	Volume	**SUCS Classification**	**Grain Size**				**Source**
			AM	No 4	No 40	No 200	
1^{ra} Base layer: Shape the final ground e= Variable. **(m^3)**	30 000	SC (sands with clayey fine-grained materials)	30 cm.	90%	73%	47%	Excavation material
2^{da} Base layer: Shape the final ground e= 30 cm. **(m^3)**	30 000		30 cm.				
Seal e= 20 cm **Waterproof barrier (clay) (m^3)**	30 000	ML or CL (Silt and clayey materials)	3 cm	100%	87%	57%	
Soil e= 20 cm **(m^3)**	20 000						

AM. Maximum aggregate

1. Construction materials

Shaping final ground levels: Construction materials to be used to shape the slopes and the site crownpe of compactor will be tested. The materials tested for the site base will be used as covering materials.

Clayey material: Material fit to waterproof will be used. A quarry nearest to the site should be found. A test enbankment will be built to determine type of compactor, number of times the soil should be compacted, and the thichkness of the loose layer.

2. Research for the site base

- Describe stratigraphy, characteristics, and properties of the site subsoil.
- Geotechnical parameters of the site subsoil.
- Description of the subsoil stratigraphy and properties based on the results of the field studies and lab research.
- Geological and hydrological characteristics of the study area.
- Ground water levels.
- Ground water depth and flow direction.
- Layer permeability.
- Physical and chemical characterristics of ground water.

3. Lab research for the site base and construction materials

- Sample classification according to the Unified Soil Classification System.
- Granulometric tests.
- Permeability.
- Standard proctor test.
- Consistency limits. (Attenberg's limit).
- One-dimensional consolidation.
- Shear resistance test (Cohesion and friction ø)
- Humidity.
- Slow and fast triaxial tests for the clay to be used for waterproofing.
- Load capacity.
- Dry and loose volumetric weight
- Porosity.
- Permeability coefficient.
- Natural volumetric weight.

Remarks: As the topographic survey requested to the investor was not available, the exact location of the areas where solid wastes were dumped is unknown. Therefore, material volume has only been estimated and may change once the survey becomes available. The closure of the landfill site is recommended to be carried out by stages, which will be identified when the executive project is conducted.

6.4 Recommendations for the New Site Project

6.4.1 Progress Report

Trench 1 construction works are still at a standstill as the required heavy equipment is not currently available. The completion of the works has been extended to February, 2014.

With regards to the water quality standard, which became a major issue for discussion during my previous assignment, it was found out that La Palma dam water falls under Class B. Therefore, there is no need to install an outfall pipe.

6.4.2 Executive Program

a. Trench Construction Works

The detailed plans for the first stage of the New Guanabacoa landfill site were submitted.

The final site shape has been changed as the geomembrane initially planned to be used for waterproofing has been replaced by clay, which can be procured locally instead.

Taking into account the maneuverability of waterproofing with clay, a step in the retaining wall and the section of the slope intended for waterproofing have both been removed from the project.

This adjustment was introduced by the Cuban side of their own accord. However, I pointed out that the final site shape is still difficult to realize even after the change introduced. I doubt that waterproofing with clay can be implemented. Therefore, the contractor should be asked to confirm in advance whether or not it can be accomplished.

I also pointed out that as locally manufactured pipes are to be used for leachate collection and drainage, a ladder-type longitudinal design using elbows to mitigate the inner current speed along the pipe and to reduce soil pressure instead of grooved pipes, which are less resistant to external pressure, has been formulated. However, its combination with waterproofing using clay makes it difficult to carry out the works.

These are some detailed issues from the point of view of the general design, and once the works get started the design may be revised as we go along. However, if they are noticed after the works had begun, they may be cause for delay. As similar problems have been repeatedly faced, I recommend they should be confirmed in advance.

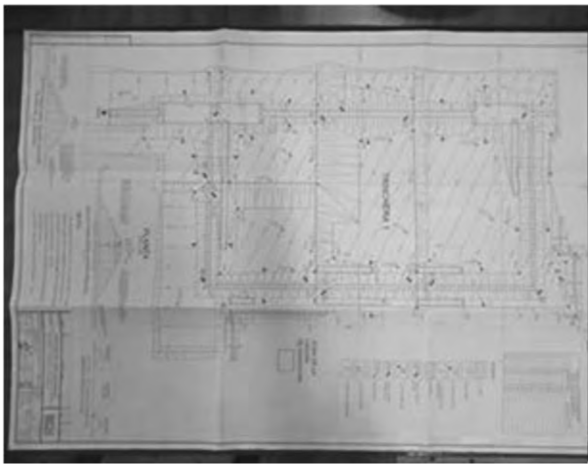


Photo 6-15: Detailed plan for trench 1

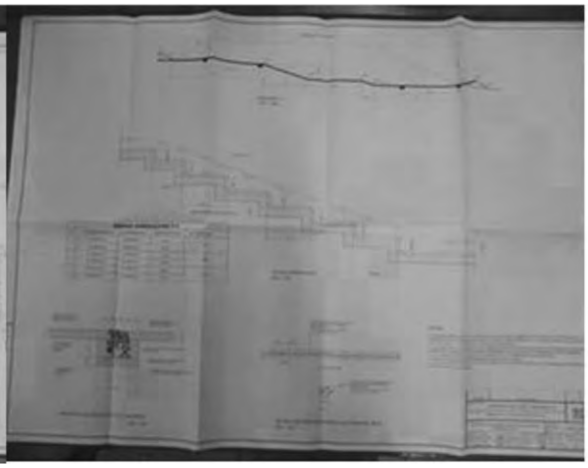


Photo 6-16: Detailed plan for the leachate collection and drainage pipe

Photo 6-17: Discussion about trench construction works

b. Recycling Plant

The detailed design plans for the construction of the recycling plant and the conveyor belts were submitted.

These were design-oriented plans, about which the expert did not have any special comment to make.

The detailed plans for the conveyor belts were detailed plant manufacturer’s plans. They do not include critical information such as conveyor belt speed, design load, etc. Therefore, they are plans the expert cannot check and give comments about.

With regards to these detailed plans, the C/P asked the expert’s opinion about them without confirming their content. Although the critical specification was to be provided and I offered the C/P some advice about them, I believe they would not be understood.

The recycling plant is relatively simple with conveyor belts for manual waste segregation. However, after checking the progress of the works for the access road and the leachate treatment lagoon, I doubt the Cuban side can build the facilities on their own. If careful consideration is not given to the feasibility of building such facilities, all may turn out to be just a fantasy.

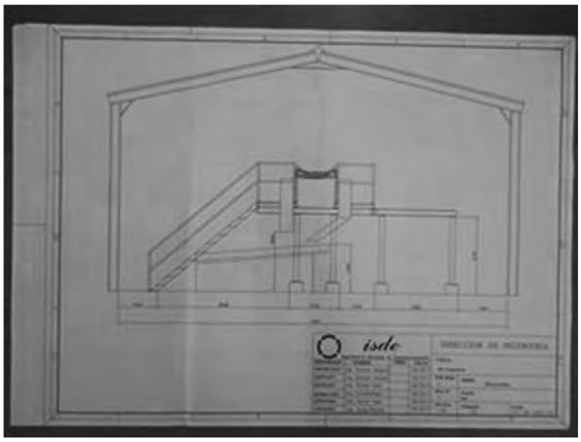


Photo 6-18: A section of the conveyor belt for waste segregation

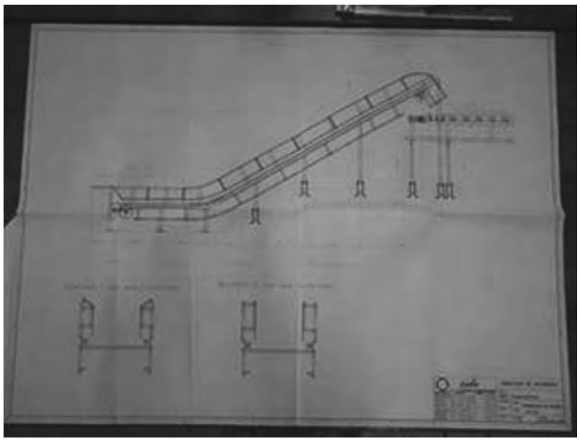


Photo 6-19: A plan of the conveyor belt

c. Construction of the Oxidation Pond

I was informed by Mr. Basilio, from DCH, that an oxidaton pond with thick covering is currently being built at Las Guásimas, Arroyo Naranjo municipality, in Havana City. I went there along with Mr. Hermes, a C/P member.

We wanted to confirm the reports that the clay being used there is the same clay to be used for the New Guanabacoa landfill site.

Some houses are being built in the ouskirts of the city to compensate for the present housing limitations in downtown Havana. The oxidation pond is intended to treat wastewater generated by the new households.

Inside the pond reeds are grown to treat wastewater.

The construction of the oxidation pond is currently at a standstill after earth moving. Clay has already been placed at the bottom. As the grass has noticeably grown, the works seem to have been suspended for a very long time.

The slope has cracked partly due to the emergence of rocks. The pond bottom is rugged in some areas as earth moving works have not been executed accurately.

As the shape of the New Guanabacoa landfill site is planned to be complicated, I recommended that waterproofing with clay should be carefully analyzed to confirm its feasibility.

Photo 6-20: Oxidation pond slope

Photo 6-21: At the bottom of the pond with Mr. Hermes

Photo 6-22: Bottom waterproofing with clay

Photo 6-23: General view of the oxidation pond

7 Activities Carried Out During Assignment Period 5

Assignment Period：From April 24 to June 5, 2014

7.1 Summary of Activities

7.1.1 Training for the Operation of Final Disposal Sites

a. Activities carried out to put out fires and measures taken to prevent fires from breaking out

An extensive fire broke out in Calle 100 landfill site on May 12, 2014. A fire is usually put out by spreading and compacting soil using 2 bulldozers. Operators from other organizations and heavy equipment from a building site nearby to total 8 machineries had to be used this time though to extinguish the fire almost completely by May 15.

During the operations the expert checked the site condition on a daily basis and advised the site manager on the ways to quench a fire. He also gave DPSC’s Investment Division some advice on how to request priority supplies, as well as the measures to prevent fires from breaking out.

Photo 7-1: Fire at the Site

Photo 7-2: Fire at the Site

Photo 7-3: Operations to quench the fire at the site

Photo 7-4: Site condition after the fire was quenched and the wastes were covered with soil

Several fires have broken out at Calle100 landfill site since February. Cuban Communist Party leaders have requested DPSC to adopt relevant measures to prevent fires from breaking at the site. Seminars attended by the site staff were consequently held on May 7 and May 20 to tackle fire generation.

At the seminars the C/P's explained the role of the landfill site in solid waste management, whereas the expert referred to specific site operations and measures to be taken to improve the current situation. Discussions among the participants then ensued.

The second seminar was considered to be particularly effective as it took place immediately after implementing a number of operations to put out a relatively large fire, which helped the site staff both to understand the importance of measures to prevent fire generation and also to revise the operations currently being implemented to put out a fire.

Photo 7-5: Second Seminar

On May 5, when we visited Ocho Vías, some smoke was being generated at the site and the situation was worse than before. Then on our way to Guanabacoa, again we inspected the condition of Ocho Vías landfill site to confirm that the fire had been reduced, but smoke was still being generated in several areas within the site.

Photo 7-6: Fire Generation at Ocho Vías Landfill Site

Tarará landfill site has been managed relatively well so far. However, as some residents complained about unusual fly breeding and foul odor generation, we decided to visit the site accompanied by the C/P's. We discussed the measures to be taken and prepared a report about the current situation and the way to tackle it.

Initially there was almost 100m from the site to the nearest houses. However, as the slope gradient was reduced to spread and compact the wastes, the dumping area got increasingly closer to the nearby houses. We advised them to fill the dumping area up to its maximum height by moving already existing covered wastes to later proceed to final covering as soon as possible to create a buffer zone.

Figure 7-1: Measures to improve the current condition at Tarará landfill site

The construction of the railway line across Calle 100 landfill site has forced to build a new access road as soon as possible. The paved concrete road and the drainage ditch are almost completed.

We have confirmed that the works for the construction of the crossing pipe at the new access road have not been neatly executed, as can be seen from the casing frames left behind at the site.

Photo 7-7: Near the weighbridge at the new access road

Photo 7-8: Crossing pipe construction

b. Construction of the new Guanabacoa final disposal site

After securing a budget amounting to 1.2 million CUP for this fiscal year, a building company (Blas Roca construction crew) has been hired to build the new site.

They expect to obtain 4 million CUP for next year. However, if they can secure 6 million CUP by using some of the budget earmarked for other projects that are not executed, they anticipate to finish the works needed for the first section, including the wastewater treatment plant.

The contractor is the same company hired when the works were interrupted in November, 2011. However, there is a different crew in charge this time, so the relevant data and background information pertaining to the works previously executed should be passed on to them.

Site construction preparations began on May 16 and the main works were fully resumed on May 20, 2014.

A meeting was held to check the work execution. The recovery of the reference points, the designs, and bibliographies, were confirmed on May 23.

A meeting.

Site construction preparations.

c. New west final disposal site (site expected to replace Calle 100)

The microlocation has been authorized. The total surface area is being determined and the administrative building is being revised. The study and design are expected to take two years (2014 and 2015) and construction should begin in 2016. We visited the candidate building site together with DCH people and I gave them some advice about the future basic plan and design.

Confirmation of the candidate building site

A meeting to discuss future plan and design

8 Final Chapter

Nine (9) activities have been carried out from February 2010 to June 2014.

I have given some advice adjusted to Cuban conditions so that based on a design the country itself may build the first sanitary landfill site despite the serious shortage of budget, materials, fuel, heavy equipment, etc.

At present, if the initial design is improved to become an environmentally-friendly landfill site, Cuba itself may build it based on an enhanced design. However, judging from my local experiences, the design should be revised every time an unforeseeable difficulty arises during the site construction.

For example, when they used clay as waterproofing material, I should have been able to give some advice regarding the proper measures to be taken depending on the possible execution scenarios. However, as it cannot be anticipated now how the use of a different kind of clay may affect the specifications of the pipes to be used for leachate collection and drainage, I was allowed to prolong my assignment for another two years. However, as the budget was not secured and the contractor's capability proved to be limited, construction works stalled for two and a half years, and I could not offer my input.

Regarding the leachate treatment plant, as in Cuba the specific model cannot be selected if the budget is not secured, the detailed specifications of such imported items as the aerator have not yet been determined.

In addition, the designer has not achieved a detailed practical design, but only a basic design of the leachate treatment plant.

Based on the above, work execution monitoring is deemed to be extremely important after the project term. However, as there is not enough experience in Cuba in this regard, some assistance by Japan is required.

On the other hand, it is extremely difficult to determine the right time to dispatch a Japanese expert to Cuba judging from the existing budget allocation situation, the Cuban way to deal with unexpected prioritized issues, and the fact that construction works will certainly be occasionally stalled due to lack of heavy equipment at the site.

The Cuban side is working on the design of the New West landfill site to replace the existing site at Calle 100.

The designer from DCH continues to be involved with the design of the New West landfill site. However, as many C/P members from DPSC and UPPH resigned during the project implementation, I am afraid they do not make the most of the lessons learned during the project in terms of work execution monitoring.

Existing final disposal sites affect the surrounding environment. As they have already exceeded their capacity, they should be properly shut down immediately after substitute sites are found to replace them.

However, the construction of substitute sites, including New Guanabacoa, is slow. Therefore, it is important to fully cover and compact existing waste dumping areas.

This is understood by the site staff, but decision makers and investors are not fully aware of the existing critical situation due to lack of communication with the working sector. Consequently, the resources needed such as fuel and heavy equipment continue to be lacking.

Consequently, there arises a vicious circle in which fires break out due to lack of resources and some operations have to be carried out to quench them, while, on the other hand, regular operations are not properly executed, thus bringing about that the wastes are poorly compacted and inadequately covered with soil.

People from the investment department and decision makers should visit the sites more often to accurately identify the site condition and know the actual work scenario.

Moreover, a positive environment should be created so that the site staff can provide the investment and decision-making sectors with ideas about how to improve exiting situation.

Of course, all this cannot be achieved overnight. However, I hope Cubans can make the most of their originality to solve existing problems and may eventually build environmentally-friendly landfill sites that they can later manage properly.