K.4.2 Movement of Injected Water in a Conceptual Model

K.4.2.1 A Conceptual Model

A conceptual groundwater model was developed to understand the movement of injected waste water in the saline aquifer. The finite difference computer software VISUAL MODFLOW simulates three dimensional groundwater flow and solute transport. It was used to generate steady-state hydraulic heads and solute concentrations for each hydraulic conductivity of the assumed aquifers. Solute concentrations in the model are expressed as mg/l of chloride, in which 1 mg/l as fresh water and 100 mg/l as sea water. However, the model does not take density-dependent flow into account in order to simplify the behaviour of the waste water plume.

a. Model Mesh and Injection Well

The model has a rectangular area of 2100 m x 2100 m and a depth of 300 m. It is composed of 14 layers. The assumed elevation of the surface is 5 m and the bottom of 14th layer is -295m. The entire model domain is divided into 50 rows, 50 columns and 14 layers. A total number of finite difference cell is 35,000 as shown in Figure K-35 and Figure K-36.

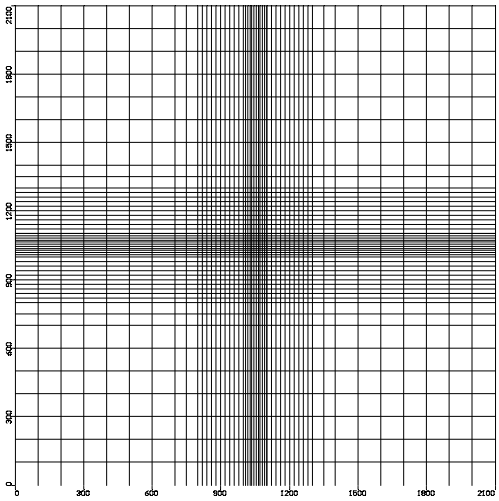

Figure K-35: Finite Diference Cells in the Plane

The model faces to the sea in its right column. In the center of the model domain, an injection well is located. The depth of the well is 125m and its screen position is from -110 to -120m of 10th layer. Waste water is injected into 10th layer at a rate of 3,880 m^3/day (45 l/s).

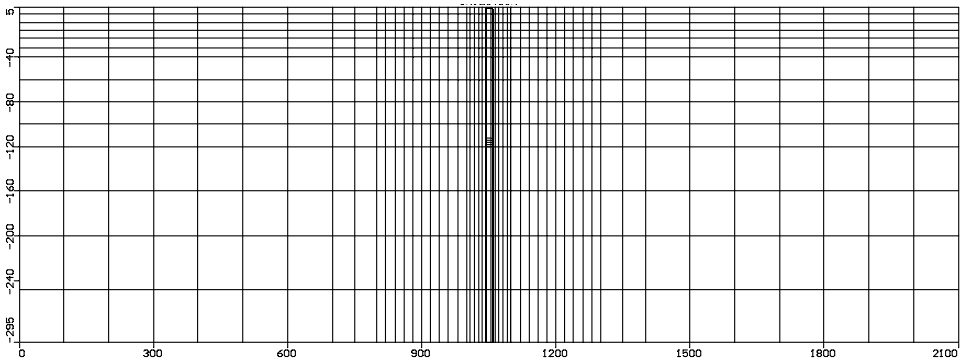

Figure K-36: Finite Difference Cells in the Cross Section

b. Boundary Conditions

b.1 Flow Boundary

The boundary conditions for the flow model are shown schematically in Figure K-37. In the inland, the left column, hydraulic head of 3.0 m was specified as a constant boundary. On the other hand, in the coastal area, right column, 0 m (mean sea level) was specified as a constant boundary. Most upper row and lower row are the no-flow boundary (impermeable boundary). The boundary of the bottom layer is also a no-flow boundary.

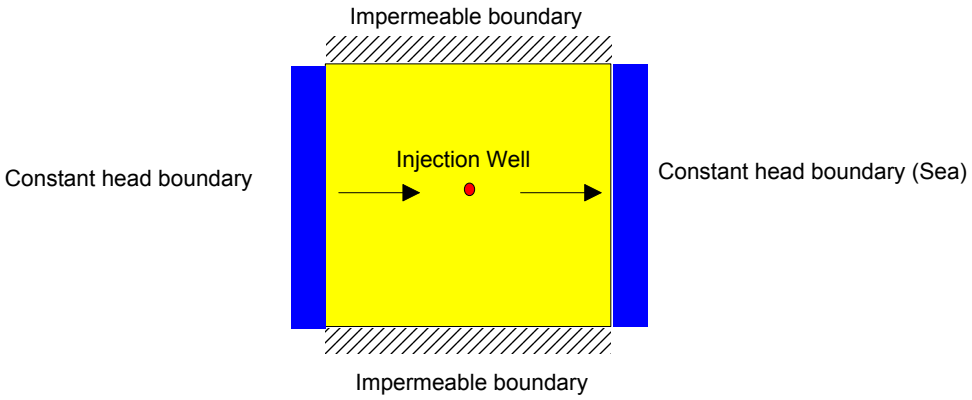

Figure K-37: Boundary Conditions for the Flow Model (Plane)

b.2 Transport Boundary

Fresh water flows into the entire model area from the upper 5 layers in the left column and flows out through upper 5 layers in the right column. Therefore, constant concentration of 1 mg/l was specified at these columns. On the other hand, from 6th to 14th layer, left and right columns were specified at 100 mg/l of concentration as sea water. The bottom boundary is a no-transport boundary as shown in Figure K-38.

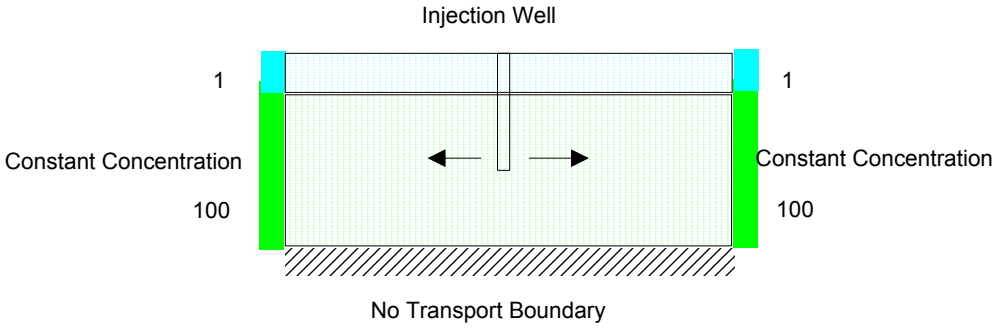

Figure K-38: Boundary Conditions for the Transport Model (Cross Section)

b.3 Initial Concentrations

Initial concentrations of the model were specified at 1 mg/l for 1st to 6th layer and 100 mg/l for 7th to 14th layer. Concentration of the injected waster water was 1 mg/l and it was kept constant during simulation period.

K.4.2.2 Model Parameters

a. Flow parameters

Hydraulic conductivities of the model were decided considering the published values in the limestone aquifers in the Yucatan Peninsula (Refer to Conductivity table in Section 1.3.1). The combination of horizontal and vertical conductivity for each model simulation run is presented in Table K-15.

Specific storage, specific yield, effective porosity and total porosity were assigned 1e-4, 0.2, 0.15 and 0.15, respectively.

b. Solute transport parameters

These parameters were assumed considering the published values. Longitudinal dispersivity was assigned 10 and horizontal to longitudinal ratio and vertical to longitudinal ratio were 0.1 and 0.01, respectively. Molecular diffusion coefficient was 0.0.

c. Recharge

Recharge was not considered.

Table K-15: Assigned Hydraulic Conductivity Values by Model Simulation Run

Simulation Run		Horizontal Conductivity (m/s)	Vertical to Horizontal Ratio
Model 2	Run 2-1	0.001	1/10
	Run 2-a	0.001	1/20
	Run2-b	0.001	1/40
Model 3	Run 3-1	0.01	1/10
	Run 3-a	0.01	1/20
	Run 3-b	0.01	1/50
Model 4	Run 4-1	0.005	1/10
	Run 4-a	0.005	1/20
	Run 4-b	0.005	1/40
Model 5	Run 5-1	0.002	1/10
	Run 5-a	0.002	1/20
	Run 5-b	0.002	1/40
Model G	Run- g1	0.001 and 0.01*	1/10
	Run-g2	0.001 and 0.01*	1/50

* 0.01 was assigned to 10th layer.

K.4.2.3 Model Results

The model was used to evaluate the behaviour of the injected waster water plume in the saline aquifer composed of 7th to 14th layers. The shape and size of a plume depend on the layer's configuration, flow and transport parameters and the injection rate and its continuity. In this model simulation, effects of hydraulic conductivity value and its vertical to horizontal ratio were evaluated by examining areal and vertical extent of the plume.

a. Effects of horizontal permeability

Areal extent of the injected wastewater plume in 10th layer is shown in Figure K-39. The plume shows elliptical shape and extends along direction of groundwater flow toward sea. In accordance with increase of the horizontal conductivity, the width of the plume becomes thin in *y*-direction and long in x-direction, and the wastewater spreads in the saline water layer rapidly. In case of low hydraulic conductivity, groundwater is moving relatively slowly and the wastewater tends to spread more laterally to form a wider plume. The plume becomes stable where the wastewater injected into the aquifer at a constant rate as it is counterbalanced with saline water or reaches sea or shallow aquifer and emerges from the underground.

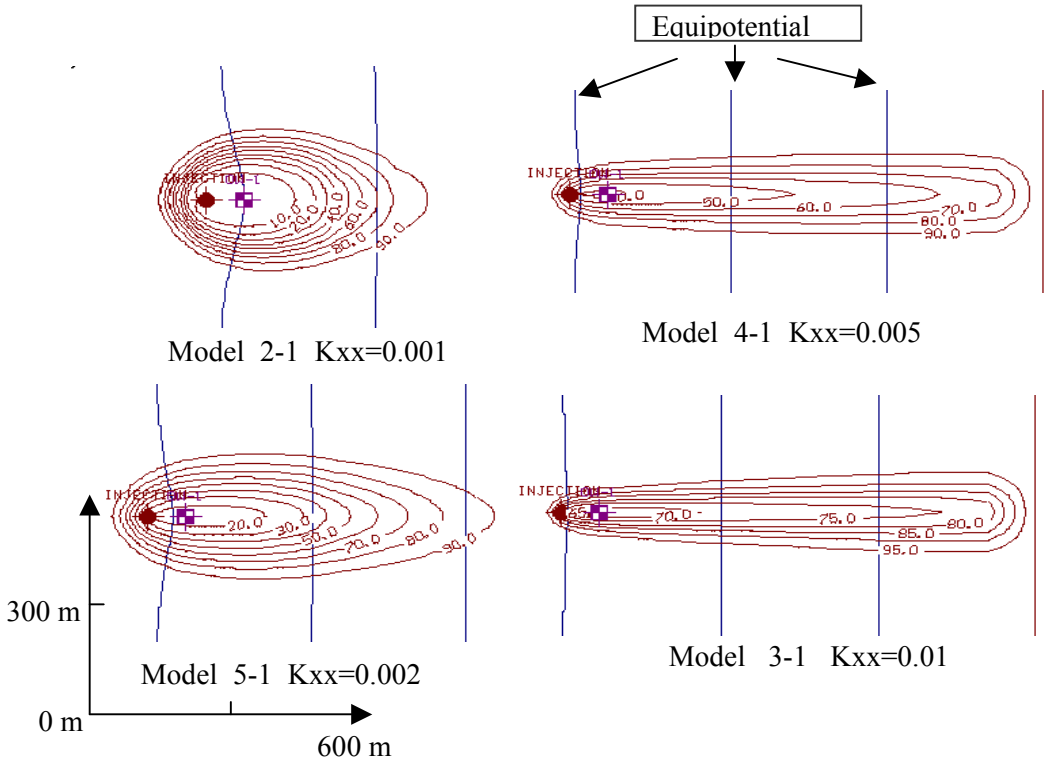

Figure K-39: Areal Extent of Wastewater Plume in 10th Layer

b. Effects of vertical to horizontal permeability ratio

Figure K-40 shows the cross sectional view of the plume at different vertical to horizontal conductivity ratio in Model 2. In case of Kzz/Kxx-1/10, the plume becomes thick and flows not only toward sea but shallow aquifers. Saline water is pushed upward and the wastewater emerges from the injected aquifer. In case of Kzz/Kxx=1/20 and 1/40, the plume flows more laterally. However, the transition zone is disturbed since saline water is pushed upward slightly.

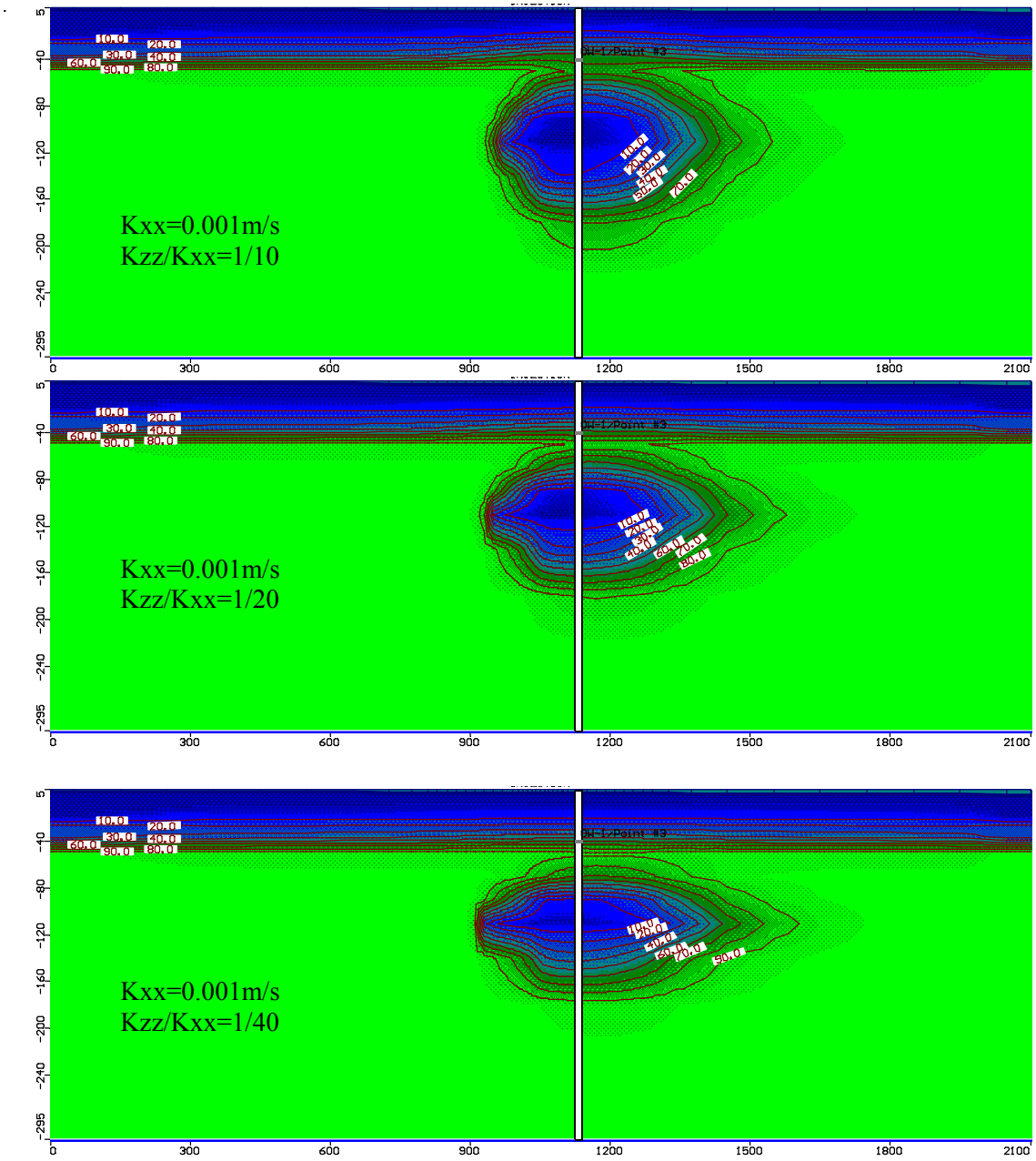

Figure K-40: Cross Sectional View of the Plume

c. Effects of high permeability layer

Cross sectional and plane view of the plume in the high permeable layer are shown in Figure K-41. The plume becomes planular as the permeability increases. In case of permeability contrast between two layers Kxx1/Kxx2 is 1/10 and Kzz/Kxx=1/40 (lower figure), injected wastewater plume does not go upward and flows laterally toward the sea.

K.4.2.4 Suggestion from Conceptual Model

The conceptual model simulation results provide the following simple but important suggestions for consideration of wastewater movement in the aquifers.

- Wastewater plume moves laterally and rapidly if permeability of injected layer is higher than that of overlying and underlying layers. Therefore, it is important to know the permeability of each layer and decide the layer to be injected. Depth of the injection point should be as deep as possible and the screen should be placed at the highest permeability layer underlying the low permeability layer.
- It is also important to know the anisotropy of permeability. The conceptual model result shows that the plume dose not flow upward and affect shallow fresh water aquifer if Kzz/Kxx is smaller than 1/40 or less. This anisotropy of the permeability must be verified by the field test.

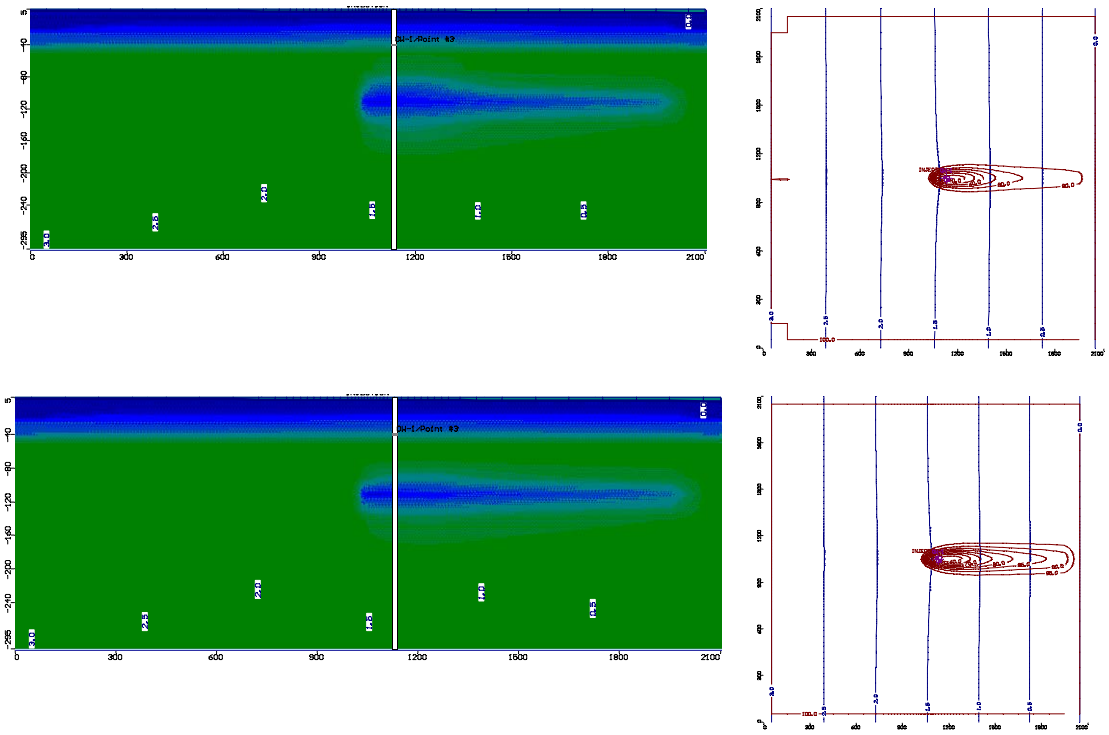

Figure K-41: Movement of the Plume in the High Permeability Layer

K.4.3 A Density-Dependent Model in Playa Del Carmen

K.4.3.1 Groundwater Flow Regime

Number of injection wells registered in CNA well inventories is 184 in Solidaridad province, which is largest among provinces in Quintana Roo State. Particularly, almost all wells are located in the coastal area along the national highway from Cancun to Tulum. Figure K-42 shows the location of injection wells in Playa del Carmen and its surrounding area.

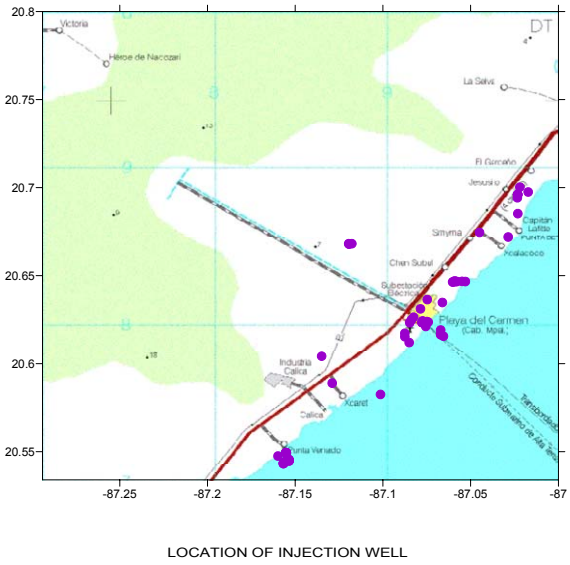

Figure K-42: Location of Injection Wells (Not modified)

A total volume of injection in Solidaridad province, which is licensed by CNA, is 26,663,721 m3/year (73,051 m3/day). An average injection rate per well is 397 m3/day.

Meanwhile, number of pumping well in Solidaridad is 222. Their distribution in Playa del Carmen is shown in Figure K-43. A total of licensed pumping volume is 2,132 LPS (184,205 m3/day) and an average pumping rate per well is 830 m3/day. If groundwater is being pumped as it is licensed, about 48 % of pumped water is returning to underground saline aquifers through the injection wells.

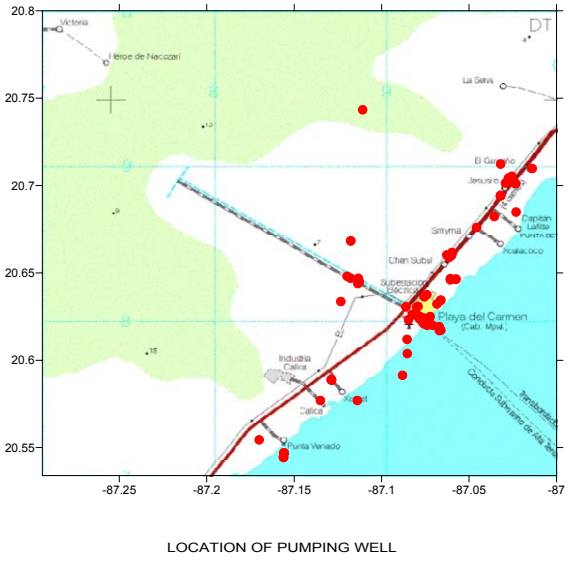

Figure K-43: Location of Pumping Wells (Not modified)

As shown in these maps, the coordinates of some wells are not correct. In addition, actual water volume which is pumped or injected is not recorded. However, groundwater flow regime in Playa Del Carmen is created by discharge (pumping) and recharges (injection) conditions in addition to natural recharge such as rainfall infiltration. Therefore, it is of useful to simulate groundwater flow and wastewater movement in the limestone aquifers considering discharge and recharge regime for assessment of wastewater disposal and establishment of injection norm.

K.4.3.2 Groundwater Flow and Solute Transport Model

The simulation of wastewater injection in the saline aquifer requires the solution of partial differential equations that describe " the conservation of mass of fluid" and " the conservation of mass of solute". To simulate movement of wastewater, FEFLOW was used. FEFLOW employs a two dimensional, finite element approximation of the governing equation in space and an implicit finite difference approximation in time. In this simulation, mass of solute is wastewater which has a density of fresh water. The saline groundwater has a density of seawater. Considering density-dependent flow, a vertical two-dimensional simulation model was developed along the line perpendicular to the coastal line of Playa Del Carmen .

a. Discretization and Boundary Condition

The vertical two dimensional model, 4,000m meter long and 200 m deep, was discretized to rectangular elements and 95 nodes in vertical direction and 1,001 nodes in horizontal direction (Figure K-44). A boundary condition is specified along the bottom of the node at a depth of 200 m, where the limestone is assumed to be impervious. A recharge boundary due to rainfall is specified on the top of the aquifer. Along the coastal boundary a hydrostatic pressure defined by

$$p = \rho_s g d$$

is imposed. Here, p is the hydrostatic pressure, ρ_s is the density of seawater, g is acceleration due to gravity, and d is the depth. Therefore, the pressure at the top of the boundary is zero and increase linearly with depth.

The boundary conditions for the transport simulation are dependent on the flow boundary conditions. Cf/Cs was specified at 0% in the recharge zone, where Cs is the concentration of the seawater, Cf is the concentration of the freshwater. On the other hand, Cf/Cs was specified at 100% in the coastal boundary.

b. Parameters

Although the aquifer is under major stress such as pumping and injection, it is assumed that the pumping is not considered because the well field for municipal water supply is located more than 15km away from the coast . The injection rate is constant with time and the aquifer is in a steady state condition.

No measurements of hydraulic parameters have been undertaken in Playa Del Carmen except dilution tests at the monitoring wells. But the conductivity estimation by dilution test is not reliable. Therefore, parameters, such as hydraulic conductivity, anisotropy of conductivity,

porosity, dispersivity etc are assumed as well as the parameters used in the conceptual model mentioned in the previous section. Several parameters are shown in Figure K-44.

Apart from the parameters mentioned above, the following fixed values was imposed in the computations: fresh water density ρ (1,000 kg/m3) , seawater density ρ s (1,025 kg/m3) , fluid viscosity μ (10-3kg/m/s), and the coefficient of fluid density change with $\partial C/\partial t$, where C is the concentration and t is time.

Injection rate of the wells in the simulation model was assumed and shown in Figure 1.3.3.3. It was specified at 0.1m3/day/m in the CAPA injection well. Injection rate of 0.02 m3/day/m was given to each assumed private injection well in the vertical model.

K.4.3.3 Results of Simulation

Figure K-45 shows the results of transport simulation by density dependent model. The upper figure shows a steady state condition of the flow, equi-potential line, the interface between fresh water and saline water and flow direction. As seen in the figure, freshwater flows from the inland to the coast, while the saline water flow from the coast to the inland. In the near shore, saline water flows upward and returns to the coast which is occurred due to density difference in saline and fresh water. In the transition zone, the flow direction is more complicated. The fresh water flows downward while the saline water flows upward.

The thickness of the freshwater is about 50m and 70m at 2.0 km and 4.0 km point from the coast, respectively. This value is rather thicker than the actual value. This is, perhaps, due to the difference of the saline water density imposed in the model and actual density. However, practically, the behaviour of the injected wastewater can be examined by starting from this steady state conditions as initial conditions of the model.

A long time after the wastewater injection, the flow and mass transport come to equilibrium as shown in the lower figure. As seen in the figure, injected wastewater flows upward at the CAPA well. It flows almost vertically along the well. Then, it flows horizontally to the downstream and upstream areas. It is interesting that the wastewater circulates in the bottom of the well. Some wastewater goes downward from the bottom of the well and it flows upward again. It is obvious that the wastewater finally flows into the freshwater aquifer and discharged to the coastal area in case of absence of the impermeable layer beneath the freshwater aquifer, even if the anisotropy of hydraulic conductivity is taken account. Accordingly, it is suggested that the wastewater must be injected into lower most aquifer beneath the impermeable layer and the screen of the well must be placed as deep as possible.

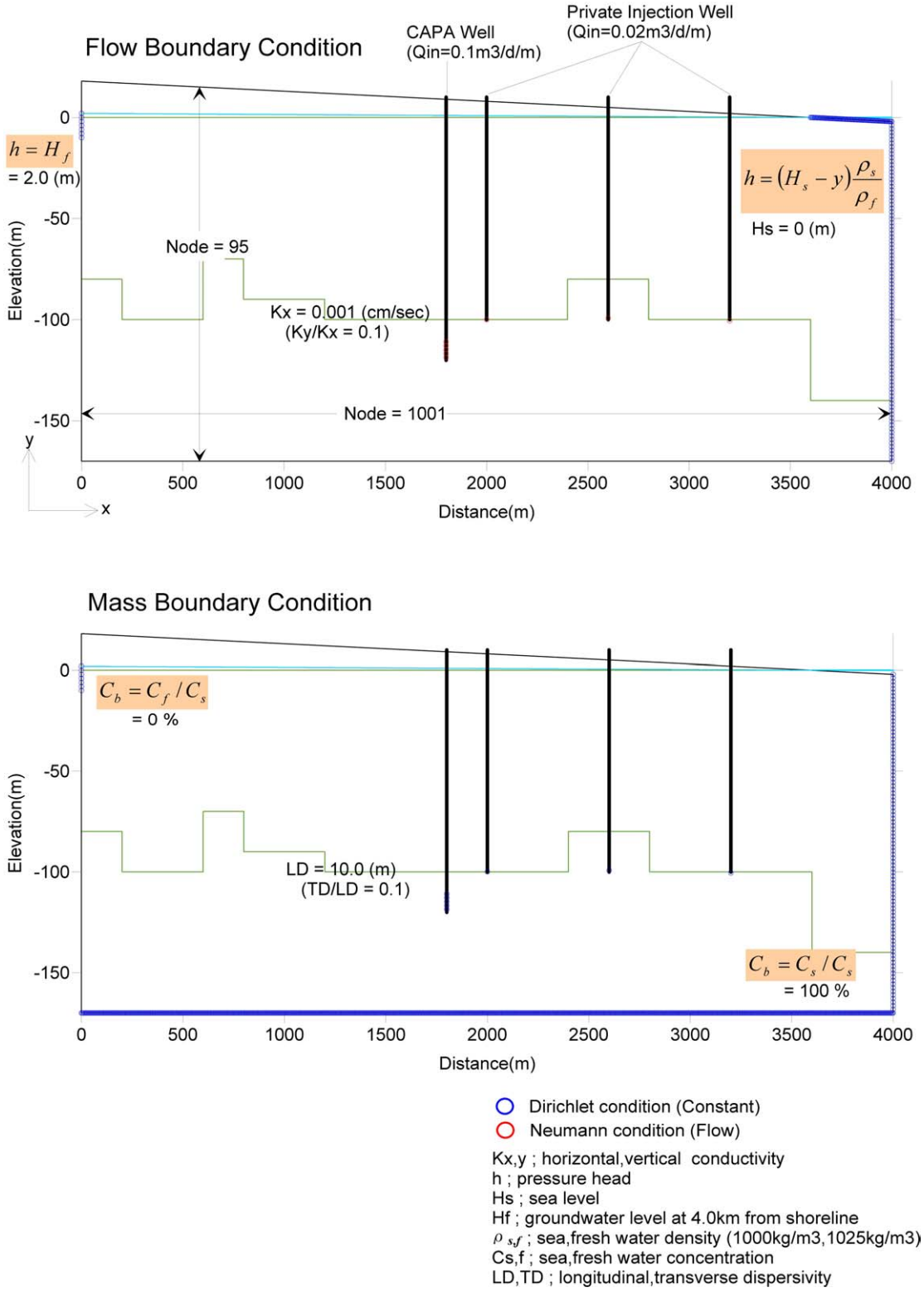

Figure K-44: Parameters and Boundary Conditions of the Model

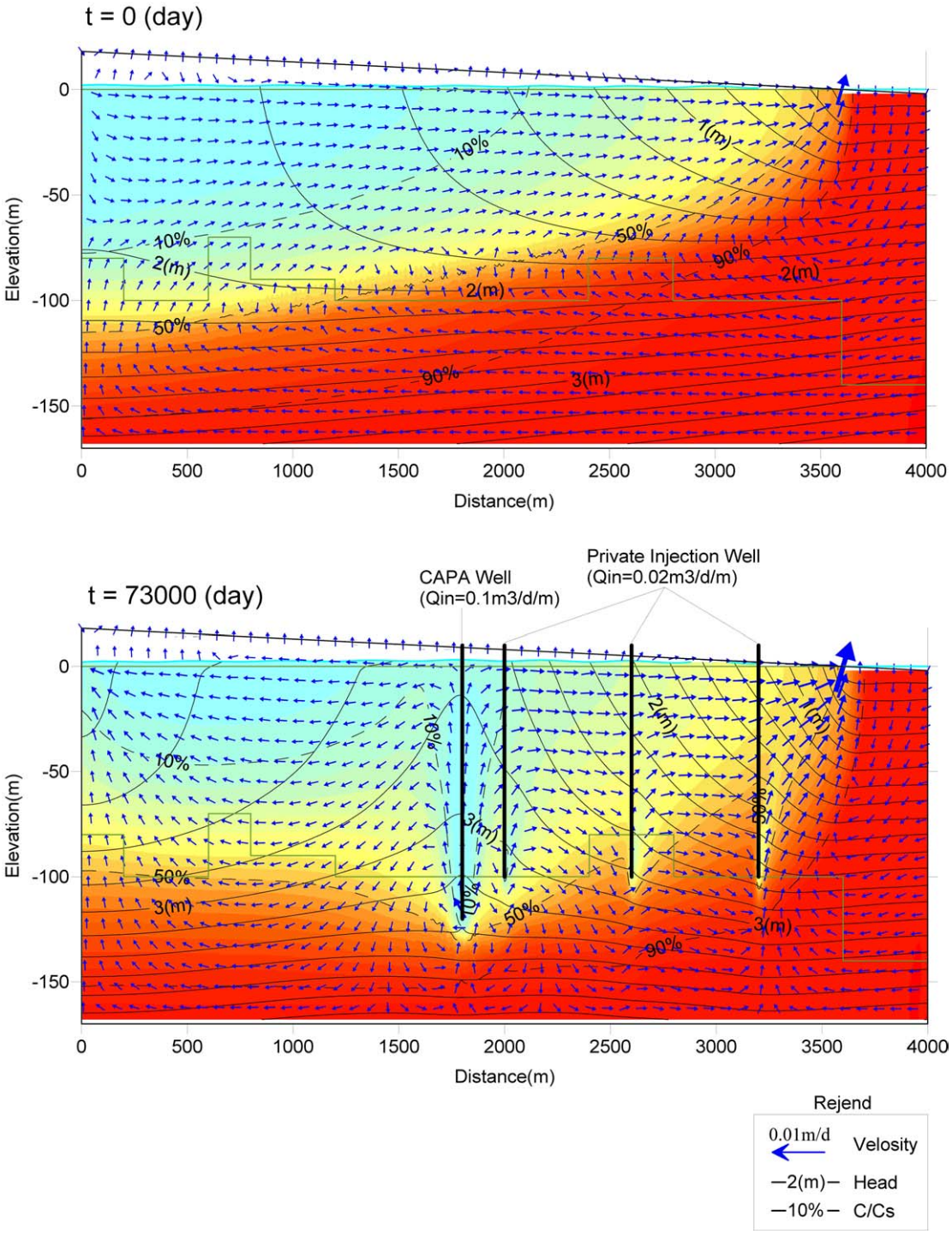

Figure K-45: Results of Density Dependent Flow Simulation

K.5 Summary and Recommendations

K.5.1 Summary of Hydrogeologic Study

K.5.1.1 Distribution and Characteristics of Limestone Aquifer

1) Underground geology of the study area can be geophysically divided into 3 resistivity layers, i.e. U1, U2 and U3, from the top to the bottom of 200m depth. These resistivity layers are widely distributed in the study area.

2) U1 layer distributes from the ground surface to the depth of 20～25m. This layer is composed of reef limestone and calcareous sandstone. It is abundant in fractures and cavities and becomes a freshwater aquifer indicating 3,000 μS/cm of electric conductivity. Drilling velocity of this layer shows 40 sec/25cm in the fracture zone. It also intercalates hard limestone bed which is showing drilling velocity of 200～400sec/25cm.

3) U2 layer is composed of limestone of abundant fractures and cavities caused by high karst development. The resistivity of the layer is less than 4 Ωm. The fractures and cavities are filled with seawater and the layer composes a seawater aquifer. Electric conductivity ranges from 5,000 to 20,000 μS/cm in the transition zone while it shows more than 40,000 μS/cm in the seawater zone. The thickness of the layer is approximately 50m. The drilling velocity is same as U1 layer. It partly intercalates hard limestone bed.

4) U3 layer is composed of limestone or muddy limestone showing 4～100 Ωm of resistivity. The facies of the low resistivity layer (4～25 Ωm) varies place to place and consists of alteration of hard and fractured limestone. The high resistivity layer (more than 25 Ωm) is not well developed in karst and composed of hard muddy limestone. This high resistivity layer is distributed at depth from 60 to 110m in the study area. The borehole drilled at the wastewater treatment plant (WTP) encountered this layer at depth of 62 m (Boring P4). This layer is compact and hard. It composes impermeable or semi-permeable hydrogeologic basement in the study area. Drilling velocity ranges from 400 to 1,200sec/0.25m.

5) Groundwater level of the boring sites ranges from 4 to 8m below ground surface. The thickness of the freshwater is about 20 m, but it increases more than 40 m in the inland area according to the geophysical survey. The seawater exists under the freshwater widely in the inland area.

6) According to the dilution tests, estimated range of permeability coefficient in U1 and U2 layer is 1.1 to 22.0 cm/sec.

K.5.1.2 Behavior of Wastewater Plume

1) The CNA injection well inventory shows that the number of the injection wells in Solidaridad province is 184 in notification basis. The daily injection volume runs up to 73,051 m^3, which is 397 m^3/day per well in average.

2) Treated wastewater is being injected into the injection well in the CAPA WTP in Playa del Carmen 3,880 m^3 per day (45 l/s). In addition to this well, another injection well is utilized for injecting untreated wastewater which exceeds ability of the WTP. It is said that the depth of these well is about 100m. But the record on the well drilling does not exist. Considering the geologic condition of the WTP, it is inferred that the wastewater is being injected into U2 layer.

3) Almost all injection wells in the study area have their well screens in U2 layer (seawater aquifer) as well as the WTP considering geologic conditions. There exists no significant impermeable layer between U2 layer and overlying U1 layer（freshwater aquifer）.Thereby it is inferred that the injected wastewater migrates upward to the freshwater aquifer. In addition, it flows through the annulus to the freshwater aquifer as the well is not sealed.

4) A mass transport model which simulates the behavior of the wastewater plume indicates that the plume migrates rapidly in horizontal direction in the seawater aquifer, if the permeability of injected zone is higher than that of underlying and overlying layers. Therefore, it is important to know the permeability of the layer, first. The injection zone should be deep as possible and the screen must be placed beneath the low permeable layer.

5) It is more important to know the anisotropy of the permeability in the layer. The simulation results suggest that the wastewater plume does not flow upward and affect overlying freshwater aquifer if vertical to horizontal ratio of the permeability is less than 1/40.

6) According to the density dependent flow model, the wastewater plume injected in the seawater aquifer migrates upward and affects the freshwater in case of the 100 m depth injection well.

K.5.1.3 Water Quality and Contamination

1) Groundwater quality of the monitoring wells shows (Na+K)-Cl type. Chloride concentration of the monitoring wells installed in the freshwater aquifer shows 600～1,800 mg/L. They are affected by the seawater. Chloride concentration of the monitoring wells

installed in the seawater aquifer shows 11,400～11,800 mg/L . It is inferred that the water is mixed with shallow fresh groundwater due to fully screened well structure. .

2) Comparing the water quality of the monitoring wells with WHO guideline value of drinking water, Cl, Na and TDS exceed the guideline in all the wells. High concentration of NH_4 was detected at the monitoring wells in WTP. This well was contaminated by the injection well located just upstream of the monitoring site. The monitoring well in Colonia Ejidal, which is not covered by the sewer system, shows high concentration of NH_4 indicating man-made contamination. High concentration of SO_4 was also found at the monitoring wells in WTP.

3) Contamination of trichloroethylene and heavy minerals were not detected.

K.5.2 Recommendations

K.5.2.1 Necessity for Establishing Injection Norm

The municipal water supply in the 3 province of the study area rely on the well fields, which are located in the inland areas some 15～40km away from the coast. Surrounding areas of the well filed are, presently, forest, grass and farm land, and groundwater contamination has not occurred yet. However, groundwater may be contaminated in the near future due to discharge of domestic wastewater to *Cenote* and seepage of fertilizer and pesticide etc. There may be unknown underground caves in these area and groundwater flows through the caves and the aquifer to the down stream area.

On one hand, the wastewater is being injected into the underground in the coastal urban area. In Playa del Carmen area, hard muddy limestone formation is widely lying at depth from 60 to 110 m. Therefore, the wastewater is injected into overlying limestone aquifer (seawater aquifer), which is abundant in fracture and cavities. The semi-pervious or impervious layer does not exist in between the seawater aquifer and the freshwater aquifer, thereby injected wastewater plume relative easily migrates upward and contaminates the freshwater aquifer.

The injection well structure is simple at present because the injection well norm has not established yet. As the fracture and cavities are abundant in the limestone, the well annulus (space between the bore wall and the casing) was not sealed with cement and clay (such as bentonite). The wastewater may leak through the well annulus and contaminates the fresh water aquifer.

As mentioned above, groundwater contamination in the freshwater aquifer is in progress in the coastal urban areas due to the wastewater injection. Since groundwater is finally discharged to the coast, seawater environment may be contaminated in the future. The sewer

system will be developed in the near future according to the master plan proposed by this study. However, it may takes some time until the urban area is fully covered by the sewer system. For the time being, wastewater injection must be continued, accordingly. In order to reduce pollution load in the water environment, the injection norm should be established and injection be controlled adequately.

The following section presents recommendations on the matters to be considered for the establishment of the injection norm.

K.5.2.2 Injection Zone

Wastewater should be injected into a formation below the lowermost formation consisting of muddy, hard and dense layer, which is thought to be confining layer and impervious or semi-pervious. The injection zone, on the contrary, must be sufficiently permeable, porous, and thick to accept injected wastewater at the proposed injection rate without requiring excessive pressure. Ideally, the injection zone should be homogeneous. It should be of sufficient areal extent to minimize formation pressure buildup and to prevent injected wastewater from upward migration to fresh water aquifers. If such injection zone is found, the wastewater could be contained in the geological structure.

In the study area, high resistivity part of U3 layer (muddy limestone), which is lying at depth from 60 to 110m, is semi-pervious or impervious and meets the above conditions. However, presence of porous and permeable layer beneath U3 layer is not yet confirmed. If a permeable and porous limestone layer or bed exists beneath or within U3 layer, it should be utilized for an injection zone. In that case, the depth of the injection well becomes at least more than 200m and drilling cost will be doubled or more expensive. This point should further be discussed in relation with the cost for expansion of the sewer system.

K.5.2.3 Regional Geological Survey For Selection of Injection Zone

In order to select appropriate injection zone, regional geological survey should be conducted in the urban areas of 3 provinces in the study area. The survey should consist of the following items.

1) Data collection, Arrangement and Hydrogeological Mapping

Data and reports on the geological survey, borehole drilling, groundwater level and water quality etc should be collected and arranged. It is advisable that the drilling industries should assist data collection. Based on the data, the hydrogeological map of each urban area should be prepared.

2) Geophysical Survey

Geophysical survey should be conducted to explore resistivity structure and fresh water-saline water interface in each urban area. The TEM method of exploration should be performed to detect more than 400m depth. In Playa del Carmen, resistivity profile of 200 m has already been clarified. Therefore, a supplementary survey should be conducted to explore resistivity structure more than 400m depth.

3) Exploratory Borehole Drilling and Logging

Based on the arrangement of existing data (hydrogeological maps) and geophysical survey results, the exploratory borehole should be drilled at each urban areas to investigate drilling velocity, resistivity, spontaneous potential of the formations, and temperature and electric conductivity of groundwater etc. A target drilling depth is 400m.The facies and characteristics of the limestone are confirmed by observation of the core and geophysical logs. Depth and areal extent of most suitable injection zone is confirmed by analysis of rock characteristics compared with the resistivity layer. In-situ test, such as permeability test, is conducted and permeability coefficient and porosity of the formation are decided.

The depth and zone of the injection well in each urban area is standardized according to analysis of the geological survey results mentioned above.

K.5.2.4 Structure and Construction of Injection Well

The injection well should be designed and constructed such that it does not allow any fluid to escape the injection string or any fluid to migrate in the borehole to shallow fresh water aquifers.

Environmental Protection Agency (EPA) of USA is implementing “Underground Injection Control: UIC” Program and classifies the injection wells into 5 categories. Figure 1.1（left）shows an idealized design of injection well using example from Class I injection well of UIC. Municipal wastewater, hazardous waste and industrial non-hazardous liquid can be injected in the class I well. In case of hazardous wastewater, the well casing is tripled, that is the surface casing, the well casing and the injection tubing, and these casing are properly cemented on the outside. The packer is set on the bottom of the tubing.

In UIC program, the injection zone is set on the formation beneath the lower most freshwater aquifer (Underground Source of Drinking Water：USDW）.

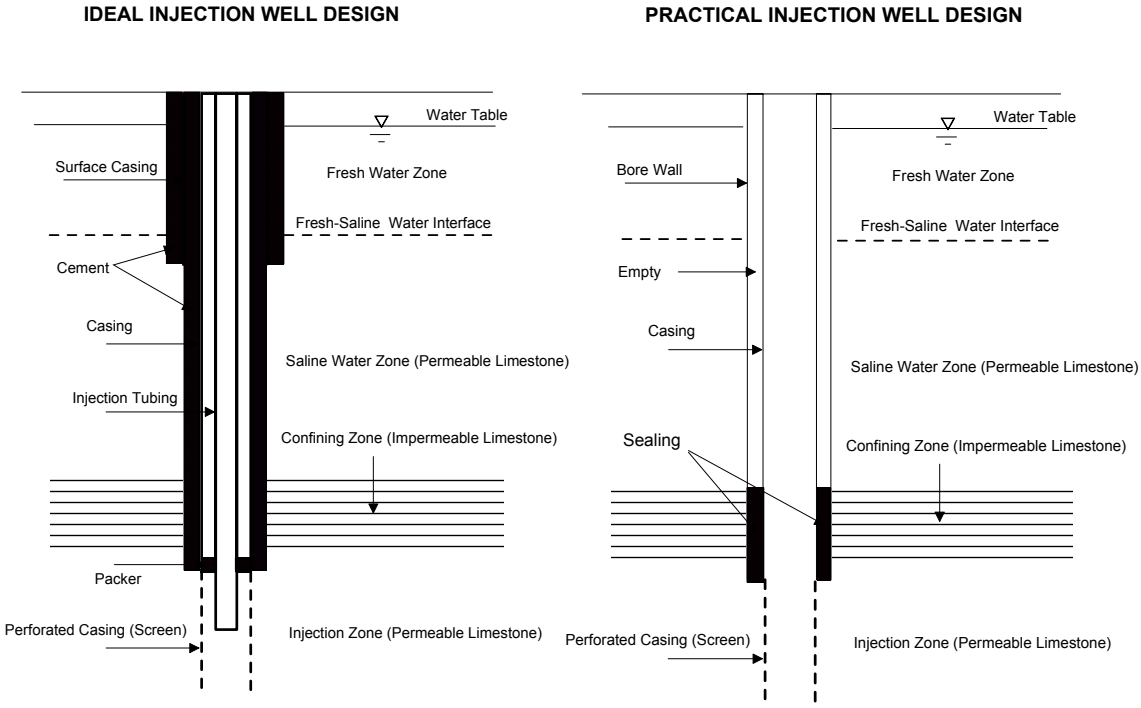

Figure K-46: Design of Injection Well (left: Ideal design right: Practical design)

Figure K-46（right）shows a practical design of the injection well. It was designed simple and practical considering geologic conditions and groundwater utilization in the study area. It is very important to place the perforated screen in porous and permeable zone below the confining impervious layer. If the lowermost layer above the injection zone is permeable, injected waster water migrates upward in spite of cement sealing outside the casing.

Aside from the wastewater migration in the aquifer, there are two possible well failures that causes well leakage. One is leak through hole in casing and the other is fluid movement through vertical channel in annulus. Casing rarely be damaged. However, there is a possibility of damage when it is placed in the borehole improperly. In order to avoid such damage, material and thickness of the casing should be carefully selected and the casings must be stored and used properly. In the well annulus, cement grouting must be performed sufficiently in order to avoid creation of bridge and space in annulus.

In the study area, the limestone layers (U1 and U2) which are abundant in fractures and cavities, distribute widely in the underground up to the depth of 60 to 110m. However, it is almost impossible to seal the annulus because the cement spills out in these formations. Considering this situation, the design is non-sealing in the upper formation as shown in Figure K-46 (right). If semi-pervious or impervious layer (confining layer) exists beneath the permeable layer, another porous and permeable layer beneath the confining layer should be injection zone and the sealing is made in the zone of the confining layer.

It is rather difficult to seal the well annulus partly in the borehole. The well drilling industries should held a workshop on the materials and construction method of the injection well under the guidance of CNA, and study, level up and establish the standard method of construction.

Figure K-47 (left) shows a conceptual design of the sealing using the packer. Figure K-47 （right ） shows the packer material.

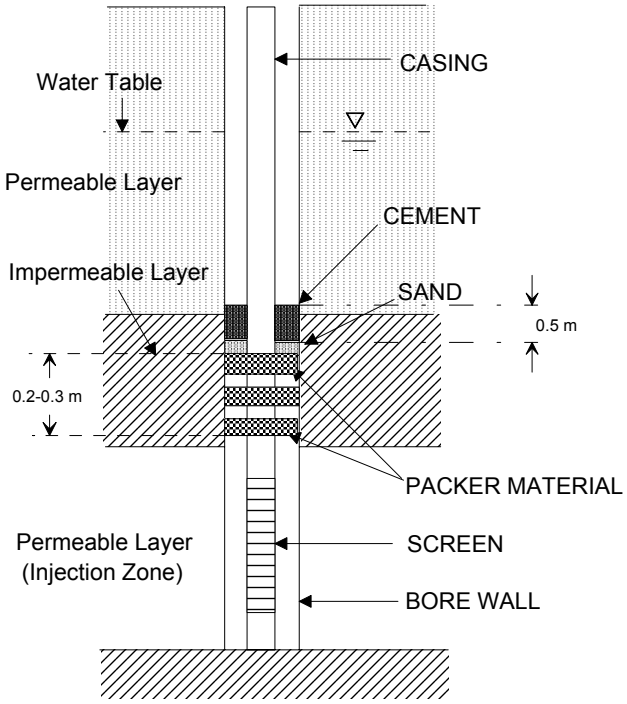

Figure K-47: Sealing by Packer (left) Packer Material (right)

The packer material is made of acrylic acid ester and synthetic rubber. It is swollen when it absorbs water as shown in the photo. The packer material is wrapped the upper part of the casing screen in three steps and placed in the upper part of the boundary between the injection zone and the impermeable layer. One or two days after installation of the casing, the upper part of the packer is filled with sand and cement.

Figure K-48 (left) shows a conceptual design of the sealing using the metal basket. Figure K-48 (right) shows an example of handmade metal basket for small diameter.

The metal basket originally utilized for the land subsidence monitoring well in Niigata, Japan in order to measure water level of a specific aquifer in the multi-layered aquifers. It is thought to be applicable in the injection well in the study area.

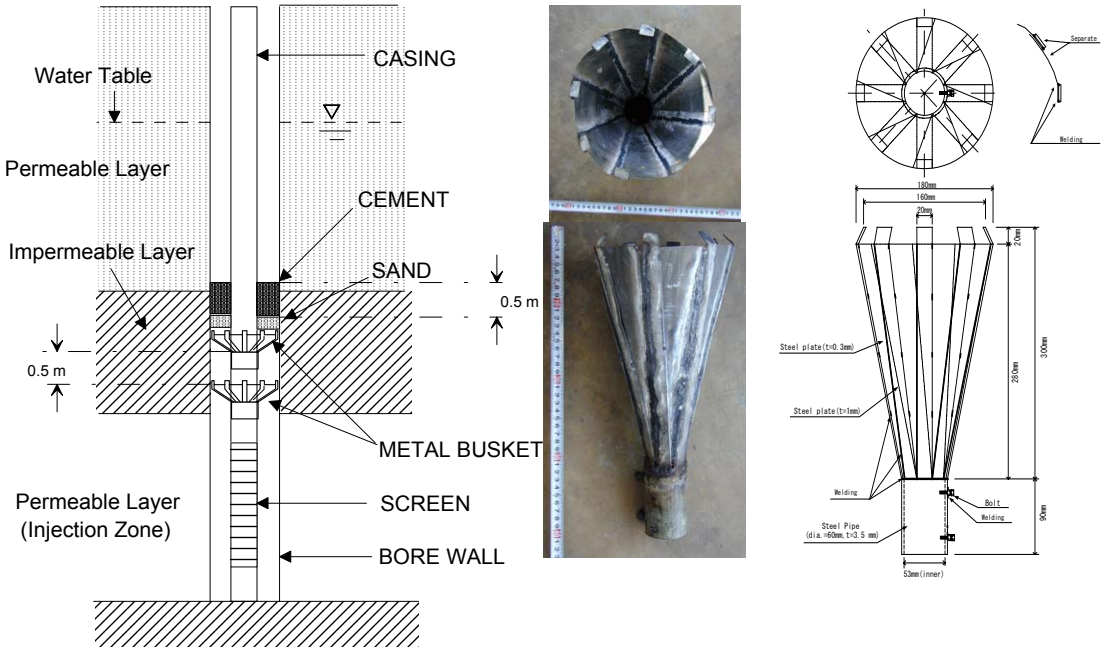

Figure K-48: Sealing by Metal Petal Basket (left) Metal Basket (right)

Two metal baskets are installed in the upper part of the screen casing at 0.5m interval and placed in the impermeable zone. The palm leaf or net is spread out in the basket and the clay is filled inside. The metal basket opens like petals in the borehole and prevents falling of sand and cement filled in the upper part of the basket. The zone of the filling of sand and cement is decided considering the thickness of the impermeable layer.

K.5.2.5 Operation, Management and Monitoring

Notification to CNA on the injection well is necessary at present. Detail of notification includes the owner name of the well, the well location (seat) and the proposed injection rate etc. However, the structure of the well (depth, diameter, casing material, screen position, sealing etc.), columnar geologic section and quality of injected water etc are not recorded. In addition, reporting on the operation and management of the licensed well is not obligated with a loose rein. The CNA should immediately establish the system of reporting and monitoring on the operation and management of the injection well as well as the norm on the injection zone, well structure, injection rate and quality of injected water etc.

1) Operation and Management

The CNA should impose the well owner a duty on the recording of the injection pressure (in case of gravity injection, water level), the injection rate and the total injection volume. In addition to the above, the well owner must quarterly records the results of analysis of physical, chemical and biological parameters of the injected water.

2) Reporting and Inspection

The CNA receives a report from the well owner quarterly and makes on-the-spot inspections for the operation and management of the injection well in case of necessity. In order to open the way for inspection and issuance of improvement direction of the injection facilities, operation and management, the institutional and legal system should be enhanced as well as establishment of the injection norm.

3) Well Closure

Upon closing the injection wells, owner must submit a plugging and abandonment report indicating that the well was plugged in accordance with the norm and regulations enforced by the CNA in the future. In closing the well, the well should be flushed with a non-reactive fluid. Each cement plug should be tested for seal before the closure is completed.

4) Monitoring Network

The CNA established a groundwater monitoring network in the northern area of the Yucatan Peninsula bounded by the line from Cancun to Merida. This network should be expanded to the urban areas in the study area. The monitoring wells constructed in Playa Del Carmen, as a model project, should be incorporated in this network.

In addition to this network, deep observation wells should be constructed in the urban areas in order to monitor water quality and water level of the aquifer which is overlying the injection zone when the injection norm is established and the wastewater is injected into deeper aquifer than U2 layer in the future.

Annex L

Village Type Wastewater Treatment

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L Village Type Wastewater Treatment

L.1 Outline

a. Background

Although CAPA had operated sewage systems for large cities such as Chetumal and Playa del Carmen, it did not have a system for emerging small communities. Meanwhile, even in a city where a sewage system has been installed, connection of household effluent to the public sewer has not become widespread due to some reasons such as economic burden and existing septic tanks.

The mentioned above has led to a situation where the large investment cannot bring about an effect and the groundwater is continuously contaminated. In order to solve those problems, a Model Project, “the Village Type Wastewater Treatment,” was planned and carried out in Subteniente Lopez, Chetumal in the Municipality of Othon P Blanco.

Wastewater treatment facility and sewer pipes in Subteniente Lopez were constructed by CAPA. This model project was to support the CAPA’s project and so that the CAPA would gain experience which could expand such village type wastewater treatment system to the other emerging communities.

b. Project Design Matrix

Project Name:	Period:	Version:
Village type wastewater treatment	January 2004 – End July 2004	No.1
Target Area:	Target group	Date:
Subteniente Lopez in Othón P Blanco	Personnel of CAPA, residents in a target area	December 2003

Project summary	Indicators	Means of verification	Important assumptions
Overall goal Establishment of small scale sewer system	1. Number of connections 2. Community response 3. Treatment effect	1. Observation of nos. of connection 2. Public hearing 3. Operation record of treatment facility	Continuous effort of stakeholders to reduce environmental impact from wastewater management
Project purpose 1. Establishment of a fund to support residents to connect sanitary sewers 2. Get a data for design & operation of small sewer treatment system	1. Number of used support fund for connections 2. Comparison of original design data and actual measured data	1. Actual number of connection and used support fund 2. Observation and data collection of treatment facility	Completion construction work of sewer system by fixed date
Outcomes 1. A manner to encourage introduction of a sewer system in a rural community 2. Technology of designing, constructing and operating the sewer system is established.	1. Number of used support fund for connections 2. Comparison of original design data and actual measured data	3. Actual number of connection and used support fund 4. Filed investigation (intake, treated water quality, intake amount and hourly fluctuation, etc.)	Completion construction work of sewer system by fixed date
Activities See the table below	Inputs See the table below		Pre-conditions Completion construction work of sewer system by fixed date

Activity Table

Activities	Outputs	Period	Inputs by S/T	Input by C/P
1. Planning of diagnosis	Diagnosis Plan	January 2004	Collaboration	
2. Implementation of diagnosis	Results of diagnosis	Ditto	Collaboration	
3. Design of connection works	Design and drawings for connection work	Ditto	Collaboration	
4. Preparation of order	Contract documents, specifications	Ditto	Preparation of order	- Acquisition of required permits - Meeting to explain to local residents
5. works	Record of works		- construction works - supervision	- Supervision
6.Filed works	Actual data		Collaboration	
7.Pre-evaluation	Pre-evaluation report		Collaboration	
8. Drawing up a manual (draft)	Manual (draft)		- Preparation of manuals (draft)	- distribution manual
9. Operation	Operation record		- Advice and guidance	- operation
10. Monitoring	Monitoring record			- monitoring
11. Evaluation	Evaluation report		Collaboration	
12.Drawing up the manual (final)	Manual (final)		-duplication of manual (final)	- distribution and use of manual

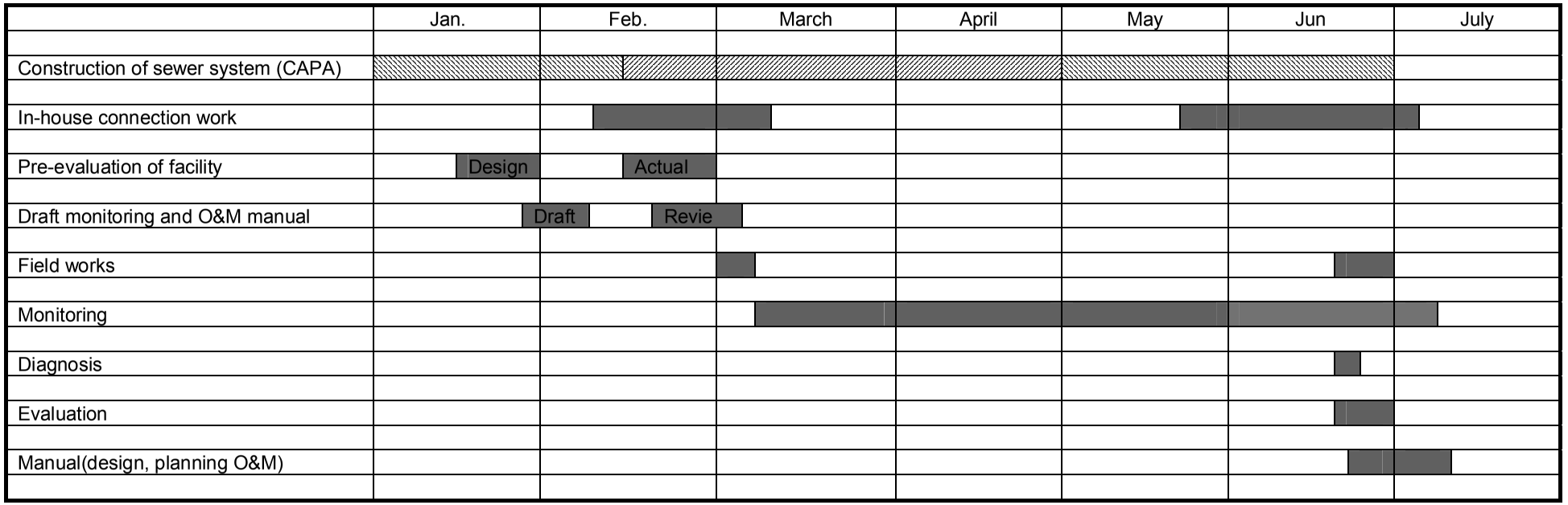
Input

Input	Study Team	Counterpart
Personnel	• Main: HiK • Assistant: • Support: IcK, MaK	• Main: One • Assistants: some • Participants: to be clarified
Material	• Manual (draft): 30 copies • Supersonic flow mater • Water quality analysis • Manual (final): 30 copies	• In charge persons • Electricity supply to measuring equipments

Task Table

Activities	Tasks
1. Planning of diagnosis	• Discussion meetings with C/P on the purpose of the Model Project • C/P: Preparation of treatment facility design data • Field investigations • Diagnosis of original treatment facility design
2. Implementation of diagnosis	• S/T: Preparation of analytical scheme
3. Design of connection works	• Design and drawings for connection work • Implementation plan
4. preparation of order	• Technical specification • Selection of Contractors • Contract document
5. works	• Quality control • Schedule control
6.Filed works	• Data recording of hourly inflow of wastewater • Water quality analysis at intake, in process and at outlet • Technology transfer of operation of the wastewater treatment facility
7.Pre-evaluation	• Design conditions • O & M method
8. Drawing up a manual (draft)	• Preparation of a guideline of performance assessment and facility design • Preparation of a guideline of operation and maintenance
9. Operation	• Follow recommended operation methods
10. Monitoring	• Operation record to be kept
11. Evaluation	• Evaluation based on the PDM
12. Drawing up the manual (final)	• Modification according to the evaluation of model project.

c. Work Schedule



L.2 In-house Connection Works

L.2.1 Concept


Septic Tank (sink hole)

One of major problems in view of Wastewater Management is that many households are utilizing septic tanks (sink hole) which seriously contaminate groundwater by infiltration. Main sewer lines are constructed by public services, so the residents are expected to connect the lines from their septic tanks to the sewers by their spending. However, the residents often hesitate to pay for the connection. Cost of the connection ranges from 3,000 and 5,000 pesos/household depending on the condition. Consequently, rate of connection to sewer system remains low.

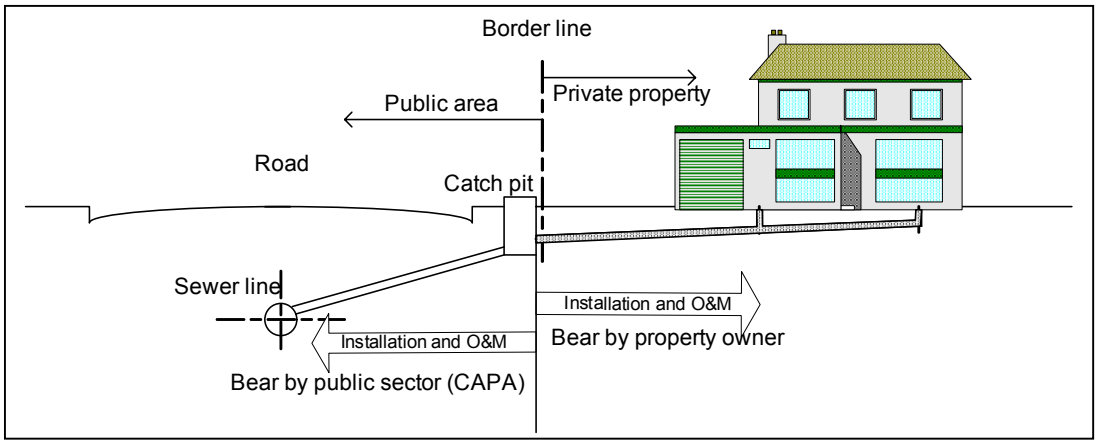


Figure L-1: Burden Share of Household Connection

In order to solve this problem, the following activities are conducted.

- In the Model Project, 99 houses are to be connected to the sewer system by means of financial support from JICA.
- The CAPA collects the fees from the resident; the fees are required for the connection and apart from ordinary sewerage charge.
- The in-house connection fund to be established. The collected fees to be deposited in the fund.
- In addition to the collected fees from the residents, funds from CAPA, subsidy from CNA and other funds to be accompanied. Then, connection to sewer to be encouraged by using the fund.

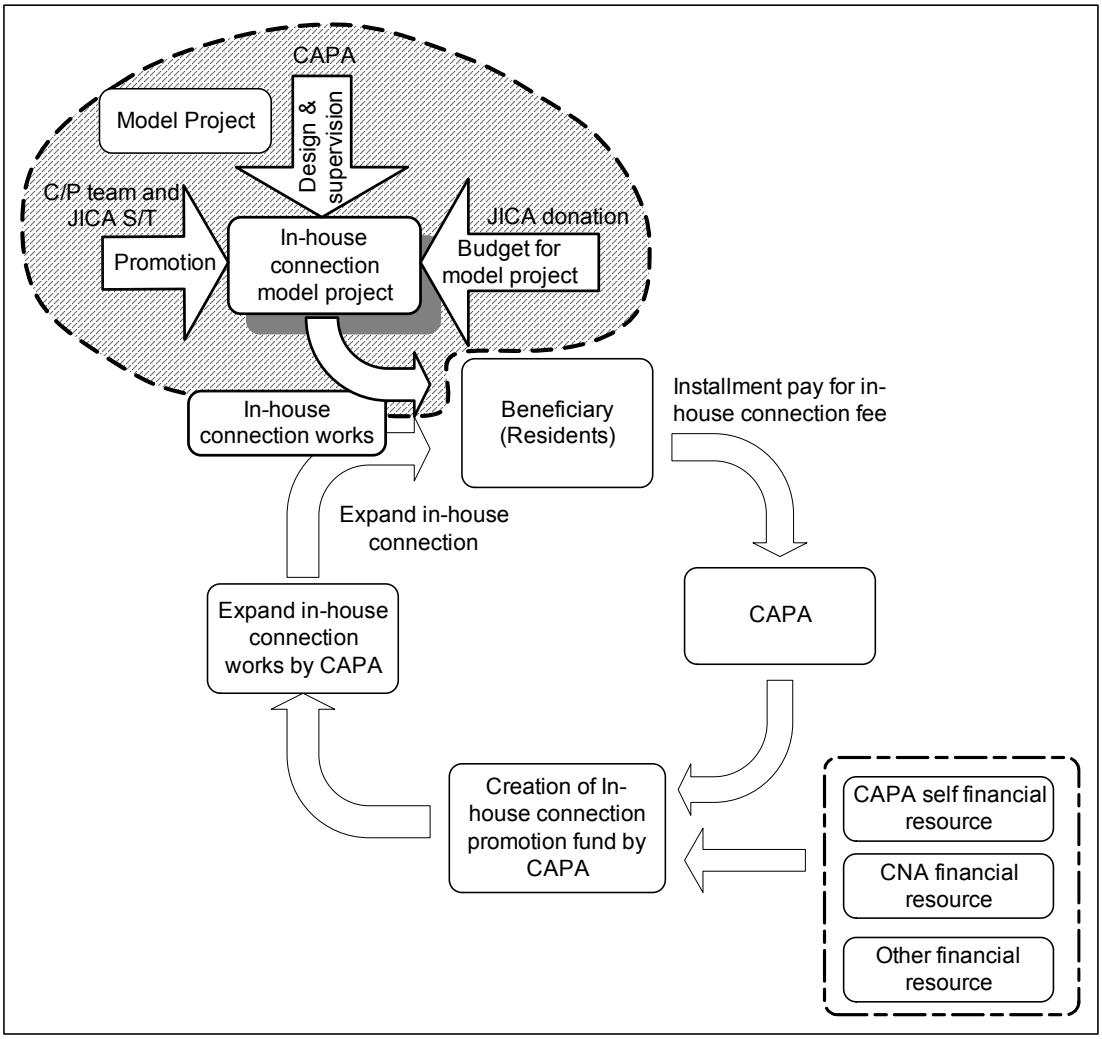


Figure L-2: Concept of Model Project and In-house Connection Fund

L.2.2 Selection of User for Model Project

At present, there exist about 390 households in the project area, Subteniente Lopez in Othón P Blanco. Some of them are illegal settlements or do not have contract with CAPA for water supply.


Sewer Line Installation Work

Prior to the Model Project, a village interviews with the explanation of sewage connection works were conducted among the residents having contract with CAPA in the project area. Then, 99 households showed their intentions for In-house Connection. The Model Project it to be carried out targeting on them.

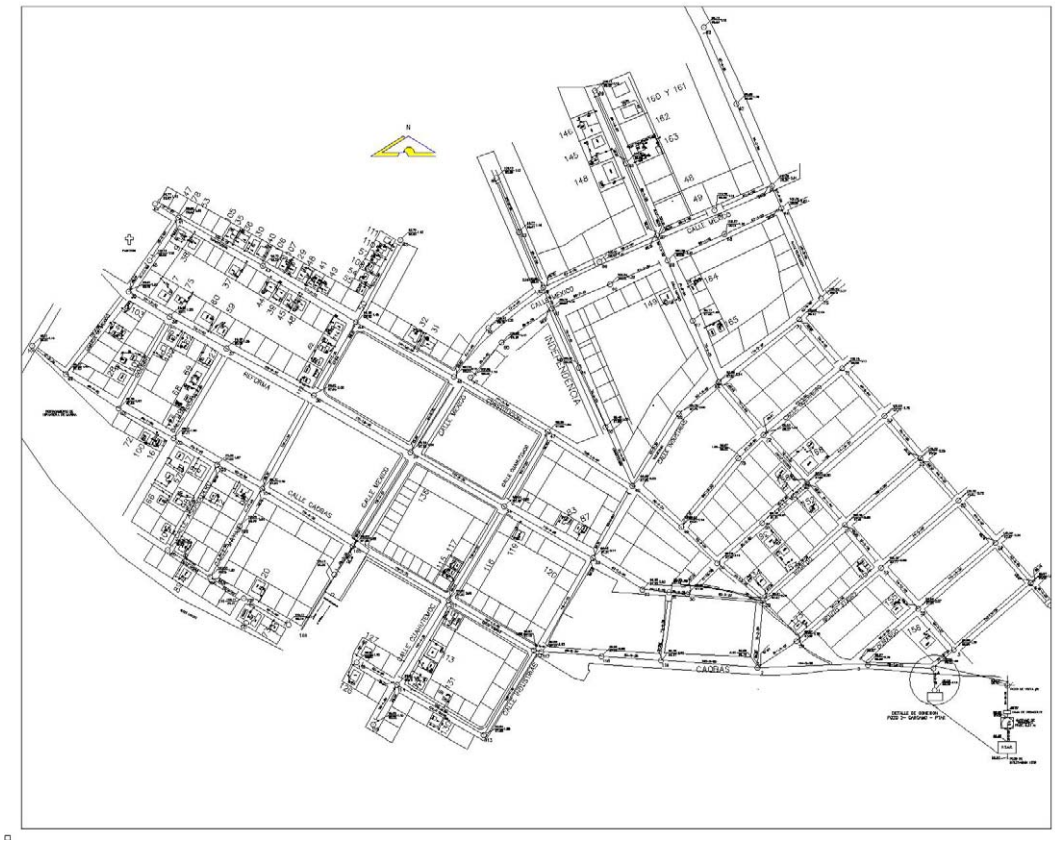


Figure L-3: Location Map of the Model Project

L.3 Pre-evaluation of Treatment Facility

L.3.1 Outline of Planning

Sewerage facility in the project area were planned and designed by CAPA. The table below shows design conditions and outlines. The facility is planned to be developed in two stages, i.e., target year in 2008 and 2023, considering with unknown factors such as future population change.

Table L-1: Design Conditions

	Life time 5 years	Life time 20 years
Population in 2003	1,678	
Population in 2023	2,320	
Target year	2008	2023
Target population	1,872	2,360
Wastewater generation rate (litre/person/day)	116.3	116.3
Treatment amount (m3/day)	212.5	274.5
Inflow BOD concentration (mg/litre)	220	220
Treated water quality (BOD mg/litre)	60	60
Sludge generation rate (m3/person/year)	0.04	0.04
Treatment Method	An-aerobic filter + aerobic filter + disinfection	

Table L-2: Outline of the Facility

Item		Descriptions
Screen pit		
Dimension		1.5m wide / 1.5m length /
Pump pit		
Dimension		3.0 m diameter / 7.3 m depth
Wastewater lifting pump		GORMAN-RUPP T4AS-B
	Capacity flow	111 US gpm (420 litre/min)
	Head	Total 42.3 ft (12.9 m)
	Dimension	suction 4in (100mm), discharge 4in (100mm)
An-aerobic reactor		
Number of reactor		2
Dimension		
	Primary	4.5m wide / 10.0m length / 2.15m depth
	Secondary	4.5m wide / 5.0m length / 2.15m depth
	Effective volume	Primary:85.5 m3, Secondary:42.8 m3 (total 128.3m3)
	Total effective volume	256.6 m3
Aerobic reactor		
Number of reactor		1
Dimensions		4.5 m wide / 4.5 m length/ 2.05 m depth
Aeration blower		COMPETITOR model 3006
	Capacity flow	160 FCM (4.5 m3/min)
	Pressure	5 psi (0.35 kg/cm2)
Sedimentation tank		
Dimensions		4.5 m wide / 4.5 m length/ 1.95 m depth
Effective volume		35.3 m3
Surface area		20.3 m2
Total length of over flow weir		11.5 m
Disinfection Tank		
Dimension		0.8 m wide / 1.75 m length / 1.29m depth
Effective volume		1.8 m3

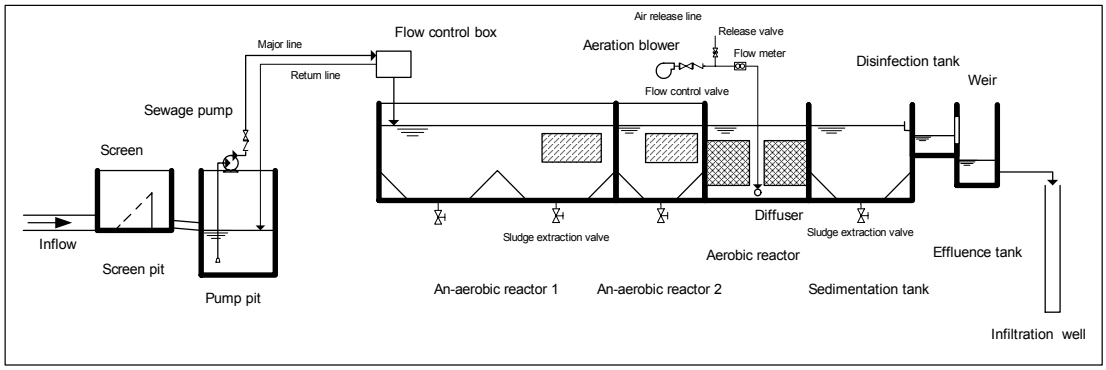


Figure L-4: Treatment Flow Sheet

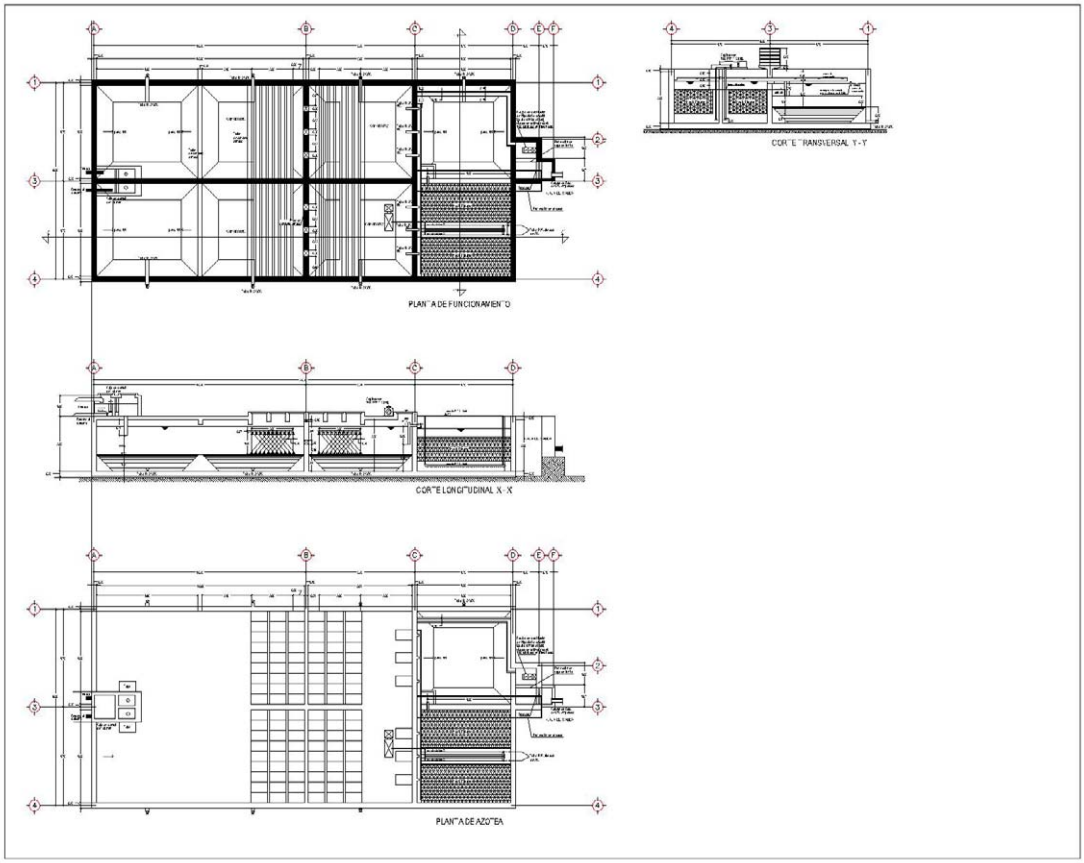


Figure L-5: Drawings of the Treatment Facility

L.3.2 Evaluation of Facility Design

This section states performance evaluation from the design conditions and the facility outline.

a. Anaerobic Reactor

Hydraulic detention time and BOD volumetric loading are some of the important design factors. The table below presents correlation between hydraulic detention time and expected BOD removal ratio of domestic wastewater at 20 degree Celsius.

Hydraulic detention time (days)	Expected BOD removal ratio (%)
1.0	50%
1.5	60%
5.0	70%

source: Environmental Health Engineering in the Tropics, Second Edition, Sandy Cairncross and Richard Feachem, JOHN WILEY & SONS

In general, the maximum inflow BOD volumetric loading to anaerobic reactor is 400gram/m^3/day and the recommended value is 250gram/m^3/day[1]. Taking them into consideration, the evaluation and the results are presented in the table below. In design of 5 year life time, BOD removal rate 50% with one or twice of sludge extractions in a year, the detention time is 1.06. Meanwhile, for the life time of 20 years, the detention time of 0.83 can not reach to the detention time of 50 % removal ratio, even sludge extraction of thrice a year is realized.

The values vary depending on the condition such as temperature. Within the Model Project, the data will be verified.

Table L-3: Verification of Anaerobic Reactor Design

Item			Life time 5 years	Life time 20 years
Treatment amount (m3/day)			212.5	274.5
Target population			1,872	2,360
Inflow BOD concentration (mg/litre)			220	220
Inflow BOD amount (gram/day)			46,750	60,390
Sludge volume (m3/year)			74.9	94.4
Total effective volume			256.6 m3	256.6 m3
BOD-volume loading (gram/m3/day)				
	Case 1	Sludge extraction frequency :once/year	257.3	372.3
	Case 2	Sludge extraction frequency :twice/year	213.3	288.4
	Case 3	Sludge extraction frequency :thrice/year	-	268.3
Hydraulic detention time (days)				
	Case 1	Sludge extraction frequency :once/year	0.86	0.59
	Case 2	Sludge extraction frequency :twice/year	1.03	0.76
	Case 3	Sludge extraction frequency :thrice/year	1.06	0.83

[1] Environmental Health Engineering in the Tropics, Second Edition, Sandy Cairncross and Richard Feachem, JOHN WILEY & SONS

b. Aerobic Filter

Inflow of 110 mg/litter BOD concentration is expected at the inlet of the aerobic filter if the anaerobic reactor achieves BOD removal rate of 50%. BOD volumetric loading in proportional to the area of fixed bed and aeration volume which keep aerobic condition are important design factors in regard to BOD removal. Therefore, this section analyzes those two factors using the design parameters of the aerobic filter shown in the table below.

Table L-4: Design Parameters of Aerobic Filter

Item	Life time 5 years	Life time 20 years
Treatment amount (m3/day)	212.5	274.5
Inflow BOD concentration (mg/litre)	110	110
Inflow BOD amount (gram/day)	23,375	30,195
Total effective volume (m3)	40.1	40.1
BOD-volume loading (gram/m3/day)	583	753
Filter media volume (m3)	19	19
Unit surface area (m2/m3)	100	100
Total media surface area (m2)	1,900	1,900
BOD-filter media surface loading (gram/m2/day)	12.3	15.9
Supply air volume (m3/min)	4.5	4.5
Supply air volume / Inflow water amount	30.5	23.6

b.1 BOD Loading per Unit Area

There are several measures in order to determine BOD loading per unit area. The formula below is developed in Japan[2]. This formula shows correlation of inflow water quality, treated water quality and BOD loading per unit area. The result from the calculations are shown in the table below.

$$\frac{Le}{Lo} = 0.176\left(\frac{45.455}{L0}\right) \bullet L^{0.707}$$

where:

Le : treated water BOD concentration (mg/litre)

Lo : inflow water BOD concentration (mg/litre)

L : BOD loading per unit area (gram/m^2/day)

[2] Design criteria and practical guide for JOKASO, Japan Building Center, 1984,

Table L-5: Correlation with Between BOD Concentration and BOD Loading per Unit Area

Lo (mg/liter)	Le(mg/liter)	L (g/m2/day)
110	105	27.9
110	100	26.0
110	95	24.2
110	90	22.4
110	85	20.7
110	80	19.0
110	75	17.3
110	**70**	**15.7**
110	65	14.1
110	**60**	**12.6**
110	55	11.2
110	50	9.8
110	45	8.4
110	40	7.1
110	35	5.9
110	30	4.7
110	25	3.7
110	20	2.7
110	15	1.8
110	10	1.0
110	5	0.4

Designed BOD loadings per unit area are 12.3 gram/m^2/day with 5 year life time and 15.9 gram/m^2/day with 20 year life time. The quality of water after treatment each becomes 60 mg/litter and 70 mg/litter, respectively. This is an empirical formula assuming water temperature to be 20 degree Celsius. The facility expects the water temperature of between 25 and 30 degree Celsius. Therefore, the better quality of treated water is expected.

b.2 Aeration Volume

Aerobic biological treatment requires oxygen concentration in a reactor no lower than 1 mg/litter. Required amount of oxygen can be obtained by the formula below.

$$O_2 = aLr + bSa$$

where:

O_2	:	oxygen demand (kg/day)
a	:	coefficient for BOD remove (kg O_2/kg BOD)= 0.5
Lr	:	BOD remove amount (kg/day)
b	:	coefficient for oxygen demand of micro organism = 0.07
Sa	:	micro organism amount (kg)

Table L-6 shows required oxygen demand of the facility. Table L-7 presents required capacity of blower with the oxygen demand at atmospheric temperature and pressure, efficiency of diffuser and safety factor.

Table L-6: Required Oxygen Amount

Item	Life time 5 years	Life time 20 years
BOD remove (mg/liter)	50	50
Water amount(m3/day)	212.5	274.5
BOD remove amount (kg/day)	10.6	13.7
Unit micro organism amount (mg/cm2)3	1.42	1.42
Total surface area (m2)	1900	1900
Total micro organism amount (kg)	27.0	27.0
Oxygen demand (kg/day)	7.19	8.74

Table L-7: Required Blower Capacity

Item	Life time 5 years	Life time 20 years
Oxygen demand (kg/day)	7.19	8.74
Oxygen concentration (kg/m3)	0.277	0.277
Required air volume (m3/day)	26.0	31.6
Efficiency of diffuser (%)	2	2
Safety factor	1.5	1.5
Required blower capacity (m3/min)	1.4	1.6

The tables show that design capacity of 4.5 m^3/min is sufficient, as the required capacity of blower is 1.6 m^3/min. Meanwhile, performance of diffuser is represented as K_{La}, which is volumetric mass transfer coefficient. Required performance of diffuser is 1.5 K_{La}. This can be developed in the equation below.

$$K_{La} = \frac{Rr}{Cs - Cl}$$

where:

K_{La} : volumetric mass transfer coefficient(t^{-1})
Rr : oxygen demand (gram/m^3/hour)
Cs : oxygen saturated concentration (gram /m^3) = 8
Cl : required oxygen concentration (gram /m^3) = 1

Table L-8: Required Performance of Diffuser

Item	Life time 5 years	Life time 20 years
Oxygen demand (kg/day)	7.19	8.74
Oxygen demand (gram/hour)	299.6	364.2
Tank volume (m3)	35.3	35.3
Rr (gram/hour)	8.5	10.3
Kla (hour-1)	1.2	1.5

[3] CAPA design data

c. Sedimentation Tank

Some of the recommended parameters in designing a sedimentation tank for hydraulic surface loading rate and hydraulic weir loading are $25m^3/m^2/day$ and $30m^3/m^2/day$, respectively. In addition, detention time of more than 3 hours is desirable.

Table L-9: Design Parameters of Sedimentation Tank

Item	Life time 5 years	Life time 20 years
Treatment amount (m3/day)	212.5	274.5
Total effective volume (m3)	35.3	35.3
Surface area (m2)	20.3	20.3
Total length of over flow weir (m)	11.5	11.5
Hydraulic surface loading (m3/m2/day)	10.5	13.5
Hydraulic weir loading (m3/m/day)	18.5	23.9
Hydraulic detention time (hour)	4.0	3.1

L.4 Implementation

L.4.1 In-house Connection Works

L.4.1.1 In-house Connection Contract

According to the contract among residents and the CAPA, the residents are agreed to pay 10 % of the construction cost (200 to 400 peso, depending on the size of the construction) , required for In-house Connection, to start the project. The rest would be paid with water fee for 12 months when the treatment operation starts. However, at the middle of June there are only 40 households which have agreed to sign up for the contract. After all, the CAPA has decided to distribute the first payment over the 12 months in order to encourage the residents to enter the contract. As a result, 99 households have agreed to sign up for the contract on June 23, 2004. From this experience, the CAPA has gained an ability to solve the difficult problems such as entering into contract agreement of In-House Connection project with the residents.

L.4.1.2 Construction Works

Construction of In-House Connection started at the end of January, 2004, before the construction completion of treatment plant. By March, In-House Connection for 10 households was started. However, since sewer lines and treatment plant have not been installed nor constructed, the final connection was not realized.

At the end of May 2004, the construction of In-House Connection restarted, along with progress of the contract between residents and the CAPA. Since then, the Study Team has continued the In-house Connection construction, but some problems had arisen such the households who entered the agreement was absent at the time of visit.

Even though there are some problems left, the plants become ready for incoming sewerage water by the beginning of July due to CAPA's vigorous operations. Then, the connection to the public sewer began from houses in which the In-house Connection construction had completed one after another.

L.4.2 Wastewater Treatment Facility

L.4.2.1 Outline

Construction of the sewage treatment plant has completed on June 2004. However, there were leakage from ground water/rain water into the sewer pipes, and much inflow water to the treatment plants was observed. The CAPA has immediately executed the investigation, and took measure to solve the problem. By the beginning of July, although there is still some

groundwater get mixed in with, the treatment plant is in a favourable condition to get started the operation.

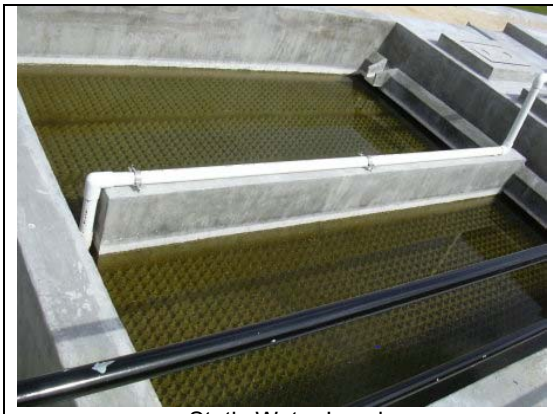
The final connection of the In-House Connection will be completed on or about 10 of July, and the sewage water starts entering into the plant after the completion. For this reason, the amount of present sewage water does not reflect the performance evaluation at this moment. And it leads to the Study Team to evaluate the hydraulic performance of the treatment facility with water instead of sewage water, and make comments and suggestions for improvement simultaneously. In addition, the Study Team prepares the monitoring manual, and trains the C/P with the manual. The C/P by itself will be able to conduct the monitoring of the plants with actual sewage water.

L.4.2.2 Evaluation of the Treatment Facility

The effectiveness of treatment can not be evaluated at this moment since there is no inflow of sewage water. Hence the hydraulic condition of the actual treatment plant is evaluated here.

a. Static Water Level and Dynamic Water Level

Before applying a prevention measure of ground water leakage into the sewage pipe, much water was entering into the treatment plant, causing the sewage pumps to repeat activations and ran-downs (for every 90 seconds). Based on the results from site measurements, the pumps have a pumping capacity of about 1.1m^3/min (1,584 m^3/day), which is 7.5 times larger than the designed capacity of 212 m^3/day. Since the pumping frequency is every 90 seconds, more sewage water than the designed was entering into the plant, causing overflow.


Static Water Level


Dynamic Water Level(over flow)

Figure L-6: Static water Level and Dynamic Water Level

Although flow control box is installed at the plant according to a suggestion by the Study Team, it does not function properly due to the excessive amount of flow.

In order to solve this problem, followings are suggested;

- Prevent an inflow of ground water into sewage pipes for the first priority.
- Make discharge rate of the pump adjustable.

The former has completed as a result of piping renovation made by the CAPA, although some problems are left. The later suggestion has led to install a valve at the outlet or the pump.

b. Pump Pit

Pump pit is cylinder type having inside diameter of 3 m. The water levels are shown below.

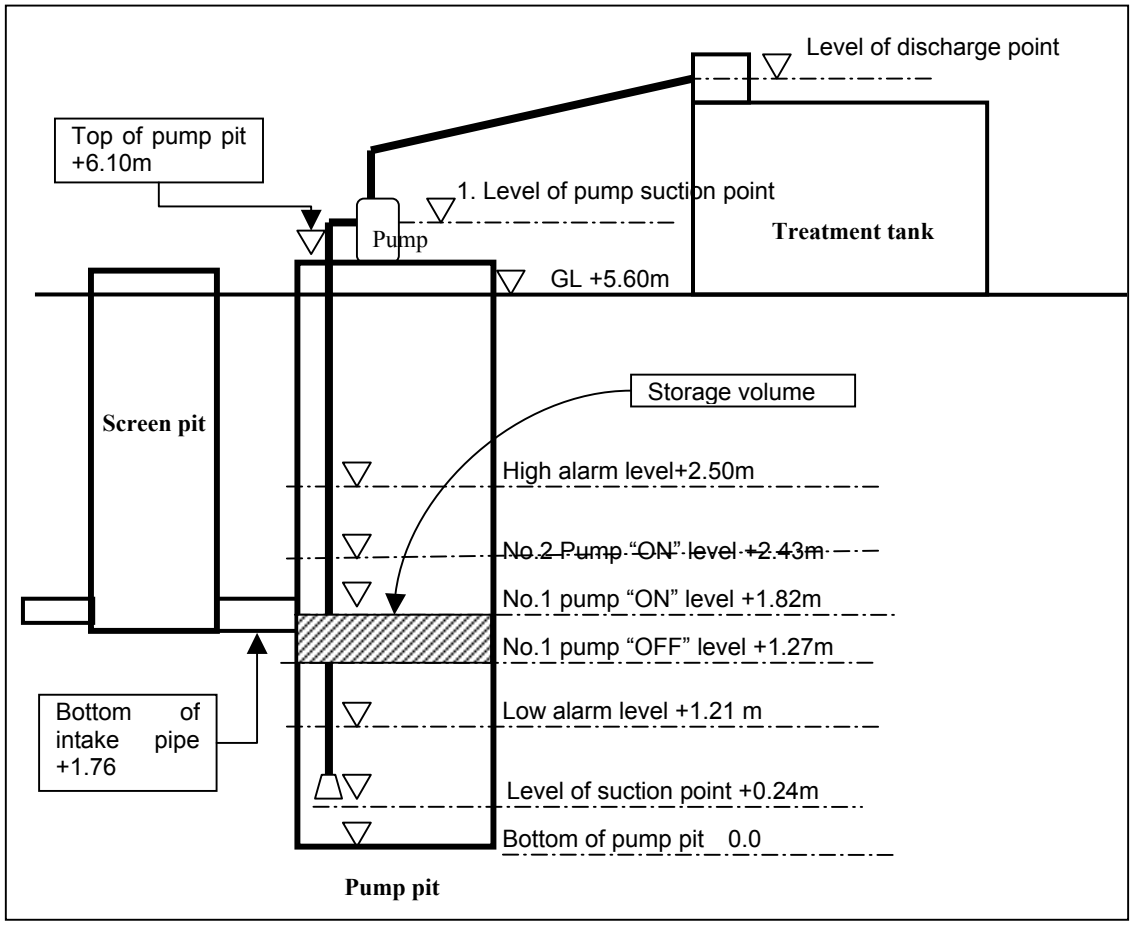


Figure L-7: Initial Water Level of Pump Pit

Two pumping equipments are installed. The pumping performance data are shown in the table below. Flow amount of 111gpm (14.8 m^3/min) is the designed value.

Table L-10: Pump Performance

Flow amount		Total head		Pump eff.	Required power
US gpm	litre/min	ft	m	%	bhp
133	503	41.6	12.7	29	4.48
111	**420**	**42.5**	**13.0**	**24**	**4.96**
88.8	336	43.5	13.3	29	5.07
66.6	252	44.5	13.6	24	5.18

Contrarily, the actual amount of pump discharge is 1.1m^3/min, which is more than the twice of the designed value. This is probably because the excess amount of pumping capacity was specified at the design stage.

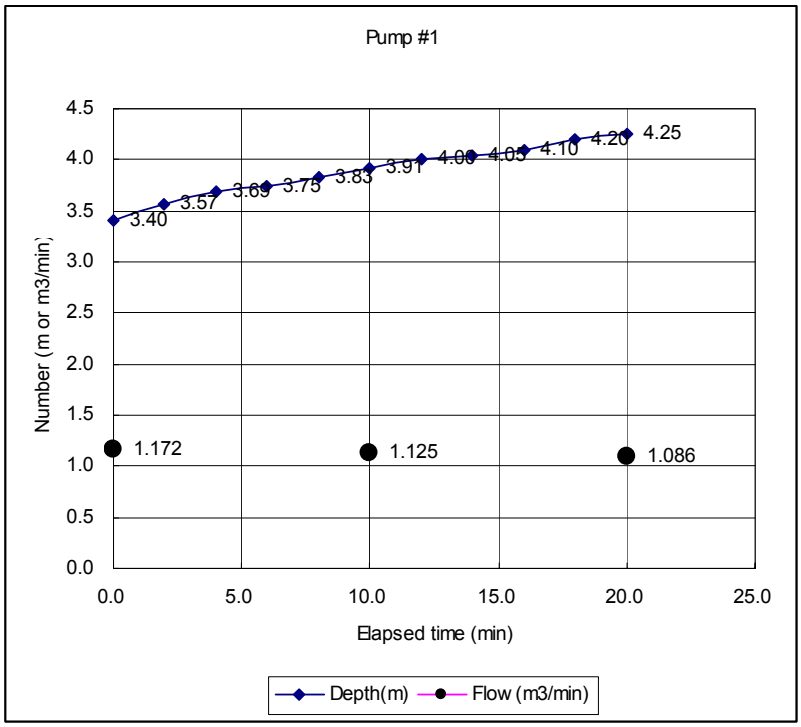


Figure L-8: Actual Pumping Discharge Amount (Pump #1)

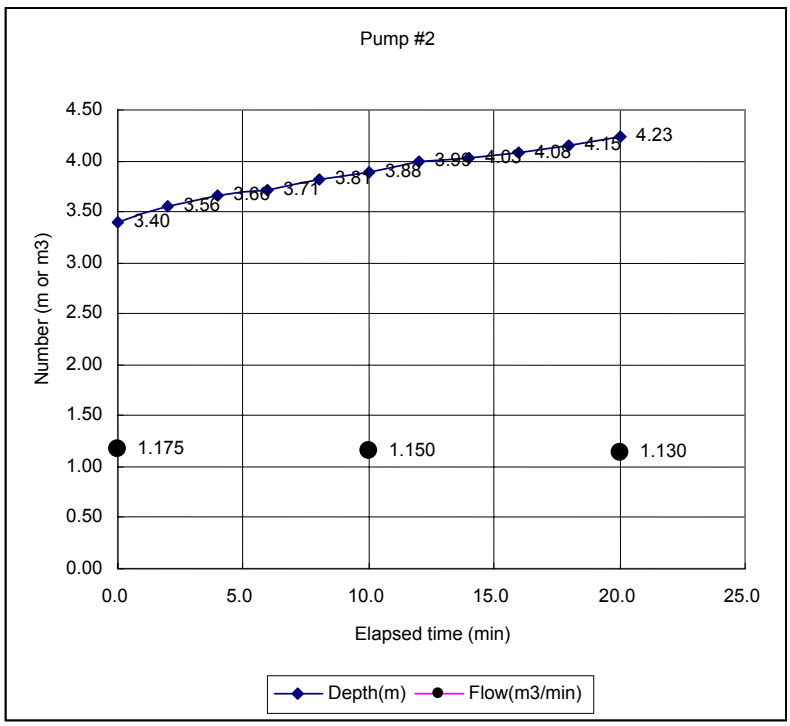


Figure L-9: Actual Pumping Discharge Amount (Pump #2)

On the other hand, effective store capacity of one pump pit is about 3.9 m^3, with the retention time of 26 minutes. This means that if the designed quantity of 212 m^3/day inflows, on-off frequency of the pump is 26 minutes at a maximum. If the peak intake quantity is considered to be double in the mean daily intake, as low as 13 minutes of the on-off frequency is required. When the treatment plant was operated based on this assumption, overflow did not occur.

Therefore, overflow can be prevented by applying the above assumption. But in order to achieve more stable treatment operation, it is desirable to adjust the discharge at the outlet of pumping equipment. Also, if it is possible, the clearance of water lines of the pump "ON" and "OFF" levels should be enlarged, which leads to the increase of effective store capacity of fluid in the pit.

c. Flow Control Box

Flow control box is installed in order to discharge a certain amount of sewage water into treatment plant. The excess amount of fluid from the pumping operation is returned to the pump pit.


Inside of Flow Control BOX

However, the actual condition is;

- As stated before, the actual pumping capacity is 7 times larger than designed.
- Because of the large pumping discharge, the flow becomes turbulent in the control box.
- Installed triangular weir is just a steel plate cut by triangle, which is not performing as a flow distributor.
- Because of the large discharge from the triangular weir and from the pumping equipment, the sewage fluid is not distributed equally into the two treatment basins.

The Study Team made several suggestions, such as to replace the triangular weir, and to install a retention wall across the entrance to the basins, which is at lower reaches from the weir, in order to distribute the equal amount of flow into two basins.

L.5 Results

a. Achievements

Narrative summary	Achievements
1. Overall goal Establishment of small scale sewer system	CAPA has acquired knowledge and skills regarding social issues, e.g., encouragement of residents to connect to public sewer, and technical issues, e.g., groundwater in pouring to sewer and operation of treatment facility. Also, a manual of operation of the facility has been prepared. Thus, CAPA is ready to operate the facility and to expand the same type of small scale sewer system over the Study Area.
2. Project purpose Establishment of a fund to support residents to connect sanitary sewers Get a data for design & operation of small sewer treatment system	• CAPA get 99 contracts for in-house connection. • Basic conditions for build up in-house connection fund were established. • Hydraulic conditions were confirmed; however biological conditions were not confirmed due to CAPA's construction works delay.
3. Outcomes A manner to encourage introduction of a sewer system in a rural community Technology of designing, constructing and operating the sewer system is established.	• Number of used support fund for connections : 99 households were connected • CAPA learned how to get in-house connection contract. • Appropriate contract conditions for in-house connection were become clear. • Comparison of original design data and actual measured data: Actual pumping amount is excessive. • Flow control box was not work properly. Suggestion on this problem has made. • CAPA leaned knowledge for new type facilities development (design, construction, operation, etc.)
4. Inputs 1) Personnel 2) Construction works 3) Equipment	• Study team :Mr. Hiroshi Kato and Mr. Icihro Kono • C/P : Mr. Juventino Castillo Pinzón, Mr. Jaime Ricardo Quiñones Baas, Mr. Jorge A. Dzul Chin, Mr. Ximenes • In-house connection works for 99 households • Supersonic flow mater • Dissolved oxygen, pH, water temperature mater

b. Other Results

Due to delay in plant construction (both piping and treatment plant) and delay in administration of contract agreement with the residents, it is now impossible to verify the actual performance of the plant with rated sewage load within the term of study. Therefore, only the hydraulic conditions were to be examined mainly.

L.6 Evaluation

L.6.1 In-house Connection

Construction of In-house Connection as well as development of sewage system play an important role of preventing contamination of the groundwater caused by domestic sewage water in the Study Area. The CAPA's responsibility was narrowed up to installation of public catch pits. And the In-house connection work was left depending on each household decision.

Therefore, even though sewage system was developed, many households in the region had chosen to utilize traditional septic tank (septic hole) for their economic reasons and lack of their understanding about the impact to their livings and to the environment. As a result, investment in the field of wastewater management had not brought a real benefit to protect the human health and the environment.

Although CAPA had known that the lack of understanding about sewage and resident's tight budget were some of the reasons for delay in bringing about an effect of the investment, no practical measures were implemented. And CAPA did not have any established system or plan to promote the In-house Connection work.

This model project has;

- Set up a new foundation to encourage the In-house Connection.
- Established a new system which CAPA involves more for In-house Connection.
- Established a method of Zero-down-payment-loan.

Hereafter, the CAPA is required to collect fees and put the fund into operation with high transparency, in order to continue and expand the sustainability of the work.

In-house Connection work normally starts after the completion of sewage system development (piping and treatment facilities); however, due to time constraint, those were promoted simultaneously in this model project. As a result, some problems arouse during the operation but the CAPA has established the capacity to attack the problems. Hence, contaminated groundwater and health risk to the residents who is utilizing the groundwater in the Study Area can be expected to be reduced in the future.

L.6.2 Treatment Facility

Construction of sewage system (piping and treatment plant) within the target area in the Model Project is a jurisdiction of CAPA. The construction completion date was set at the end of December 2003; however, it was extended to the beginning of July 2004. The final In-house Connection work by the Study Team was delayed as well. And at the end of June, the facility has no sewage water intakes. Considering the period of bacteria growth, it is impossible to conduct the performance evaluation of the treatment plant. Therefore, only the suggestions for Plant improvement were made.

The Study Team had been following the progress of construction; however, the project experienced a big delay. This is because;

- The characteristic of the region which is an extremely high groundwater level was not regarded as important factor for facility design and construction.
- Capacity of the contractor was low.

Also with regard to the pumping equipment,

- Due to the lack of experience in designing facility of water supply, proper capacity size of pumping equipment was not installed.
- And as a result, adjustable range of pump performance is narrowed.

In the future when the similar facility is to be planned and designed, use of submerged pump for sewage water is recommended since it has low suction head and also it is relatively economical.

The CAPA has accumulated considerable experiences and now is able to solve problems stated above.

Other recommendation is that the person in charge to prevent intrusion by unauthorized personnel in the plant. The treatment plant is surrounded by fences and gates, but the gates are unlocked open and anyone can enter the area. This may cause serious accidents or property loss. Some measure, such as securing the gates, should be taken so that the third personnel can not enter the prohibited area.

L.7 Conclusion and Recommendation

Due to the big delay of construction of sewage system, the initial goals were not achieved. But CAPA now appears to be capacitated toward solving problems. It is expected that CAPA expands the project following the M/P over the Study Area, utilizing this experience.

L.7.1 In-house Connection Works

The CAPA is now on the stage of utilizing an asset provided by JICA, effectively practicing the methods of contract agreement acknowledged from the Model Project. It leads to the suggestion that the in-house Connection Work be processed not only within the target area of the Model Project but in the wider study area on purpose of improvement of sewage system.

In-house Connection was designed by CAPA in this model project. But there are some disagreements of plans between CAPA and the residents, causing problems at the time of construction. The problem can be solved by promoting more dialogue with the residents and at the same time, establishing a new section which is in charge of contract agreement of In-house Connection and design/construction all together within CAPA.

L.7.2 Treatment Facility

It is impossible for Study Team to conduct the performance evaluation of the treatment plant due to the big delay of the construction of sewage system within jurisdiction of CAPA. The Study Team strongly recommends that the CAPA execute the monitoring according to the manual prepared by Study Team, and goes on to the performance evaluation and design review of the plant.

In order to avoid delay of construction work, several considerations or any measures should be made; such as, not only for the ability of construction workers, but also for types and method of survey precedes to design and construction, how to reflect the results from site survey into design and construction planning, and cost estimates based on construction planning and site inspection after contract. Those can be improved through PDCI (Plan, Do, Check, Improvement) cycle by repetitive practice.

Annex M

Establishment of an Integral Solid Waste Management Information System

Contents

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List of Tables

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M Establishment of an Integral Solid Waste Management Information System

(General Law for the Prevention and Integral Management of Waste. October 08th, 2003)

M.1 Outline

a. Background

It has been affirmed that the inadequate management of solid waste is contributing with 40% of the pollutant load rate (BOD) that filters to the aquifer. Such contamination is the principal motive of the high incidence of acute diarrheic diseases (DEA's by its initials in Spanish), which are affecting somehow the economy of the households and causing and increase on the poverty levels.

For that reason, the Master Plan takes into account several projects aiming to control the pollutant load rate associated to solid waste, whose main purposes are to protect the aquatic environment and to improve public health.

Therefore, it is necessary to reinforce the coordinated action of the three government levels in order to create synergy and to gain efficiency.

The new General Law for the Preservation and Management of Waste establishes the implementation of an Information System for the Integral Management of Solid Waste, whose main purpose would be the creation of a mechanism of coordination and information among the three government levels, on the subjects of sharing responsibility, prevention of the generation, valorization and the integral management of solid waste.

The Model Project aims to cooperate in the setting-up of the Information System forecasted in the General Law; likewise it intends to use this system as an instrument which may continue tracking the development of the Master Plan.

b. Project Design Matrix

Project name:	Period:	Version:
Establishment of an Information System for the Integral Management of Waste	Early October 2003- End July 2004	No. 2
Target Area: Study Area	Target Group: 1. (Information System) SEMARNAT, SEDUMA and the municipalities of Othón P. Blanco, Felipe Carrillo Puerto and Solidaridad. 2. (Master Plan) The three government levels in the State of Quintana Roo	Date: January, 2004

Project Summary	Indicators	Means of verification	Important Assumptions
Overall goal 1. Establishment of an Integral Waste Management Information System, which has been foreseen in the new General Law for the Prevention and Integral Management of Waste	1.1 The three government levels coordinate their activities and generate data established by Law	1.1 Information sent to the National System of Environmental Information and Natural Resources	1. The new Law is enforced and the three government levels agree on the establishment of an Integral Waste Management Information System
2. M/P is implemented	2.1 Established goals in the M/P 2.2 BANOBRAS' disbursement plan	2.1 Timetable for the execution of the M/P 2.2 BANOBRAS' loan contract	2. The M/P has been approved by all parts and economic means for the works are available
Project Purpose 1. The constitution of a mechanism of coordination and information among the three government levels on matters of prevention of generation, valorization and integral management of solid waste	1.1 Network establishment on the Information System for the Integral Management of Waste	1.1 On each government level has been established a network benchmark on the Information System for the Integral Management of Waste	1. Authorities from the three government levels support the project.
2. Promotion and monitoring on the implementation of the M/P	2.1 The works of the M/P are already executing	2.1 M/P timetable and BANOBRAS' disbursement program	
Outcomes A. Information system 1.The system is established	1.1 The network has been installed and working	1.1Benchmanrk on the network regarding the three government levels	1. Decision of the authorities from the three government levels regarding the execution of the disposed by the Law and the Regulation on the Rendering of Services
2.The coordination among the three government levels is efficient	2.1 Activities of the three government levels gain synergy	2.1 Execution of the disposed by law and the Regulation on the Rendering of Services	
3. Information flows all over the system and this is sent to the National System of Environmental Information and Natural	3.1 Information is generated and used on Integral Waste Management	3.1 Information sent to the National System of Environmental Information and Natural Resources	

Project Summary	Indicators	Means of verification	Important Assumptions
Resources B. Master Plan 4. The implementation of the M/P is promoted 5. Implementation and outcomes of the M/P are monitored by the System	4.1 Available funds and starting of works programmed in the M/P. 5.1 Improvement on Solid Waste Management 5.2 Aquifer protection	4.1 M/P timetable and BANOBRAS' disbursement program 5.1 M/P timetable and BANOBRAS' disbursement program 5.2 DOB discharges are forecasted in the M/P	4. Decision of SEDUMA and municipal council authorities regarding the implementation of the M/P
Activities See the table below			Pre-conditions SEMARNAT, SEDUMA and the Municipal Councils support the project

Activity Table

Activities	**Outputs**	**Period**	**Inputs by S/T**	**Inputs by C/P**
1. Diagnosis	Diagnosis report	See the Excel table	Collaboration	
2. Implementing the improvements and the monitoring	Record of the implementation and the monitoring	Ditto	Collaboration	
3. Results	Report of the results	Ditto	Collaboration	
4. Evaluation	Report of the evaluation	Ditto	Collaboration	
5. Conclusion and recommendation	Report	Ditto	Collaboration	

Input

Input	**Study Team S/T**	**Counterpart C/P**
Personal	• Principal: ViO • Assistant: Hiram Diaz • Support: IkM	• Principal: Four • Assistants: • Participants: to be clarified
Material	• Three computers	• Telephone lines: two • Internet service: two

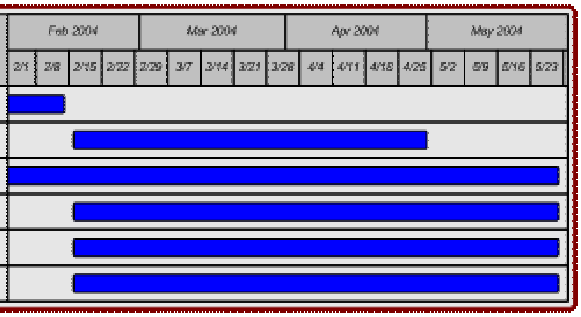
Task table

Activities	Tasks
1. Diagnosis	1.1 Evaluation of the current situation a. Shared responsibility b. Prevention of the generation c. Valorization of solid waste d. Solid waste integral management e. Structure of participant organizations f. Means and level of information and coordination among the three government levels g. Communication with the public

Activities	Tasks
	h. Institutional frame 1.2 General Law for the Prevention and Management of Waste and the Information System for the Integral Management of Waste SIGIR by its initials in Spanish) a. Law objective b. Roles and responsibilities of the three government levels in the ambit of their respective competences c. Information System for the Integral Management of Waste d. Content of the information for the National System of Environmental Information and Natural Resources e. Information to the public f. Evaluation indicators in the application of the General Law g. The SIGIR as instrument of information h. The SIGIR as instrument of coordination i. The SIGIR as instrument which tracks the implementation of the Master Plan j. The SIGIR as instrument to promote the application of the Regulation for the Rendering of Public Service of Integral Management of Urban Solid Waste 1.3 Conclusions and recommendations of the diagnosis ANNEX 1 General Law for Prevention and Management of Waste and the Information System for the Integral Management of Waste (SIGIR) ANNEX 2 Content of the information on the level of SEDUMA and each of the municipalities, to be submitted to the National System of Environmental Information and Natural Resources ANNEX 3 Draft of the Regulation for the Rendering of Public Services on the Integral Management of Urban Solid Waste ANNEX 4 Monitoring and implementation of the Master Plan
2. Implementing the improvements and the monitoring	a. Implementation of the Information System b. Spread the General Law c. Consultation and approbation of the Regulations for the Rendering of the Public Service on the Integral Management of Urban Solid Waste d. The SIGIR as means of information to the public d. The SIGIR as a tool which continues tracking the implementation of the Master Plan
3. Evaluation	a. Effectiveness To what extent have the contributions became products b. Efficiency To verify if the purpose of the project has been achieved and how the products contributed c. Impact What negative and positive effects, direct and indirect, have had the implementation of the Project d. Relevance The Main Goal and the Purpose of the Project are still important objectives e. Sustainability For how long the recipient organizations will be able to maintain the positive effects of the project after the Study Team had left

c. Timetable

ID	Actividad	Start	Finish	Duration
1	Instalación del Sistema de Información (SIGIR)	1/15/2004	2/13/2004	4.4w
2	Difusión de la Ley General	2/16/2004	4/30/2004	11w
3	Consulta y aprobación del Reglamento	2/2/2004	5/28/2004	17w
4	Información con el público	2/16/2004	5/28/2004	15w
5	Seguimiento a la implementación del Plan Maestro	2/16/2004	5/28/2004	15w
6	Monitoreo y evaluación del SIGIR	2/16/2004	5/28/2004	15w



M.2 Diagnosis

A diagnosis was performed together with the Mexican C/P, comparing the current situation with what is now set on the General Law for the Prevention and Management of Waste.

This evaluation allowed to determinate the competence of each of the three government levels and allowed to shape the roles, responsibilities and functions that they must play during the application of the Law.

Being set forward the duties of each organization, it is therefore possible to coordinate their activities in order to achieve individual and common objectives with the purpose of protecting public health, preserving the environment and maintaining natural resources.

The establishment of an Information System will facilitate the coordination among the competent organizations and will generate the required synergy.

M.2.1 Evaluation of the current situation

a. Shared responsibility

- The juridical framework is not clear and it does not state the responsibilities of the three government levels on the subject of solid waste management. The new General Law for the Prevention and Management of Waste will remedy this current difficulty.
- Insufficient policies, strategies and programs make evident the lack of coordination.
- The private sector recently begins to assume its shared responsibility concerning solid waste generation. The initiative of ECOCE A.C. (Ecology and Business Commitment), on the topic of recycling PET bottles, is an activity that should be encouraged and promoted.

b. Prevention of the generation

- Nowadays, policies regarding the prevention of generation are inexistent. The program "National Campaign for a Clean Mexico" is a good beginning, whose principal objective is to achieve cities and fields free of hazardous and non-hazardous waste that negatively affect public health.

- The SECTUR program "Clean and Loved Mexico" may be useful in order to promote that touristic activities be carried out in ways compatible with natural resources. These ways are the support of the activity; furthermore, it is crucial to encourage an image of cleanliness in the Mexican destinations.
- Instruments that encourage minimization are inexistent.

c. Valorization of solid waste

- Waste is not valorized for its exploitation as input of productive activities.
- The structure for the trade of subproducts derived from waste is incipient.
- Organic resources represent the major component of waste; the portion able to undergo composting processes should be used.

d. Integral Management of Solid Waste

- The concept of Solid Waste Integral Management is not practiced
- Each activity is carried out individually without considering objectives of valorization and, sanitary, environmental, technological, economical and social efficiency.
- Generally, the rights for the service are not charged.

e. Structure of the participant organizations related to information and coordination in the subject of solid waste

- SEDUMA: Department of Prevention and Control
- Municipality of Othón P. Blanco: Department of Municipal Public Services; Department of Ecology
- Municipality of Felipe Carrillo Puerto: Department of Municipal Public Services
- Municipality of Solidaridad: Department of Municipal Public Services; Department of Environment

f. Means and levels of information and coordination among the three government levels

On the subject of solid waste management:

- The municipalities restrict the service to collection, swept of streets and final disposal in dumping sites
- There are not established routes of information nor coordination among the three government levels

g. Communication with the public on the subject of solid waste management

As regards of solid waste management:

- The public does not receive routine information
- Do not exist structures nor informative programmes

- The public does not participate effectively in the performance of the service

h. Institutional framework

- General Law of Ecological Balance and Environmental Protection
- Law of Ecological Balance and Environmental Protection in the State of Quintana Roo
- General Law for the Prevention and Management of Waste
- Regulations for the Rendering of the Public Service of Urban Solid Waste Integral Management del (In consultation)

M.2.2 General Law for the Prevention and Management of Waste and the Information System for the Integral Management of Waste (SIGIR)

a. Objective of the Law

The Law is statutory of the rules of the Political Constitution that refer to environmental protection, in the subject of the nationwide prevention and integral management of waste.

Its regulations are of public order and national interest and have as objective to guarantee the rights of all citizens to proper environments. Furthermore, they pave the way for sustainable development through the prevention of generation, valorization and integral management of hazardous waste, urban solid waste and waste of special management; moreover such regulations prevent the contamination of places with these types of waste and finally they intend to carry out their sanitation.

In the formulation and development of the policy, the following principles will be observed:

- The rights of individuals to live in adequate environments for their proper development and wellbeing;
- To match the activities related with the generation and integral management of waste to the methods that suggest the public order and interest, in order to achieve national sustainable development;
- The prevention and minimization in the generation of waste, its discharge to the environment, and its transference from one environment to another, as well as its integral management is important in order to avoid risks to public health and damages to ecosystems;
- It is responsibility of whoever generates waste the assumption of the costs derived from its integral management, and in case, the amends due to damages;
- In order to achieve environmentally efficient, technologically viable and economically feasible integral management of waste, it is crucial the shared responsibility of producers, importers, exporters, traders, consumers, companies which provide services of waste management and the authorities of the three government levels;
- The valorization of waste for its exploitation as input coming from productive activities;
- In order to achieve the prevention on generation and sustainable management of waste it's important the access from the public to information, environmental education and training;

- The final disposal of waste is restricted only to those whose valorization or treatment is not economically viable, technologically feasible and environmentally proper;
- The selection of places for final disposal of waste in conformity with the Mexican official norms and with the programmes of ecological ordinance and urban development;
- The immediate execution of sanitary actions in contaminated places in order to prevent and to reduce imminent risks to public health and to the environment;
- Clean production as a method to achieve sustainable development, and
- The valorization, shared responsibility and integral management of waste, applied under conditions of environmental, technological, economical and social efficiency, on the design of tools, programmes and plans of environmental policy for the management of waste.

b. Roles and responsibilities of the three government levels in the field of their respective competences

SEMARNAT:

- To formulate, conduct and evaluate national policies;
- To formulate and arrange the Programme for the Prevention and Integral Management of Waste;
- To issue juridical regulations in order to regulate the integral management of solid waste;
- To establish and to apply incentives;
- To determinate indicators in order to evaluate the applicability of the Law.

SEDUMA:

- To formulate, conduct and evaluate state policies;
- To formulate the State Program for the Prevention and Integral Management of Waste (1);
- To elaborate the programmes in the subject of waste of special management;
- To participate in the formulation of the National Programme for the Prevention and Integral Management of Waste;
- To establish coordination with the municipalities in the subject of microgenerators of hazardous waste;
- To establish coordination with the municipalities in the subject of big generators of urban solid waste;
- To establish coordination with the Health Department in the subject of waste generated by health centers.

MUNICIPALITIES:

- They are in duty of the integral management of urban solid waste, which consists in collection, transportation, treatment and final disposal.
- They are responsible for the formulation of the Municipal Programme for the Prevention and Integral Management of Urban Solid Waste (1).

- They regulate the use of soil in conformity with the programmes of ecological ordinance and urban development, where will be considered the areas where final disposal of urban solid waste and waste of special management will be established.
- They emit regulations and other legal-administrative orders of general observance within their jurisdictions in order to achieve what has been established in the General Law.
- They collect the payment coming from the services of the integral management of urban solid waste and they, as well, allocate revenues to the operation and strengthening of the same.

Note: (1) The state and the municipalities, in the ambit of their respective competences, may elaborate and arrange local programmes for the prevention and integral management of urban solid waste and waste of special management, taking into account the Basic Diagnosis for the Integral Management of Waste and other applicable regulations. These programmes should contain at least the following:

- The basic diagnosis for the integral management of waste of their competence, in which will be mentioned the capacity and effectiveness of the available infrastructure that will fulfill the services requested;
- Local policy in the subject of urban solid waste and waste of special management;
- The definition of local objectives and goals in order to prevent generation and to improve the management of urban solid waste and waste of special management, as well as the definition of strategies and terms for its achievement.
- The means that will finance actions considered in the programmes;
- The mechanisms that will promote links among the municipal programmes in order to create synergy, and
- The technical assistance rendered by SEMARNAT.

c. Information System for the Integral Management of Waste

It has as objective to constitute a mechanism of coordination and information among the three government levels, in regards of shared responsibility, prevention of generation, valorization and the integral management of solid waste.

The system will integrate the information prepared by the state and the municipalities, relative to the integral management of urban solid waste and waste of special management. This information will later be delivered to the National System of Environmental Information and Natural Resources.

d. Information Content for the National System of Environmental Information and Natural Resources

The system will contain information relative to:

- Local situation
- Inventory of waste generated
- Available infrastructure for its management
- Legal regulations applicable to regulation and control
- Other aspects that facilitate the achievement of the objectives of the General Law and the ordinances from it derived

Note: Formats for the gathering of information may be found in the ANNEX XX

e. Information to the public

The authorities of the three government levels will elaborate and spread periodical reports concerning relevant aspects contained in the information systems.

f. Evaluation indicators in the application of the General Law

SEMARNAT will determinate the indicators that allow the application of the General Law and will integrate the results to the National System of Environmental Information and Natural Resources.

g. SIGIR as an instrument of information

- It promotes the participation of the public in the rendering of the services
- It acts as support in the diffusion of sanitary and environmental education programmes
- It helps with the reinforcement of the management ability in the rendering of services
- It is an instrument for performing public opinion surveys

h. SIGIR as an instrument of coordination

- It makes easier the coordination among the Federation, states and municipalities, in regards of prevention of the generation and the integral management of waste, under the principle of concurrence foreseen in the article73, section XXIX-G of the Mexican Political Constitution
- It promotes responsible participation of all social sectors in the actions tending to prevent generation, valorization and the achievement of an adequate integral management of all environmental waste, which may be as well technologically, economically and socially feasible.
- It promotes the integration, operation and running of consultative organisms where participate representatives of the industrial, commercial, services and academic sectors; sectors of research and technological development; professional and consumer associations; and finally participate intersector networks related to the topic. Such sectors participate in the process destined to classify waste, evaluate technologies for its prevention, valorization and treatment; plan the development of infrastructure for its management; and to develop technical proposals of normative and other type of instruments which help to achieve the objectives planned.

i. SIGIR as an instrument which tracks the implementation of the Master Plan proposed by JICA

- Public information on the benefits and development of the Master Plan
- Facilitate inter institutional coordination
- Act as a communication network and source of information among the organizations involved
- Keep tracking the activities programmed and verify their progress according to the agreed timetable

j. SIGIR as an instrument which promotes the application of the Regulation for the Rendering of the Public Service of Integral Management of Urban Solid Waste

- Promote the knowledge of the regulations
- Act as a referent centre concerning normative effectiveness

M.2.3 Conclusions and recommendations of the diagnosis

a. Conclusions:

- Despite that the General Law for the Prevention and Management of Waste establishes the institutional framework in the subject of solid waste, it is not well spread.
- The aspects related to shared responsibility, prevention of the generation, valorization and the integral management of solid waste in the study area are not subjected to defined policies, norms and programmes.
- There is neither systematic production nor sharing of information by each of the organizations that have competence on the subject of solid waste.
- Organizations execute activities related to solid waste in a weak ambit of coordination; the opportunity of creating synergy is lost.
- The public is not informed about the situation of solid waste management; despite that its participation is important and vital, this is not promoted.
- The goods and services private sector should be part of the solutions and share its responsibility with the public and the consumers.

b. Recommendations:

- To spread the General Law for the Prevention and Management of Waste with the purpose of achieving its objectives.
- To promote the consultation and to approve the Regulations for the Rendering of the Public Service on the Integral Management of Urban Solid Waste, with the purpose of establishing the “rules of the game” in the rendering of the service.
- To establish the Information System on the Integral Management of Waste (SIGIR)
- To use SIGIR as an instrument of information and coordination among the competent organizations and consequently achieve synergy.
- To use SIGIR as a way to inform the public and therefore be able to count with its active participation.
- To use SIGIR as an instrument to continue the implementation of the Master Plan and contribute with the preservation of the groundwater and the coastal aquatic environment.

M.3 Implementation

In the following table the activities that must be developed until June 2004 will be shown.

It is intended that during February 2004, the system be installed in the offices of SEMARNAT, SEDUMA and the three municipalities of the study area; between the months of March and May 2004 the Mexican counterpart will carry out tasks to be monitored and together with the study team the results will be evaluated on June 2004.

a. Installation of the Information System for the Integral Management of Waste (SIGIR)

Results:

SIGIR is installed and working

Tasks to be monitored:

i. Installation of the computer equipments
ii. Installation of the information programme
iii. Staff training
iv. Evidence and starting
v. Evaluation on the effectiveness of SIGIR as a tool which may establish the information flow and strengthen the coordination among the competent organizations

b. Spread the General Law

Results:

The competent organizations, private sector and the public know and apply the General Law

Tasks to be monitored:

i. Workshop about the content and importance of the General Law
ii. Spread information about the roles, responsibilities and functions of all organizations and the public through SIGIR

c. Consultation and approval of the Regulation for the Rendering of the Public Service of Integral Management of Urban Solid Waste

Results:

Regulations come into effect.

Tasks to be monitored

i. Tracking of the consultation and official approval of the Regulations
ii. Workshop about the content and scope of the Regulations

iii. Spread information about the roles, responsibilities and functions of all organizations and the public through SIGIR
iv. Evaluation on the effectiveness of the regulation

d. SIGIR as a way to inform the public

Results:

- The public receives periodical reports on the integral management of solid waste and the development of the Master Plan's implementation.
- The public actively participates on the prevention of generation and in the rendering of the solid waste management service.

Tasks to be monitored:

i. Design of the section concerning the integral management of solid waste on SEDUMA's website
ii. Evaluation on the effectiveness of SIGIR as a method to inform the public about the achievement of their participation and collaboration.

e. SIGIR as a tool to track the implementation of the Master Plan

Results:

- Tracking and generation of information about the implementation of the Master Plan
- SIGIR is used as a tool for the coordination among the competent organizations in the implementation of the Master Plan

Tasks to be monitored:

i. The design of the programme concerning track and coordination
ii. The training of staff who will give continuation and coordination to the programme
iii. Starting up the programme
iv. The evaluation about the effectiveness of SIGIR as a tool of continuation and coordination.

ANNEX 1

General Law for the Prevention and Integral Management of Waste

Information System on the Integral Management of Waste

The new General Law for the Prevention and Integral Management of waste (LGPGIR by its initials in Spanish), published in the Federation's Official Magazine on October 08th, 2003, establishes the following regarding coordination and communication:

Article 1, to establish the rules for; part III states: "*To establish the mechanisms of coordination that in the subject of prevention of generation, valorization, integral*

management of waste, belong to the Federation, the states and the municipalities, under the principle of concurrence foreseen in article 73 section XXIX-G of the Political Constitution of the Mexican United States".

Article 1, to establish the rules for; part IX, says: *"To create an information system relative to the generation and integral management of hazardous waste, urban waste and waste of special management, as well as a system of polluted and sanitized places".*

Article 2, the following principles will be observed; part VII says: *"The access by the public to information, environmental education and training, in order to achieve the prevention of generation and the sustainable management of waste".*

Article 2, the following principles will be observed; part XII, says: *"The valorization, shared responsibility and integral management of waste, applied under conditions of environmental, technological, economical and social efficiency, in the design of instruments, programmes and plans of environmental policy for the management of waste".*

Article 7, it is responsibility of the Federation; part XVII, says: *"To integrate within the National System of Environmental Information and Natural Resources, which is located within the General Law of Ecological Balance and Environmental Protection, subsystems of national information on the integral management of waste".*

Article 7, it is responsibility of the Federation; part XXII, says: *"To determinate the indicators that permit to evaluate the application of the current ordinance, and to integrate the results to the System of Environmental Information and Natural Resources".*

Article 9, it is responsibility of the State; part XIII, says: *"To contribute with the Federal Government in the integration of the subsystems of national information regarding the integral management of waste of their competence".*

Chapter IV, Right to Information; Article 37 says: *"The authorities of the three government levels, in the ambit of their respective competences, will integrate the* ***Information System for the Integral Management of Waste****, which will enclose information related to the local situation, the inventories of generated waste, available infrastructure for its management, legal regulations applicable to its regulation and control, and other aspects that assist in the achievement of the objectives and ordinances that proceed from the Law and from the General Law of Ecological Balance and Environmental Protection; the Law of Transparence and Access to Public Information; and other applicable regulations".*

Chapter IV, Right to Information; Article 38, says: *"The authorities of the three government levels will elaborate and spread periodical reports on the relevant aspects enclosed in the information systems, which refer to the present chapter".*

Chapter IV, Right to Information; Article 39, says: *"The three government levels, according to their respective attributions, will elaborate, update and spread the inventories regarding the generation of hazardous waste, urban solid waste and waste of special management, which will be based on the data given to them by the generators and the waste management companies, according to what is stipulated by Law in the legal ordinances from it derived.*

Furthermore, inventories of dumping sites or places where other types of waste have been disposed illegally will be integrated in all states. In such inventories will be registered information regarding their location, origin, characteristics and other information that may be relevant to the authorities, in order to develop measures aiming to avoid or to reduce risks. The integration of inventories will be supported in judgments, methods and information systems, previously agreed, standardized and spread".

Title Sixth, Of Prevention and Integral Management of Urban Solid Waste and Waste of Special Management; Unique Chapter; Article 96, says: *"The federative entities and the municipalities, in the ambit of their respective competences, with the purpose of promoting the reduction of the generation, valorization and integral management of urban solid waste and waste of special management, aiming to protect public health and to prevent and to control environmental pollution caused by its management, will carry out the following actions:*

Fraction V, says*: "To integrate information relative to the integral management of urban solid waste and waste of special management to the National System of Environmental Information and Natural Resources*"**.**

ANNEX 2

Information content from SEDUMA and each municipality to be remitted to the National System of Environmental Information and Natural Resources.

The General Law of Prevention and Integral Management of Waste establishes that SIGIR will integrate the information being prepared by the state and the municipalities, relative to the integral management of urban solid waste and waste of special management, which will be sent to the National System of Environmental Information and Natural Resources.

The following tables may be used for arranging the data; the information covers the following aspects which are stipulated in the General Law:

- Local situation
- Inventory of generated waste
- Inventory of legal or illegal dumping sites
- Waste of other nature
- Available infrastructure
- Legal regulations applicable to regulation and control
- Other aspects that facilitate the application of the General Law

Local situation

Area of the municipal territory (km2)

Urban area	
Rural area	
Total area	

Population forecast

Population	2003	2005	2010	2015
Urban				
Rural				
Total				

Note: Localities with less than 2,500 inhabitants are considered rural

Forecast on the number of tourists

	2003	2005	2010	2015
No. of tourists				

Generation rates by categories of urban domestic waste (kg/person/day)

Category	2003	2005	2010	2015
Domestic				
Non-domestic				
Touristic				

Generation rates by income level of domestic urban waste (kg/person/day)

Level of income	2003	2005	2010	2015
High				
Medium				
Low				

Generation rates of non-domestic waste

Category		Unity	2003	2005	2010	2015
Commercial	Restaurant	g/employee/day				
	Others	g/employee/day				
Institutional		g/employee/day				
Market		g/employee/day				
Street cleaning		g/lineal meter/day				

Inventory of generated waste

Generation of urban waste (tm)

Category	2003	2005	2010	2015
Domestic				
Non-domestic				
Touristic				
Total				

Covering of the collection service (2003)

	% of the total population	Collection frequency
Urban population		

Domestic urban waste composition

Subproduct	% in weight
Cotton	
Cardboard	
Leather	
Fine waste (all material that passes the screen M 2.00)	
Waxed cardboard container	
Hard vegetal fiber (sclerenchyma)	
Synthetic fiber	
Bones	
Rubber	
Tin	
Pottery and ceramic	
Wood	
Construction material	
Ferrous material	
Non-ferrous material	
Paper	
Disposable diaper	
Rigid plastic and film plastic	
Polyurethane	
Expanded polystyrene	
PET	
Alimentary waste (consult observations)	
Gardening waste	
Cloth	
Color glass	
Transparent glass	
Others	

Comments: The classification belongs to the norm NMX-AA-022-1985

Generation of waste of special management (tm)

Type of waste	2003	2005	2010	2015
Rocks				
Health services				
Fishing, agriculture, forestry, cattle-raising, including waste of inputs				
Transport service				
Mud of treatment plants				
Shopping malls in big volumes				
Construction				
Technological				

Registry of companies with management plans

Establishment	Address	Line of business	Type of waste	Annual discharged amount (kg)	Authorized company of management service

Registry of microgenerators

Establishment	Address	Line of business	Type of waste	Annual discharged amount (kg)	Authorized company of management service

Note. Micro generator: Industrial, Commercial or Services establishment that generates until 400 kilograms of hazardous waste per year or its equivalent in another measure unity.

Inventory of dumping sites where waste of diverse composition have been abandoned illegally.

File card for the inventory of illegal dumping sites

Location	
Name of the property's owner	
Land registry	
Property area	
Area occupied by waste	
Average height of waste	
Estimated volume of waste	
Predominant type of waste	

Available infrastructure

Parking and shop

Location	
Land area in m2	
Office area in m2	
Shop area in m2	
Parking area in m2	
Describe the kind of reparations practiced	
Equipment and machinery for reparations and maintenance	

Vehicles

Type of vehicle	No. of unities	Average capacity (m3)	Number of vehicles by condition			Number of vehicles by age in years			
			B	R	M	>10	5-10	2-5	<2
Compactor									
Dumper-truck									
Fold									
Sweeper									
Crane									

Note: (B) Good condition; (R) Regular; (M) Bad

Final disposal

Structure	Yes	No	Comments
Protection fringe			
Perimetric fence			
Weighing station			
Entry control			
Quarry soil			
Control of rain water			
Biogas control			
Reception of lixiviates			
Treatment of lixiviates			
Electric energy			
Drinking water			
Treatment of waste water			
Equipment:			
Bulldozer			
Loader			
Digger			
Compactor			
Dumper-truck			

Personal

Type of personal	Work area						
	A	S	RT	LB	G	M	Others
Administrator							
Engineer							
Technical assistant							
Technician							
Mechanic							
Mechanic assistant							
Supervisor							
Driver							
Worker							
Others							
TOTAL							

A = Administration
S = Supervision
RT = Collection and transportation
LB = Cleaning and sweeping
G = Final disposal
M = Mechanic and maintenance

Tariffs for the rights of the rendering of services

Type of tariff	Amount and comments
Domestic	
Non-domestic	
Touristic	
Other tariffs	

Legal regulations applicable to regulation and control

Legal regulations	Application
Draft of the Regulations for the Rendering of the Public Service of Urban Solid Waste Integral Management	In revision for its consideration by the H. City Councils

Other aspects that facilitate the application of the Law

ANNEX 3

Draft of the Regulations for the Rendering of the Public Service of Urban Solid Waste Integral Management

ANNEX 4

Monitoring of the implementation of the Master Plan

M.4 Results

The results of the Model Project are shown in the following table.

Table M-1: Results of the Model Project Establishment of an Integral Solid Waste Management Information System (SIGIR)

Project Summary	Results
Overall goal 1. Establishment of an Integral Waste Management Information System, which has been foreseen in the new General Law for the Prevention and Integral Management of Waste 2. M/P is implemented	The structuring and operation of SIGIR has been achieved according to the General Law. With the operation of SIGIR the recommendation of the Master Plan of setting up a system of information and coordination among the three government levels is achieved.
Project Purpose 1. The constitution of a mechanism of coordination and information among the three government levels on matters of prevention of generation, valorization and integral management of solid waste 2. Promotion and monitoring on the implementation of the M/P	The mechanism has been constituted and the participant entities keep contact through electronic communication via internet. The implementation will be promoted and monitored according to the strategy and measures proposed in the Master Plan.
Outcomes A. Information system 1.The system is established 2.The coordination among the three government levels is efficient 3. Information flows all over the system and this is sent to the National System of Environmental Information and Natural Resources B. Master Plan 4. The implementation of the M/P is promoted 5. Implementation and outcomes of the M/P are monitored by the System	A. Information system 1. SIGIR has been established in SEDUMA and in the municipalities of Othon P. Blanco and Felipe Carrillo Puerto. In each organization there is a telephone number and an email address available. 2. Personnel of the three institutions were trained in processing and registering information; the text of the new General Law was diffused as was the draft of the Regulation for the Rendering of the Public Service in the Integral Management of Urban Solid Waste; the system is used as an instrument of consultation and coordination of activities among the three organizations. SEDUMA is going to place a window in its web page concerning SIGIR with the purpose of: a) informing periodically to the public about the management of solid waste; b) demand the participation of the public in minimization programs; c) diffuse the plans and projects of the three government levels; d) collect the opinion of the public about the project of the new Regulation. 3. The information processed will be sent to the National System of Environmental Information and Natural Resources. Regrettably, this System is not yet in operation; in coordination with the Mexican C/P it was agreed to process the information and to send it to the SEMARNAT office in Quintana Roo. B. Master Plan 4. It has been agreed with the C/P that the implementation of the Master Plan will be promoted through SIGIR. This activity will start with the official appropriation of the Master Plan by the Mexican authorities. 5. SIGIR will be the instrument to be used in the monitoring of the implementation of the Master Plan 6. Other organizations of the three government levels have manifested their interest in participating in SIGIR: FONATUR, BANOBRAS, CAPA, CNA, and other municipalities in the state.

Project Summary	Results

Inputs

Personnel of the S/T

The work team was leaded by Ing. Victor Ojeda, who was in charge of the establishment of the strategy and design of the net. Hiram Diaz conducted the activities of installation of the system and its operation. Ing. Ximena Alegría reviewed the structure of information capture. Ing. Kunito Ishibashi reviewed the system of information of SEDUMA and suggested the procedure for the creation of a window in the web page of SEDUMA concerning SIGIR. The strategy of the model project and the development of the activities were controlled by Ing. Ikuo Mori.

Personnel of the C/P

The installation and operation of SIGIR in the organizations involved is in charge of the following officers (email address and telephone are from SIGIR):

SEDUMA: Department of Prevention and Control Ing. Carlos Acosta, Biologist José Guerrero (projica@hotmail.com) (phone: 832 2646)

Municipality of Othon P. Blanco: Department of Urban Development, Arch. Hector Morín; Department of Municipal Public Services, Dr. Rodrigo Camín.
(jica3@prodigy.net.mx)
phone: 285 5005

Municipality of Felipe Carrillo Puerto: Department of Municipal Public Services, Mr. Noé Baena (dspmfcp@prodigy.net.mx)
phone: 267 1106

Infrastructure and materials

In each organization was designed an office area in order to attend the needs of SIGIR.

JICA donated a computer and gave assistance on the installation of the infrastructure for communication. The total amount donated was $25,000 pesos.

M.5 Evaluation

a. Efficiency

The participation of the members of the S/T and the C/P has been the main support in this model project: the establishment of the strategy, design of the net, installation of the system, structure of database capture, training of personnel and operation of the system.

The contribution in infrastructure and materials was conformed by three computers with their respective operative systems and phone connections to the net and internet. The contribution of JICA was of $25,000 pesos.

The Mexican counterpart contributed with important suggestions which enriched the strategy and operation of the system; Mexican operative personnel were assigned in its moment and also room and furniture for the office were designed.

The products obtained constitute a valuable contribution in order to create more synergy among the three government levels in respect of the management of solid waste. It can be said that the contributions were used efficiently.

b. Effectiveness

All products obtained with SIGIR, in respect of the purpose of the project answer: a) what has been established in the General Law in the subject of management on solid waste information; b) to have available an instrument which may be used as a medium for coordination among the three government levels and public information; c) for promoting later on the implementation and implementation of the Master Plan.

The establishment of an Integral Solid Waste Management Information System (SIGIR) is a precept of the General Law for the Prevention and Integral Management of Waste (General Law) (published in the Official Magazine of the Federation in October 08th, 2003 and from April 08th, 2004 has covered full effectiveness).

c. Impact

The net of information and coordination has been created and, at the moment, it constitutes a useful mechanism for the three government levels. Other governmental organizations have manifested their interest in participating in this net and integrating themselves to SIGIR.

After the delivery of the Final Report of the M/P, the monitoring of its implementation through SIGIR may take place.

Officers from CAPA have suggested that SIGIR should cover as well some aspects related to potable water, sewer and treatment, given their relationship with the management of solid waste in a common front on the protection of the aquatic environment.

The impact of the model project has been positive in terms of the achievement of the general goal to establishing SIGIR.

d. Relevance

The creation of synergy among the three government levels through the use of SIGIR as a mechanism of coordination and information will make possible that the efforts of the competent organizations reach better levels of efficiency and effectiveness.

The three government levels are obliged to assume their respective competences and responsibilities established in the General Law in the subject of: hazardous solid waste (federal government), waste of special management (state government) and municipal solid waste (municipalities).

Likewise, the General Law establishes the responsibility that concerns the productive sector and the community in general in regards of shared responsibility, prevention of the generation, valorization and integral management of solid waste.

These responsibilities as well as the incentives that are foreseen in the General Law, should be from the knowledge of generators of SW of all nature. Likewise should be all information concerning the costs in the rendering of the service, foreseen investments, legislation and other topics of public interest.

The monitoring of the implementation of the M/P will have a special relevance in all its aspects and in particular, the sustainability of the services.

e. Sustainability

The strict observance of the General Law will assure the sustainability of SIGIR. The permanent operation of the Integral Management of Waste is a precept of the General Law that must be achieved.

The three government levels are obliged to deliver, to the National System of Environmental Information and Natural Resources, created by the General Law of Protection to the Environment, all information concerning the integral management of solid waste that is in the realm of their respective competences.

Therefore, each government organ has a scope of responsibility and action and must report the activities, achievements and obstacles in the attainment of its objectives and goals.

The General Law establishes as well, that it is compulsory to inform periodically to the public all the results of the integral management of solid waste.

The system has all necessary infrastructure and the personnel designed for its operation is well trained; the organizations linked through the net have said that SIGIR is a utile mechanism for the achievement of their obligations associated with the integral management of solid waste and their responsibility with the protection of the aquatic environment and at the same time they are able to operate the system in an independent way.

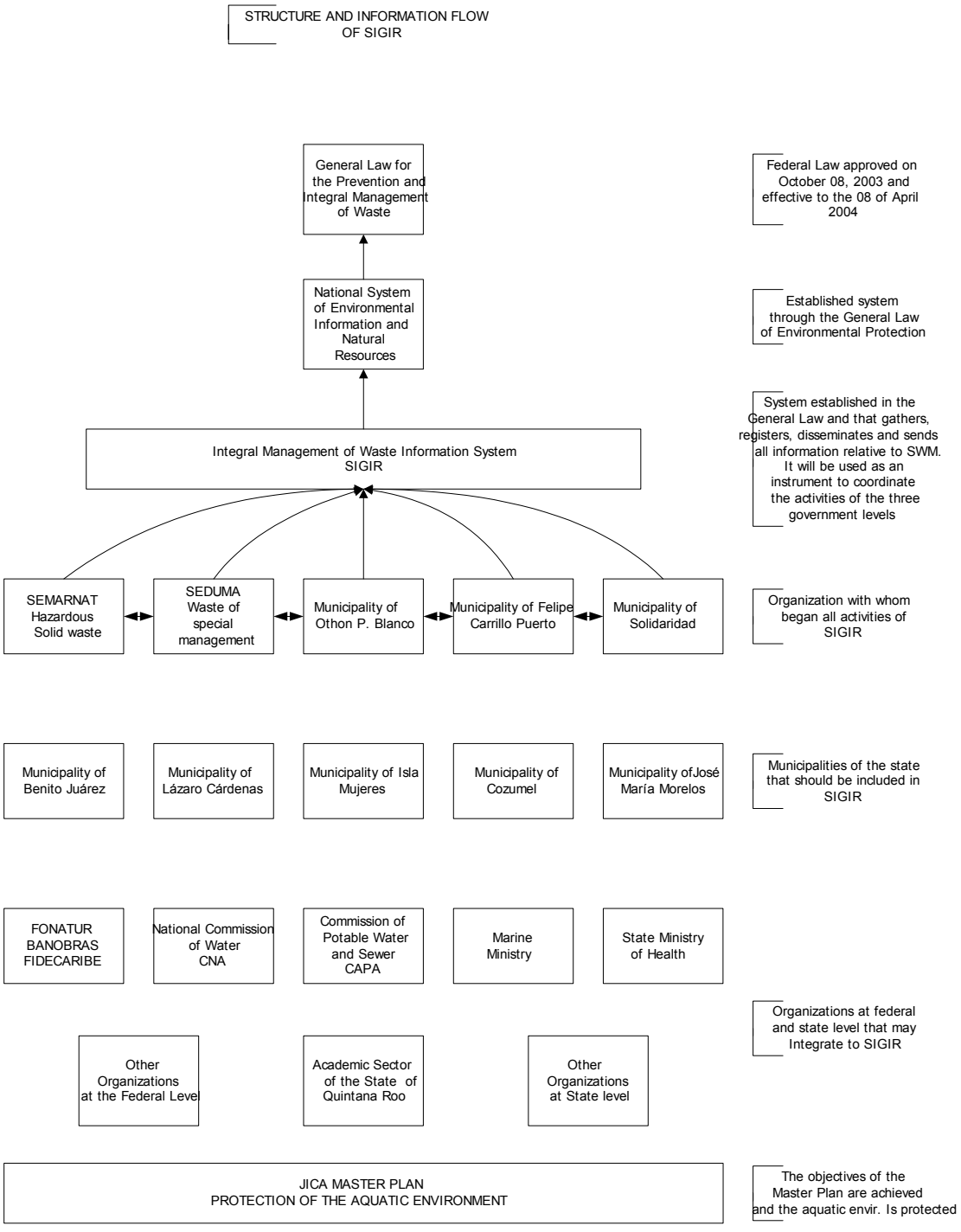
M.6 Conclusions and Recommendations

a. Conclusions

- The establishment of SIGIR responds to a precept of the General Law and to an evident need of creating more synergy among the three government levels for taking care of the integral management of solid waste in the scope of their respective competences.
- The organizations linked through the net agree in the importance of SIGIR as a mechanism of information and coordination among them.
- SIGIR is an ideal instrument which informs the public and which accomplish the general participation in the subject of shared responsibility, prevention on the generation, valorization and integral management of solid waste.

b. Recommendations

- To assign in a permanent basis an operator for SIGIR in each participant organization.
- Routinely prepare and send to the National System of Environmental Information and Natural Resources, the information foreseen in the General Law. The Department of SEMARNAT in Quintana Roo will receive and register such information while the National System is activated.
- In the moment when the program of implementation of the Master Plan be prepared, its monitoring will start.
- SIGIR should incorporate other organizations of the three government levels and specially the other municipalities of Quintana Roo state in the subject of solid waste management.
- SIGIR would be able to link all organizations that will be in charge of the implementation of the Master Plan in the subject of wastewater management and specially the protection to the aquifer and the aquatic environment in general.
- SIGR may be an ideal instrument for starting the structure of the Executor Unit of the Master Plan. SEDUMA is suggested as the coordinating organ for this Executor Unit.
- JICA should consider an electronic connection with SIGIR and the possible Executor Unit, with the purpose of giving continuity and assistance to the implementation of the Master Plan during the period of execution (2004-2015).


STRUCTURE AND INFORMATION FLOW OF SIGIR
General Law for the Prevention and Integral Management of Waste
Federal Law approved on October 08, 2003 and effective to the 08 of April 2004
National System of Environmental Information and Natural Resources
Established system through the General Law of Environmental Protection
Integral Management of Waste Information System SIGIR
System established in the General Law and that gathers, registers, disseminates and sends all information relative to SWM. It will be used as an instrument to coordinate the activities of the three government levels
SEMARNAT Hazardous Solid waste
SEDUMA Waste of special management
Municipality of Othon P. Blanco
Municipality of Felipe Carrillo Puerto
Municipality of Solidaridad
Organization with whom began all activities of SIGIR
Municipality of Benito Juárez
Municipality of Lázaro Cárdenas
Municipality of Isla Mujeres
Municipality of Cozumel
Municipality ofJosé María Morelos
Municipalities of the state that should be included in SIGIR
FONATUR BANOBRAS FIDECARIBE
National Commission of Water CNA
Commission of Potable Water and Sewer CAPA
Marine Ministry
State Ministry of Health
Organizations at federal and state level that may Integrate to SIGIR
Other Organizations at the Federal Level
Academic Sector of the State of Quintana Roo
Other Organizations at State level
JICA MASTER PLAN
PROTECTION OF THE AQUATIC ENVIRONMENT
The objectives of the Master Plan are achieved and the aquatic envir. Is protected

Annex N

Capacity Building of Executing Agency in Othon P Blnaco

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N Capacity Building of Executing Agency in Othon P. Blanco

N.1 Outline

a. Background

Solid waste management (SWM) is a service provided by the Othon P. Blanco (OPB) municipal government, where municipal finances has been sound, showing surplus of around 6% in 2001 and 2002. However, following a pattern common in many cities in the world, the SWM in OPB has faced financial imbalance, since income from SWM user charges covered only a minimal fraction of SWM cost, 6.25% in 2001 and 6.31% in 2002. The income from SWM user charges accounted for 0.68% of municipal income in 2001 and 0.73% in 2002. On the other hand, the SWM cost as a proportion of municipal expenditures increased from 11.5% in 2001 to 12.4% in 2002.

The following Table shows the financial characteristics mentioned above.

Table N-1: Financial Aspects of OPB Municipality & SWM

Item	2001	2002
Income surplus (% of total municipal income)	5.62	6.21
Income from user charges of SWM (% of costs of SWM)	6.25	6.31
Costs of SWM (% of total municipal expenditures)	11.50	12.39
Cost per ton assuming a generation of 120 ton/day (Pesos)	501.59	569.10
Income per ton assuming generation of 120 ton/day (Pesos)	31.33	35.92

Source: Ayuntamiento OPB

In general, financial imbalance can result from low income, high cost, or both. Insufficient income in SWM service in OPB resulted partly from the fact that user charges were imposed only on business firms (7,919 paying firms in January 2003), while no obligation existed for households to pay user charges for SWM service. The income potential from households is high since the projected population in Chetumal in 2002 (2003) was 127,372 (130,257), resulting in 29,621 (30,292) households, based on average family size of 4.3.

The income side of the financial problem is likely to have a political solution, since a recent Federal Law (Ley General para la Prevención y Gestión Integral de los Residuos) passed on 8 October 2003 established as an obligation for all users of the SWM service to pay user charges. In accordance with this new Federal Law, the Study Team prepared a municipal regulation on SWM in the Study Area, and when this regulation is passed by one or all three of the Municipalities in the Study Area, all users of the SWM service – including households – in a Municipality will have the obligation to pay the corresponding user charges. Then, if SWM user charges are set at the appropriate levels and updated periodically, income

improvement can be expected from the proper application and enforcement of the proposed municipal regulation on SWM.

The Study Team considered that improved understanding of the SWM cost by the OPB municipal government officers would have to be given a higher priority, taking into account the following facts: (1) lack of cost accounting specific to SWM; (2) cost estimation of SWM requiring special requests to the Accounting Section, without being a routine operation; (3) cost estimation based on the tracking down of appropriate accounts of the government budgeting system; (4) difficulty in monitoring cost performance of SWM activities over time due to the shortage of quantified indicators (for example, cost per ton of solid waste collection over time); and (5) the lack of cost performance indicators by SWM activity resulting in difficulty to focus and guide improvement measures.

b. Project Design Matrix

Project Name:	**Period:**	**Version:**
Capacity Building of an Executing Agency	Early October 2003 – End July 2004	No.2
Target Area:	**Target Group:**	**Date:**
Othon P Blanco	Personnel of Othon P. Blanco Munic.	January 2004

Project summary	Indicators	Means of verification	Important assumptions
Overall goal M/P is implemented			
Project Purpose Capacity of the executing agency is improved.	1. A procedure is established for systematic record keeping and calculation of solid waste service costs, resulting in the generation of cost performance indicators. 2. A system is established to improve the agency capacity to control solid waste service costs.	Report of the study showing improved record keeping on cost of solid waste service.	The Municipal Government has the political will to do what is needed to improve cost control of solid waste service.
Outcomes 1. Capability of the executing agency is improved. 2. A program of capacity building is prepared.	1.1 Cooperation among Departments of the municipal government is improved (DDU, DE, DSM, Treasury). 1.2 Measures are taken to collect, keep and record cost data systematically. 2. A Manual is completed.	1.1 Mechanism is established on inter departmental exchange & use of operation/cost data. 1.2 Involved persons understand and perform their roles. 2. Manual on cost control of solid waste service in OPB Municipality	The Municipal Government sets aside the personnel, office space, and equipment needed for the data collection, storage and processing.
Activities See the table below	**Inputs** See the table below		**Conditions**

Operation Plan

Activities	Outputs	Period	Inputs by S/T	Input by C/P
1. Planning of diagnosis	Diagnosis Plan	See the table of EXCEL	- Collaboration	
2. Implementation of diagnosis	Results of diagnosis	Ditto	- Collaboration	
3. Planning of improvement	Improvement Plan	Ditto	- Collaboration	
4. Implementation of Improvement	Implementation record	Ditto		- Provision of office space
5. Drawing up a draft of manual	Manual (draft)	Ditto	- Duplication of manuals (draft)	- Distribution and use of the manual
6. Monitoring	Monitoring record	Ditto	- Advice and guidance	- Implementation of monitoring
7. Evaluation	Evaluation report	Ditto	- Collaboration	
8. Drawing up the Manual (final)	Manual (final)	Ditto	- Duplication of manuals (final)	- Distribution and use of the manual

Input

Input	Study Team	Counterpart
Personnel	• Responsible Person: MaO • Assistant: • Support: XiA, IkM	• Responsible person: One • Assistant: one • Participants: C/P & persons in charge of computing in Collection Improvement Model Project; Accounting
Material	• Manual (draft): • Manual (final):	• Office space

Task Table

Activities	Tasks
1. Planning of diagnosis	1.1 Discussion meetings with C/P on the purpose of the Model Project 1.2 Confirmation of P/R 1 data, and judgment on requirement of additional data for further analysis 1.3 C/P: Preparation of relevant data on finance & accounting, if additional data is deemed necessary (income and cost) 1.4 S/T: Preparation of analytical scheme to assess present situation and problem points, if further analysis is deemed necessary
2. Implementation of diagnosis	2.1 S/T: Analysis of relevant data provided by C/P 2.2 Joint task: examination of analysis results 2.3 Joint task: agreement on problem points
3. Planning of improvement	3.1 Joint task: agreement on desirable improvements 3.2 Joint task: agreement on methods to improve cost control of solid waste service. 3.3 Joint task: coordination with other Departments, and other Model Projects (Improvement of Collection and Final Disposal) 3.4 Joint task: Testing & learning the use of software 3.5 S/T: Design of necessary forms
4. Implementation of Improvement	4.1 S/T: Training of C/P 4.2 Joint task: Installation and actual use of software for systematic record keeping, and calculation of costs performance indicators

Activities	Tasks
5. Drawing up a draft of Manual	S/T: Preparation of the Manual on the basis of what was done up to then
6. Monitoring	6.1 C/P: Securing data from Collection Improvement Model Project, and Accounting Section or commercial firms 6.2 C/P: Input of data into computer 6.3 C/P: Cost calculation, generation and use of performance indicators for monitoring
7. Evaluation	Joint task: Analysis and evaluation of the Model Project
8. Drawing up the Manual (final)	S/T: Preparation of the Manual incorporating results from monitoring and evaluation of the Model Project

c. Work Schedule

Item	Feb-04				Mar-04				Apr-04				May-04			
	1-	8-	15-	22-	7-	14-	21-	28-	4-	11-	18-	25-	2-	9-	16-	23-
Coordination w/ offices	■	■														
Design of necessary forms	■	■														
Collection of prices			■	■												
Testing &learning COSEPRE				■	■											
Data collection: MPSO & Accounting					■	■	■	■	■	■	■	■	■	■	■	■
Data input COSEPRE					■	■	■	■	■	■	■	■	■	■	■	■
Cost calculation, circulation of results								■				■				■

N.2 Diagnosis

N.2.1 Present Situation

As stated by a UNEP document of December 2002, sustainable development is the goal, and capacity building is a means to achieving it. The UNEP document goes on to elaborate that capacity building is a holistic enterprise, encompassing a multitude of activities, from building abilities, relationships and values, to strengthening processes, systems and rules, that influence individual and collective behavior, to enhance their performance. Capacity building means enhancing people's technical ability to prepare them to play new development roles, as well as to adapt to new demands and situations.

Capacity building, as stated by the said UNEP document, may be a result to be obtained jointly from the group of Model Projects encompassing Capacity Building, Collection Improvement, Solid Waste Management in Costa Maya, Improvement of Final Disposal Site, and Environmental Education. This particular Model Project, Capacity Building of an Executing Agency in Othon P. Blanco, individually, is quite modest if judged by the UNEP statement on capacity building, because it deals with only a subset of the financial aspect of one of the services provided by the Municipality of Othon P. Blanco. However, the Study Team considered that grasping the cost of the solid waste management service was essential if improvement measures are to be taken. Once a procedure to estimate the SWM cost is established, and the quality of service is assessed, then quality improvement of the service and its financial implications can be analyzed.

Progress Report 1 presented the first estimate of the SWM cost in Othon P. Blanco Municipality in 2001 on the basis of an estimated generation of 170 ton per day. It pointed out that the resulting cost of 270 Pesos per ton or 27 USD per ton was more appropriate to be regarded as the SW collection cost per ton due to the incomplete nature of cost data and the lack of weight data on solid waste, generated or disposed of in the final disposal site. Compilation of weight of solid waste at the final disposal site is expected to start in March 2004 but only for the waste generated in Chetumal. However, more complete 2002 cost data became available for the following activities, Collection, Street Sweeping, Parks, and Overhead, resulting in a total SWM cost of 401 Pesos per ton or around 40 USD per ton, if the assumed daily generation was 170 ton. On the other hand, if the daily generation were assumed to be 120 ton, then the total SWM cost would have been 569 Pesos per ton or around 57 USD per ton in 2002.

Table N-2: Total and Unit Cost of SWM in OPB in 2002

Item	2002 Total Cost Pesos	Unit Cost 120ton/day USD/ton	Unit Cost 170ton/day USD/ton	CEPIS Reference 2001 USD/ton
Collection	10,535,848	24	17	25-40
Street sweeping	8,184,830	19	13	15-20 per km
Parks	2,234,686	5	4	
Transfer station	0	0	0	8-12
Overhead	3,971,043	9	6	
Final disposal	0	0	0	4-10
Total	24,926,407	57	40	

Source: OPB Municipality
CEPIS "Indicadores para el Gerenciamiento del Servicio de Limpieza Pública", Lima, 2001

Accurate record keeping of cost items, together with the calculation of precise service cost by component activity of solid waste service, are the essential starting basis if improvement measures are to be introduced.

a. Lack of regular cost estimation of SWM

Costs of SWM are not computed regularly or routinely. Cost records corresponding to 2002 were made available by the Accounting Section of OPB Municipal Treasury, as a result of a special request of the S/T, the SWM being classified into the following component activities: solid waste collection (42%), street sweeping (33%), parks (9%), and overhead (16%). It can be seen that the "**final disposal**" or "**landfill**" cost was not explicitly computed by the accounting method, despite being an important activity of the SWM.

It appears that the allocation of cost items to specific SWM service activities needs to be improved, in order to give a more precise result on the unit cost by activity. For example, cost per ton of solid waste collection can be more precise, albeit higher, when such expenses as those on Uniforms, Equipment Rentals, Materials, and Hired Services are re-allocated from Overhead Expenses to the specific component activities. This concentration of some expense items in Overhead Expenditures indicated that possibly there was room for improvement in the estimation accuracy of unit costs of component activities.

The cost of SWM service increased in relation to the total expenditures of OPB Municipality, from around 11.5% in 2001 to around 12.4% in 2002.

In 2002, the largest cost component of the SWM service was Personnel & Benefits with around 80%, and fuel with around 15%. This appeared to indicate that funds for maintenance were quite limited.

b. Absence of monitoring of cost indicators

The performance levels of activities of the service provided could not be monitored due to the shortage of quantified data to compute the appropriate indicators. The absence of cost indicators for monitoring indicated weakness in the opportunity to improve efficiency.

In addition, the lack of cost indicators by component activities made SWM service improvement difficult to focus and guide. As solid waste collection comprised 42% of total SWM cost in 2002, the logical action was to focus improvement on this component activity. A suitable indicator would be the cost per ton of collection service, monitored periodically over time.

c. Financial imbalance of SWM

The largest income component of OPB Municipality has been the transfer of funds from the higher levels of government. This income source is generally regarded as unreliable, as it is likely to decrease when the economy worsens and the tax collection declines.

The SWM service appeared to be provided without regards to the cost and income specific to the service. Municipal income from SWM user charges was minimal, accounting only for slightly over 6% of the cost of the SWM service in 2001 and 2002. User charges were collected from around 8,000 business firms, but around 30,000 households in Chetumal were ignored as sources of potential income that could make a significant difference in the financial situation of the SWM service.

If income data are not classified by customer type, immediate actions cannot be targeted to specific groups of service users differentiated by tariff level. Presumably, the prevailing user charges applied in 2003 were $30 and $50 per month, except in January. Average monthly payment by business firms during the first eight months of 2003 ranged between 13.46 Pesos and 61.72 Pesos, as shown below.

Table N-3: Average Payment by Firms in 2003

Month	Average Payment per Firm (Pesos)
January	61.72
February	44.14
March	30.43
April	19.07
May	26.27
June	16.83
July	19.80
August	13.46

Source: OPB Municipality

The tariff structure of 2003, consisting of a long list of service charges, had probably the purpose of eliminating any doubts in the application of tariff to each specific SWM service

user. But it resulted in a rather unsystematic user charges structure consisting of 80 business types, further classified into 218 categories, to which 12 tariff levels were applied. The service charges passed by the city government for 2003 were a long list of types of business firms with predominance of the $50 monthly tariff, although the range spanned from $30 to $1,200 per month. Although probably intended to be a comprehensive list of businesses so as to make tariff application transparent, it ended up being just a long list with only a few tariff levels actually applied.

Equity or justice issue refers to the lack of application of service charges on domestic or household dischargers of solid waste, a group that has the potential to generate significant income for SWM. This discrimination favoring households appears to be a purely political decision that can be corrected with another political decision, perhaps induced by a new Federal Law.

N.2.2 Expected Improvements

The cost of SWM is expected to be calculated by component activity, and this cost data is expected to help the introduction of other relevant performance indicators of the service. Monitoring of cost indicators over time will be possible and strongly recommended, opening the possibility of introducing appropriate countermeasures in the right place or activity of the SWM service on a timely basis. Cost efficiency in SWM service will become a realistic goal, and if combined with the political decision to impose user charges on all users of SWM service without exception, then financial self-sufficiency and sustainability of SWM service will also become a realistic goal.

a. Introduction of special cost accounting software

The purpose of the Model Project is to introduce the COSEPRE (Costos de Servicios Prestados, translated by the World Bank as Costs of Urban Cleaning Services) software, which was prepared by CEPIS (Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente, or Pan American Center for Sanitary Engineering and Environmental Sciences). The software serves to systematically register all costs of the SWM service, with the flexibility to choose the component activities, for example collection and final disposal, so as to adapt to the situation of SWM in each city. The input data on physical quantities of materials and supplies used in SWM, as well as those on the hours worked, will come from the Collection Improvement Model Project, and the corresponding price data will come from the Municipal Treasury. The output is the cost per ton of component activities and the overall cost of SWM service, as administrative cost is also computed and added during the calculation of the total cost of the service.

b. Estimation of cost indicators

Input of relevant data will automatically produce the cost of the service, being possible to obtain the overall cost as well as the cost of specified component activities like SW collection or final disposal. The cost per ton is the summary indicator, but other quantified performance indicators will need to be monitored and controlled if a satisfactory value of cost per ton is to be achieved.

COSEPRE is designed to give results on annual costs of SWM services on the basis of the input of monthly data. Accordingly, during the implementation period of the Model Project, input data for every month between March and May 2004 should give the corresponding cost results for one year on the assumption that the SWM service was provided with the operating characteristics of each of the said three months. When the necessary input data are completed for the period encompassing January through December of a given year, the corresponding costs resulting from COSEPRE would represent the operating characteristics of the whole year.

c. Monitoring of cost indicators

Once cost indicators are computed, their evolution over time can be monitored, thereby becoming a tool for permanent improvement. The reference values given by CEPIS for Latin America may be the initial benchmark, but subsequently the improvement will have to be over the performance of the service activity in the previous period. For instance, the cost per ton of SW collection service in April is expected to be lower than that of March. In other words, it has the potential of becoming a self-improving tool.

d. Coordination & cooperation among Municipal Offices

The SW collection activity comprised 42% of total SWM cost in 2002. Therefore, another Model Project deals with improving SW collection, and yet another Model Project deals with the improvement of final disposal. The SW collection and final disposal are services provided by the Municipal Public Services Office; therefore, their close cooperation is needed to obtain the physical data to be used as input in the COSEPRE software. On the other hand, for the price data of the physical input, also required by COSEPRE, a close cooperation will be needed with the Accounting Section of the Municipal Treasury. The implementation of this Model Project is expected to improve the coordination and cooperation among the different offices of the Municipality.

e. Financial equilibrium of SWM

If the cost indicators are correctly used for monitoring and for the introduction of appropriate countermeasures, then the SWM service will undoubtedly become more cost efficient, that is, the cost per ton of the service can be lowered for the same level of service, or the quality of service can be improved without much change in service cost. In addition, enactment of the municipal regulation on solid waste, reflecting the new Federal Law, will mean the obligation of all users of the SWM service to pay the corresponding user charges, thereby taking care of the equity or justice issue and resulting in higher income. Lower cost and higher income may open the door to financial equilibrium of the municipal SWM service, depending on the level of user charges and the updating mechanism. If financial results of SWM are favorable, the income from SWM user charges is recommended to be earmarked for improving the SWM service. Then, finally, the SWM may be on its way to financial sustainability.

N.3 Implementation

For the application of COSEPRE, preparation of the input data is necessary. Some of the data are handled by the Municipal Public Services Office, while others are handled by the Accounting Section of the Municipal Treasury. It is suggested here to systematize collection of all data by activity and cost component items on a monthly basis. The necessary forms have been prepared for the implementation of the Model Project.

Taking into consideration that the 2002 SWM cost indicated Personnel Cost to comprise around 80 % of the total cost, the suggestion is to make a list of personnel by activity, specifying the job, its municipal accounting code, name of the employee and payroll number, salary and social benefits. All the said information should be summarized by activity and by month, for example, Personnel of Collection Service in January 2004 would list all the employees working in solid waste collection specifying salary and benefits.

Likewise, the cost of fuel comprised 15% of SWM cost in 2002. Then, the cost of fuel and lubricant, tires and batteries, as well as the parts for repair, is suggested to be specified by vehicle identified with a unique number, by activity and by month. For example, cost registration should specify how many gallons or liters of fuel and lubricant was used by "dump truck 1993" for SW collection in January 2004, and how much was spent on the parts needed to repair the same truck in the same month. Similar data should be collected for vehicles in the Administration of SWM that are used for supervision of SWM.

In a similar way, data on materials and supplies needed in the SWM, like uniforms handed over to personnel as well as tools for specific services, are suggested to be systematically collected by activity and by month. For example, how many shirts or pairs of boots were handed over to personnel in the Collection Service in January 2004. Likewise, how many tools, like shovels and brooms, were handed over to personnel in Street Sweeping in January 2004.

Systematizing data collection will require time and efforts, but will facilitate data input and use of COSEPRE software.

Systematic data collection, input into COSEPRE software, and monitoring of the implementation will be conducted during the three months of March and May 2004. The implementation and monitoring during three months are expected to result in cost figures of the SWM in Othon P. Blanco that are more precise, activity specific, and closer to reality. Then, appropriate countermeasures can be taken regarding the finances of SWM. These countermeasures may refer to those concerning cost reduction or income increase.

Ultimately, capacity building of Othon P. Blanco Municipality as provider of SWM services should result from improved finances, where the first step is a better cost estimation. This should be combined with a better control of SWM costs resulting from improvements in the SW collection and the final disposal services. Significant contribution is expected from improvement in citizens' awareness resulting from environmental education, and the improvement in the legal and institutional framework resulting from the enactment of the new municipal regulation on SWM. The latter is expected to result in improved income.

N.4 Results

Narrative Summary	Achievements
Overall Goal Implementation of the Master Plan	The continued application of the suggested software for the systematic record keeping and calculation of solid waste management cost, as a tool for cost control, can open the door to the financial self-sufficiency of the service.
Purpose of the Model Project Calculation and control of the cost of solid waste management in a routine way, and formation of a mind set, attitude or awareness on provision of SWM on the basis of costs and revenues specific to the service, so as to seek the financial self-sufficiency of the service	The city government of Othón P. Blanco has installed and has used the software COSEPRE for the systematic record keeping of the cost of SWM and the calculation of the costs of solid waste collection and final disposal. The scope of the Model Project has been restricted to the data collected in the Model Projects on Collection Improvement and Landfill Improvement, with the cooperation of other municipal offices which are in charge of data on unit costs and prices, but the scope can be easily expanded to encompass all activities of the service such as street sweeping and parks.
Outcomes 1. Mechanism to collect the necessary data from other municipal offices 2. System to organize and process the collected data for input into the software 3. Criteria for the input of the collected data	1. A mechanism has been established to collect the necessary data which are handled by other municipal offices. Communication channels have been opened and cooperation has improved noticeably during the implementation of the Model Project. 2. The collected data frequently require prior processing for the input into the software, and for this purpose, appropriate tables or forms have been prepared. 3. The above mentioned data processing requires some criteria, sometimes based on accounting, other times based on reality, and these criteria have been transmitted to the municipal officers appointed for the implementation of the Model Project.
Input 1. Personnel 2. Softwares	1. Mr. Masaru Obara, a member of the S/T was responsible for the Model Project, with the close support of Mrs. Ximena Alegría and Mr. Ikuo Mori. During the absence of the S/T, Mr. Hiram Díaz was in charge of the follow up. On the C/P side, Mr. Héctor Morín, architect, was in charge of the Model Project, with the cooperation of Miss Maria Dolores Velazco Té, architect, and Miss Lilibet Eunice Arjona Pérez, biologist. 2. The software COSEPRE has been handed over with its Manual, as the basic software for the calculation and control of SWM costs. The software operates on an annual basis. Tables or forms have been prepared to facilitate collection and processing of data as summaries of groups of data prior to data input into the software. In addition, for the calculation and control of costs over more flexible analytical periods, the software “Costos de MRS” and its Manual have been prepared.

N.5 Evaluation

N.5.1 General Evaluation

The software COSEPRE for the systematic record keeping and calculation of SWM costs has been installed in several computers of the municipal government, and its application has been understood by the concerned municipal officers. The software is being used to calculate the cost of SWM, specifically the cost of solid waste collection and the cost of final disposal. The cost calculation is the basis for the control of SWM costs, and this effort is expected to continue into the future.

In addition, in order to give more flexibility to the effort to calculate and control the SWM costs, a specific software and its Manual has been prepared. This specific software is known as "Costos de MRS", and will serve to calculate and control the direct costs of SWM during periods of analysis that can be set according to the interest of the analyst or the decision maker. It is a flexible program that makes it possible the calculation of direct costs for any length of time, from one to several days, although the probable minimum analytical period would be a week or two weeks.

a. Efficiency

The cost of the Model Project is estimated at 10,000 Peoss. In terms of cost, the Model Project can be regarded as one of high efficiency, as the potential is high for controlling and reducing costs for amounts many times larger, as the result of introducing greater efficiency in the SWM service.

The results from COSEPRE can be subjected to comparative analysis with the cost of SWM in Othón P. Blanco estimated with accounting data of 2002. Another analysis can examine whether the results obtained in the Model Project on Solid Waste Collection are reflected in the cost calculated by COSEPRE. And results from COSEPRE should be subjected to monthly comparative analysis during the three months of the Model Project, in order to analyze the evolution of the cost per ton of the service over time. These analyses can indicate the scope of the efficiency achieved.

b. Effectiveness

The Model Project can be considered as an effective instrument that can contribute to the capacity formation of an executing agency, i.e., the municipal office responsible for the provision of SWM services.

Although the financial improvement of SWM may be a small aspect in the financial improvement of the municipal government, the change in mentality or attitude in the sense of

approaching the operation of a public service on the basis of specific costs and own revenues of the service would be a step forward in the municipal public administration. If this mentality or attitude could be expanded to other aspects of municipal administration, it would be a valuable contribution in the capacity formation of an executing agency in the municipal government.

c. Impact

A high impact potential has been established, depending on such factors as the real use and continued application of the software, the correct interpretation of obtained results, and the practical use of these results for making corrections in the activities of the SWM that may be incurring high costs.

It is expected that the importance of approaching a municipal service on the basis of its costs and revenues will continue to be understood and will continue to be of interest to the municipal authorities responsible for making the relevant decisions. It is important to collect the necessary data, to process the data and input into the software in order to obtain the results. But the real importance rests upon the correct interpretation of the results, and the use of these results for the decision making to improve the SWM services. If this practice becomes a routine activity, the impact will be high.

d. Relevance

The relevance of the Model Project is unquestionable as the systematic record keeping of costs and the calculation of costs as the instrument to control the SWM costs can become a routine task instead of being an extraordinary task that is tackled only in response to a special request.

Once the record keeping and calculation of costs become a routine task, it would facilitate the monitoring of costs over time, and this permanent monitoring will make it possible to make decisions in a timely fashion to introduce the countermeasures leading to the reduction of SWM costs and to the financial self-sufficiency of SWM.

e. Sustainability

The application and the routine use of the software can be sustainable depending on the continued interest of the concerned municipal authorities who are responsible for making the relevant decisions and have strong and sincere interests to make the SWM service more efficient.

The COSEPRE software is being operated by two employees of the municipal government who were appointed for the implementation of the Model Project. The experience acquired by

these two employees should be continued and expanded with the unfailing support from their supervisors as well as the municipal authorities directly responsible for SWM and the financial management of the municipal government.

N.5.2 Inherent Aspects to the Model Project

The practical application of the COSEPRE software requires a close cooperation between the different offices of the municipal government. This cooperation can be initially difficult due to a strong feeling of "ownership" over the data handled by a particular municipal office. This "ownership" feeling is understandable, but should give place to a spirit of cooperation with the purpose of attaining a common good and a common goal, the improvement of SWM. To attain and to maintain this cooperation among the different municipal offices is a constant challenge.

The data pertaining to the municipal government should be handled as a common resource by all the responsible officers in charge of the public administration of the city, and not as the property of a particular office within the municipal government. All relevant municipal officers should have access to these data, which are necessary for the design and implementation of policies, and for taking the practical measures for the benefit of the city residents.

N.6 Conclusion and Recommendation

a. Conclusion

- The awareness has been instilled into the concerned municipal officers about the need to approach the SWM service on the basis of its specific cost and revenues.
- The recommended COSEPRE software is being usefully applied in the Urban Development Office of Othon P. Blanco Municipality.
- Channels of communication and cooperation have been established among the different offices within the municipal government.
- The results obtained with the software are being subject to analysis for the practical application in the improvement of SWM services.

b. Recommendation

- The use of the COSEPRE software should be expanded to other municipal offices, specifically Accounting and Finance, and the interested municipal employees should be given the chance to learn and use the software.
- The data collection system for the COSEPRE software should be continuously improved according to the accumulation of experience by the operators of the software.
- The results obtained should be discussed among those municipal officers responsible for the SWM and those from Finance, Accounting, Human Resources, Urban Development and Education. The clear understanding of the objectives that are sought with the application of the COSEPRE software can improve the cooperation needed among the different municipal offices.
- Constant improvement should be sought in the cooperation and exchange of information among the diverse municipal offices.
- The software “Costos de MRS” was written using Microsoft Access, and should be improved and modified in order to adapt it to the peculiar needs of the municipality according to the accumulation of experience and the needs that may arise.

Annex O

Improvement of the Existing Disposal Site in Othon P Blnaco

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O Improvement of the Existing Disposal Site in Othon P Blanco

O.1 Outline

a. Background

All the solid wastes generated in Chetumal municipality are currently disposed in Calderitas Dump Site. The wastes disposed in this site are scattered around the area, and those wastes are exposed to the atmosphere. As a result, the water from rainfall penetrates into the wastes, causing the leachate to the ground. The leachate from wastes is pollutant water which easily contaminates groundwater.

Furthermore, the site does not have any facility to weigh the incoming solid wastes. Lack of basic data, such as weight of wastes, makes it difficult to evaluate the current condition and to achieve the successful solid waste management.

This model project is formed to solve these problems with full collaboration of the specialists among JICA study team and C/P.

b. Project Design Matrix

Project Name:	Period:	Version:
Improvement of the existing disposal site in OPB	Early October 2003 – End of July 2004	No.2
Target Area:	**Target Group**	**Date:**
Othon P Blanco	Personnel of Othon P. Blanco	January 2004

Project summary	Indicators	Means of verification	Important assumptions
Overall goal Sanitary land-filling is realized.	Daily soil cover • Leachate control • Community response	Operation record • Monitoring well • Mass media	Continuous effort of stakeholders to reduce environmental impact from landfill operations.
Project purpose Improve the operation of the existing disposal site	• Number of complaint • Reduce unloading time	• Mass media • Weigh bridge record	• Operation will be carried out according to the manual
Outcomes 1. Traffic ability is improved. 2. Chances of fire are reduced. 3. Sanitary condition is improved 4. Waste disposal amount is known.	• Perimeter road is constructed • Number of fire incidents • Wastes are covered with soil • Daily waste disposal amount table	• Field Investigation • Operation record • Field Investigation • Weigh Bridge Record	• Electricity to be supplied on time • Heavy machinery is available
Activities See the table below	Inputs See the table below		Pre-conditions

Activity Table

Activities	Outputs	Inputs by S/T	Input by C/P
1. Planning of diagnosis	Diagnosis Plan	- Collaboration	
2. Implementation of diagnosis	Results of diagnosis	- Collaboration	
3. Design and O&M plan	Design and plan	- Design and O&M plan	- Acquisition of required permits
4. preparation of order	Contract documents, specifications	- Preparation of order	- Acquisition of required permits
5. works	Record of works	- construction works - equipment - supervision	- Supervision
6. Drawing up a manual (draft)	Manual (draft)	- Preparation of manuals (draft)	- distribution manual
7. Operation	Operation record	- Advice and guidance	- operation
8. Monitoring	Monitoring record		- monitoring
9. Evaluation	Evaluation report	- Collaboration	
10.Drawing up the manual (final)	Manual (final)	- duplication of manual (final)	- distribution and use of manual

Input

Input	Study Team	Counterpart
Personnel	Main: IcK Assistant: Support: NaO, XiA	Main: One Assistants: some Participants: to be clarified
Material	Manual (draft): 30 copies Works: lump sum Weighbridge: lump sum Manual (final): 30 copies	Heavy machinery such as bulldozer, shovel, excavators Electricity Supply to Weigh Bridge

Task Table

Activities	Tasks
1. Planning of diagnosis	Field investigations Land survey
2. Implementation of diagnosis	Selection of improvement alternatives
3. Design and O&M plan	Design layout of facilities Phase wise operation plan
4. preparation of order	Technical specification Selection of Contractors Contract document
5. works	Quality control Schedule control
6. Drawing up a manual (draft)	Contents and methods to be practicable and affordable to the C/P
7. Operation	Follow recommended operation methods
8. Monitoring	Operation record to be kept daily
9. Evaluation	Evaluation based on the PDM
10. Drawing up the manual (final)	Modification according to the evaluation of model project.

c. Work Schedule

Item	2003			2004						
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Planning and Design										
Implementation										
Improved Operation and Monitoring										
Evaluation										

Figure O-1: Schedule of Model Projects

O.2 Diagnosis

a. Existing Conditions

The existing conditions of Calderitas Dumping Site are summarized as follows.

Table O-1: Existing Condition of Calderitas Dump Site

1. Location	• The site, covered with forest, is located at about 8 km north of Chetumal City. There are few dwellings around the area. • The area is flat, and water hardly inflows or outflows from/to the surroundings.
2. Area	• Around 12.5 ha (250 m x 500 m)
3. Facilities/ Operation	• There is no structure to prevent wastes from scattering but no significant scattering is identified. • Filling operation is carried out mainly at south-west corner of the site. The wastes are accumulated to the elevation of 16 m, where existing ground level is 8 m from sea level. • The site does not have leachate retaining structure but outflow to the surroundings is not observed. • Concrete lined drainage and injection well are located at the west boundary of the site. The drainage and well are filled with debris, preventing water running. • Entrance gate with chain lock is located at south-east boundary of the site. • Wastes are covered with soil at a small area, the rest are left uncovered. • The site is not equipped with gas extraction facilities which are required for prevention of fire incidents. • Monitoring wells with diameters of 200 mm and 300 mm are located at each corner of the boundaries, but they are not utilized. • Security fences along the boundary of the site are deteriorated. • The site does not have truck scale.
4. Machinery	• Two bulldozers (One D9 class and one D6 class) • One crawler shovel • All the machinery is old minimum operation rate.
5. Disposal Amount	• The exact figure is not available but around 100 tons of solid wastes are disposed every day.
6. Others	• There are three potential borrow pits near the site. • The site is near the town but isolated by wooden surrounding.

The existing wastes contour lines are shown in the map below. The figure indicates that the wastes are filled at west south of the area mostly, and the volume is reaching to almost 285,000 m3.

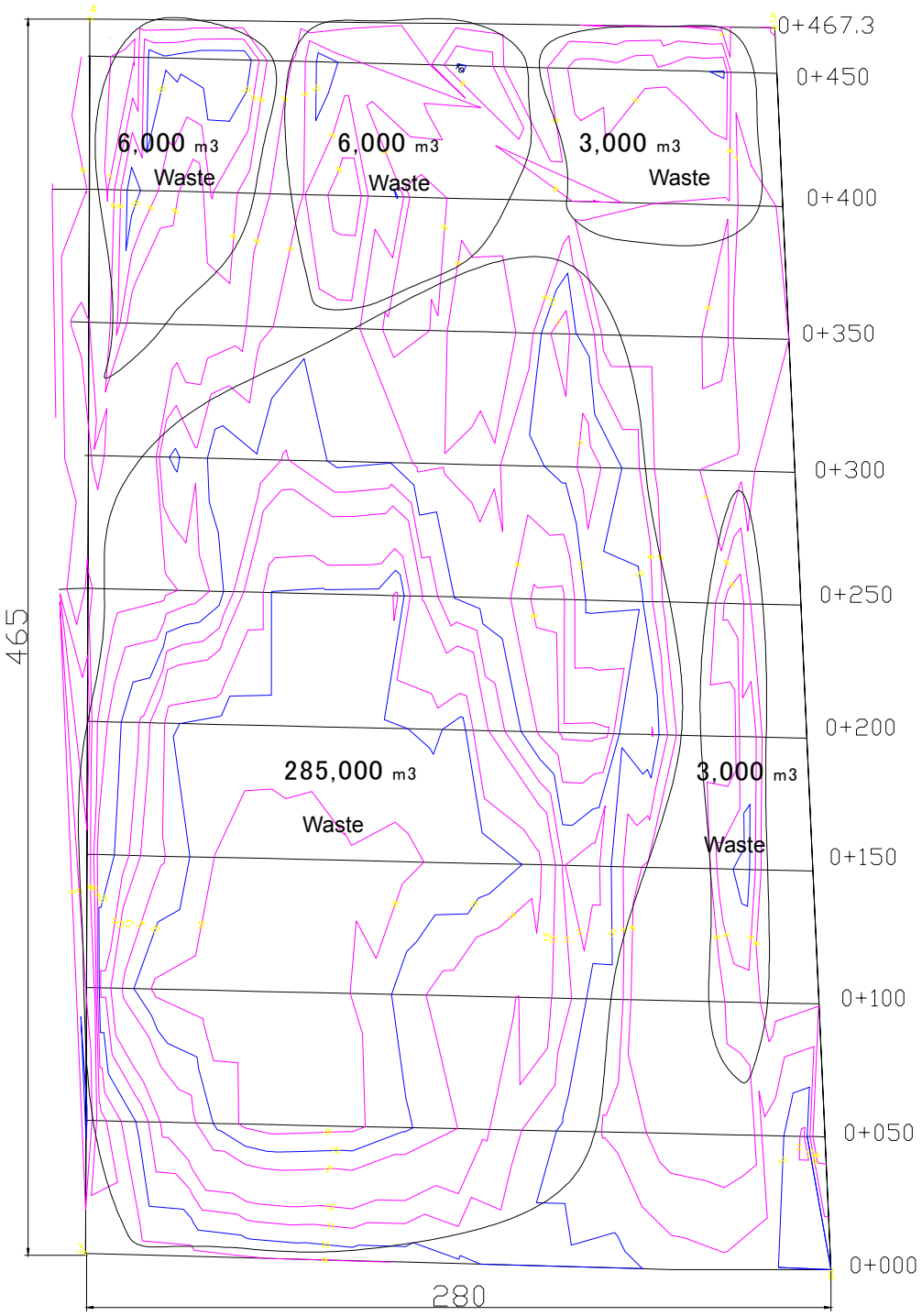

Figure O-2: Plan of Existing Calderitas Dump Site

b. Evaluation of existing dump site

The conditions of Calderitas Dump site are classified with main items of "Site Development", "Equipment" and "Operation and Maintenance" as below, and evaluated in each detail.

Table O-2: Evaluation of Calderitas Dump Site

Item	Level	Remarks
1. Site Development		
1.1 Main Facilities		
Enclosing Facilities	×	dikes, deviders
Drainage Facilities	△	Perimeter Drain, Surface Drain
Access Road	△	
1.2 Environmental Protection Facilities		
Buffer Zone	△	Surrounding by natural forest
Litter Control Facilities	×	Movable fence, etc
Gas Remeval Facilities	×	
Leachate Collection Facilities	×	
Leachate Circulation Facilities	×	
Seepage Control Facilities	×	
Leachate Treatment Facilities	×	
1.3 Building and Accessories		
Site Office	△	
Weigh Bridge	×	
Workshop and store	×	
Safety Facilities	×	Gate, Fence, Lights
Fire Prevention Facilities	×	Water Tank, Extinguisher
Monitoring Facilities	△	Monitoring Well
Car Washer	×	
2 Equipment		
Landfill Equipment	△	Machinery is very old and frequently breakdown
Others	×	Water Truck, Inspection Vehicle
3 Operation and Maintenance		
Personnel	△	
Cover Material	△	Available but not applied
Fuel Tank	×	
Water	×	
Electricity	×	
Chemical	×	Insecticide

O.3 Implementation

O.3.1 Principles of Improvement Plan

In consideration of the existing conditions, following principles are adopted for formulating the improvement of plan.

- Sanitary conditions to be improved.
- Accurate weight of incoming solid wastes to be recorded.

O.3.2 Activities

Activities are divided into three phases. Phase 1 was implemented under this model project by JICA and the C/P. Consecutively, phase 2 and 3 are implemented by the C/P independently following the operation manual.

a. Phase 1

Following activities were executed in this phase.

- To construct elevated perimeter access roads, which acts as enclosing dikes, preventing wastes and leachate outflow to the surroundings.（width of the road=10m、average height=2.0m）
- To bunch up the wastes together, compact and cover with soil at south-west of the site.
- The mount of wastes shall be compacted for every 50 cm up to the appropriate elevation. The surface will be utilized as access roads.
- EL=16m is the finishing level of land-filling surface. The surface shall be covered with soil.
- Gas extraction pipe shall be installed through the bottom of the wastes to the top soil surface. The pipe shall be made of used drum filled with crushed stone.
- Weigh Bridge is installed at the entrance of the site to obtain an accurate data of incoming solid wastes.

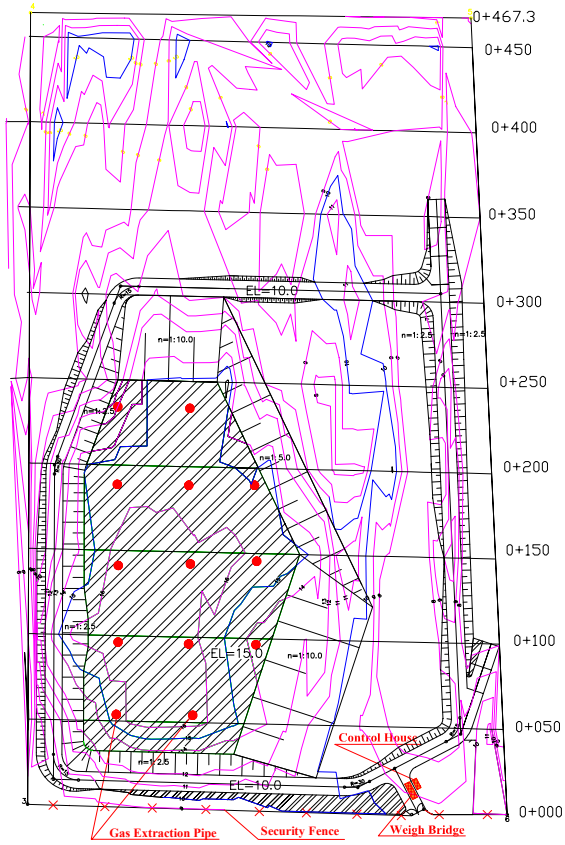

Figure O-3: Phase 1 Improvement Plan

b. Phase 2

Inside area of the perimeter access road in east half of the area, which was constructed under phase 1, is filled with collected solid wastes in following manners.

- The cell method shall be employed for implementation of land-filling operation.
- Filling shall be compacted in every 2 meters and covered with soils. Filling operation shall be continued vertically until the surface elevation reach up to the elevation of 16 m. The surface shall be covered with soil.
- Gas extraction pipe shall be connected and installed from existing ground level of EL=8 m to the surface level of EL=16 m according to the filling progress.
- Finally, surfaces of both the area operated in phase 1 and 2 are graded together and covered with soils. At the same time, the new access roads along the north of the site shall be constructed for the preparation of phase 3 operation.

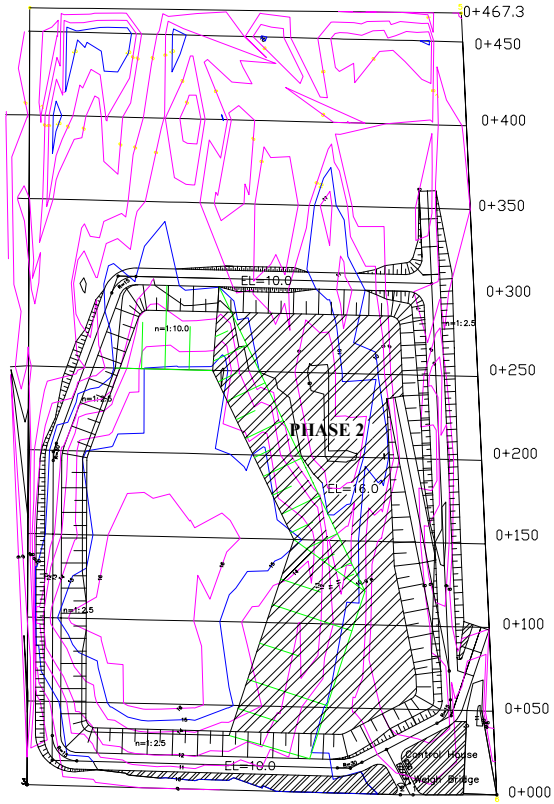

Figure O-4: Phase 2 Improvement Plan

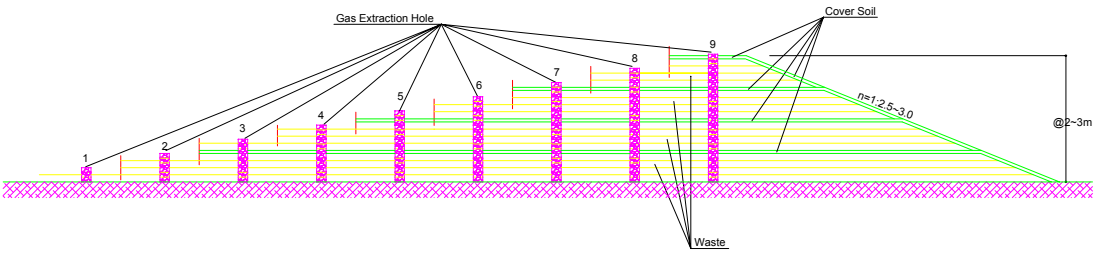

Figure O-5: Extension of Gas Extraction Pipe

c. Phase 3

In this phase, north of the site shall be filled with incoming solid wastes. Improvement measures will be implemented as follows.

- At first, the perimeter access roads shall be extended to the north and enclose the area for filling.
- Filling operation is be implemented within the enclosed area
- At this stage, daily soil cover is strongly recommended.
- Gas extraction pipes shall be installed as in phase 2.

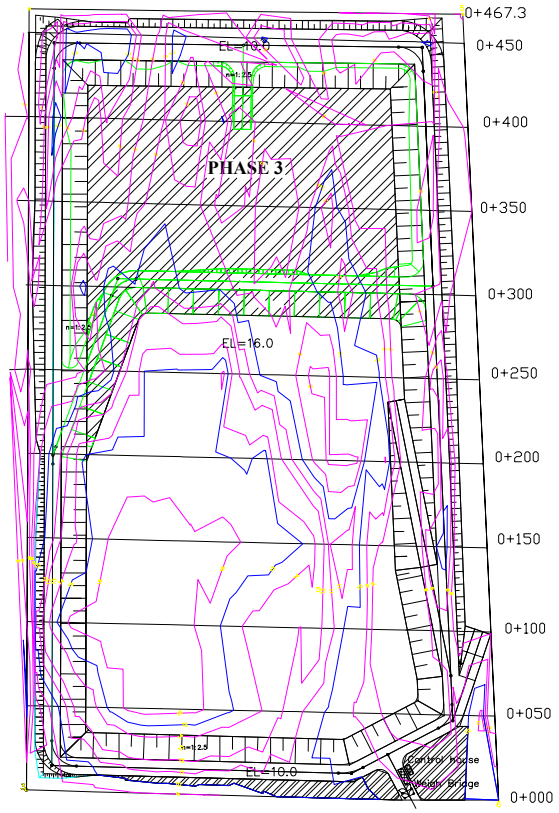

Figure O-6: Phase 2 Improvement Plan

d. Closure of Landfill Site

After filling of phase 3, this area shall be closed as a land-filling site.

Following facilities shall be maintained through out the operation period and be inspected periodically. Repairing works shall be carried out if necessary.

- Control Building
- Weighbridge
- Enclosing dike and Access road
- Gas extraction pipe
- Surface of soil cover
- Drainage
- Security Fence
- Monitoring well
- Flow of leachate

Landfill capacity and useful life period is estimated as follows.

Table O-3: Estimated Life Time of Calderitas Dump Site

Existing volume （as of Nov 2003）	Landfill capacity（m3）	Life time （year）	remarks
Phase 1	303,000	-	-
Phase 2	168,000	2.3	200m3/day
Phase 3	204,000	2.8	200m3/day
Total	675,000	5.1	-

Figure 7-7 shows the state of closure of Calderitas Dump Site.

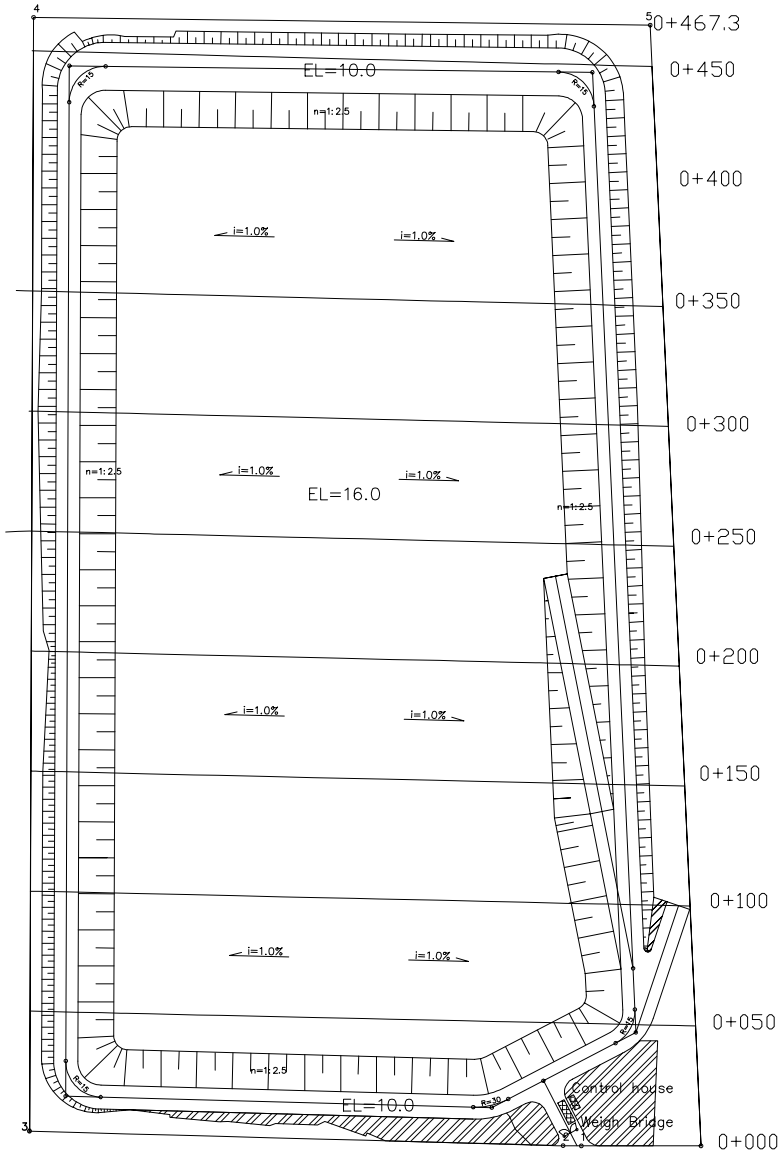

Figure O-7: Final Shape of Calderitas Dump Site

O.4 Results

O.4.1 Achievements

The table below summarizes purposes, outcomes, inputs and results of the Model Project.

Narrative Summary	Achievements
Overall Goal • Sanitary Land-filling is to be realized by the municipality.	• The public service dept. has achieved a better understanding of land-filling operations.
Project Purpose • Improvement of the operation at the existing disposal site.	• Work loads were reduced by improvement of trafficability. • Leachate from waste was blocked off by soil compaction.
Outcomes • Waste leachate is prevented. • Fire incidents are reduced. • Easy access to garbage disposal is realized. • Waste disposal amount is known. • Computerized system is introduced.	• Wastes were compacted and covered with soil. • Fire incidents did not occur. • Perimeter roads were constructed. • Weigh bridge has been utilized. Data obtained told average waste disposal amount was 161.6 ton/day.
Inputs • Professional personnel with assistants from both S/T and C/P were assigned to the project. • The allocation of funds: $16 millions pesos. • Operation manuals were provided by S/T. • Advice & guidance were given by S/T to C/P. • C/P has carried the plan into practice. • Two bulldozers have been equipped by C/P. • Survey and investigation are conducted in order to examine the existing condition, and then plan and implement for the project in collaboration. • Facilities are designed w/ O&M plan by S/T.	

O.4.2 Descriptions of Achievements

The entire area of the previous-dumping is uncovered and would be so for years as a result of neglecting. It keeps absorbing the water run-off over the surface, and then the water permeates into the ground until they reach to the deep underground water level by certain velocities and flow rates.

On the other hand, the improved Land-filling section, which was accomplished in this project, is completely covered with soil layer and the wastes are compacted enough to be consolidated. This exercise minimizes the potentiality of infiltration of polluted water into ground following upon the surface water tends to flow down to the lower elevation instead of infiltrate. Moreover, short trees and shrubs are growing in a wide area of the surface for abundant lights and water in this tropical climate.

Furthermore, on-site trafficability has been impressively improved. The longitudinal and transversal roads had been constructed as planned; in addition, newly extended access roads towards the north area of the site are observed. Consequently, the site workers had constructed the roads for their own conveniences. As a result, the trucks are now able to reach the north part of the area for waste disposal.

Moreover, chance of fire has been eliminated due to compaction and soil covering of wastes. As a result, ignitious/combustible materials in the waste had lost the contacted area to the air, and then the whole area lost the chance of fire eventually. In fact no fire incidents have been reported at the site during the project.

One of the most remarkable findings is that the waste disposal amount has been recorded from 6 am to 10 pm daily. The average daily waste amount from March 8th to May 31st was 161.6 tons. The data are taken from the Weigh Bridge which was installed in the previous phase. When the garbage trucks pass the bridge, the amounts of weight are shown automatically on the digital screen. The numbers shown on the screen are automatically recorded by computerized system and the stored as a data. The system simplifies the site work and eliminates the errors made by humans.

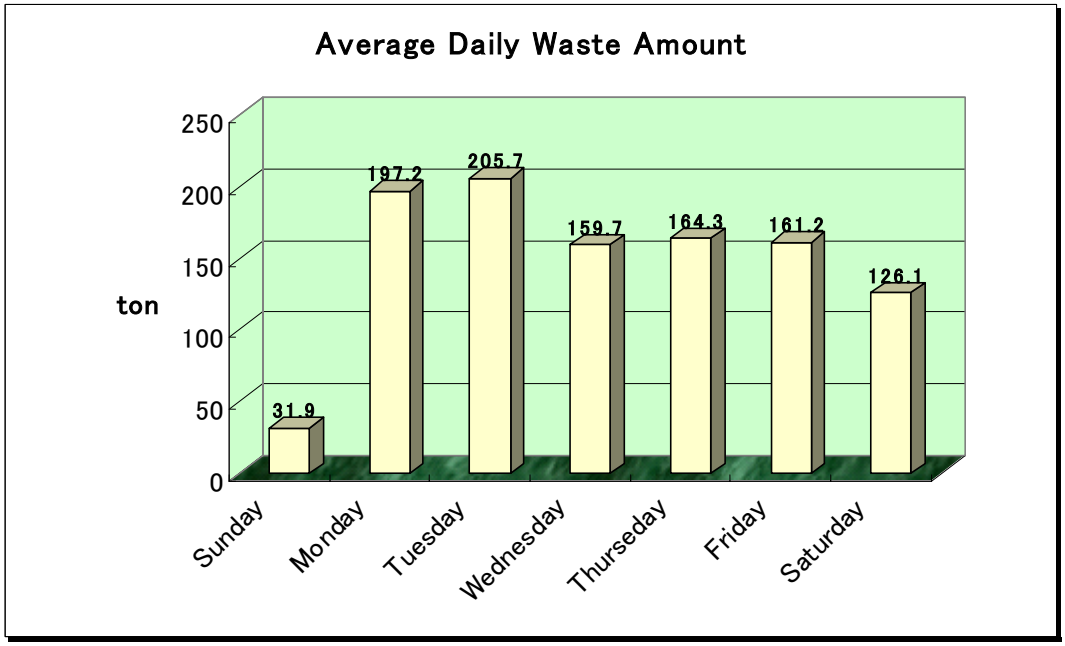

Figure O-8: Average Daily Waste Amount

By interview, neither health/physical problems nor serious injuries have been reported among the site-workers so far. The workers have a periodical vaccination against major epidemic/infectious diseases. And the vaccinations are offered by the department of social security.

Although waste was not covered with soil daily as the manual had proposed, the soil cover has been conducted every fifteen (15) days. One of the bulldozers is out of work and waiting for its repair.

Another findings are; the site operation is carried out in two (2) shifts, from 6:00 to 14:00 and 14:00 to 22:00, each shift has eight (8) workers, the salaries of the workers vary from 700 to 1,200 pesos per every fifteen (15) days, depending on the types of work in charge, there are five (5) to six (6) scavengers on site, collecting the recyclable materials for selling, the site is completely closed from 22:00 to 6:00.

O.5 Evaluation

The project was evaluated based on the PDM, as well as findings from observations and interviews were applied.

The quantity of the inputs, such as the project fund, was small in amount but the quality of inputs, such as the professional personnel, was high. Thus, this project has achieved the "*EFFICIENCY"*. It is also necessary to state that the administrative management of the project was comprehensive and excellent.

The project purpose was to improve the operation of the existing disposal site. This purpose has been achieved by the outcomes of; leachate control, reduction of fire incidents, forest regeneration, and daily recording of waste disposal amount by computerized system. Those outcomes are crucial factors and closely related to the project purpose; therefore, the *"EFFECTIVENESS"* has been fulfilled.

The FONATUR is now considering helping the municipality arrange financing for construction of Sanitary Land-fillings in Costa Maya. This is a significant impact which the project has made. There is no other findings of *"IMPACT"* on economy, society and politics, however, this project has raised attentions of certain group of people how the garbage treatment could affect the environment in their region. The site workers and managerial stuff has gained a knowledge of land-fillings and now have an overall view of its operation and management. Thus the technical *"IMPACT"* has been brought to the people who work at the land-filling as well.

Since the environment is one of the top issues in development in Mexico, this project has succeeded the *"RELEVANCY"*.

The *"SUSTAINABILITY"* can not be recognized at this moment. The land-filling operation has been realized as a project; however, realization of the further operation is still questionable. Establishment of a new funding system is the key for the continuous operation.

O.6 Conclusion and Recommendation

a. Conclusion

As a conclusion, there are several elements brought out from the results being discussed here.

First of all, the model project has been successful within the term of the project; however, there is a little doubt that the Sanitary Land-filling to be prosperous after its handover. Apparently, the municipality is facing a lack of budget allocation toward the waste operation, because the municipality is greatly depending on funding from the central government. It is very difficult to continue the public work, such as waste collection, without collecting fees from the residents who receive the public services. This is probably one of the reasons why an on-site bulldozer has been torn down for a while.

Second of all, although there is a few negative circumstances found out through the project, this project seems to be completed successfully. It follows that the obvious difference of the outcomes between the improved Land-filling and previous dumping is easily discovered within the site.

Vegetation on the soil over the waste has revived. It preferably hardens the ground, and for this reason, prevents the land sliding.

Also the construction of new access roads has achieved the reduction of the work loads. This fact indicates that they are pioneering to attacking the problems within their capacity.

The amount of wastes was assumed to be 100 ton/day in weight, or 200 m^3/day in volume after compaction. Those numbers were calculated based on the population in the target area. However, the actual amount of wastes was 162 ton/day or 324 m^3/day in average, which is a bit larger than the estimated. The result indicates that the dumping site will be over flown before the estimated life time of 5.1 years. It can be assumed that there are some excess of wastes but the types are not known.

Finally, at the sequence of record keeping, there are some errors made by humans; however, it is a clear indication that the act of record keeping is gradually taking root as one of their responsibility. From this point of view, a positive change of working habits can be expected within the short period of time. As a result, the amount of solid waste disposed is known, and this fact leads to the successful solid waste management.

b. Recommendation

The conclusions stated above can draw recommendations as follow.

For a purpose of utilizing as much the capacity of the landfill as possible, more frequent operation of waste compaction and soil coverage are encouraged. Some action should be taken immediately so that disposal machineries are kept up with their daily loads. Besides, a course of inspection and maintenance is an important component of machinery operation.

The best solution to stop overflow in a land-fill is to reduce the amount of excess wastes. The amount of excess wastes can be determined by the classification of collected solid wastes.

Finally, the municipality has strengthened their capability to operate the disposal site properly by means of implementing the model project. This is an indication that the municipality is technically prepared to operate sanitary land-fillings. And probably this is the best time to take another run for reconsidering the suspended project, which is a new land-filling facility in the area adjacent to the existing disposal site.

Annex P

Collection Service Improvement in Othon P Blanco

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P Collection Service Improvement in Othón P. Blanco

P.1 Outline

a. Background

The collection service provided at the municipality of Othón P. Blanco is carried out by the Head Office of Municipal Public Services in the city of Chetumal, the municipal seat and its surrounding villages. In the rest of the territory the service is handled directly by Mayoralties with funds allocated by the municipality.

The service depending on the Head Office of Municipal Public Services is conducted directly by the Department of Public Image, which schedules the collection service on a rather elemental basis, which allows for the establishment of collection areas and assignment of vehicles and staff. Nevertheless, the current planning hinders the maximization of the resources, as well as the control on the service; and yet the latter has been planned to attain a 100% coverage, it falls short of this object, being evidence of that the accumulation of wastes on public thoroughfare in some locations of the city, or the presence of illegal dumping sites at vacant property.

In general terms, it can be stated that on the one hand the collection service under the Head Office of Municipal Public Services is efficient, since it collects most of the wastes generated at the coverage area; but on the other hand, is lacks efficiency given the inadequate exploitation of the resources, which consequently has an impact upon the costs of the service.

The cost hike due to an inappropriate planning, plus the lack of money collection for the service, will eventually render this service inadequate in the short run, and event the collapse of the same; therefore, measures have to be taken at once to prevent such scenario.

On the other hand, for the rest of the villages that render some collection service, it is based on the needs and availability of funds, and therefore the mayoralties, boroughs or sub-boroughs lack the adequate infrastructure that allows for the planning, design and monitoring of an efficient collection service.

In addition, the allocation of resources from the municipality does not always fit the real needs of each location, and thus there are some locations where funding is insufficient, while in others the resources are underexploited.

Taking the above as a whole, it can be said that municipal solid waste collection in Othón P. Blanco is inefficient, given the lack of planning and design of the service, additionally to the

inappropriate organization of the same that prevents the integral management of the wastes and, in consequence, the attainment of economies of scale. This situation greatly adds up to the costs of the service and curtails the possibilities of raising the service coverage due to the lack of budget.

In order to revert the status quo, a project oriented at the improvement of the current collection service is deemed convenient, so as to achieve a level of efficiency that allows, in the short term, for a considerable cost reduction and an enhanced quality of the same; as well as the reinforcement of the system's organization so that waste management can be integrally outlined and a better allocation of resources can be achieved, which in turn will contribute to expand coverage towards outer locations.

b. Project Design Matrix

Table below shows the Project Design Matrix, which was drafted in order to clarify its purpose, its expected results, activities and input required.

Table P-1: Project Design Matrix

Name of the project:	Period	Version
Collection Improvement (1)	Early October 2003/end of July 2004	N 1
Target area	Target group	Date
Othón P. Blanco	Othón P. Blanco staff	September 2003

Project abstract	Indicators	Check means	Important assumptions
General goal M/P is implemented			
Purpose of the project Improved collection efficiency in Chetumal	The collection service is carried out in accordance with an optimized planning and design	1. Quality indicators 2. Actual observation of the operation(s)	The C/P understands the importance and need to have a correctly planned and designed collection service
Collection improvement in small locations	The Technical Support and Coordination Unit is underway, whose functions are as follows: 1. Coordinate the audit and use of resources 2. Technical backup for planning and design of the service at the locations 3. Implement the use of indicators to assess the service	1. Observation of the Technical Unit operation(s)	The C/P understands the importance and need to coordinate all the waste management activities conducted within the municipality
Outcome 1. Collection costs are trimmed	Costs are reduced vis á vis the previous ones, with the proviso of a same quality	This Report	The C/P is ready to implement the service improvement measures

Project abstract	Indicators	Check means	Important assumptions
	service		
2. Collection is scheduled	100% of the collection routes respond to an optimum design	This Report	The C/P has the resources to implement the new service
3. A handbook for collection improvement is prepared	There exists a document that outlines in detail the procedures to an optimal design of collection routes	Manual	
4. Coordination between the municipality and small locations improves	Procedures under which coordination between the municipality and the several locations will take place are set forth	1. This Report 2. Functional organization chart 3. Structural flowchart	The municipality and the locations agree coordination to implement the Technical Unit
Activities			
See table below			Pre-conditions

Table of Activities

Activities	Results	Period	Contribution by the S/T	Contribution by the Counterpart
Diagnosis planning	Diagnosis Plan	See excel chart	Collaboration	
Implementation of diagnosis	Results of diagnosis	Idem	Collaboration	
Improvement planning	Improvement Plan	Idem	Opinion Survey Collaboration	Collaboration
Implementation of improvement	Implementation of improvements	Idem	Purchase of a computer Elaboration of informative flyers	Provisioning of an office space
Handbook preparation (draft)	Handbook (draft)	Idem	Duplication of handbooks (draft)	Distribution and use of the handbook
Monitoring	Monitoring	Idem	Counseling and guidance	Monitoring implementation
Assessment	Assessment report	Idem	Opinion survey	Collaboration
Elaboration of final handbook	Final handbook	Idem	Duplication of handbooks (final)	Distribution and use of handbook

Contribution

Contribution	Study Team		Counterpart	
Staff	- Person in charge	XiA	-Person in charge	Head of Urban Cleansing Area
	-Assistant		-Assistant	Some
	-Support	MaO, IkM	-Participants	Collection and audit/service control personnel
Material	-Handbook (draft)	30 copies		
	-Handbook (Final)	30 copies		

Table of Duties

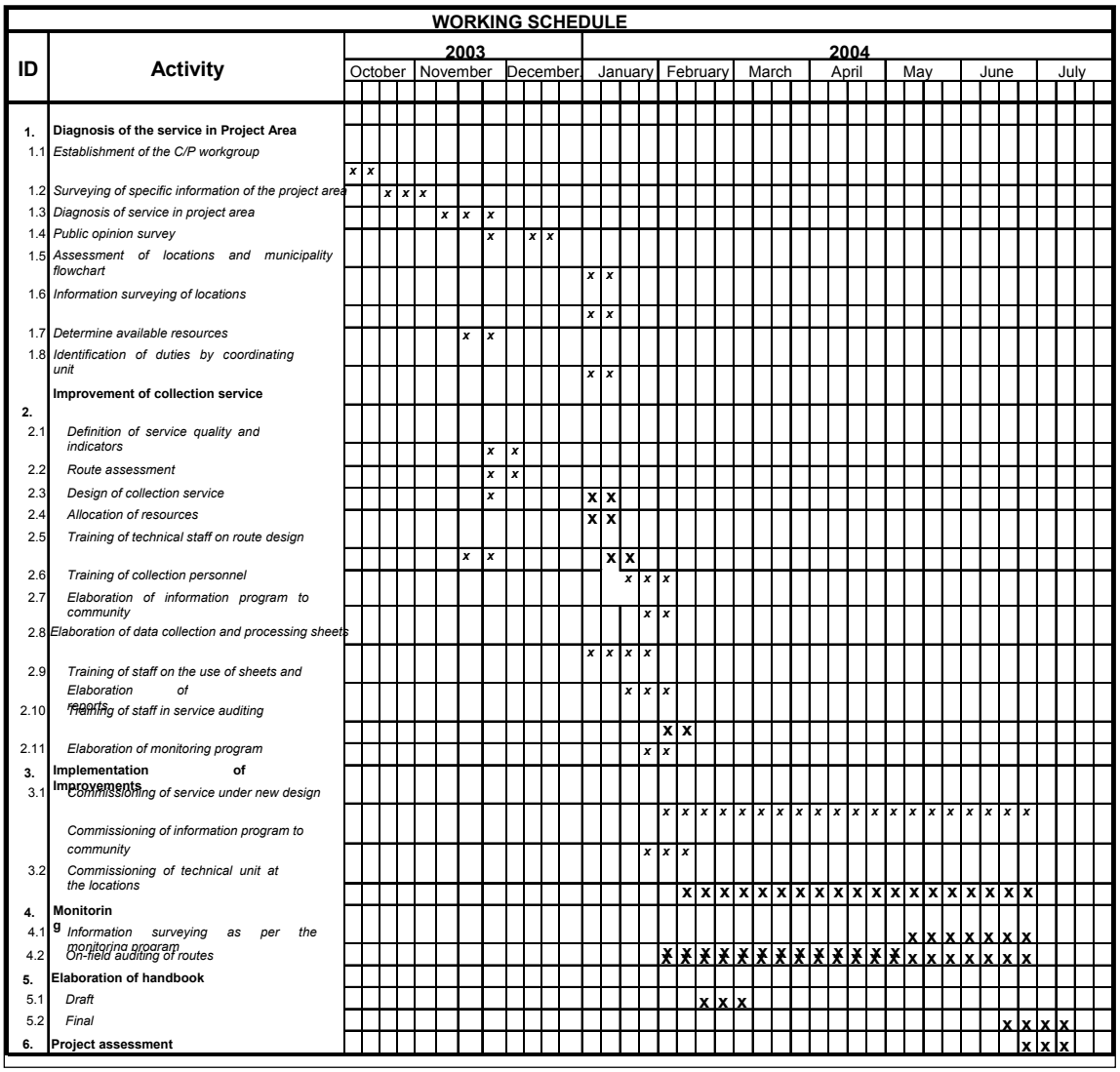
Activities	Duties	Remarks
1. Diagnosis planning	Validation of the data handed in advance is considered, therefore, the following will be checked on field: 1. Features of the collection routes (area covered, plotting of routes, frequencies, schedules, vehicle and crew assigned) 2. Dumping site entry control system (records, quantification of wastes, information handling) 3. Detection of major problems in the conditioning and storage of wastes 4. Opinion survey concerning the service	S/T design Surveying and verification of information S/T and C/P
	For the creation of the Technical Support and Coordination Unit the following information will be reviewed: 1. Organizational flowchart 2. Roles and duties of the Head Office of Municipal Public Services 3. Roles and duties assigned to the mayoralties and boroughs 4. Coordination levels between the municipality, the Head Office of Municipal Public Services (DSPM) and locations 5. Definition of objectives and functions of the Technical Support and Coordination Unit	Joint work between S/T and C/P
2. Diagnosis implementation	With the above information, the following activities shall be conducted: 1. Definition of quality of service aimed at 2. Selection of quality indicators 3. Evaluation of the service by applying the results of the two items infra. 4. Conclusions and recommendations	Joint work between S/T and C/P
	1. Determination of characteristics and functions of the proposed unit on the grounds of the needs outlined in the current model project 2. Analysis and interpretation of results	Joint work between S/T and C/P
3. Improvement planning	1. Planning of the service based on target quality 2. Redesign and plotting of routes 3. Allocation of resources (human, material) 4. Personnel training 5. Planning of information program to the community	Joint work between S/T and C/P
	1. Design of the Technical Support and Coordination Unit 2. Coordination procedures	Preparation by S/T Review by C/P and S/T
4. Improvement implementation	1. Elaboration of informative flyers 2. Implementation of information program for the community 3. Verify availability of the resources allocated 4. Commissioning of the improved service 5. Training of staff	Joint work between S/T and C/P
	Commissioning of the Technical Unit	Joint work between S/T and C/P
5. Elaboration of a draft handbook	Preparation of procedures handbook for collection improvement	Preparation by S/T Review by C/P and S/T
	Preparation of the Technical Unit's structure	Preparation by S/T Review by C/P and S/T
6. Monitoring	1. On-field information surveying of the route development (measurement of basic variables to calculate indicators) 2. Tour of the routes to check the compliance with the target quality	Joint work between S/T and C/P
7. Assessment	1. Calculation of indicators 2. Comparison with target indicators 3. Cost analysis 4. Opinion survey on the model project 5. Final assessment	Joint work between S/T and C/P

Activities	Duties	Remarks
	Assessment of the unit's performance	
8. Elaboration of final handbook	Review, final version, printout	Joint work between S/T and C/P

c. Working Schedule

The table below displays the activities' scheduling.

Table P-2: Model Project Timetable



P.2 Diagnosis

a. COVERAGE

Urban solid waste management at the municipality of Othón P. Blanco is the responsibility of the Head Office of Municipal Public Services, which executes the service directly through the Department of Urban Image and renders the service to the city of Chetumal (municipal seat) and the locations of Subteniente López, Xul-Ha, Huay-Pix, Raudales, Laguna Guerrero and Luis Echeverría. In the locations of Bacalar, Nicolás Bravo, Calderitas, Javier Rojo Gómez and Álvaro Obregón, the service is carried out independently by the mayoralties or boroughs, and their resources, directly funded by the municipality, correspond to the delivery of vehicles and payroll of the employees. There exists a single privet service that serves the location of Mahahual and funded directly by the municipality.

The rest of the villages lack a collection service, and therefore their wastes are disposed of by burning means.

The coverage attained by the collection service and provided by the Head Office of Municipal Public Services hovers around 90%. In other locations where service collection exists, the coverage reaches roughly 80%. Taking into account that the total population in Othón P. Blanco is 249,085 people and that the total number of inhabitants being rendered the collection service reaches 180,000 people, total service coverage in the municipality adds up to 72%. Figure P-1 shows the locations with collection service.

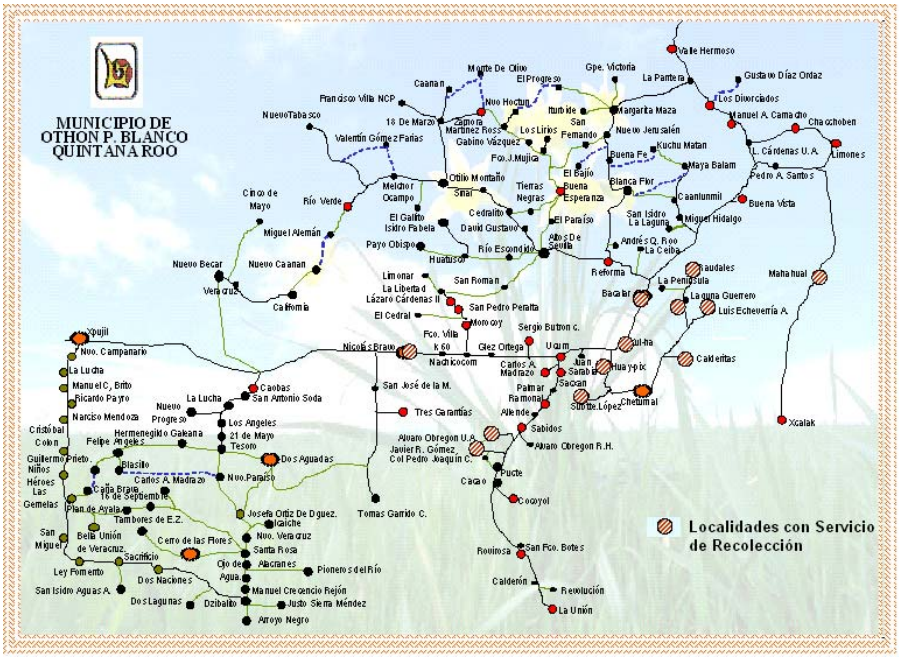


Figure P-1: Locations with Collection Service

The municipality's large area and dispersion of small villages are reasons behind the lack of collection service; however, maybe the most important reason is that the system is structured such that each location works independently without allowing the rational use of the resources.

If it is analyzed how the system works at the locations with availability of the service, it can be observed that they request for funds to the municipality in order to carry out the collection service. The municipality in turn, and as per the availability of the same, allocates them for each location to use them in particular. Thus, the following weaknesses in the system are perceived:

- The collection service does not follow a rational design and, in general terms, it is conducted under improvised programs aimed at working out the immediate issues. This is mainly due to the fact that the locations lack technical staff to lay out the service and also that they are not supported by the municipality in this regard.
- No on-field information surveying exists on the exploitation of the resources, generation of wastes, development of the service, and so on, that allows for an appropriate designing of routes, or the establishment of resource needs.
- This lack of information also prevents the municipality from achieving a wider knowledge of the situation that allows it to allocate or distribute funds among locations in a proper way.
- The service privileges the attention on downtown areas of the locations, and therefore is more inconsistent at the periphery.
- The locations lack the infrastructure for the correct maintenance of vehicles, which has a direct impact on their mechanical status and service life of the same.

The fact that the locations perform as independent entities in regards to the collection service significantly alters the costs of the service at a municipal level, as the benefits arising from an integral management are not exploited. For instance, the mayoralty of Bacalar has two trucks to provide the service, one of them works three days a week and the other one four days a week; therefore, there is availability of one truck for five days in total (assuming each of the trucks work for six days a week) to be employed in collection tasks at other locations, but this does not take place. On the contrary, the other instance is the mayoralty of Javier Rojo Gómez, which has its only truck working Monday through Saturday and does not meet the community needs. Under an integral waste management system, such situation would not take place, because the allocation of resources would occur on the basis of the global needs of the system, which would allow parts of the resources assigned to Bacalar –and that are not

exploited today – to be assigned to Javier Rojo Gómez, thus achieving a wider coverage of the service.

On the other hand, since the municipality has the Head Office of Municipal Public Services to manage the wastes of the city of Chetumal and surrounding locations, the advise would be to channel the entire management the municipality's wastes through this Head Office, in order to allow this office to structure, plan and set out the resource needs of the service (physical and personnel) for each location, whereas the mayoralties, boroughs or sub-boroughs can execute the service under supervision by the Head Office.

Under this system, not only an adequate distribution of resources would be attained, but also the economies of scale, reducing current costs and expanding the coverage with the same budget.

Additionally, the integral management of wastes would allow the municipality to have a global vision of the service costs, as well as a panorama of future investments, and therefore the necessary background to establish a fee for the service.

b. SERVICE PLANNING

The urban solid waste collection service in the city of Chetumal depends of the Head Office of Municipal Public Services through its Department of Urban Image. This Department is in charge of planning, operating and auditing the collection, haulage, sweeping and final disposal service of solid wastes generated in the city of Chetumal and surrounding locations.

For the provisioning of the collection service, the Department of Urban Image follows a rather simple planning where the city of Chetumal has been divided into three areas referred to as "Plane 1", "Plane 2" and "Plane 3", being each one of them additionally divided into sub sectors, and each one representing a collection route. In total, there are six sub sectors being served Monday through Saturday during the day, whereas 25 sub sectors are attended three times a week, 22 of them on the day shift and only three on the evening shift (see Figure P-2). In addition, there is a sub sector defined by the city's main streets where the collection service is carried out during the night shift, on a daily basis and attention Monday through Sunday. Planning of the service regards the control of fuel refilling and truck entry to the municipal dumping site, where staff records the departure and entry time to the dumping site for each tuck trip. Auditing of the service is conducted directly on-field by two supervisors.

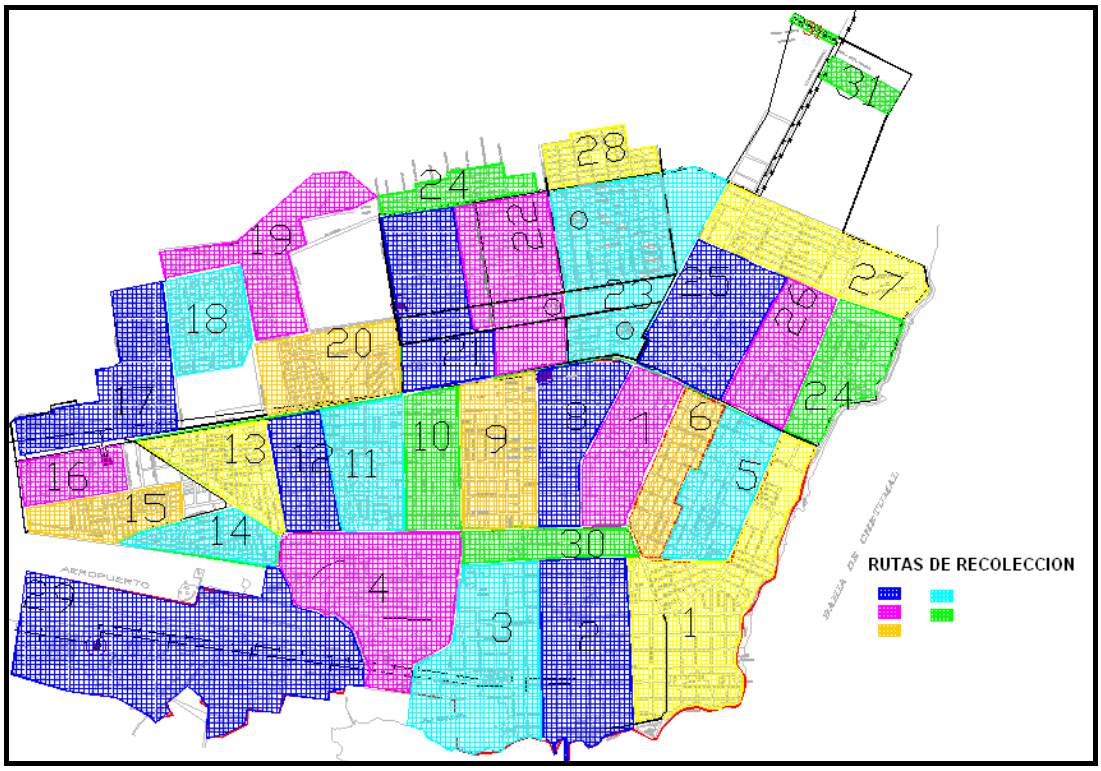


Figure P-2: Area Distribution and Service Frequency

The current planning of the service, yet it has achieved a wide coverage level, is not structured based on a rational design; as a result, there is no classification or plotting of routes by sectors that allow the optimization of resources and the following vulnerable points are observed.

- Sector distribution: Yet it is true that collection sub sectors exist, they have not been defined based on technical criteria that allow them to allocate the proper amount of work to each collection crew at full capacity. The latter is exemplified by the sub sectors where the collection truck does a second trip but it collects less that 50% of the vehicle's nominal capacity; i.e., an additional trip where only from 1 to 2 tons are collected: This could be avoided if the sub sector were defined based on the generation of wastes and on the truck's loading capacity.

- Route plotting: No plotting of the tours is available, being therefore up to the driver's criterion to decide the same and that, in most of the occasions, these tours are inefficient and translate into unnecessary shifting that adds up to the traveling time without collection tasks, thus having a repercussion on the duration of the working shift (overtime) and on the cost of the service.

- Fewer availability of trucks: The distribution of sub sectors per working shift is not being conducted in order to balance the number of routes for the morning and evening

shifts, which would translate into fewer tucks per shift. Under the current schedule, the total number of routes that are being served three times a week is 25, 22 out of which are attended during the morning - 11 of them on Monday, Wednesdays and Fridays and 11 on Tuesdays, Thursdays and Saturdays –; i.e., each morning a total of 11 trucks for the three-times-a-week scheme and 6 vehicles for the daily frequency scheme are required, turning out into 17 collection vehicles operating in the morning shift. Regarding the evening shift, the total routes being served is 3, 2 out of which are attended on Tuesdays, Thursdays and Saturdays and one on Mondays, Wednesdays and Fridays; i.e., each evening two trucks are required as a maximum. Now, if the distribution of the routes were balanced, 50% of the same could be attended on the morning and 50% on the evenings; i.e., out of 12 routes being served on Mondays, Wednesdays and Fridays, 6 can be attended during the day and 6 on evenings. Meanwhile, out of 13 routes attended on Tuesdays, Thursdays and Saturdays, 7 routes are served on the morning and 6 on the evening. Likewise, the same scheme can be applied to the daily frequency routes by working three of them on the morning and 3 on the evening, and in this manner the required number of trucks in each shift significantly decreases from 17 to 10, accounting for an equipment requirement reduction of roughly 41%. This route redistribution between shifts would also have a positive impact on the auditing of the service, because the area to be controlled would shrink and, on the dumping site front, the distribution of trucks would be uniform, preventing in this way the discharge of a considerable volume of wastes at an specific time; the above would definitively reduce the staff and machinery needs.

- Route features: Another aspect that has not been taken into account within the distribution of routes per shift is the peculiarities of the sectors themselves, such as the vehicle traffic on the streets, particularly for the routes that provide the service to downtown areas. It has been observed that the tours are carried out during rush hours, thus delaying the collection of the wastes; in this case, the most adequate hour of attention would be a night shift.

c. FIELD INFORMATION SURVEYING

No record on how the routes developed is available, such as the departure and entry times to the vehicle depot, collection start and completion times, amount of wastes collected, hours worked per vehicle and personnel, fuel and lubricants consumption and other input, distances traveled, and so on, that allow the accumulation of reliable data to assess the route, cost control and elaboration of budgets to develop the service.

One of the records available corresponds to the entry and departure from the dumping site; which registers the number of daily trips; however, no data processing is conducted that allows the control of parameters such as cycle times, percentage of load hauled, mean collection times, etc. The only concept associated with this number of trips is total tons transported per truck that enter the dumping site; however, there is a severe mistake as to the fact that every truck is considered as being loaded at full capacity in each trip, which generates a value far above the actual number of tons being handled. This is quite a significant issue if a fee system is being considered for the service, because charges should be based on the unit cost (cost per ton) and inversely proportional to the total tons handled; hence, the fee to be applied would not cover up the service costs.

An additional variable being controlled is fuel refill; however, said is not justified because each vehicle is assigned a fixed fuel volume per working shift and regardless of the route being serviced. The fixed assignation of fuel and lack of control of the vehicle's actual consumption hinders the estimate the vehicle's fuel consumption and performance.

The generation of accurate and timely information is a must for the optimum planning of the collection service, as it provides a background for route designing, their evaluation and programming of futures activities, namely the elaboration of cost and investment plans required by the service to achieve the coverage and quality outlined in municipal programs. Due to the above, a route control system must be operational in the short term (logbook) that allows for creditable data on how the system develops.

d. AUDITING PROGRAM AND ON-FIELD ROUTE CONTROL

Since no route plotting is available, it is impossible to determine the tour followed by the collection truck, and therefore the supervisor or inspector waste quite some time while seeking the truck; additionally, there are no route control points where they can verify the passing time of the truck and the areas already provided with the service. Attention to the great majority of routes on the morning shift, in conjunction with the reduced number of supervisors (two in total) hinders the proper auditing of the service; thus, it was observed on several occasions that some drivers steer away from their assigned areas and head to other sectors where they collect commercial waste or bulk waste that, due to their characteristics, should not be loaded into compaction trucks. This situation has a strong repercussion upon the quality and cost of the service; on quality, because the time devoted to the collection of wastes in a zone is rather spent on a different one and therefore the collection in the first place is left unconcluded, and because the truck steered away from its route, this in turn delays the service to the user, who is unaware of the real schedule when his/her wastes are collected.

Regarding the cost increase, it is consequence of a greater input consumption, longer working hours for the staff and reduced loading capacity of the truck, due to the loading of different wastes and to a shortened service life of the same.

An additional aspect not being covered by the auditing is related to the quality of the collection works; in many cases it is observed that collection of the wastes is not conducted adequately by the collection workers, and an important percentage of the same are scattered on the streets or in front of houses.

An adequate design and plotting of the route would considerably ease the duties of the auditing staff, especially if they can have access to the route control document at all times, to be carried by the driver during the execution of the collection works.

e. CONTROL OF ADMINISTRATIVE AND OPERATIONAL COSTS

Both the Head Office of Municipal Public Services and the Department of Urban Image have a proper expense control arising directly from the collection service, such as those associated with preventive and corrective maintenance of the vehicle fleet and the input for their operation: There exists an organization and procedure manual that regulates such controls. Nevertheless, costs are controlled at a global level, and therefore it is necessary for them to be related to the routes and collection vehicles, as well as to the tons collected. By achieving the latter, the Head Office will be in conditions to prepare annual operating and investment budgets of the service, to be reported to the municipality, which in turn, based on this background, will allocate the resources. By having a clear knowledge of the service's unit costs, the possibility of enforcing fees for the collection of the service can be analyzed.

f. APPLICATION OF SERVICE QUALITY INDICATORS

Planning of the collection service does not regard the utilization of quality indicators that determine the failures or underperformance of the same or enforce the required corrective measures. At best, the use of such indicators currently is impossible because there is no on-field information available that allows their estimation.

The incorporation of a route control sheet would allow the implementation of such indicators in the short term, which would be used to assess the routes and calculate efficiency levels.

g. CONCLUSIONS

From the diagnosis of the current status of the collection service in Othón P. Blanco, it can be concluded that the same has a series of weak issues that can be grouped into two classes, as follows:

- Lack of planning and rational design of the service, and
- Inappropriate organization to provide the service from an integral management perspective of the municipality's urban solid wastes.

The enforcement of a collection service improvement project that aims at overcoming the above weaknesses would allow the municipality to run an efficient service, to trim down its current costs in the short term, to effect a rational allocation of resources and expand the collection coverage towards other locations. To achieve the latter, it is necessary that the improvement project considers the following activities as a minimum:

- Designing of the collection service that takes into account the rational plotting of routes, thus optimizing the use of resources.
- Implementation of a route monitoring and auditing program that generates information data for the later statistical handling of the data.
- Control and evaluation of the service through the management of the surveyed information and comparison of the same versus optimal values set in the design.
- Definition of a structure that outlines the links and responsibilities between the municipality, the locations and the Head Office of Municipal Public Services, which also allows the establishment of an integral management of wastes within the municipality.
- Implementation of a cost control system of the service, by the Head Office, that allows the same to prepare annual operating and investment budgets, being such information indispensable for the municipality to allocate the resources.

Implementation of the above measures will permit the establishment of:

- A well planned and structured service that sticks to technical criteria and where improvisations are inexistent.
- The efficient use of resources, both material and human.
- An integral design of the collection service in the municipality
- A strong organization that can deal with the projected changes
- Service quality and coverage improvement.

P.3 Implementation

P.3.1 Gathering of information

The first activities carried out corresponded to gathering field information, in order to obtain the necessary background for carrying out the optimization of the service and therefore increase its efficiency.

The gathering of information included:

a. Analysis of the characteristics of the study area

With the purpose of knowing and establishing the characteristics of the study area, field information was gathered. It was later recorded on a city plan, in order to use it in the design of the service. The following antecedents were gathered:

- Identification of zones (residential, commercial, institutional, others, over generators)
- Number of inhabitants
- Street road characteristics and status of the same
- Location of the final disposal site
- Detection of particular situations that may affect the development of the collection service, such as direction of the traffic, double roads, etc.

b. Characteristics of the current service

For the development of the model project four routes were selected and this can be classified according to the sector they serve. The routes selected correspond to:

Route 2 Principally serves the commercial sector

Route 4 Serves the residential sector of high socioeconomic strata

Route 9 Serves the residential sector of medium socioeconomic strata

Route 23 Serves the residential sector of low socioeconomic strata

The following figure shows the routes selected.

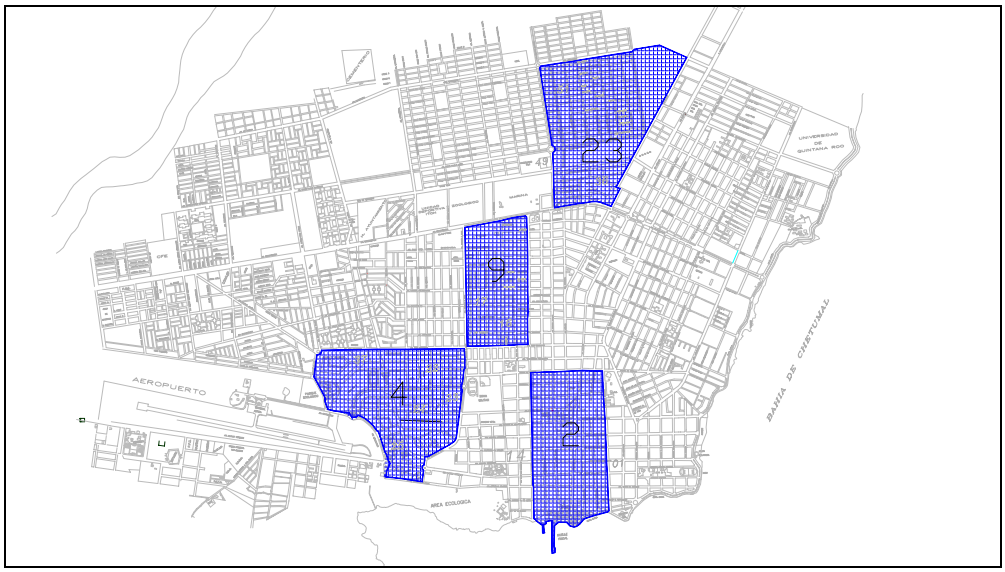


Figure P-3: Routes Selected

During the first weeks of the model project, the tracking of the routes was performed, in order to know the area covered, the journeys, frequencies, days and timetable of the service, resources used, times associated to the service and finally, the particular characteristics of the route. The work was conducted together with the C/P.

Before starting gathering the information, a document called "Route Sheet" was designed. This document permits to register the times of the routes as well as personnel and combustible allocated. Such document was put into operation not only for the routes analyzed but for all the routes of the service. All personnel were trained in how to register the information.

Additionally two calculus[1] books were created in excel format; the first one allows capturing the information contained in the route sheet and also estimates the time per activity, consumption of combustible and personnel allocated per route; this book was called Base Datos.xls. The second book, called Informe_OPB_mes.xls, imports data from the previous book and through the use of tables and dynamic graphics, obtains the consolidated monthly information of the service. It also details information per route, vehicles for collection and personnel. Supervisors and technical personnel of the Direction of Municipal Public Services (D.M.P.S.) were trained on regards of the management of the calculus books. Similar to the case of the Route Sheet, in both books was incorporated the information of all routes.

For the routes selected, a direct monitoring on the field was carried out. The following information was gathered:

[1] Refer to the Manual

- Exit time from the parking place (base) and mileage of the truck[2]
- Total amount of combustible supplied to the vehicle
- Hour and mileage of when collection starts, identification in a plane of the starting point
- Diagramming of the journey, information that was drawn in a city plane.
  During the development of the journey was verified the existence of situations like areas of higher generation, existence of containers, commercial zones, markets, etc. Everything was indicated in the plane.
- Hour and mileage of the ending of collection, showing in a plane the completion point
- Hour and mileage of entry and exit from the dumping site
- If the truck performed more than one journey per route, information about the other journeys was gathered; otherwise, information about the hour and mileage of entrance to the base was recorded.

Starting from the data collected, a plane for each route was elaborated with the antecedents of the current service.

Together with the gathering of information, the parameters to be monitored and the indicators that were used to evaluate the routes were selected. They correspond to:

- Number of journeys per day
- Distance traveled
- Worked hours per day
- Collection hours per day
- Occupation index of the vehicles
- Collected tons per day
- Tons per hour

The values obtained for the indicators in each route and the goal values that were used later on for the evaluation are shown in the following table.

Table P-3: Indicators of the quality of the collection service

Indicator	Initial value				Goal Value
	R2	R4	R9	R23	
Tons vs. Collection Hours	--	--	---	--	1,6
Tons vs. Paid Hours	--	--	--	--	0.30 to 0.35
Tons vs. Worked Hours	--	--	--	--	
Collection hours vs. Worked hours	0,75	0, 78	0,63	0,66	
Index of occupation of the vehicle	--	--	--	--	0,9 to 1,1
Tons/assistant/day	--	--	--	--	4,5
Efficiency of combustible L/hour	5,1	5,5	4,9	4,7	

Initially, there was no information about tons, however, some indicators were related to the tonnage taking into account that the weighbridge of the final disposal site was under construction and therefore, during the model project, there was not information available for comparing it with the goal values.

[2] The mileage was measured in the odometer of the tracking service, because trucks do not have such instrument.

c. Elaboration of a public opinion survey

In December 2003 a public opinion survey about the quality of the solid waste collection service was carried out in Chetumal city, specifically in the area served by the four routes selected. This survey had as objective to know the perception of users in relation to the service. In total, 126 households and 24 shops were surveyed. Through this survey the following was inferred:

Residential Sector

- The female surveyed people represented an important section of the people interviewed in general; approximately 72% of the people surveyed were women.
- 98% of the users said that they have the service of waste collection, 2% mentioned not to have such service.
- 90% of the users said that their wastes are collected by the municipality and 9% said that they burn their wastes in their yards or in the streets.
- 49 % of the surveyed said to be unsatisfied with the collection service, 40 % said to be satisfied with the service and only 1% mentioned to be very unsatisfied with the service.
- Interviewees said that the main problems associated to the management of solid waste are that waste looks pretty ugly 33%, the presence of offensive odors 20%, increase of mice and animals 19%, and the blocking of the sewer due to wastes 14%.
- 91% of the interviewees said not to pay for the collection service, 67% mentioned however, that they would be able to pay a fee if the service is improved.
- In respect of if existed a high availability to collaborate with a model Project, 86% of the interviewees said to able to collaborate in a model project in order to improve the quality of the waste collection service.

Commercial Sector

- According to the people surveyed, the main wastes generated in their stores belong to 28% paper, 28% plastic and 26% cardboard.
- 100% of the surveyed said that the municipality collects their wastes.
- Consulted in respect of the collection frequency, 92% of the surveyed said that their wastes were collected daily and 4% mentioned that they were collected three times per week.

- 78% of the surveyed said that the service is not performed in a defined hour.
- In relation to the degree of satisfaction with the service 60% said to be very satisfied, 32% satisfied and 8% not very satisfied.
- 63% of the surveyed said to pay a fee for the collection service, from this, 86% mentioned that the amount was cheap.
- 65% of the surveyed said to be able to pay less that 100 pesos for the service, 26% mentioned to be able to pay between 100 and 300 pesos and 9% among 300 and 500 pesos.

P.3.2 Optimization of the collection service

The optimization of the collection service was carried out in four rotes and the activities developed included:

- Training of technical personnel
- Optimization, diagramming and verification of routes
- Training of operative personnel
- Implementation of routes

Before starting the implementation of the model project, the counterpart allocated the following professionals and personnel that directly participated in the experience.

Based on the requirements indicated, the C/P selected the following personnel:

- 2 Supervisors
- 2 Technician in informatics
- Drivers
- Collectors

a. Training of technical personnel

Technical personnel were trained on the procedures for the design; the training process included:

- Calculus procedure to determinate the generation of waste; production on peak and normal days according to the collection frequency.
- Calculus procedures of indicators.
- Calculus procedures to determinate sectors and sub sectors.
- Calculus procedures for the verifications of the transported tons per truck per shift according to the hours of the journey.
- Procedures to determinate the limits of the sectors and sub sectors.
- Procedures of diagramming, rules of diagramming.
- Procedures of verification of the routes.
- Procedures for the implementation of routes.
- Method for the evaluation of routes.

The training was carried out at the same time that the activities related to the management and analysis of the information gathered, calculus of indicators and design of the routes. Later this was reinforced during the whole period of implementation of the project.

Training also included the procedures related to the management of information and operation of the calculus books.

b. Optimization, diagramming and verification of routes

The first stage of the new routes corresponded to the estimation of tons to be collected in peak days[3] and normal days[4]. For that reason, were defined first the frequencies and work shifts for each one of the routes. In addition, according to the classification of the routes, the P.C.P. was established. When the routes were designed, there were not antecedents of tonnage; therefore it was not possible to verify if the values allocated to P.C.P. were within the rank. Later on, when the weighbridge started to operate in the dumping site, the data was corroborated; confirming that for route 2, the P.C.P. is 1,3; for route 4 is 1,0; for route 9 is 0,8 and for route 23 is 0,5.

The following table shows the antecedents for each route and the tons estimated for peak and normal days.

Table P-4: Antecedents of the routes

Nº of route	Frequency	Shift	Inhabitants	P.C.P.	Ton/normal day	Ton/peak day
2	Daily	Morning	4.931	1,2	5,9	11,8
4	Daily	Morning	5.487	1,0	5,5	11,0
9	3 times	Morning	4.770	0,8	3,8	11,4
23	3 times	Morning	5.987	0,6	3,6	10,8

The vehicles were selected and the number of shifts that will be performed per journey were set.

Table P-5: Antecedents of the vehicles

Nº of route	Nº of vehicle	Type	Load capacity
2	207	International year 2003	6 ton
4	158	M. BENZ FL70 year 2000	6 ton
9	26	DINA 551 year 1993	6 ton
23	26	DINA 551 year 1993	6 ton

Later, for each one of the routes the number of sub sectors was estimated, the number of daily journeys and as well was verified the total amount of tons that the truck can collect within the

[3] Peak day, day of higher accumulation

work shifts, taking into account the times measured during the lifting of wastes and during the estimated dead times. For each route these are:

Table P-6: Dead times for the routes

Times (hours)	Route 2	Route 4	Route 9	Route 23
Base-Sector	0,20	0,25	0,33	0,33
Sector-Landfill	0,33	0,37	0,40	0,37
Landfill	0,20	0,20	0,20	0,20
Landfill-Sector	0,33	0,37	0,40	0,33
Landfill -Base	0,25	0,25	0,25	0,25

The results of the verification are shown in the following table:

Table P-7: Verification of the design of the routes

Variable	Unit	Route 2	Route 4	Route 9	Route 23
Ton/peak day	Ton/day	11,8	11,0	11,4	10,8
Ton/hour	Ton/hour	2	2	2	2
Dead time 1st journey	hr	1,19	1,43	1,19	1,27
Max. Tons/ 1st journey	Ton/journey	6	6	6	6
Collection time 1st journey	hr	3	3	3	3
Total time 1st journey	hr	4,19	4,43	4,19	4,27
Remaining time for the 2nd journey	hr	3,81	3,57	3,81	3,73
Dead time 2nd journey	hr	0,78	0,9	0,78	0,82
Available time for collection 2nd journey	hr	3,03	2,67	3,03	2,91
Tons to be collected 2nd journey	Ton/journey	5,8	5	5,4	4,8
Necessary time for collection 2nd	hr	2,9	2,5	2,7	2,4
Total tons collected in the shift	Ton/shift	11,8	11	11,4	10,8
Worked hours	hr	7,87	7,83	7,67	7,49
Remaining time during the shift	hr	0,13	0,17	0,33	0,51

It was corroborated that it is possible to collect the totality of tons accumulated in the day of maximum generation, in each one of the routes, within the daily shift.

Later on was performed the diagramming of the route, hence the common rules of diagramming were followed. In order to perform this work, the technical personnel went to the field to verify the layout. Likewise went the operative personnel and they were shown the journey and the way to complete the route sheet.

It was considered important to measure the daily consumption of combustible, but regrettably, for administrative reasons, that was not possible to achieve and the trucks continued operating with a fixed allocation per day.

[4] Normal day, day of least accumulation

c. Training of operative personnel

Once the routes were optimized and before their implementation, operative personnel were trained regarding the way on how to develop the service. The topics approached were:

- Training in the use of the Route Sheet
- Form to perform the collection and security measures
- Training in the tracking of the route allocated

The training was reinforced during the development of the project.

d. Implementation of the routes

On February 16th started the new collection service, which everyday monitored the times and journeys, using for that reason the Route sheet.

- During the fist week, information on times and movements were taken by the S/T and the truck driver, later on this labor was developed exclusively by the driver.
- Every week was supervised the execution of the routes by the person in charge of the service.
- Information contained in the route sheet was recorded on a daily basis to the data base and the results were verified.
- The consolidated report of the service was made in a monthly basis, including in it the antecedents of the routes that were optimized.

P.3.3 Improvement of collection in small communities

In order to create the technical unit of support and coordination, several meetings with the Director and technicians of Municipal Public Services were held, as well as with the person in charge of the Coordination between the Municipality and the city halls and the representatives of the city halls.

In these meetings were analyzed in a fist stage the objectives of the unit and the activities that should be developed in order to achieved them. As a result, it was decided to create this unit and the following work program was established:

- The localities will put into operation the route sheets for the gathering of information of the collection service; in this process technical personnel of the D.M.P.S. will train personnel regarding the lifting of information.

- The information will be sent to the D.M.P.S. so personnel of the informatics area may register and process the information and as well elaborate a report with the information consolidated and the evaluation of the routes. For that motive, they will make use of the calculus books aforementioned.

- The reports will be sent to the respective city halls for their understanding and analysis of the evaluation.
- Later on will be carried out a joint work between the city halls and the D.M.P.S. in order to determinate if it is necessary to optimize the routes and to set an implementation program.
- The optimization of the routes will be in charge of technicians from the D.M.P.S., the city hall will be in charge of approving a new design and implementing the solution proposed.
- The D.M.P.S. will be in charge of the evaluation of the route once this is optimized.
- The monthly information of the service in the communities will be included in the monthly report of the D.M.P.S., which will be sent to the Municipality.
- With the information of the service in the localities, the costs of the same will be determined.
- Later on and with basis on the antecedents of the evaluation of the routes, the D.M.P.S. will propose to the city hall a program of optimization of routes, the same procedure will be indicated for the service in the city of Chetumal.

Nowadays, the city halls of Bacalar and Calderitas are working in a coordinated way with the D.M.P.S., information of the routes is being gathered and the antecedents are being delivered to the D.M.P.S., which is processing the data. Additionally, the city halls are registering the antecedents of the service in their informatics system, using the same system than Chetumal. The activities are constantly supervised and coordinated by professionals allocated by the D.M.P.S.

P.4 Results

P.4.1 Achievements

Narrative Summary	Achievements
General Goal M/P is implemented	With the implementation of the model project, the use of resources has been optimized as well as the costs of the service have been reduced. The savings achieved may be destined to augmenting the coverage in collection in other localities or in improving the final disposal of waste, achieving in this way two particular objectives of the M/P: "To provide an adequate living environment" through the removal of waste from households and communities and "to mitigate the impact to the environment caused by wastes" through a proper disposal of collected waste. The incorporation of other localities to the program of optimization of the service will allow extending the coverage of the collection service, achieving the implementation of the M/P.
Purpose of the Project Improvement in the efficiency of collection service in Chetumal	With the implementation of the model project, the planning and optimization of the routes was achieved, improving the efficiency on the collection by reducing the shift, the distance traveled and by increasing the efficiency of the resources, achieving in this way the purpose of the project. The operation of the monitoring system and control of routes, has delivered enough and necessary information, through which the D.M.P.S. has designed a program in order to optimize the routes with less efficiency. The program of control of routes permitted to detect anomalies in the use of resources, putting the D.M.P.S. a set of measures to control and remove such situations, which will positively impact in the efficiency of the service. The optimized routes have a diagramming and control points that facilitate the supervision and avoid the way out of the journey, like happened before. The information generated makes easier to the D.M.P.S. to develop the budget for the service and at the same time to study a tariff for charging the service.
Collection service improvement in small localities	A technical unit is under operation. This unit is formed by personnel of the D.M.P.S. and representatives of the city halls in Calderitas and Bacalar. This unit is actually carrying out the analysis of the service and elaborating a program for the optimization of the service in such localities.
Outcomes 1. The collection costs are reduced	Through the optimization of the routes was achieved: Reducing the total time of operation of a truck in 11%. Reducing the hours paid to operative personnel in 11%. Increasing the total tons collected per hour in 3% as medium value and 10% as maximum value. Increasing the efficiency of the tons collected per assistant in 8% and in average 3%. The previous results reflect a reduction in the direct costs of the service, among them combustible, lubricants, maintenance of the vehicle and cost of personnel.
2. Collection is programmed	The diagramming planes for each route that was optimized were made, indicating in them the starting and completion points of each journey, besides of the location of control points for supervision. The Direction of Municipal Public Services incorporated within its administrative and operational process the use of the "route sheet" for gathering information in all the collection routes. Two calculus books were designed and put into operation in excel format. These books allow recording the information gathered in the route sheet, the consolidation of information per route and vehicle, the estimation of resources used (manpower, vehicle) and estimation of quality indicators. These instruments are used for the whole service. The D.M.P.S. allocated two informatics technicians for the management of information of the collection service, who at the same time are in charge of the information relative to the entry of vehicles to the dumping site. The coordination of both activities allows comparing both services, to detect if there are discrepancies between them, the causes and to inform to their superiors for the application of corrective measures. The application of quality indicators for all the routes came into operation; goal values were established for each one of them and a table of priorities was designed for the optimization

Narrative Summary	Achievements
	of the routes. A program of supervision in the field was implemented in order to verify the execution of the journeys and the quality of the service. Such supervision is programmed in function of the efficiency measured for each route. The D.M.P.S. decided to elaborate a monthly report which details the operation of the collection service, including an analysis of its efficiency. The purpose is to evaluate the service, to have the necessary antecedents in order to effect the changes and to elaborate budgets. Technical and informatics personnel are in condition of implementing the optimization of the other routes and to make that 100% of them respond to an optimum design.
A manual for the improvement in the collection service is prepared	A procedures manual was elaborated for the optimization of the collection routes. An instructive for the recording of data and the use of the calculus book was elaborated. Personnel were trained on the use of both documents.
The coordination between the municipality and small localities is fortified	Coordination meetings were carried out among the organizations involved and the Technical Unit was created. The localities are operating the route sheet, performing the monitoring of the routes and sending the information to the D.M.P.S. The D.M.P.S. is giving technical support to the localities for the optimization of the service. The elaboration of a monthly report came into operation with the background of the services in Chetumal and in other localities and the technical and economical evaluation of each service.
Contributions Personnel S/T The study team was leaded by Ing. Ximena Alegria, who was in charge of coordinating the strategy, planning, designing and conducting the activities. Lic. Hiram Diaz was in charge of the coordination of information between the D.M.P.S. and the S/T. Lic Citlalli Suarez conducted the public opinion survey. Ing. Mario Valle compiled and analyzed information form several sources. Personnel C/P Dr. Rodrigo Camin, Director of D.M.P.S. was responsible of the decisions adopted during the development of the project, of the incorporation of new procedures to the service and of coordination with other localities. Ing. Jose Tut Wan was in charge of the revision of coordination of the activities between the D.M.P.S. and the S/T. The technicians Jose Mendez and Edilberto Quintero participated in the process of design of the routes and in the implementation and control of the same. The informatics technicians Angelina Tut and Roberto Tun were in charge of managing and processing the information as well as the elaboration of the reports. Equipment The S/T donated to the municipality of Othon P. Blanco a computer and a printer, which were installed in the offices of the D.M.P.S. in order to control the collection service.	

P.4.2 Other results

In the following table are shown the results of the variables monitored during the development of the project.

Table P-8: Results of the monitoring of the routes

Route Nº	Data	Initial	Model Project		
			March	April	May
	Worked days	25	27	25	26
	Totality of journeys	50	54	52	53
	Totality of tons	179	193	179	186
2	Totality of assistants	54	54	50	52
	Hours/month	245	240	223	226
	Hr. Collection/month	184	186	185	184
	Total combustible	1.250	1.350	1.250	1.250
	Worked days	27	27	27	25
	Totality of journeys	54	51	51	48
	Totality of tons	176	176	176	163
4	Totality of assistants	54	54	54	49
	Hours/month	245	239	236	216
	Hr. Collection/month	190	193	188	170
	Total combustible	1.350	1.350	1.350	1.250
	Worked days	13	15	11	13
	Totality of journeys	26	30	21	27
	Totality of tons	118	136	100	118
9	Totality of assistants	26	30	22	26
	Hours/month	132	123	92	112
	Hr. Collection/month	83	87	69	89
	Total combustible	650	750	550	650
	Worked days	12	13	10	12
	Totality of journeys	24	26	19	23
	Totality of tons	97	105	81	97
23	Totality of assistants	24	26	20	22
	Hours/month	128	111	80	103
	Hr. Collection/month	84	83	59	81
	Total combustible	600	650	500	600

Data on tonnage is included only for the month of May, period where the weighbridge in Calderitas worked in a permanent basis.

P.5 Evaluation

Considering that in the first months there is no information on the amount of tons collected, and due that the routes that were optimized serve the same area, in order to evaluate the indicators related to the weight of waste, an average weight per journey has been determined, with base on the information obtained from May. The estimation of previous months was based on the information from May.

P.5.1 Efficiency

a. Worked hours per month

With the optimization of the routes it has been possible to reduce the hours worked per month, considering the routes in 11%. In route 2 the reduction achieved is 8%, for route 4 is 12%, for route 9 is 15% and for route 23 is 19%. This reduction in the times of work is due to the increase in the efficiency of the collection (ton/hour), increase in the efficiency of workers (ton/assistant/day), execution of the diagramming of the routes and the lower distance traveled, which, according to the new journeys was reduced in a 15%.

The lower amount of hours worked per month impacts in the hours of operation of the vehicles, reducing them in the rate indicated previously. With this it is possible to reduce the maintenance costs, combustible and lubricants.

The lower amount of worked hours also impacts in the costs of personnel, because the hours per shift have been reduced. In case of route 2 there was a reduction of 10%, for route 4 in 4%, for route 9 in 17% and in route 23 in 21%, giving as an average a reduction of 11%.

Currently, the D.M.P.S. has established a bonus system for the workers besides their salaries, in order to cover extra hours. As the results have shown, the other routes can be optimized and performed within the shift and therefore this bonus can be eliminated, causing higher economies to the service.

b. Collection hours vs. worked hours

Through the optimization of the routes it was possible to increase the amount of hours dedicated to collection and to reduce the totality of hours worked. This was due to the diagramming of the routes and to their supervision, which avoided that the vehicle went off the route in order to collect waste from other sectors that were not their responsibility.

With the model project, the collection hours represent 79% of the total time; before 72% was dedicated to collection. This, together with the reduction of the total time worked, indicates that the efficiency in the collection per hour has increased.

c. Collected tons vs. collection time and total time

The total tons collected per collection hour in average increased in 3%, being 1% for routes 4 and 9, 3% for route 2 and 10% for route 23.

By the same token increased the efficiency of collected tons per worked hours, reaching 13% considering the four routes; the higher increase in efficiency was in route 23, i.e. 24% and the lower in route 2, which only achieved 5%.

The efficiencies achieved are under the optimum settled as goal, i.e. 2,0 ton/hr per collection. The route with better efficiency is route 9, with 72% of the goal value, which is owe to the high collection of pruning waste (branches, small logs, leaves, etc.) which demands quite a lot of time, besides that the vehicle completes its load by volume and not by weight.

d. Tons vs. assistant day

The daily efficiency of the collection assistant increased in 3%. The increment was higher in route 2, reaching 8%, in routes 4 and 9 the increment was minimal and in route 23 it reached 3%. Efficiency is highly affected by the way in which users dispose their wastes or the place where they store it, especially for routes 2 and 4 because in many occasions collectors have to enter private properties in order to withdraw the wastes, considerably delaying their labor. With respect of the fixed goal value, route 9 accomplished to have optimum efficiency, route 23 attained 93% of the optimum and the routes 2 and 4 are under the optimum, attaining 80% and 73% respectively of the value.

e. Consumption of combustible

The reduction of the work hours per month and the reduction of the distance traveled impact in the consumption of combustible; therefore it is expected a reduction of this expenditure. However, as the D.M.P.S. keeps into operation the system of allocation of a fixed amount to the vehicle per day; it was not possible to determine the real expenditure and therefore the reduction achieved.

If the reduction achieved when the truck is operating is analyzed, as well as the distance traveled per month and the increase of the collection hours, then the consumption of combustible should experience a reduction of approximately 10% in relation to the initial consumption that not necessarily coincides with the value allocated.

P.5.2 Effectiveness

The purpose of the project was achieved because the design of the routes allowed improving the efficiency on collection, personnel, on reducing the distances traveled as well as the work shift.

With the optimization of the routes, it was possible to have control over resources, their quantification and their minimization.

The optimization of the service and the control over resources allowed reducing considerably the direct costs of the collection service in the routes that were optimized. The application of this model to other routes will generate important savings to the D.M.P.S. who will be able to use them in the improvement of the final disposal of waste, accomplishing like this the goals of the M/P.

P.5.3 Impact

A main positive impact of the model project is that the D.M.P.S. has been able to prove that it is possible to have a collection service that responds to a planning and technical design through which it is possible to supervise the service, to reduce the costs and to offer a quality service.

The above-mentioned has had a positive impact on the procedures of the D.M.P.S. because decisions that allowed the incorporation of new systems of control and supervision have been taken in the field as well as through the processing of information. Additionally, some measures for the control of resources have been taken, i.e. in the management of combustible and in the selection of ideal personnel.

The implementation of the model project has had a positive impact on the direct costs of the service, reducing the costs of personnel, maintenance, combustible and lubricants.

The project has had a strong impact on the behavior of workers; the supervision has prevented them from using vehicles for the collection of private waste and for improving their efficiency.

As far as the D.M.P.S. has obtained higher information of the service, it has been able to detect problems, mainly related to personnel who make inadequate use of resources or who charges for the service. This has permitted to have a positive impact because a set of measures which allow correction and/or avoiding such bad habits have been applied while at the same time it permits to have ideal personnel for carrying out the collection tasks.

The model project has motivated all technical personnel to get involved in the different activities of the service and to actively participate in the formulation of solutions and measures that will improve the efficiency of the works.

The centralization of information of the final disposal and collection services has had a positive impact because it has integrated all the activities and has achieved that the service be managed in a global way, by incorporating other communities.

The project has had a multiplying positive impact in the D.M.P.S., firstly because it has motivated all technical personnel to get involved with the design and to set goals, which makes them to promote solutions and to carry out constant supervision in the field and in the information obtained through the processing of data. On the one hand this has motivated informatics personnel to constantly update the information and on the other hand it has obliged and motivated operative personnel to correctly execute their functions, improving the quality of the service. As result of the above-mentioned, the D.M.P.S. has generated some changes in its management that entail improving the efficiency on the service.

The processing of information has allowed having wide knowledge of the service while at the same time counting with all necessary tools which will forecast the costs and requirements of the service, aspect that was previously unknown for the municipality. Nowadays the municipality is in condition of estimating and programming annual costs and of formulating a tariff for charging the cleaning service, which will positively impact the budget of the city council.

The incorporation of other localities to the system of management of information and optimization of routes will allow improving the collection service in the municipality of Othon P. Blanco and at the same time, will allow carrying out a better distribution of resources, positively impacting all the community.

P.5.4 Relevance

The optimization of the collection routes and the minimization of costs will allow to the municipality redistributing resources, increasing those related to final disposal and allowing the implementation of the measures proposed in the M/P regarding this subject.

P.5.5 Sustainability

Through the different measures adopted by the D.M.P.S. like the new control of resources, selection of personnel, monthly evaluation of the routes, execution of the goals proposed, the program of optimization of the routes, coordination of the service with other localities, etc, the sustainability of the project is assured.

The D.M.P.S. has taken as principal objective the optimization of the collection service in order to enforce in the short term a tariff for charging users and improving this way the final disposal, aspect which is very relevant to the sustainability of the project.

The D.M.P.S. has personnel and adequate infrastructure which will allow planning, designing and operating in an efficient way the collection service.

P.6 Conclusions and recommendations

P.6.1 Conclusions

The strategy and measures proposed in the M/P are being executed.

The optimization and control achieved on the collection service has shown to the D.M.P.S. that it is possible to considerably improve the service through a rational plan of collection, which will permit not only increasing the efficiency and quality of the service but also achieving an adequate level of competitiveness and attaining important reductions of the costs.

During the development of the experience a set of problems have been evidenced; these problems affect the quality and efficiency of the service and are not related to its design but to parallel activities that drivers and collectors perform. These problems should be eliminated in the optimization of the routes in order to achieve effective results.

Besides increasing the efficiency of the service, its quality has also improved, fulfilling with the attention days, established timetables and carrying out an optimum collection. After the service is performed it is not possible to observe scattered waste on the streets. These achievements have been possible due to the constant participation of all personnel that took part in the model project, those who put in practice the knowledge obtained through the training program. The adequate diagramming and daily control of the parameters monitored by part of technical personnel, allowed making the necessary adjustments in the routes. The constant supervision of the routes assured the execution of the journeys and hence the coverage of the service. Finally, the correct execution of the route and the lifting and load of waste strongly influenced the increase on the efficiency and effectiveness of the service.

The D.M.P.S. has agreed in the importance of optimizing the service and in the need of formulating in the short term a type of charge for the cleaning service, which will allow its sustainability.

The city halls are interested in improving and controlling the collection service and are able to cooperate with the D.M.P.S. in order to achieve the objective.

P.6.2 Recommendations

With the purpose of increasing efficiency on personnel and that the savings achieved due to the optimization of the routes are reflected in lower cost of personnel, it is recommended to modify the system of payment of bonus to the personnel, paying instead exclusively for the hours worked. This may be carried out because the new system of control of routes allows knowing the hours that were effectively worked.

It is recommended to eliminate the allocation of a fixed amount of combustible per vehicle, which avoids any type of control over the resource. Nowadays there are variations over 20% of consumption for the same vehicle, which strongly impacts on the costs of the service. If the allocation is not possible according to real requirements, then it is recommended to establish it according to the characteristics of the vehicle and the route served (worked hours, distance traveled).

It is recommended to perform more supervision in the area of routes, with the purpose of assuring the execution of the journeys.

It is recommended to carry out in a separate basis the collection of household waste from vegetable waste (especially pruning waste); this is with the purpose of improving the efficiency on the collection, avoiding damages to the compactor equipment due to over size elements and using to the maximum the load capacity of the vehicle. This measure is directed to those wastes that are placed in front of the households in high volumes, in this case, the way of operation could be through the identification of the place by the driver, who could later inform to the Direction and therefore this would program a bunker truck for its collection during the afternoon shift or during the time when there are less activities. The waste collected may be taken to the dumping site, where there is a special place for the elaboration of composts.

It is recommended to acquire new trucks that can replace small trucks and dumping trucks, due to their low efficiency and because they are not suitable for the service that are currently performing. While the replacement of vehicles is carried out, it is recommended to evaluate technically and economically if it is convenient to keep using small vehicles for the collection of household waste, due to the high consumption of combustible and the low efficiency presented. Based on the results, it is proposed to evaluate the execution of the routes served by these vehicles during the afternoon shift with the compacting vehicles; instead it is proposed to use small trucks only for withdrawing pruning waste or commercial waste of high volume.

Annex Q

Collection Service Improvement in Felipe C Puerto

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Q Collection Service Improvement in Felipe Carrillo Puerto

Q.1 Outline

a. Background

The municipality of Felipe Carrillo Puerto has low collection service coverage of municipal wastes (household, commercial, institutional, and so on). In effect, the service is carried out only in the city of Felipe Carrillo Puerto, the municipality's seat; in the remaining locations grouped as mayoralties, boroughs and sub-boroughs, only some specific programs are executed, such as the "junk waste elimination" program, which is conducted once or twice a year. In these locations, the disposal of wastes generally is takes place though the burning of the same. On the other hand, the collection service in the city of Felipe Carrillo Puerto, under charge of the Head Office of Municipal Public Services, covers only part of the area, thus serving 9, 000 inhabitants from a total of 19,000; that accounts for a 47% coverage in the city and 18% for the entire municipality.

The reasons behind this low coverage are related to the scarce budget available by the municipality for these activities, ranging from 10 to 12% of the total budget, the poor conditions of the collection vehicles and a lack of planning of the service.

Inexistence of service planning is evident since the Head Office of Municipal Public Services lacks a rational design for the service, which leads to improvising the tours, and therefore some sectors are attended twice or thrice, whereas other remain unattended. Additionally, lack of auditing of the service and information surveying prevents the Head Office and the municipality from having a clear vision of the service needs.

The above situation can be reverted if a program aimed at the improvement of the collection service is implemented, thus achieving such an efficiency that the coverage of the same can be raised in the shot term. The proposed model project aims at such improvement through the following phases:

- Designing of collection service with a technical criterion,
- Implementation of routes as per the proposed layout
- Preparation of a Plan to expand coverage
- Preparation of a Handbook that will constitute the basic tool to share the experience towards other locations

b. Project Design Matrix

The Project Design Matrix was formulated with the purpose of clarifying the purpose, expected outcome, activities and input required. It is outlined in the following table.

Table Q-1: Project Design Matrix

Name of the Project	Period	Version
Collection Improvement (2)	Early October 2003/end of July 2004	N 1
Target Area	Target Group	Date
Felipe Carrillo Puerto	Felipe Carrillo Puerto staff	September 2003

Project abstract	Indicators	Check means	Important assumptions
General Goal			
M/P is implemented			
Purpose of the project			
Collection coverage improvement in Felipe Carrillo Puerto (FCP)	The collection service is provided as per a planning and technical design that allows for a wider coverage of the same, by using the current resources.	1. A wider coverage area 2. A higher volume of wastes collected 3. Continuity of the service and compliance with the days and times of attention	The C/P understands the importance of raising the coverage of the collection service
Outcome			
1. Collection coverage is improved	A greater number of users is attended, which can be seen by a larger area being serviced and an increased volume of wastes collected	This Report	The C/P is ready to implement the measures of the newly designed service
2. A handbook for the planning and design of the collection service is prepared	There is a document that details the procedures for the collection service design	Handbook	
Activities	Input		
See table infra			Pre-conditions

Table of Activities

Activities	Results	Period	Contribution by the S/T	Contribution by the Counterpart
Diagnosis planning	Diagnosis plan	See excel chart	Collaboration	
Implementation of diagnosis	Results of the diagnosis	Idem	Collaboration	
Improvement planning	Improvement Plan	Idem	Opinion Survey	Collaboration
Improvement implementation	Implementation of improvements	Idem	Purchase of a computer Elaboration of informative flyers	Provisioning of an office space
Handbook preparation (draft)	Handbook (draft)	Idem	Duplication of handbooks	Distribution and use of the

Activities	Results	Period	Contribution by the S/T	Contribution by the Counterpart
			(draft)	handbook
Monitoring	Monitoring	Idem	Counseling and guidance	Monitoring implementation
Assessment	Assessment report	Idem	Opinion survey	Collaboration
Elaboration of final handbook	Final handbook	Idem	Duplication of handbooks (final)	Distribution and use of the handbook

Contributions

Contribution	Study Team		Counterpart	
Staff	- Person in charge	XiA	-Person in charge	Head of Urban Cleansing Area
	-Assistant		-Assistant	Some
	-Support	MaO, IkM	-Participants	Collection and audit/service control personnel
Material	-Handbook (draft)	30 copies		
	-Handbook (Final)	30 copies		

Table of Duties

Activities	Duties	Remarks
1. Diagnosis planning	Validation of the information delivered previously is considered, therefore, the following will be checked on field: 1. Features of the service as peer covered areas, frequencies, schedules, vehicle and staff assigned 2. Identification of users that generate in excess and areas with greater production. 3. City's traffic characteristics 4. Opinion survey concerning the service	S/T design Information surveying and verification by S/T y C/P
2. Implementation of diagnosis	The above information, the following activities will be carried out: 1. Determination of available resources 2. Identification of areas with greater generation, in order to establish the collection frequencies in coordination with the above number 3. Identification of problematic zones for the collection of wastes due to their traffic features 4. Identification of areas to be incorporated into the collection service	Joint work between S/T and C/P
3. Improvement planning	1. Planning of the service as per the new coverage area 2. Route design and plotting 3. Design of the service monitoring and control system (use of some indicators) 3. Allocation of resources 4. Personnel training 5. Information program to the community	Joint work between S/T and C/P

Activities	Duties	Remarks
4. Improvement implementation	1. Elaboration of informative flyers 2. Implementation of information program to the community 3. Verification of availability of resources allocated 4. Commissioning of the new collection service 5. Personnel training	Joint work between S/T and C/P
5. Handbook preparation (draft)	Preparation of procedures handbook for the design of the collection service	Preparation by S/T Review by C/P and S/T
6. Monitoring	1. Information surveying as per the monitoring program 2. Tour of the routes to verify the compliance with the plotting and covered area	Joint work between S/T and C/P
7. Assessment	1. Compliance with the service as per the frequency, schedules and plotting designed 2. Comparison of coverage achieved vis á vis the actual coverage and target coverage 3. Opinion survey on the model project 4. Calculation of indicators	Joint work between S/T and C/P
8. Elaboration of final handbook	Review, final version, printout	Joint work between S/T and C/P

c. Working Schedule

The table below presents the activities' scheduling.

Table Q-2: Model Project Timetable

ID	Activity	WORKING SCHEDULE																																							
		2003												2004																											
		October				November				December				Januar.				February				March				April				May				June				July			
1.	**Diagnosis of the service in Project Area**																																								
1.1	*Establishment of C/P workgroup*	x	x																																						
1.2	*Information surveying*			x	x	x																																			
1.3	*Diagnosis of service in project area*						x	x	x																																
1.4	*Public opinion survey*								x		x	x																													
1.5	*Elaboration of plot with current routes And trip features*							x	x																																
1.6	*Identification of excessive generators*							x	x																																
1.7	*Determination of available resources*							x	x																																
1.8	*Identification of areas to be incorporated Into the service*							x	x																																
2.	**Collection Service Improvement**																																								
2.1	*Route design and plotting*							x	x					x	x																										
2.2	*Design of the service monitoring and control service (sheets)*								x	x				x	x																										
2.3	*Allocation of resources*													x	x																										
2.4	*Training if technical staff on route design*			x	x			x	x					x	x	x																									
2.5	*Training of collection staff*														x	x	x	x																							
2.6	*Elaboration of information program to the community*								x						x	x	x																								
2.7	*Elaboration of data collection and Processing sheets*										x	x			x	x																									
2.8	*Training of staff on the use of data sheets and elaboration of reports*															x	x	x	x	x																					
2.9	*Training of staff in service auditing*																x	x	x	x																					
3.	**Implementation of Improvements**																																								
3.1	*Commissioning of the service under the new design*																x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
3.2	*Commissioning of information program to community*																x	x	x	x																					
4.	**Monitoring**																																								
4.1	*Information surveying as per monitoring program*																x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
4.2	*On-field monitoring of the routes*																x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
5.	**Elaboration of Handbook**																																								
5.1	*Draft*																	x	x	x	x																				
5.2	*Final*																																			x	x	x			
6.	**Project Assessment**																																								
6.1	*Verification of service compliance as per the deign*																			x	x	x														x	x	x	x		
6.2	*Coverage achieved*																			x	x	x														x	x	x	x		
6.3	*Opinion survey on model project*																																		x	x	x				

Q.2 Diagnosis

a. Coverage

The municipality of Felipe Carrillo Puerto has a total land surface of 13,806 km^2, with a total population of 63,752 to 2003, out of which 19,000 are concentrated in the municipal seat of Felipe Carrillo Puerto (Figure 1).

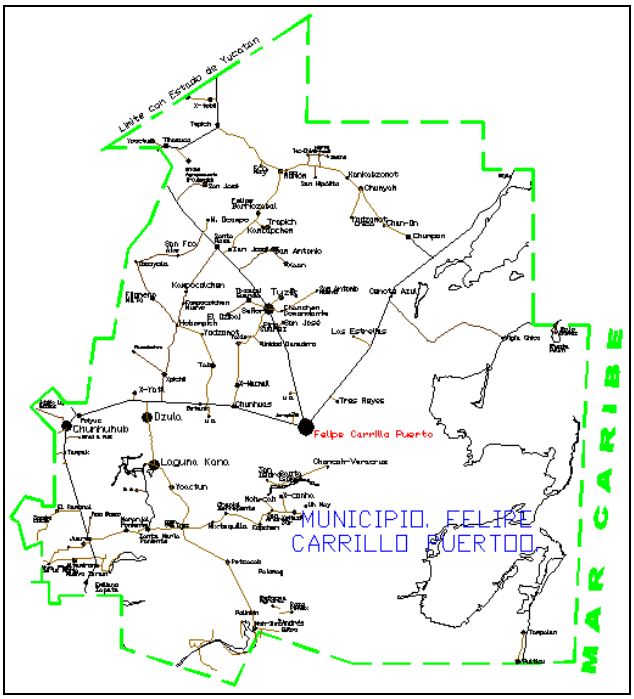


Figure Q-1: Municipality of Felipe Carrillo Puerto

Regardless of the fact that the municipality's responsibility is to manage household, institutional and commercial solid wastes generated throughout its territory, the collection, sweeping and final disposal service is actually carried out in the city of Felipe Carrillo Puerto only by the Head Office of Municipal Public Services.

The lack of attention in the remaining territory is attributable to two factors. The first one is associated with the lack of resources; in fact, the budget allocated to solid waste management of 30% is far below the municipal's global budget, a value set by the World Bank as appropriate to carry out the management of wastes. Additionally, the service is not charged with a fee, whose collection would help meeting the costs of the service, at least partially.

The second issue deals with the administrative structure of the Head Office of Municipal Public Services, which is oriented to attending the city of Felipe Carrillo Puerto exclusively, leaving the remaining locations of the municipalities grouped into mayoralties, boroughs and

sub-boroughs out of any solid waste management policy or program. As a consequence of the above, 70% of the total population of Felipe Carrillo Puerto is not covered with the collection service.

The activities of the head Office of Municipal Public Services are aimed exclusively at the execution of the collection, sweeping and final disposal service of solid wastes in the city of Felipe Carrillo Puerto, and therefore the municipality allocates physical and personnel resources, which does not mean they are sufficient to meet its real needs; this situation has a repercussion on the quality of the service and increases the percentage of population with unavailability of a proper solid waste management.

The inappropriate allocation of resources is partly due to the lack of funds (tight budget) and to the fact that the municipality lacks the information to establish the actual service needs; information that should be provided by the Head Office of Municipal Public Services.

However, not only does the inadequate allocation of resources impact the quality and coverage of the service, but the absence of programming and designing of the same as well. In effect, currently the collection service design has been developed at quite a basic level, with the definition of some areas of attention, particularly in downtown commercial or residential areas closer to the city's downtown and with no consideration of route plotting.

The absence of routes means that the tours are decided by the driver's criterion and, since there is no service auditing, in some areas the collection is conducted more than once a day, while other remain unattended and regardless of the fact that they are located within the area assigned to the collection vehicle (see the following figures).

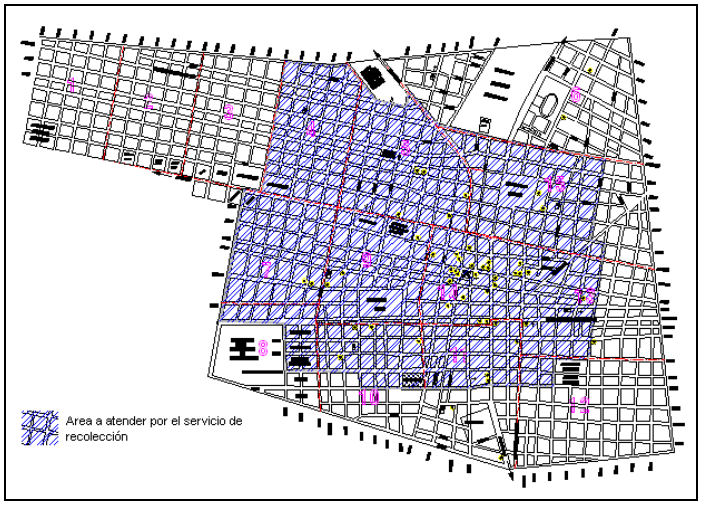


Figure Q-2: Service Area as per the Collection Program of the Head Office of Municipal Public Services (D.S.P.M.)

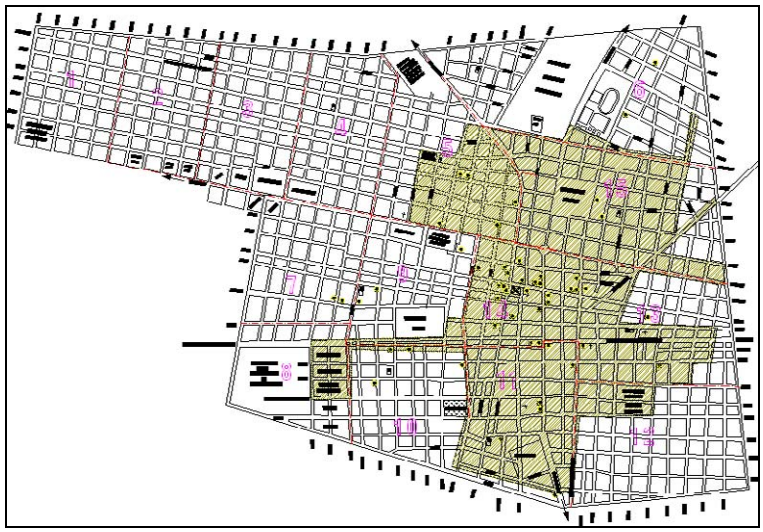


Figure Q-3: Actual Area Covered by the Collection Service

As perceived from the above figures, the real area covered by the service is actually smaller than programmed; in terms of covered surface, it accounts for 65% of the total area regarded in the programming of the service. In terms of population being served, the service is actually rendered to around 9,000 people, being the population considered within the program of 11,300; thus, a programmed coverage of 79% is being achieved.

On the grounds of the above, it can be said that the current solid waste collection service in the municipality of Felipe Carrillo Puerto covers around 15% of total population and 47% of the population in the city of Felipe Carrillo Puerto. The table below summarizes the current coverage ranges.

Table Q-3: Current Coverage of the Collection Service

Total coverage	Programmed Coverage	Actual Coverage	Coverage in FCP
%	%	%	%
15	18	15	47

The low coverage of the collection service in the municipality of Felipe Carrillo Puerto becomes evident by the constant accumulation of wastes at the side of roads or in vacant property, which turn into small to medium size dumping sites where birds, insects and other fauna proliferate. Also, burning of wastes is customary, and such activity is observed even at zones nearby the city's downtown.

In case the service coverage is not increased, the above issues will gradually augment because of a population increase or saturation of wastes, which will inevitably affect the people's standard of living (more diseases) and the environment (direct contamination of soil, superficial and underground waters due to wastes and/or leachate, or air due to the burning of wastes).

Achieving a wider coverage depends not only of greater resources but of the rational and optimal utilization of the same, aspects that constitute the most important factor within the system. The rational and optimal use of resources allows for a considerable reduction of the service costs, minimization of the equipment being on idle, a higher efficiency of the service and a longer service life of the equipment.

Based on the above, it is evident that a proper planning of the service, oriented towards maximizing the use of resources available to the municipality of Felipe Carrillo Puerto, will translate into an increased coverage of the same.

b. Service Planning

As previously stated, the collection service is executed according to the needs and resources available, but with no design of the same, with the exception of areas assigned to be served and defined exclusively in accordance with the needs, its closeness to the city's downtown, existence of businesses, places with a higher concentration of population and accessibility for the collection truck.

Lack of planning results in an improvised development of the service in accordance with the priority; i.e., places where there is a higher accumulation of wastes. Also, there is no collection frequency established and therefore the users are unaware of the collection days by the truck and people take out their wastes at any time, which results in an important accumulation of wastes that end up scattered by animals, as shown in the following figure.

Figure Q-4: Waste Scattered due to Lack of Planning

It can be said that the service is provided more regularly in the neighborhoods around downtown. However, as these neighborhoods are farther away from the center, the service is more inconsistent and, in several cases, not provided. The lack of service forces the user to

search for alternatives to get rid of their wastes, such as burning of the same, an activity that is performed at any time during the day and generally in their backyards or in front of the dwellings.

The Head Office of Municipal Public Services is unaware of the amount of wastes generated and has no control over the number of trips made daily in each area or an entry control to the dumping site. Lack of this information, in addition to the scarce loading capacity of the trucks, causes several of the trips to be uncompleted and therefore wastes accumulate on public thoroughfare, with the resulting negative aesthetic landscape.

An additional factor affecting the development of the service is the status of collection vehicles (see the following figure). As a consequence, during the execution of the service, they suffer from failures and they cannot complete the areas assigned and, in this case, such sector remain uncollected until the vehicle is fixed.

Figure Q-5: Characteristics of Collection Vehicles

Lack of planning generates important operating expense increases, which are attributable to the tours being improvised and to the driver's criterion. Some of the causes behind the expense increments are as follows:

Repeated tours: Since there is no route plotting, vehicles concentrate in downtown and its surrounding areas, and in some sectors wastes are collected up to three times a day, whereas some are left unattended. The following figure shows the areas where collection tasks took place, and includes both shifts.

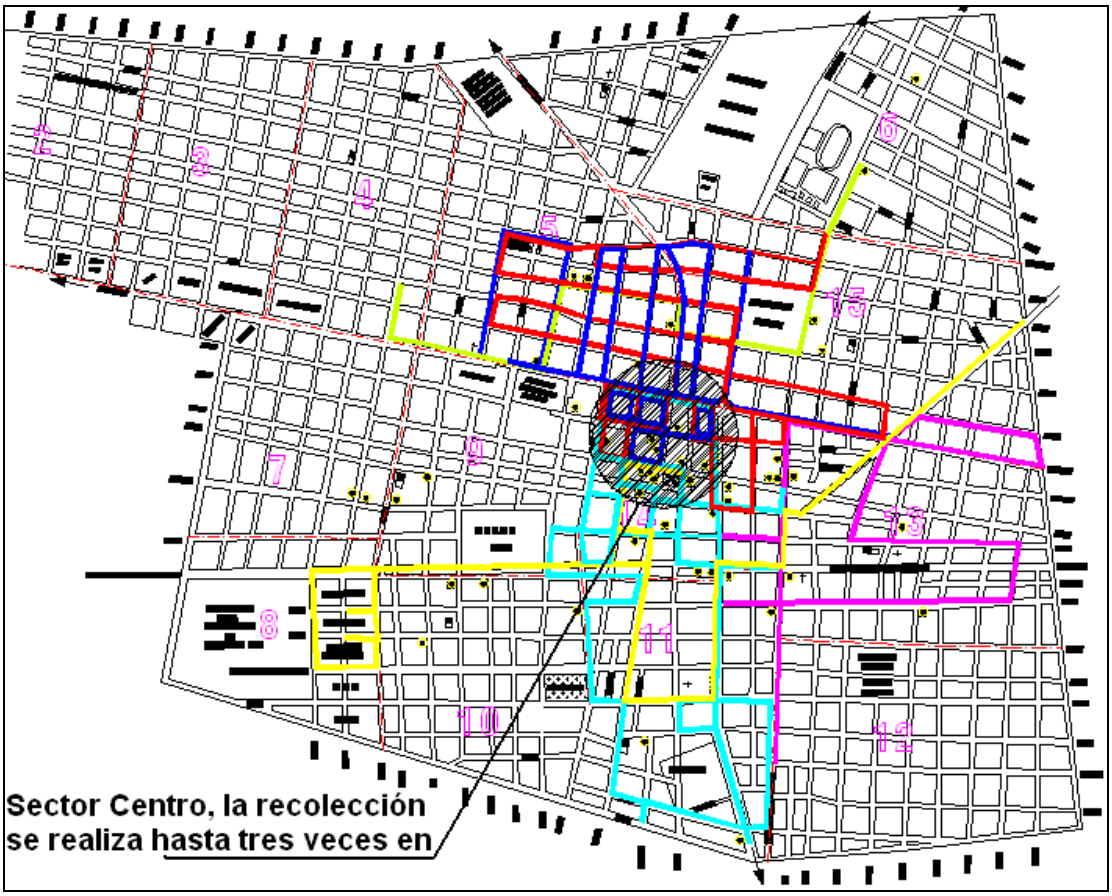


Figure Q-6: Repetition of Tours

It can be seen from the figure that some sectors are attended twice in the day and even thrice a day. This situation proves that utilization of resources is inappropriate; there is no planning or auditing of the service that could have helped detect that situation and enforce the corrective measures.

- Longer haulage times: In most of the cases the trucks travel through most of the city to pick up the wastes from an specific point, especially highly populated sectors, regardless of the fact that an additional collection truck is working in the same area. As a consequence, most of the time the truck is traveling distances instead of collecting wastes. Contributing to this situation is the fact that several times drivers steer away from the assigned areas to eat.

- Longer times due to traffic: Many times the collection tasks are conducted during hours of high concentration of public and vehicles, which consequently delays the collection at such areas.

- Repeated service: Since the service is not being provided within a fixed frequency or time, wastes are not taken out by the users when the collection truck passes by, and therefore the user demands the Head Office for the service and the latter devotes a vehicle exclusively for the collection of such wastes, instead of having a vehicle within that area collect the same.

- Diminished load transported: Since the service executed on evenings generally involves the same area attended during the morning shift, the waste volumes being collected decrease considerably, and in consequence the trips to the dumping site by the truck are with less than 50% the vehicle's loading capacity.

All of the above can be easily fixed with a proper planning of the collection service that contemplates the route design and plotting, an efficient use of collection vehicles, training of the personnel and community participation. This in result would generate a qualified service, subject to established frequencies and schedules and wherein the user is certainly aware of the days and time of attention. On the other hand, the resources available would be properly allocated and operated, and in result the coverage would increase.

c. Monitoring and Auditing of the Service

Lack of planning and route design prevents the supervision staff of having background to audit how the system is developing. In fact, most of the times the whereabouts of the collection vehicle is unknown, and so it is hard to find it. Also, as the Head Office does not have vehicles to conduct an on-field inspection, this is not carried out.

In addition to the above paragraphs, no control on the mechanical status of the vehicles is conducted that would allow a timely maintenance of the same, therefore, taking into consideration their poor conditions, they suffer failures constantly on the way and their repair time is long.

Regarding the information surveying of the service, the Head Office of Municipal Public Services has no record of the daily activities performed by each truck that would allow a comprehensive knowledge of the area attended, the working schedules, tasks and personnel assigned, number of trips to the dumping site, and so on. These data would help to understand the development of the service in each area in particular and check the compliance with the duties.

The dumping site also lacks staff that records the entry of trucks, and therefore it is impossible to verify the times or loads of each trip.

Lack of auditing and information surveying hinders the possibility of make any evaluation of the service and detect serious issues in its execution (e.g., duplicated attention, under-loaded trips, etc.), which could be easily fixed.

On the other hand, the fact that the Head Office of Municipal Public Services does not survey information holds up the evaluation of the service and prevents it from acquainting the service's real requirements, and therefore any resource request to the municipality will not have sufficient technical background to be authorized. In parallel, since the municipality does not receive such technical data to back up the resource request, the allocation of the same does not meet the needs, and the situation turns into a vicious circle.

d. Conclusions

The scarce resources available to the municipality of Felipe Carrillo Puerto, in addition to the inexistence of a fee collection system for the management of municipal solid wastes causes the collection service to provide a rather low coverage, which brings about the creation of illegal dumping sites, scattered wastes throughout the communities and a high percentage of wastes being burned.

The above situation is aggravated for the fact that the resources available to the municipality are mismanaged, especially for the lack of planning of the service, the absence of a technical design and auditing of the execution of the same.

From the diagnosis of the status quo, it can be concluded that part of the problem can be solved if the collection service is improved through the optimization of the existent resources. To achieve such objective, it is necessary to do the following:

- Design a collection service that considers the rational plotting of routes, thus minimizing idle capacity of vehicles and staff.
- Follow-up of routes, surveying information generated during the trips.
- Service control through the on-field information surveyed and comparison of the same with optimal values outlined in the design.
- Direct on-field service auditing, checking the compliance of routes, frequency, days and schedules of attention and coverage area.
- Establishment of actual requirements of the service, through the assessment of the same.
- Information to the community of the new collection service, keeping them informed in regards to the changes that would eventually take place. At the same time, the user's

behavior should be monitored, so that the latter can adjust to the features of the service and complies with the provisions of municipal regulations.

The enforcement of the above measures will translate into the following:

- A well planned and structured service that responds to technical criteria and wherein improvisations are inexistent.
- The efficient use of resources, both material and human.
- An adequate response from the user, who is aware of attention days and schedules and who delivers and discharges wastes as programmed, thus avoiding the accumulation and scattering of the same on public thoroughfare.
- A precise knowledge on how the collection service works, which will allow the Head Office to acquaint the real needs of the service and inform the Municipality of the same, so that public investments can be programmed.

By enforcing all of the above, the service will gradually increase its coverage and will have the capacity to manage the same at locations such as mayoralties, boroughs and sub-boroughs.

Q.3 Implementation

Q.3.1 Search of information

The first stage of the model project considered the compiling of field information. The objective was having records that allow us to design the gathering service, to evaluate the improvements that are achieved with the new design, and to verify the achieved covering.

The gathering of information included the following issues:

a. Study of characteristics of the study area

During the study of characteristics of the study area the main objective was to know the conditions and physical characteristics of the area of the project. It was compiled information that finally was used for designing a map, such map was the starting point of the service design.

The collected information included the following background:

- Identification of the residential zone (neighborhoods), commercial zone, industrial zones and over generating zones.
- Number of inhabitants and households per neighborhood.
- Vial characteristics of the city and conditions of the same one.
- Location of the final disposal site.
- Identification of special situations that could damage the collection service (for instance, streets where the collector vehicles can not transit, circulation way, etc.).

b. Characteristics of the actual service

With the purpose of knowing the characteristics of the current service such as how was the cover soil done, the frequency days and time of attention, used resources, identification of over generators of solid wastes and areas of major generation. In coordination with the C/P, there was carried out a tracking of collection trucks and the following information was gathered.

- Identification of the collection truck and personnel
- Time the truck used to leave the parking lot.
- Total amount of combustible per collection truck.
- Starting time of collection (It was identified the point of beginning on a street map)

- Diagramming of the journey, information that was drawn in a city map. During the travel it was verified the existence of every special situation, areas of higher generation, existence of containers, commercial zones, market, institutions, etc. all this was drawn on the route diagramming.
- Ending time of collection (It was identified the ending point on a map)
- Entrance and exit time to the final disposal site.
- In the cases when the truck used to give more than one journey, the information was recovered again for the following journey and started from the initial collection data, but in the opposite case the entrance time had to be informed to the base.

It was recorded information related to the used combustible and worked hours during one month; this data was used for making routes evaluation.

After having a background of all routes, it was pointed out the service area on a map. Next, taking into account the possible monitoring data, the following indicators there were selected:

- Number of journeys per day
- Number of journeys per route
- Worked hours/day
- Collection hours/Total hours worked

Once having the indicators and background, the actual service indicators were calculated. The obtained values were on zero and the model project was evaluated with this data.

With the intention of having an adequate instrument for compiling information, it was designed a format called “Route Sheet”, such route sheet was given to every truck driver for recording compiled information on their assigned service. In order to record and manage the obtained information from the "Route sheet", there were designed two books in Excel named "BASE_DATOS_(month).xls " and "Informe_FCP_(month).xls ". The first is for recording the "Route sheet" information and the calculation of times of cycle of the service, and the second one is for making tables and/or graphs that deliver the consolidated information of the service, as well as the calculation of indicators of the project.

c. Elaboration of a public opinion survey

On December 2003, it was developed a public opinion survey in regards of the quality of the solid waste collection service in Felipe Carrillo Puerto. Such survey had the objective of

knowing the service perception of users. In total 129 housing and 21 stores were interviewed. Through this survey it was possible to infer that:

Residential sector:

- An important percentage of women were interviewed, almost 80%.
- Regarding the solid waste collection service, 96% answered that they already have the service, and 4% answered that they do not have the service.
- 58% of the users said that their solid wastes are collected by the municipality service and 32% said that their solid waste is burned on their own street or courtyard.
- 67 % of the users said that they were not satisfied with the collection service and 37% said that they were satisfied.
- Regarding the main reason of dissent, 34% said that frequency of the collection service is not regular and 33% said that the frequency of collection service is not enough.
- Regarding the main problems caused by the solid waste management: 21% said that it is because it gives a bad image, 20% that it is because there is an increasing number of mice and animals, 20% said that it is because the burned waste and 20% said that it is because of the bad odor.
- Regarding the payment of the service: 97 % of the interviewed said that they do not pay and 78 % said that they would be able to pay a tariff for the service just in case the service improves.
- There existed a high predisposition to collaborate with the model project, 84 % of the interviewed said that they would be able to collaborate with the model project in order to improve the quality of the solid waste collection service.

Commercial sector

- Regarding the main solid wastes generated at commercial zones, 28% are paper, 28% plastic and 26% cardboard.
- 85% of the users said that the solid waste collection service is made by the municipality service.
- Regarding the frequency of collection, 43 % of the interviewed said that solid wastes are gathered twice a week, and 24 % indicated that solid waste collection service is daily.

- 76% of the users said that the service is not realized according with the scheduled hours.
- Regarding the degree of satisfaction with the service, 10 % said to be very satisfied, 52 slightly satisfied %, 19 very slightly satisfied and 19 unsatisfied %. The reasons for which they are not satisfied are: irregular frequency 38 %, low frequency 25 %, and the irregular schedule 19 %.
- 86 % of the interviewed said to be able to pay less than 100 for the service, 14 % would be able to pay between 100 and 300 pesos.

Q.3.2 Design of the Collection service

In order to design the service the following activities were made:

- Technical personal training
- Definition of the coverage area
- Division by sectors
- Designing and diagram of the routes
- Training of the operative personnel
- Establishment of the routes

Before staring the design and the schedule of the model project, the C/P assigned responsible personnel which participated. The work team was as follow:

- 1 Coordinator engineer
- 1 technician on collection
- 1 technician on computers
- 1 Secretary
- Drivers
- Collectors

a. Training of the technical personnel

Before continuing with the solid waste collection service design, the technical personal was trained about the process for designing. The process included the following:

- Procedure for calculating the solid waste generation amount on normal and peak days according to the frequency of collection.
- Procedure to calculate indicators.
- Procedure for calculating sectors and sub sectors.
- Procedure to determine the sector and sub sector limits.
- Procedure for diagramming and rules for diagramming
- Procedure for routes verification
- Procedure for the routes implementation
- Method of routes evaluation

The training, management, analysis, calculation of indicators and design of the collection service of compiled information was made at the same time. Since that moment new routes were implemented and this information was reinforced every week. Training also included procedures related to the information management and Excel book works.

b. Determination of the coverage area

In order to determine the coverage of collection service area, the availability of resources (personnel and vehicles) where verified and it was calculated the waste generation daily amount on neighborhoods in Felipe Carrillo Puerto.

After taking into account the minimum number of journeys and the load capacity of vehicles, it was calculated the transport capacity for journey, for every one of the vehicles and, for the whole fleet. The frequency of collection and the production of solid wastes for neighborhood were used to determine the area that can be attended by the service.

The results of this phase were the following:

Table Q-4: Available vehicles and load capacity.

Truck Nº	Type	Volumetric Capacity [1] m3	Ton	% maximum lodge per journey [2]	Ton/journey	Ton/shift
1	Dump truck	13,5	2,7	70	1,9	3,8
2	Dump truck	13,5	2,7	70	1,9	3,8
3	Compact truck	10	3,50	75	2,6	5,3
4	Cargo truck	8,9	1,78	70	1,2	2,5
Total		45,9	10,68		7,7	15,3

To determine the capacity of transport per shift of each truck, it was considered that each truck carries out two journeys to the dumping site per shift.

Regarding the personnel availability there is the existence of four and three gangs[3] of workers for giving the service on the morning and afternoon shifts respectively. It means that it is possible to operate a maximum of seven routes daily.

[1] For dump and cargo trucks the transported waste density was 0,20 ton/m^3. For the compactor truck it was 0,35 ton/m^3.

[2] It was estimated the maximum load per journey is a percentage of the useful load capacity, due the antiquity and the bad conditions of the collection vehicles.

[3] A gang is integrated by one driver and two waste collectors.

Therefore, the maximum number of solid waste amount that can be gathered daily in the city is around 28,1 tons taking into account that trucks 1, 2 and 3 perform two shifts daily and the truck number 4 only works in the morning shift.

Table Q-5: Population per neighborhood in Felipe Carrillo Puerto[4].

Nº s/map	Neighborhood	Nº of inhabitants	% of inhabitants attended	Nº of inhabitants attended
4	Plan de Ayala	617	65	401
5	Leona Vicario	2.138	100	2138
6	Emiliano Zapata	988	95	939
7	Lázaro Cárdenas	320	65	208
8	Rafael Melgar	560	95	532
9	Cecilio Chi	1.386	100	1386
10	Javier Rojo G.	1.352	100	1352
11	Juan B. Vegas	2.429	100	2429
12	Mario Villanueva	946	70	662
13	Francisco May	2.352	95	2234
14	Centro	1.110	100	1110
15	J. Martínez R.	2.653	100	2653
Total		16.851		16.044

In some cases it was not considered the total neighborhood inhabitants because of the existence of particular situations that forbid giving the service, for instance, the road conditions and the low demography.

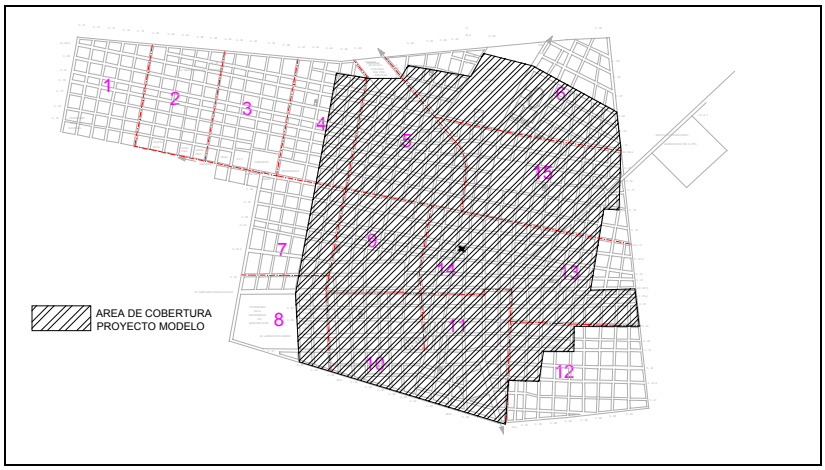
Table Q-6: Daily production of solid waste by neighborhood

Neighborhood	Inhabitants	PPC	Ton/day
4	401	0,8	0,3
5	2.138	0,8	1,7
6	939	0,8	0,8
7	208	0,8	0,2
8	532	0,8	0,4
9	1.386	0,8	1,1
10	1.352	0,8	1,1
11	2.429	0,8	1,9
12	662	0,8	0,5
13	2.234	0,8	1,8
14	1.110	1,0	1,1
15	2.653	0,8	2,1
Total	16.044		13,1

[4] Only neighborhoods where vial infrastructure does not forbid the collection vehicle transit were considered.

The frequency of collection is going to be daily; because of the community custom of burning their wastes and the difficulty of making them keep their wastes at homes. The total amount of solid wastes to be collected, taking into consideration the neighborhoods is 26,2 ton/day.

With the availability of the resources, it is possible to collect only 28,1 ton/day, and it is possible to give the service to the 12 neighborhoods considered at the beginning. The following figure shows us the coverage area for the project.



c. Division per sectors

Once the coverage collection service area was determined, the division of the area was realized. There were defined the conditions on which the service would be delivered.

Frequency of collection	Daily
Number of journeys	2
Number of worked days at week	6
Useful Load for the dump truck	1,9 ton
Useful Load for the compact truck	2,6 ton
Useful Load for the cargo truck	1,2 ton

Next, it was calculated the solid waste amount to be collected weekly and the day of maximum accumulation and the normal day for each neighborhood. The following table summarizes the information.

Table Q-7: Production of solid waste on pick days

Neighborhood	Ton/week	Ton/normal day	Ton/peak day
4	2,2	0,3	0,6
5	12,0	1,7	3,4
6	5,3	0,8	1,5
7	1,2	0,2	0,3
8	3,0	0,4	0,9
9	7,8	1,1	2,2
10	7,6	1,1	2,2
11	13,6	1,9	3,9
12	3,7	0,5	1,1
13	12,5	1,8	3,6
14	7,8	1,1	2,2
15	14,9	2,1	4,2
Total	91,4	13,1	26,1

In this case the frequency is 6 and the attention days per week are also 6. The number of sectors is one, however, due that the service may be executed in two shifts, it has been considered two defined sectors with the following nomenclature:

S1 Sector 1, attention days Monday to Saturday, in the morning shift.

S2 Sector 2, attention days Monday to Saturday, in the afternoon shift.

The number of sub sectors or routes was determined by the number of trucks that operate in each sector. As was previously indicated, in the morning shift the number of trucks available is 4, having a collection capacity of 15,3 ton/day and in the afternoon shift the number of vehicles that can collect a total of 12,8 ton/day of waste, is 3. On the other hand, the amount of waste to be collected in peak days is 26,1 ton/day, i.e. under the system of operation designed, it is possible to collect all waste, resting an additional capacity of 2,0 ton/day.

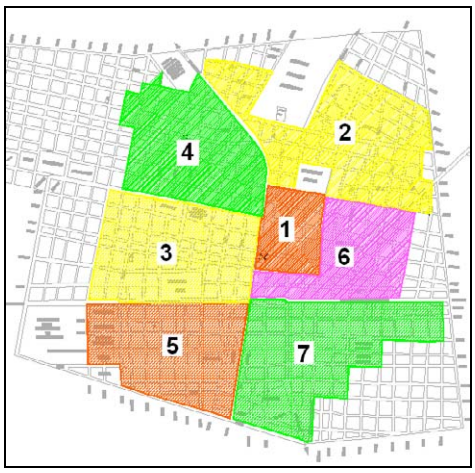
Due to the above mentioned, the total of sub sectors (routes) is 7, four in the sector S1 and three in the sector S2. The totality of wastes possible to collect per route and sector is shown in the following table.

Table Q-8: Sectors of the collection service

Sector	Sub sector	Ton/shift
1	1	3,8
	2	3,8
	3	5,3
	4	2,5
2	1	3,8
	2	3,8
	3	5,3
	4	2,5

d. Design and diagramming of the routes

With base in the generation of wastes per colony and the transport capacity of vehicle during the shift, the definition of each one of the sub sector was performed. This is shown in the following diagram:



With the delimitation of sub sectors, a diagramming of the route was carried out. For that reason, the common rules of diagramming were followed, considering mainly the "Comb" layout. Once the diagramming was performed, technical personnel went to the ground in order to verify the layout.

Table Q-9: Characteristics of the routes

Route Nº	Sector	Days of attention	Shift	Timetable
1	S-1	Monday to Saturday	Morning	06:00 to 13:00 hr.
2	S-1	Monday to Saturday	Morning	06:00 to 13:00 hr.
3	S-2	Monday to Saturday	Afternoon	13:00 to 18:00 hr.
4	S-1	Monday to Saturday	Morning	06:00 to 13:00 hr.
5	S-2	Monday to Saturday	Afternoon	13:00 to 18:00 hr.
6	S-1	Monday to Saturday	Morning	06:00 to 13:00 hr.
7	S-2	Monday to Saturday	Afternoon	13:00 to 18:00 hr.

e. Training of operative personnel

Once the routes were optimized and before their implementation, operative personnel were trained in regards of how to develop the service. The topics approached were:

- Training in the use of the Route Sheet
- Form to perform the collection and security measures
- Training in the tracking of the route allocated

The training was reinforced during the development of the project.

f. Implementation of the routes

On February 16th started the new collection service, with the daily monitoring of the times and journeys traveled, using for that the Route sheet.

- During the fist week, information on times and movements were taken jointly by the technicians and the truck drivers, later on this labor was developed exclusively by the driver.
- Also during the first week, downtown and the shopping area were visited, in order to inform users on the way to dispose their wastes and to privilege the use of *tambos* or small containers with the purpose of facilitating the collection works.
- Due to their bad mechanical status, vehicles suffered constant damages during the development of the model project and in many cases they were not able to offer the service. In such situations and with the purpose of executing the service, trucks that were in operation, after collecting the waste in the route they had allocated, assumed the collection of routes where damaged trucks should work. In some cases their work was supported by a Nissan truck.
- Every week the execution of the routes was supervised by the person in charge of the service.
- Information contained in the route sheet was recorded on the data base on a daily basis and the results were verified.
- The consolidated report of the service was made in a monthly basis, including in it the antecedents of the routes that were optimized.

Q.4 Results

Q.4.1 Achievements

Narrative Summary	Achievements
General Goal M/P is implemented	The execution of the model project has allowed withdrawing waste from a higher number of houses and colonies, fulfilling like this one of the particular objectives of the M/P that is "to provide a sanitary living environment". In fact the collection rate in the urban area increased from 27% to 49%.
Purpose of the Project Improvement in the collection coverage in Felipe Carrillo Puerto	The city of Felipe Carrillo Puerto has a new collection service, which is provided in a continuum form and within established timetables. Using the same resources used before starting the model project, it has been possible to increase the collection coverage and to generally improve the service. With the implementation of the model project, it was possible to increase the coverage of the service in the municipality (urban area) from 27% to 49%. The M/P considers as goal for 2007 a coverage equal to 70,1% for urban group 6, conformed by Felipe Carrillo Puerto and Señor. The model project has over passed such goal, achieving a collection rate of 74%. The design of the collection service has permitted to optimize the use of resources. The improvement of the coverage becomes evident by observing that the activity of burning waste has been reduced, just like the volume of waste inadequately disposed in empty land and streets. The amount of users has increased in 78%, with respect of the initial value. These new users got used to the fact that their wastes are withdrawn from their households and inclusively, in response to that, they have improved the storage system. This is especially true for the commercial area and downtown. This has obliged the D.M.P.S. to maintain the new collection service, assuring its sustainability.
Outcomes 1. The coverage in collection is improved	✓ The new collection service was put into operation in Felipe Carrillo Puerto, whose design was based in basic criteria, which allowed the optimum use of the resources available. ✓ The number of users being attended by the new collection service is higher than 16.000 inhabitants, which represents an increment of 78% in the coverage in the city of F.C.P. ✓ Planes for the service, for each one of the routes, were made, with the corresponding diagramming, which are used by drivers in carrying out the journey and by the supervisors, in order to supervise the routes. ✓ The direction of Municipal Public Services incorporated within its administrative and operational processes the use of the Route Sheet that allows gathering field information of the services. ✓ A computer schedule was put into operation for the registering and management of data obtained through the route sheet and a schedule for the consolidation of information and the estimation of indicators. ✓ A program of field supervision was implemented in order to verify the execution of the journeys and the quality of the service. ✓ The use of indicators was enforced, setting for each one, specific goal values and evaluating each month the routes. The necessary correction was carried out. ✓ The municipality decided to incorporate to the Direction of Municipal Public Services a technician that is in charge of the computer management and processing of field information, the elaboration of monthly reports and the evaluation of routes through the use of indicators. ✓ Each month, a report is being elaborated, concerning the development of the service. In it there is contained information per route, vehicles and personnel. The consolidated information permits to control resources, mainly combustible and man hours, previous to the implementation of the model project such controls did not exist. ✓ The number of hours worked per month was reduced as well as the number of journeys. ✓ Personnel of the D.M.P.S. are trained for carrying out the design of the collection service, making possible to extend the experience to other areas of the city or communities.
A manual for the planning and design of the collection service is	✓ A procedures manual was elaborated for the design of the collection service and the optimization of the collection routes

Narrative Summary	Achievements
prepared	✓ An instructive for the recording of data and the use of the calculus schedule was elaborated. ✓ Technical personnel were trained on the use of both documents.

Contributions

Personnel S/T

The study team was leaded by Ing. Ximena Alegria, who was in charge of coordinating the strategy, planning, designing and conducting the activities. Lic. Hiram Diaz was in charge of the coordination of information between the D.M.P.S. and the S/T. Lic Citlalli Suarez conducted the public opinion survey. Ing. Mario Valle compiled and analyzed information form several sources.

Personnel C/P

Ing. Eduardo Escalante from the Direction of Public Works was in charge of coordinating the activities between the Municipality and the S/T. The director of Public Services, Mr. Noe Baena was in charge of approving the new design of the collection service and the incorporation of new administrative procedures and control of the service. The technician Manuel Gongora participated in all the process for designing the routes and was in charge of all field activities. The technician Cesar Guzman was in charge of managing and processing the information. Bio. Jose Guerrero, officer of SEDUMA, carried out coordination tasks between the municipality and this organism.

Equipment

The S/T donated to the municipality of Felipe Carrillo Puerto a computer and a printer, which were installed in the offices of the D.M.P.S. in order to control the collection service. A manual was elaborated and delivered to the C/P for its revision and comments. Later on, the final version was edited.

Q.4.2 Other results

In the following table are shown the results of the variables monitored and the indicators during the development of the project

✓ Population served in the project

In the following table is shown the background regarding the coverage of the collection service before and after the implementation of the model project.

Total Urban Population	33.025	Inhab.
Population Urban Group 6	21.784	Inhab.
Population Served Initially	9.000	Inhab.
Population Served With the Model Project	16.044	Inhab.
Initial Coverage Urban Area	27%	Inhab.
Initial Coverage Group 6	41%	Inhab.
Project Coverage Urban Area	49%	Inhab.
Project Coverage Urban Group 6	74%	Inhab.

✓ Results of monitoring the service.

The table shows the monthly results for the variables of control of the service.

Table Q-10: Results of monitoring the routes

Month	Worked hours	Collection hours	No. of shifts	Consumption of combustible
January	732	488	301	3.474
February	680	486	218	2.867
March	691	511	218	2.698
April	682	516	224	2.598
May	669	497	210	2.605
Average project	680,5	502,6	217,5	2.692,0

Q.5 Evaluation

Due that before implementing the model project the service responded to a daily programming, where vehicles were assigned sectors or avenues, the evaluation of the project was carried out based on the monthly information of the service.

Q.5.1 Efficiency

The efficiency achieved by the model project was evaluated in function of the results obtained from the different variables that were controlled during the development of the project.

a. Worked hours per month

With the operation of the new collection service it has been possible to reduce the total amount of worked hours in the whole service in 7% in relation to the initial situation. Besides, this lower amount of hours is able to serve 7,000 more users, which means that the current efficiency is 23,6 users/worked hour; before the implementation of the project the efficiency was 12 users/worked hour. Therefore, costs associated to direct manpower through the implementation of the model project have been reduced, which impacts on the tariff and permits to reduce the costs per user served.

Additionally, the hours dedicated to collection increased in 3% by implementing the model project, which together with the reduction of total hours, indicates that the vehicle is now dedicating less time to transportation and final disposal. Operating under the optimized design, from the totality of time worked, 74% is destined to collection; previously it was 67%.

b. Number of users per vehicle

This variable permits us to establish the efficiency of the vehicle. The values attained before and after the model project were 2.250 and 4.000 inhabitants/collection vehicle respectively, i.e. the number of users served by the current group of vehicles increased in 77%. By optimizing the use of this resource, it was possible to achieve the coverage proposed as well as to reduce the transportation costs.

c. Number of journeys per month

The totality of journeys per month has reduced in 28% with the application of the model project; therefore the capacity of transportation per vehicle has increased. In fact, if the per capita production adopted in the service is considered, the totality of tons per journey has increased from 0,7 ton/journey to 1,8, which means an increment in the efficiency of the

transport in 108%. This situation is the result of the application of a collection service where routes are designed under technical criteria and are not the decision of the driver. The design avoids the duality of journeys, minimizes the transportation time and assures the collection in the whole sector. The higher efficiency of transportation reduces the operative costs of the service (personnel, lubricants, combustible, maintenance, etc.).

d. Consumption of combustible

With the implementation of the model project it has been possible to reduce the monthly consumption of combustible from 3.500 L/month to 2.700 L/month. This represents a consumption of 15,6 L/ton and 7,2 L/ton of combustible respectively; achieving therefore a reduction of 54% in the costs of combustible per ton collected. The reduction on the consumption of combustible is not only the result of the implementation of an optimized design but also of an adequate and constant supervision program.

e. Costs of the service

It is evident that the efficiency achieved through the implementation of the model project has impacted on the costs of the service. While this may not be observed directly in the global costs for the municipality (monthly costs have remained almost constant), it is clear when unitary costs are evaluated. The cost of the service has an approximate value of 1,2 million pesos yearly. If the estimated production of waste is used in the design of the routes, the annual tons collected before and after the implementation of the project are 2.673 ton/year and 4.766 ton/year respectively. Therefore, with the application of the model project it was possible to take the unitary cost from 448,9 $/ton to 251,8 $/ton, which represents a reduction of 44%.

Besides increasing the efficiency of the service, its quality also improved, executing on time the established attention days and timetables, while at the same time carrying out an optimum collection service, observable in the lack of scattered wastes on the streets.

These achievements have been possible due to the constant participation of all personnel that took part in the model project; those who put in practice the knowledge obtained through the training program and at the same time learnt how to capture and manage data. These allowed the evaluation of the service, supported in the efficient use of the computer which was donated.

Q.5.2 Effectiveness

The purpose of the project was achieved because it has been possible to incorporate to the collection service a total of 7,000 users, increasing the coverage of the urban area from 27%

to 49% and in the city of Felipe Carrillo Puerto from 41 to 74%, without increasing the use of resources.

The M/P has set as goal for 2007 a 70% collection rate for urban group 6 (the cities of Felipe Carrillo Puerto and Señor). With the implementation of the project, the collection rate achieved for the same segment of the population was approximately 73%, which shows the level of effectiveness achieved.

Additionally, under the operation of a new collection service, resources have been optimized, increasing the global efficiency of the service.

The project has been effective because it has increased the coverage and quality of the service; wastes are collected daily in the shift and timetables established (aspect that has positively impacted on the quality of life of people by reducing the burning practices and the bad disposition of waste in empty places and streets).

Q.5.3 Impact

The main impact of the application of the model project has been the increment on the coverage of the collection service, achieving the values settled as goal values for year 2007 of the M/P.

It has also had a positive impact on the costs of the service, because the use of resources has been optimized.

Within the community the project has generated a set of positive impacts; maybe the most important one is related to the improvement on the quality of life, because through the collection of wastes in a regular basis, these are not burnt nor thrown in households' backyards and/or streets.

Another positive impact within the community is the formation of management of wastes' culture. The method to manage wastes has changed, now they are stored and placed in front of people's households during the time when the truck collects and inclusively, some people have incorporated the use of small containers, avoiding like this that fact that wastes remain for long periods on the streets and their dispersion by animals. This change in habits is related to changes in the management of final disposal, as was previously mentioned.

Such impacts have been positive as well for the Direction of Municipal Public Services (D.M.P.S.). The design of the collection service and the procedure for its control have had a multiplying effect, firstly because they have motivated technical personnel to get involved in both the design and establishment of goals. This produces a constant supervision on the field and on verifying the adequate use of resources. Adequate supervision of the service has

obliged and motivated personnel of operation to correctly execute their labors, improving the quality of the service. All those elements have resulted in the creation of a culture that gives sustainability to the project within the Direction.

There are also visible positive impacts on personnel, considering that some bad habits have been eliminated and work hours are distributed evenly, which is traduced in a shorter shift for all workers.

The control and development of the service has permitted to have wide knowledge about its characteristics and at the same time to count with the necessary tools to project the costs and requirements of the service, aspect that was previously unknown to the Municipality. Nowadays the municipality is in condition of programming annual costs and of formulating a tariff for charging the cleaning service, which will positively impact in the city council budget.

Q.5.4 Relevance

The increment in the collection coverage and the optimization of resources, constitute a mechanism through which the goals of the M/P will be achieved. Its relevance relies in these aspects.

Q.5.5 Sustainability

The project is going to be sustainable as long as the D.M.P.S. has availability on its vehicles, which is the only weak aspect of the system. The service is designed in an optimum way. Technical personnel are trained for modifying the design and operative personnel develop their functions according to what has been programmed. In relation to this aspect, the Municipality has considered to buy two collection vehicles for this year, in such case, the sustainability of the project is assured.

It is important to mention that all personnel working in the D.M.P.S. as well as other officers that participated in the model project are in fact used to the practices that demands the new collection service. Such practices originated in the first place important changes on their work behavior and what was expected from them. However, as long as some results were visible, their posture changed, modifying their habits, a really important aspect in order to assure the sustainability of the project.

Q.6 Conclusions and recommendations

Q.6.1 Conclusions

The strategy and measures proposed in the M/P are being executed.

Authorities of the municipality have agreed that the adequate management of waste will allow improving the living conditions of the community, reducing gastrointestinal diseases and minimizing negative impacts on the aquatic environment.

The implementation of the model project has generated a management of wastes' culture, both in the community as well as in the D.M.P.S.

With the new system adopted by the D.M.P.S. in order to develop and control the service, the City Council is ready to study a tariff for the service, in order to obtain incomes that are required for carrying out the replacement of equipment and increasing the coverage to other communities.

The adequate design and control of the service has shown to the municipality that this is an efficient mechanism through which the coverage of attention may be increased.

Authorities of the Municipality have understood the need of settling in a short term a kind of fee for the cleaning service. This fee will permit them to maintain the new service and to extend it to other communities.

The community is aware of the importance of the adequate management of wastes and is able to collaborate with activities carried out by the municipality in this subject.

Q.6.2 Recommendations

The objectives formulated in the M/P of Solid Waste Management should be considered as part of the municipality development plans.

It is important to study in a technical way and to enforce on the short term a tariff for charging the service. A proper alternative is to charge on the first place commercial sectors and over generators and later to charge the community. In the later case, the cashing may be associated to the application of a subsidy directed exclusively to the lower income sector.

To approve and to apply in the short term a Regulation for the Rendering of the Public Service of Integral Management of Urban Solid Waste.

To purchase two trucks with compacting bunker and to improve the mechanical status of the current bunker trucks.

To improve the operation of the final disposal place. It is crucial that together with the improvement and increment of the coverage of the collection service, the final disposal place be improved. The current conditions of operation represent a serious risk to the environment and the implementation of the M/P. In this respect, it is recommended that the municipality destines in regular basis equipment for the accommodation of wastes in order to minimize the area contaminated with wastes and the generation of fires. The operation of the dumping site should be directly supervised by the D.M.P.S. who should establish an advancement program for the final disposal of waste.

Annex R

Establishment of Solid Waste Management System in Costa Maya

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R Establishment of Solid Waste Management System in Costa Maya

R.1 Outline

a. Background

In Mexico, the touristic industry is an important economic activity only surpassed by the oil sector. The state of Quintana Roo is one of the main touristic destinies in the country.

The visit of four million tourists to Quintana Roo generates an income of US 4,000 millions, which approximately represents 40% of the total national touristic income. This revenue is vital for the Mexican economy and as such, should be maintained.

In the decade of the 60s the area where Cancun is now located was practically uninhabited. It was in 1970 when the construction of Cancun started and in 1974 was enacted the creation of the Free and Sovereign State of Quintana Roo

Actually, Cancun has over 35,000 hotel rooms and its airport is only surpassed on traffic by the International Airport of Mexico City. Furthermore, it is annually receiving almost three million tourists.

The coastal strip known as Riviera Maya comprises from Puerto Morelos to Tulum and all along the coast are located Punta Bete, Playa del Carmen, Xcaret, Puerto Aventuras, Xpu-Há, Akumal and Xel-Ha. There are approximately 15,000 hotel rooms and the area receives more than 800,000 tourists annually.

Cancun and the Riviera Maya, are both generating simultaneously some economic growth in the state economy whilst at the same time are impacting the environment and natural resources. Such impact may potentially deteriorate resources and consequently make less attractive these important tourist destinations, just like has happened in other places in Mexico.

Costa Maya is located from Punta Herrero to Xcalak and touristic development is considered the way to achieve the economic growth on the south of Quintana Roo.

The Costa Maya development project pretends to promote low impact tourism and tourism of low density with an exclusive destiny. It will be specifically directed to small groups who will visit reserves, beaches, reefs, archeological places and hotels built in harmony with nature. In other words, the tourism development plan pretends to promote sustainable development

The Model Project is oriented to the development of a minimization culture regarding the integral management of solid waste. This is thought to be maintained and to progress altogether with the development of the touristic industry and future human settlements.

These initial steps will conduct to shared responsibility, prevention of the generation, valorization and to the integral management of solid waste foreseen in the new General Law for the Prevention and Integral Management of Waste (Federation's Official Magazine, October 08, 2003).

b. Matrix Design Project

Project Name:	Period:	Version:
Establishment of a new SWM in Costa Maya	Early October 2003 – End July 2004	No.2
Target Area:	**Target Group**	**Date:**
Costa Maya	Personnel of Othon P. Blanco, hotels and residents in Costa Maya	January 2004

Project summary	Indicators	Means of verification	Important assumptions
Overall goal M/P is implemented	Costa Maya has a new SWM service.		M/P was approved by all parts
Project purpose The creation of a minimization culture in the integral management of solid waste, to be maintained and strengthen according to the development of the touristic industry and future human settlements. The main purpose is to Project the aquatic environment.	a. The discharge of solid waste has been reduced; final disposal goes to a manual landfill; the financial situation is sustainable. b. The current and new establishments and urban settlements adjust with SMIRSU.	a. Improvement programme for the current system. b. Basis for the future development of the System of Integral Management of Urban Solid Waste (SMIRSU by its initials in Spanish)	SEDUMA, Othon P. Blanco Municipality, hotels, residents, tourists and generators of containers, all agree and participate in the organization and provision of the SWM system.
Outcomes A. Current system 1. Formation of the organizational structure	1.1 An agreement between all organizations related is already signed 1.2 A special committee is created "Costa Maya Solid Waste Authority" for conduct the implementation of works and the rendering of the services	1. Publication in Diario Oficial del Estado de Quintana Roo.	SEDUMA Othon P. Blanco Municipality, hotels, residents, tourists and generators of containers, all agree and participate in the organization and provision of the SWM system.
2. SW minimization	2.1 The discharge of SW has been reduced in 50%;	2.1 Recycling and Composting programmes.	

Project summary	Indicators	Means of verification	Important assumptions
3. Improvement of final disposal	3.1 The final disposal of SW is carried out in a manual landfill;	3.1 Design and construction of a manual landfill	
4. Sustainability in the service	4.1 The incomes cover the cost of the service.	4.1 The rights for the service are charged according to the tariffs decided by the Municipality.	
B. Future development 5. Protection of the aquatic environment from the impact of solid waste	5.1 Fundaments for the future development of the System of Integral Management of Urban Solid Waste (SMIRSU).	5.1 "Costa Maya touristic Corridor, "POET"; Urban Development Project from Othón P. Blanco Municipality; Forecasts from JICA's Study Team.	
Activities See the table below			Pre-conditions SEDUMA's Secretariat Office and Othon P. Blanco Municipality support the Project.

Operation plan

Activities	Outputs	Period	Inputs by S/T	Inputs by C/P
1. Diagnosis	Diagnosis plan	See Excel table	Collaboration	
2. Implementing the improvements and the monitoring	Implementation record	Ditto	Collaboration	
3. Evaluation	Evaluation report	Ditto	Collaboration	

Input

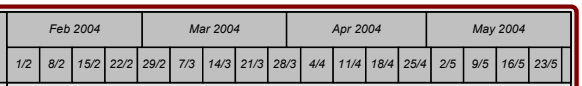
Input	Study Team S/T	Counterpart C/P
Personnel	• Main: ViO • Assistant: Citlalli Suarez • Support: IkM	• Main: One • Assistant: Some • Participants: to be clarified
Material	• Sanitation of the present dumping site and construction of a manual landfill	

Task table

Activities	Tasks
1. Diagnosis	A. Current situation • Population and generation of SW • Minimization and treatment • Storage and discharge • Collection and transportation • Cleaning of beaches • Final disposal • Public information • Financial aspects • Organizational structure • Conclusions and advice B. Vision of future development • Population • Minimization and treatment • Storage and discharge • Collection • Transport and final disposal • Financial aspects • Participation of the public • Institutional framework • Organizational structure
2. Implementing the improvements and monitoring	A. Current situation • Sanitation of the actual dumping site • Community organization • Amount and composition of solid waste • Recycling programme • Composting programme • Programme of public information and environmental education • Improvement of the collection service • Cleaning of beaches • Financial aspects • Institutional framework • Municipal organizational structure
3. Evaluation	3.1 Efficiency In what ways the inputs have become outputs 3.2 Efficiency To verify if the purpose of the Project has been achieved and how much did the inputs contributed 3.3 Impact What positive or negative, direct and indirect effects has had the implementation of the project 3.4 Relevance If the Main Goal and the Purpose of the Project are still important objectives 3.5 Sustainability How long the recipient organizations will be able to maintain the positive effects after the Study Team has left

c. Timetable

ID	Actividad	Inicio	Finalización	Duración
1	a. Remediación del Tiradero	2/9/2004	3/31/2004	38d
2	b. Organización de la Comunidad	2/2/2004	4/30/2004	65d
3	c. Cantidad y Composición de los R.S.	2/2/2004	2/13/2004	10d
4	d. Programa de Reciclaje	2/16/2004	5/31/2004	76d
5	e. Programa de compostaje	2/16/2004	5/31/2004	76d
6	f. Programa de información pública y educación ambiental	2/2/2004	3/31/2004	43d
7	g. Mejoramiento del Servicio de Recolección	2/2/2004	2/27/2004	20d
8	h. Limpieza de Playas	2/2/2004	3/31/2004	43d
9	i. Aspectos Financieros	2/2/2004	4/30/2004	65d
10	j. Marco Institucional	2/16/2004	4/30/2004	55d
11	k. Estructura Organizativa Municipal	2/16/2004	4/30/2004	55d



R.2 Diagnosis

R.2.1 Current system of solid waste management

a. Population and generation of solid waste

In Mahahual, the sources generating solid waste are principally constituted by households, establishments (restaurants and hotels) and tourists that arrive via cruisers.

According to a census carried out in 2000, there were 149 inhabitants living in 47 households.

In the last years the arrival of tourists has increased notably, due mainly to the construction of the harbor for cruisers.

The following table shows the number of tourists that arrive to Mahahual via cruisers.

Table R-1: Tourists with arrival to Mahahual in the last three years

Years	2001	2002	2003
N° of cruisers	37	142	173
N° of tourists	75,401	305,776	371,655

Source: SEDETUR Quintana Roo

Most tourists that reach Mahahual via cruisers are old people who usually stay in the facilities of the harbor where there they participate in cultural and recreational activities. Other tourists

take bus tours offered by the company AVIOMAR and visit places like Bacalar, Chacchoben, Dzibanche and Kohunlich.

Only a minority of young tourists goes to Mahahual and enjoys the sea, takes horse ride activities and consumes food and beverages in the local restaurants, generating a small quantity of solid waste, which is mainly composed of PET and glass bottles, tins, snack bags and leftovers of coconuts.

With the purpose of stating the amount and composition of solid waste, a survey will be carried out during February 2004.

This survey has as main objective to know:

- The generation amount in households, restaurants, hotels, shops, streets and in the facilities of the harbor
- Composition of solid waste oriented to minimization and treatment

b. Minimization and treatment

In 2000 the municipality of Othon P Blanco carried out a programme of solid waste separation with the purpose of protecting the environment and to sensitize the population concerning its proper management. This programme was discontinued due to the lack of interest by the population and support by the municipality.

The only minimization activity is carried out by the Cooperative Society of Tourism "Mahahual Golden", through a recycling programme of aluminum and glass in which all members and restaurant's owners participate.

c. Storage and discharge

In most households waste is disposed in plastic bags that are stored within containers without lids. Such containers are placed in front of the households and are later picked up for its discharge to the collection system.

Most hotels and restaurants discharge their waste in plastic bags and in some cases in "tambos" or containers that are returned to the original place after the waste has been discharged to the collection vehicle.

d. Collection and transportation

The municipality has signed a contract for the service of waste collection and transport with a contractor, who at the same time owns the land used as the current dumping site.

The contract has a biannual validity. The contractor is obliged to collect, transport and finally dispose from Monday to Saturday all waste generated in the urban zone of Mahahual. Furthermore, it is predetermined in the contract that he should keep streets and beaches free of any kind of solid waste.

The contractor uses his own vehicle for collection and transportation, which has capacity of one tone and a trailer of 15 m3.

In practice the collection frequency is three times per week for the residential sector and daily for the commercial sector, excepting Sundays.

The visit of tourists that arrive via cruiser (two or three times per week) causes an increment on the waste generated in restaurants, streets and beaches.

Waste generated in the facilities of the harbour is collected through an additional route that is carried out after the cruiser has sailed.

e. Cleaning of beaches

It is very common the presence of small waste (plastic bottles, aluminum containers, snack bags, etc) in the streets and in the beach. Usually these wastes are picked up by restaurant owners that have placed pieces of furniture in the beach in order to serve their clients. The contractor does not maintain beaches and streets clean of waste.

The areas that are not cleaned by restaurant owners remain dirty.

In order to encourage cleanliness some pedestrian rubbish containers and some advertising in Spanish and English have been placed on the streets.

f. Final disposal

The municipality has temporary leased to Mr. Paulino Ponce a property of 55 has, located in the Km. 9.7 of the road Mahahual- Xcalak. Such land is being used for the final disposal of solid waste generated in Mahahual. Currently, 3 has are being used.

The contractor throws waste in the property without any kind of management; the same method is used by people that eventually dispose their waste in the dumping site.

Certainly, this place may be described as and open sky dumping site, with the consequent impacts to human health and the environment.

Last December 13, 2003, the Municipality of Othon P Blanco used machinery to carry out improvement works in the dumping site. Dispersed solid waste on the property was gathered, compacted and covered with soil.

After the municipal improvement works, the practice of throwing waste continued as usual and it is again visible the dispersion of solid waste in the dumping site.

g. Public Information

Not any relevant activity in the subject of solid waste has been carried out by the municipality after the programme of waste separation, performed in 2000.

Amigos de Sian Ka'an has placed in the community the only environmental signs that promote cleanliness and has also promoted the use of pedestrian containers known as "tambos".

h. Financial aspects

The municipality does not charge for the service of waste collection.

The municipality pays the contractor an amount of six hundred pesos every two weeks due to the service provided. The amount is paid via payroll and 100 pesos are additionally paid daily due to the rent of the vehicle.

By the same token, the municipality has contracted tree persons that help the contractor and they are paid every two weeks via the municipal payroll.

i. Organizational structure

The Department of Municipal Public Services, through the Department of Urban Image, supervises the service rendered by the contractor.

The community of Mahahual does not have any organizations linked to the promotion or support on the management of solid waste. As it was mentioned previously, only the Cooperative Society of Tourism "Dorados de Mahahual" participates with a recycling programme.

j. Conclusions and Recommendations for the current system

Activity	Conclusions	Recommendations
Waste generation	There is not available information regarding the amount and composition of SW in Mahahual	It is proposed the execution of a sample on the amount and composition of solid waste, oriented to know the recuperation level of subproducts.
Minimization and treatment	Minimization only occurs through the programme of recycling carried out by the Cooperative Society of Tourism Dorados de Mahahual. The subproducts that are not picked up by the programme are disposed in the dumping site. Organic waste is thrown without	Considering the importance of minimization, it is necessary to reduce the discharge and dispose only those wastes that cannot be treated nor used again. A programme of separation of materials will be designed and directed to the commercial residential level, which will

Activity	Conclusions	Recommendations
	management in the dumping site.	be oriented to recycling activities. Recycling programme. Organic waste will be treated through a composting process, for its later use as organic fertilizer. Composting programme.
Storage and discharge	Containers without lid make easier the access of vectors to waste, with the consequent danger of food pollution.	The use of containers with lid should be promoted. The recyclable subproducts, previously separated, should be stored in residences and commerce and later be discharged to the collection service in plastic bags of different colors, for the identification of the type of waste contained in them. Non-reusable waste will be discharged to the regular collection service.
Cleaning of beaches	The dirtiness of the beaches owes its aspect to the lack of maintenance and suggests an unhealthy environment to tourists. The contractor is obliged to keep streets and beaches free of waste, aspect that is not observed.	On the basis of an efficient recycling programme and public information, the aspect of the beaches may be improved. The possibility of having the participation of hotel and restaurant owners in the organization of a committee of cleaning of beaches may be analyzed.
Collection and transportation	The frequency stated on the contract is not observed and waste bags remain on the streets, with the consequent dispersion due to the action of animals. Part of the waste coming from establishments is transported in bulk and is dispersed on the way to the dumping site.	There will be two routes per zone of service: collection of recyclables (a weekly route) and regular collection (twice a week). Recyclable subproducts will be transported to the gathering centre and the non-reusable materials to the manual dumping site.
Final disposal	The property is an open sky dumping site; waste will pollute the environment through the production of smoke, odors, gas and lixiviates.	The current dumping site will be sanitized and designed as a manual landfill. The operator of the landfill will gather weekly the volume of the necessary covering material in order to confine waste at the end of the day.
Financial aspects	The result is negative for the interests of the municipality. The costs for the rendering of the service should be covered with the contribution of users through just and equitable tariffs. It is necessary to improve the quality of the service with the purpose of protecting health and the environment whilst promoting a sustainable tourism.	The improvement of the integral management of waste and an efficient and transparent action of public information may achieve a largest contribution to the incomes of the service. All users should pay for the service they receive.
Public information	The public is not properly informed about the relationship among the maintenance of public cleaning and the attraction of tourism.	Minimization of solid waste through recycling and composting programmes, the clearing of beaches and the improvement of the final disposal and

Activity	Conclusions	Recommendations
	Examples like the desertification of some beaches of the country due to the pollution of their coasts must be known and evaluated by the residents of Mahahual.	collection, must necessarily have the support and unconditional participation of residents. A programme of public information will be designed and will include: talks, educative material, cleaning campaigns and people's participation in the planning and development of improvement works and in management of the service's budget.
Organizational structure	Lack of supervision by part of the municipality.	Under the auspice of the Othon P Blanco City Council, a committee of representatives of the users of the service will be conformed by residents, commerce and services. This committee will have as principal function the organization and participation of its representatives in the operation of the SWM service and will act as counterpart of the Municipality. It is recommended to create a special group in the municipal structure in order to follow the development of Costa Maya.

R.2.2 Future development (System of Integral Management of Urban Solid Waste)

Having in consideration the programmes of touristic development and urban development, there are still many uncertainties regarding the timetables and dimensions of the private investors.

Taking into consideration this limitation, the model project has been oriented in its first phase to the establishment of a minimization culture, and in its second phase, to the development of a system of integral management of solid waste that considers the participation of the private sector, just like has happened in the municipalities of Benito Juarez and Solidaridad.

If the minimization culture is adopted now, it can be expected that all projects that are going to be executed and the urban development, that inevitably is going to happen, adopt as well the minimization culture as a requirement for the achievement of sustainable development.

The government policy considers that the development of Costa Maya should be based on low impact tourism, and therefore, the following *Vision* is presented in the regards of the management of solid waste.

- Minimization of solid waste with the purpose of preserving health, protecting the environment and conserving natural resources
- Sustainability on the service of solid waste management through the payment of rights.

- Participation of the private sector.

a. Population

Population growth is closely related to the touristic development of the area; we can take as examples what has happened in Cancun and the Riviera Maya.

The urban development plans are applied rigorously.

b. Minimization and treatment

Separation at the source is both institutionalized and compulsory. The collection of recyclable subproducts is performed by the private sector.

Companies producing water, beverages and liquors assume their responsibility in the management of the containers in which their products are sold.

The production of composts at the residential/commerce levels is generalized.

The municipality uses composts in the construction and maintenance of green areas.

The discharge of solid waste is equivalent to 50% of the generation.

c. Storage and discharge

Recyclable subproducts are stored and discharged separately according to the instructions of the service. Color bags are delivered without costs for the users by the concessionary of the recycling programme.

Non-reusable subproducts are discharged in the regular service.

d. Collection

Each area of service will have two routes: collection of recyclables and regular collection. Frequencies and timetables will be established according to the quality of the service agreed.

e. Transportation and final disposal

The current project for transportation and final disposal is adjusted according to the growth in the demand of the service.

The private sector is in charge of this activity.

f. Financial aspects

All costs are covered by the users of the service through equitable and just tariffs that conduct to sustainability.

The municipality assumes, totally or partially, all the tariffs charged to households of low incomes through personalized incomes.

g. Participation of the public

Through permanent programmes of sensitization and information, it is achieved the maximum participation of the users and the general public regarding the integral management of solid waste.

h. Institutional framework

The regulation for the Management of Solid Waste in Costa Maya is applied with rigor and is updated according to the needs.

i. Organizational structure

The administrative unit for the management of solid waste in Costa Maya acquires a high professional level and carries out its work with great efficiency.

j. Participation of the Private Sector (PPS)

On the basis of the experience on the management of solid waste in Benito Juarez and Solidaridad, and the confirmation of the projects of private investment in the touristic sector, a master plan regarding the integral management of solid waste in Costa Maya is being prepared.

The regulatory framework for the PPS regarding management of solid waste is drawn up and passed. Competence regarding the service of collection and transportation, and another for the treatment and final disposal of solid waste is encouraged with the aim of avoiding monopolies.

R.3 Implementing the improvements in the current system

A programme of improvement works in Mahahual has been conformed and contemplates the establishment of a manual landfill. Also the organization of the community has been considered through the following aspects: the creation of a Committee of Solid Waste in Costa Maya, the determination of the quantity and composition of solid waste, two programmes of minimization with the objective of reducing the discharge of recyclable subproducts and organic material, a programme of public information and environmental education with the purpose of promoting and reinforcing the culture of minimization, the improvement on the collection service, the cleaning of beaches, the reinforcement of the financial aspects, the conformation of an institutional framework, and the organization of an administrative unit for the management of solid waste in the municipality of Othon P Blanco.

The execution of the tasks, established for each one of the objectives, will be monitored during February, March, April and May 2004.

With the execution of these tasks the purpose of the model project is pretended to be achieved, which is launching a culture of minimization in the integral management of solid waste, and that should be maintained and reinforced according to the development of the touristic activity and human settlements in the future and in this way the aquatic environment will be protected.

a. Sanitation of the dumping site

Objective: to protect the aquifer and human health

Result:

- Manual and controlled dumping site

Tasks to be monitored:

i. Design of the manual landfill
ii. Participation of the municipality of Othon P. Blanco in the sanitation and operation of the landfill
iii. Execution of the works
iv. Manual of operations
v. Staff training
vi. Operation of the manual landfill
vii. Supervision of the operations
viii. Calculations of the cost for final disposal

b. Community organization

Objective: to achieve the organized and permanent participation of all actors

Results:

- Committee of Solid Waste in Costa Maya

Tasks to be monitored:

i. Identification of the actors
ii. Elaboration of the constitutive act of the Committee
iii. Presentation to the community of the Project of improvement on the management of solid waste.
iv. Subscription of the constitutive act of the Committee
v. Election of the directive positions of the Committee
vi. Approbation of the working plan of the Committee
vii. Official recognition of the Committee by the City Council of Othon P Blanco

c. Amount and composition of solid waste

Objective: to know the amount and composition of solid waste generated, with the purpose of minimize it.

Results:

- Amount of solid waste generated in residences, restaurants, hotels, shops, streets and in the facilities of the harbour.
- Amount of recyclable subproducts: PET containers, aluminum containers, returnable bottles, paper and cardboard, organic material susceptible to composting.

Tasks to be monitored:

i. Gathering information regarding the number of residents and occupied households, restaurants, hotels, pedestrian tourists and tourists in the facilities of the harbor.
ii. Amount of solid waste generated by each group
iii. Amount of subproducts generated by each group
iv. Analysis of the inventory of purchases and expenses in shops, restaurants, hotels and in the facility of the harbour.

d. Recycling programme

Objective: to reduce the discharge of recyclable products

Results:

- The recycled products are removed from Mahahual in a controlled and permanent way by the organizations contracted.

Tasks to be monitored:

i. Identification of the suitable organizations for the recycling of subproducts

ii. Hiring of selected organizations
iii. Placement and use of pedestrian containers
iv. Supervision of the installation of informative signs
v. Management plan of recyclable products
vi. Cost of a general plan of recycling

e. Composting program

Objective: to reduce the discharge of organic material susceptible to composting

Results:

- Organic material susceptible to be composted is processed and is later used.

Tasks to be monitored:

i. Identification of the proper process of composting to the conditions of the area.
ii. Selection and acquisition of material or equipment
iii. Organization of four demonstrative centers of composting
iv. Utilization of composts
v. Evaluation of the results in order to spread the programme
vi. Cost of a general composting plan

f. Programme of public information and environmental education

Objective: to promote and affirm the culture of minimization

Results:

- The actors adopt the procedures of minimization as part of the routine activities

Tasks to be monitored:

i. Sensitization talks
ii. Workshops
iii. Participation in programmes of integral management of solid waste placing emphasis in minimization
iv. Evaluation of the results

g. Improvement of the collection services

Objective: To keep the locality clean

Results:

- Establishment of a norm of quality in the collection service

- Improvement of the collection service

Tasks to be monitored:

i. Writing of the norm of quality in the service
ii. Approbation of the norm by the municipality of Othon P. Blanco and the Committee
iii. Improvement of the routes, frequencies and timetables
iv. Calculation of the cost of the improved service

h. Cleaning of beaches

Objective: to keep beaches clean

Results:

- Establishment of a norm of cleaning of beaches
- Active participation of the users in the maintenance of clean beaches

Tasks to be monitored:

i. Writing of a norm about the preservation of clean beaches
ii. Approbation of the norm by part of the municipality of Othón P. Blanco and the Committee
iii. Programme of cleaning and supervision
iv. Calculations of the cost of maintenance of cleaning activities

i. Financial aspects

Objective: Financial sustainability in the integral management of solid waste with emphasis in minimization

Results:

- Non-balanced quotation

Tasks to be monitored:

i. Preparation of the plan of total costs
ii. Block of tariffs for the rights on the service of collection, transportation and final disposal
iii. Financing of the general plans of recycling and composting
iv. Preparation of a quotation considering all necessary costs and incomes
v. Presentation of the quotation to the consideration and approval of the municipality of Othon P Blanco and the Committee

j. Institutional framework

Objective: to institutionalize the integral management of solid waste with emphasis in minimization

Results:

- Regulations on the Integral Management of Solid Waste in Costa Maya

Tasks to be monitored:

i. Elaboration of the draft of the regulation
ii. Consideration and approval of the draft by the municipality of Othon P. Blanco and the Committee
iii. Public consultation of the draft of the regulation
iv. Adjusts to the draft of the regulation and approval by the municipality of Othon P. Blanco and the Committee
v. Consideration and approval by part of the City council of Othon P. Blanco
vi. Legal approbation and publication
vii. Begins its validity

k. Municipal organizational structure

Objective: Management and conduction of the integral management of solid waste in Costa Maya

Results:

- Administrative unit in the organizational structure of the municipality of Othon P Blanco with responsibility in the integral management of solid waste in Costa Maya

Tasks to be monitored:

i. Determination of the roles, functions and responsibilities of the administrative unit
ii. Design of the organizational structure
iii. Assignation of staff and equipment
iv. Staff training

R.4 Results

The results of the Model Project are shown in the following table.

Table R-2: Outcomes of the Model Project Establishment of Solid Waste Management System in Costa Maya

Project Summary	Outcomes
Overall goal M/P is implemented	The strategies and measures proposed in the M/P for the establishment of Solid Waste Management System in Costa Maya are being achieved.
Project Purpose The creation of a minimization culture in the integral management of solid waste, to be maintained and strengthened according to the development of the touristic industry and future human settlements. The main purpose is to protect the aquatic environment.	The community of Mahahual is incorporating in the management of solid waste the practice of minimization. The formation of a minimization culture is assured through the approval of an institutional and organizational framework and the participation of the municipal authorities, residents and visitants, educational centers, hotels, restaurants and stores, harbour and the facilities for cruisers. Solid waste is disposed in a manual landfill. The municipality of Othon P. Blanco is incorporating in the revision of the Urban Development Program of Mahahual the recommendations contained in the M/P and it has started the procedures for obtaining funds from FONATUR for the construction of a new landfill in Costa Maya.
Outcomes A. Current system 1. Formation of the organizational structure. 2. Minimization of Solid Waste. 3. Improvement of final disposal 4. Sustainability in the service B. Future development 5. Protection of the aquatic environment	A. Current system 1.1 Creation and municipal acknowledgement of the Commission for the Management of Solid Waste in Mahahual. (CSWM) 1.2 Approval of the Community Regulation for the Collection, Management and Final Disposal of Solid Waste in Mahahual The project of the Regulation for the Rendering of the Public Service of Integral Management of Urban Solid Waste has been given to the Municipal Town Council of Othon P. Blanco for its approval. 1.3 The municipality of Othon P. Blanco is incorporating in the revision of the Mahahual Urban Development Program, the recommendations contained in the M/P. 1.4 The municipality has decided to structure an administrative unit in charge of the development of Costa Maya. 2.1 In the main avenue were installed five stations of waste separation. 2.2 Two composters where donated to a group of restaurants in order to start a program of management of organic waste. The experience did not result positive due to the high content of humidity in the wastes. 2.3 In the Tele High school was constructed a composter in order to receive the waste of restaurants. The experience has been successful. Students plan to install a school orchard using all compost that has been produced. 2.4 Beaches are clean. Visitants make use of the infrastructure of separate discharge. 2.5 ECOCE Company has started its negotiations with the CSWM in order to collect all PET containers. 3.1 A manual landfill has been constructed. The municipality will be in charge of the operation. 3.2 The municipality has started the procedures with FONATUR in order to obtain funds for the construction of a landfill that gives service to all Costa Maya. 3.3 The municipality has started to charge for the services of solid waste management to stores and to the enterprise which owns the cruisers' harbour (Puerto Costa Maya). A rate/fee structure is in preparation, which may assure the financial sustainability of the system. B. Future Development The generation of BOD coming from solid waste will tend to be moderated and manageable and consequently will be the impact over the quality of the aquifer and the aquatic environment.

Project Summary	Outcomes
	Urban growth will be regulated by the Urban Development Program where the recommendations of the Master Plan will be incorporated. The minimization and the correct application of the Regulation for the Rendering of the Pubic Service of Integral Management of Urban Solid Waste will contribute to the effective control of the generation of leachate.

Contributions

Personnel of the S/T

The work team was leaded by Ing. Victor Ojeda who was in charge of the design of the strategy, planning and conduction of the activities. Lic. Citlalli Suarez compiled and analyzed the information from several sources and conducted the opinion survey. Lic. Hiram Diaz directed the construction of the infrastructure and controlled the construction of the manual landfill. Ing. Ikuo Mori reviewed and approved the strategy.

Amigos de Sian Ka'an participated in the works of quantity and composition of solid waste; organization of the community; evaluation of the recycling and composting programs, program of public information and environmental education. Its participation has been very important in achieving the objectives of the project.

Personnel of the C/P

Ing. Héctor Morín has been the officer of the counterpart; reviewed and approved the strategy and plan of activities; he investigated the execution of the infrastructure works and the construction of the manual landfill. The biologist Luis Gonzalo Vidaña conducted the programs of environmental education in the community.

Personnel of the community:

The participation of the community leaded by the Commission for the Management of Solid Waste of Mahahual has made possible that in short time be achieved the objectives of the model project. It can be affirmed that the challenge of establishing a culture of minimization has been taken by the community with seriousness and responsibility.

Infrastructure and materials

The total amount donated by JICA was $250,000 pesos. Five stations of waste separation were constructed and several posters were hanged inviting people to dispose waste: in their place and separately.

A manual landfill was constructed with two trenches of 67.5 m3 each one and also tools and uniforms were delivered to the operators. Didactic material was delivered in educative centers in order to promote minimization.

R.5 Evaluation

a. Efficiency

The S/T called the representatives of diverse organizations in the community in order to introduce them the model project that was pretended to be developed in the community of Mahahual. Several meetings were carried out and the activities foreseen were adjusted to the comments of the participants. The budget of $250,000 pesos was donated by JICA.

It has been possible to assure the creation of an organizational structure at the community level through the creation of the Commission of Management of Solid Waste in Mahahual and the approval of the Community Regulation for the Collection, Management and Final Disposal. The municipality of Othon P Blanco will also have a specialized structure which will direct the urban development of Costa Maya and which necessarily will include the integral management of SW. These advances were achieved thanks to the participation of community and municipal members.

The process of a minimization culture has started with the separation of recyclable materials in the five stations constructed and with the composting of organic waste coming from restaurants. Students from the Tele High School are pioneers in the utilization of composting by starting shortly a school orchard. If this practice is universalized, then it would create a source of jobs and supply of aliments which characterizes organic agriculture.

Final Disposal has been improved through the construction of a manual landfill which has an initial capacity of 125 cubic meters; the discharge of SW to the landfill has reduced substantially.

The three government levels have asked the private sector to participate in the touristic development of Costa Maya with the purpose of strengthen the economic growth of the southern zone of the state. FONATUR, as governing organ at the federal level, is leading all these actions.

The funds provided by JICA have been used efficiently given the importance of the products achieved in the short term.

b. Effectiveness

The purpose of the project has been achieved partly because the practice of minimization started with huge interest of the participants. In the short term this practice will become in a culture that will be part of the community behavior on the protection of its natural resources and its sources of employment.

The results on the development of the model project have motivated FONATUR to finance the new landfill that will serve Costa Maya and which will incorporate two transfer stations. The construction of this landfill will require an important investment at the final stage, assuring in this way the protection of the aquatic environment through the control of leachate discharge (BOD) in the aquifer.

Concerning the development of a minimization culture and the integral management of solid waste, the strategy of the model project showed its effectiveness.

c. Impact

The model project has generated only positive impacts. Both the community and the authorities of the three government levels have agreed in that the implementation of the Master Plan is the alternative for the effective protection of the aquatic environment against the impact of solid waste. A culture of minimization is the base of this strategy given the geological and hydrological conditions of the Yucatan Peninsula.

d. Relevance

Minimization in the discharge of solid waste is associated to diverse aspects of economic and financial nature, social, cultural, environmental, technological and political: lower costs in the collection, transportation and final disposal of waste; reduction of the illness related to the pollution of the aquifer and the consumption of bottled water; protection of the coastal aquatic environment and preservation of the reef system; touristic promotion as a destine of sustainable development; generation of jobs and improvement of the life conditions in the southern zone of the state.

e. Sustainability

Through the General Law for the Prevention and Integral Management of Waste (Official Magazine of the Federation, October 08th, 2003), the areas of responsibility of the three government levels regarding the management of solid waste have been established.

SEMARNAT, SEDUMA and the municipalities have an area of responsibility and action in the management of solid waste in Costa Maya. In the organizational structure of each one of them there is an administrative unit associated to the management of solid waste.

However, the relation of coordination is still weak according to what is stipulated by law and which obliges to a coordinated action.

The implementation of the Master Plan may be a mechanism through which the activities of the organizations may be coordinated, by presenting objectives and specific goals to be achieved.

A system of information and coordination has been structured as a tool through the model project "Establishment of an Integral Waste Management Information System".

If the project "Regulation for the Rendering of the Public Service of Integral Management of Urban Solid Waste" is approved in the next municipal council, the regulatory and organizational framework will be stipulated and the sustainability of the integral management of solid waste in Costa Maya will be assured.

Additionally, the municipality of Othon P. Blanco has taken the commitment of structuring an administrative unit of urban development for Costa Maya, which will include the planning and control of the management of solid waste and will formulate a scheme of fair and equitable fees which permits the financial sustainability of the system.

The participation of the community in the regulation of the services is through the Commission for the Management of Solid Waste in Mahahual and through its "Community Regulation for the Collection, Management and Final Disposal of Solid Waste in Mahahual", both of recent creation and approval.

The sustainable development of Costa Maya should be the goal in order to maintain the touristic attractions which allow a permanent harmonic growth.

Costa Maya has places of unique beauty but with huge ecological fragility. It is crucial to establish, transmit and apply all regulations that protect these natural resources in order to avoid the repetition of negative and expensive experiences that have happened in other zones of the state.

The three government levels should coordinate their efforts within the ambit of their respective competences and assure the sustainability of the development of Costa Maya. By the same token, FONATUR will consider the financing of a new landfill under the base of the document "Executive Project for the Management and Final Disposal of Municipal Solid Waste in Costa Maya, Municipality of Othon P. Blanco", prepared by the College of Geologists of Mexico, A. C. (February 2002).

R.6 Conclusions and Recommendations

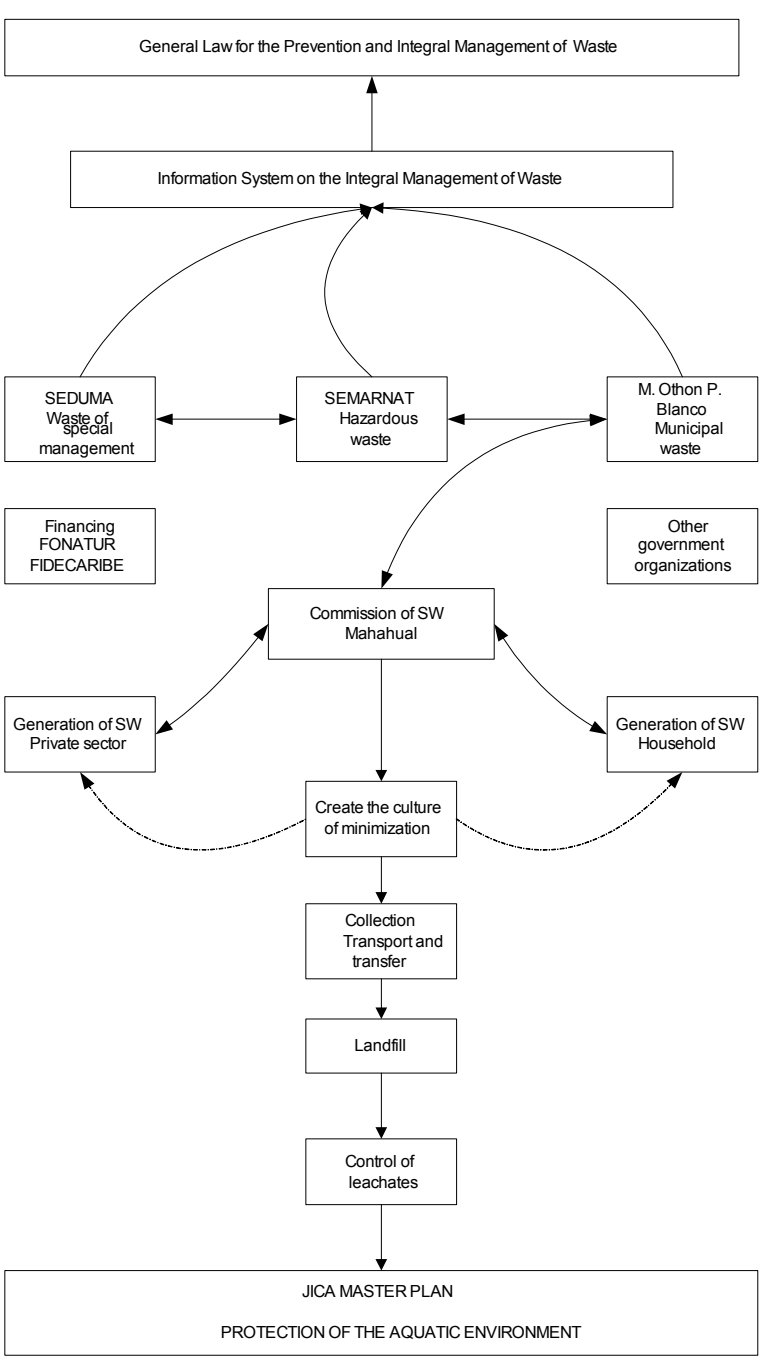
a. Conclusions

- The strategy and the measures proposed in the M/P are being executed.
- The promotion of the touristic development in Costa Maya is a fact; the competent authorities are inviting investors.
- The community of Mahahual is incorporating the practice of minimization in the management of their solid waste.
- The authorities of the three government levels have agreed in that the implementation of the Master Plan is the alternative for the effective protection of the aquatic environment against the impact of solid waste.
- The information and coordination among the three government levels is still weak.

b. Recommendations

- The implementation of the Master Plan must be considered as an objective of the public policies of the three government levels.
- Apply the regulations established in the "General Law for the Prevention and Integral Management of Urban Solid Waste".
- The municipal authorities should consider the approval of the project "Regulation for the Rendering of the Public Service of Integral Management of Urban Solid Waste".
- The municipality of Othon P. Blanco should incorporate the recommendations of the M/P in the revision of the Mahahual Urban Development Program" and structure an administrative unit which assumes the responsibility of the management of solid waste in Costa Maya.
- Officially recognize and support the Commission for the Management of Solid Waste in Mahahual and apply the "Community Regulation for the Collection, Management and Final Disposal of Solid Waste in Mahahual".
- Support the initiative of FONATUR for financing the new landfill and the transfer stations in Costa Maya.
- To require the private sector to participate in the activities of minimization of solid waste by taken as an example ECOCE.
- Structure and apply equitable and fair fees that permit to assist the cost of the rendering of the service of solid waste management.

FLOWCHART OF INFORMATION, COORDINATION AND OPERATION



With the approval of the new Regulation the General Law will be achieved

Each government level has set its sphere of competence. The municipality responds to the rendering of the service in coordination with the Commission of SW

Other organizations support the development and the rendering of the service

The Commission integrated by residents and managers of the Service start the establishment of a culture to minimze SW

Both the discharge and the operation costs are reduced
Fees are more fair and equitable

FONATUR considers the financing of the new andfill and the transfer stations.
With the general profit in efficiency it may be assured a final disposal that meets the regulations

The objectives of the Master Plan are achieved and the aquatic environment is protected


Main Avenue


Manual Landfill
Note the quality of the ground


Manual Landfill
Filled Trench


Station of Waste Separation


Composter in the Tele High School


Separated Material in the Tele High School


New Construction for the gathering of separated material


Collection Equipment


Waste Generated in the Cruiser Harbor

Figure R-1: Pictures of the Model Project

Annex S

Environmental Education and Recycling Activities

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S Environmental Education and Recycling Activities

S.1 Outline

a. Background

a.1 Conditions at national level

In Mexico, several associations are engaged in recycling activities. These associations are working in coordination with the state governments and/or at own initiative. Several companies are purchasing material considered as waste for use like alternative fuel, collecting for the later sale, melting and processing the material to use again in the original form.

According to the Federal Government, the protection of the environment is being promoted through the "National Crusade for a Clean Mexico", which contains four main components:

- A national campaign for diffusion, communication and topics on environmental education.
- Preparation of the first National Program for the *Integral Management of Municipal, Industrial and Hazardous Waste* which will allow to unite and coordinate efforts of the three government levels and different sectors of the society.
- Development and support for the construction of infrastructure and equipment, which allow to minimize, collect, transport, treat, recycle and dispose in sure form the solid waste in the whole country; and finally,
- Development of a regulatory frame and of promotion instruments which strengthens the institutional capacities in the three government levels, to promote the active participation of the society and the industry.

a.2 Conditions at state level

At the state level, there is a Law of Ecological Balance and Environmental Protection of the State of Quintana Roo, which includes several articles related to the solid waste management and recycling. A series of actions are listed below:

- To carry out actions toward waste reduction, reuse and recycling of domestic and non hazardous industrial waste.
- To prepare and propose programs for social participation, which contribute to delegate people responsibilities for conservation and improvement of the environment.

- To promote and spread informative material regarding environmental problems, the suitable method to mitigate them and solve them, as well as methods to taking advantage of the natural resources, using the different means of local media, promoting a new ecological culture in the citizens of the State.
- To promote, diffuse and coordinate programs of formal and non formal environmental education that are given in the State.

Regarding the above, there are many institutions which are working with environmental education programs. However, there is no coordination among them; therefore, the environmental education does not take the diffusion and practical dimensions focused to the problem of an appropriate solid waste and wastewater management. Recycling activities are not promoted at governments' level (state and municipal). This activity is mainly practiced informally by the private sector.

a.3 Study Area

Othón P. Blanco (Chetumal)

With the objective to know the solid waste recycling activities conditions at the municipal level, a survey was conducted in Othon P. Blanco. The result was discouraging, since, only one company in Chetumal city, collects and uses directly recyclable materials for processing. This company is processing paper and cardboard to manufacture roofing sheets.

The material which can be recycled is only bought by storing centers (most of them intermediary companies). Few people are dedicated to promote the advantages of recycling. This activity is limited to low income people that do not have other way to obtain economic revenues and by personnel of Municipal Public Services Office which through this activity can collect extra money at the same time that they perform their duties.

At the beginning of October 2003, ECOCE (Ecology and Managerial Commitment), company created by a group of beverages companies with the purpose of recovering and recycling PET bottles, began to receive this material in the city of Cancun, starting the recovery of these PET bottles in the final disposal site.

Costa Maya

In Mahahual, a waste separation program was carried out by the Department of Urban Development and Ecology in 2000. The main objective was to raise public and tourist awareness of the importance of caring for the environment and using natural resources in a sustainable manner. The program emphasized on appropriate waste management. Containers of five different colors were set up to dispose paper, glass, metals, plastic and organic waste

separately. At the beginning, the results were positive, but the lack of practices, interest and financing support caused the fall of the program.

The "Cooperativa Pesquera Dorados" (Dorados Fishing Cooperative) of Mahahual is one of the only organizations in Costa Maya which separates waste, like cans and bottles, and transports them to storing centers in Chetumal city for sale.

Felipe Carrillo Puerto

There are no recycling programs at municipality level. However, some people collect domestic waste and carry out waste separation, separating especially aluminum cans and copper material. The city of Felipe Carrillo Puerto has storing centers that buy metals, which are transported to an iron and steel industry in Merida city and to other storing centers located in central zones of the country.

Solidaridad

One of the most recent actions implemented in Playa del Carmen to promote recycling activities, it began with the placement of different containers for waste in the 5th Avenue. In addition, some containers for recycling together with an environmental education program were implemented in schools. This program was initiated by a private company (Publimedia) as a pilot program.

A program to recover a large part of recyclable materials in the tourist corridor of Tulum is being carried out. This campaign is called "waste for food" and it is promoted by the municipality; its main objective is to raise public participation in exchange of 1 kilogram of food per 5 kilograms of recyclable materials that people deliver to the municipal waste collectors.

In Xel-Ha, an ecology park managed by a private company, is carrying out a solid waste management program with the objective of promoting reuse and recycling of waste that are generated in the park, which are taken to a storing center. The organic waste is used for compost production. Other recyclable waste as glass, hard plastic, aluminum cans, paper and cardboard are taken to other storing centers, and transported to other Mexican states for recycling.

b. Project Design Matrix

Table S-1: Project Design Matrix

Project Name: Environmental Education and Recycling Activities	Period: October 2003 – July 2004	Version: No.2
Target Area: Study Area	Target Group Personnel of SEDUMA, CAPA, Municipalities of Othon P. Blanco, Felipe C. Puerto and Solidaridad Teachers and students of the above municipalities	Date: October 2003 ~ June 2004

Project summary	Indicators	Means of verification	Important assumptions
Overall goal 1. Formulation and implementation of an M/P. 2. Waste minimization through recycling 3. Conservation of resources	Knowledge and interest about aspects on SWM and recycling among students and residents are increased.		
Project purpose 1. Children who will be major players of the next generation are acquainted with importance of recycling and resource conservation. 2. The Model Project becomes and origin of resource conservation trough recycling activities.	1. Environmental activities in schools, analysis and evaluation. 2. Environmental education program planned and continued by the C-P.	1. Report of this Study 2. Program and follow-up by C/P team	● Revision of the M/P based on the results of the Model Project ● C/P established an Executing Unit to expand this model project to other schools and communities in the coast of QR ● Schools and communities understand the necessity of resource conservation and the importance of recycling activities.
Outcomes 1. Communication between concerned institutions within federal, state and municipal territory for environmental education activities is improved. 2. Target children acquire knowledge of resource conservation 3. Target children learn how to contribute resource conservation through specific actions 4. A recycling system centering on schools is established.	1. Federal, State and Municipal institutions will jointly work with other related organizations. 2. A large number of schoolchildren understand the benefits of resource conservation. 3. A large number of schoolchildren understand the proper concept of recycling. 4. A large number of schools undertakes or are encouraged to continue recycling activities.	1. Future programs of environmental education. 2. Evaluation results.	● The Executing Unit will assure the continuation of the program
Activities See table below	Input Human resources ● Member of S/T ● Members of C/P ● NGO		The Executing Unit through SEDUMA commits to carrying out the environmental education model project.
	Materials ● Education guide ● Education panels ● Education video ● Póster, leaflets, others.		Pre-conditions JICA and the C/P side agree to conduct the Model Project.

Operation Plan

Activities	Outputs	Period	Inputs by C/P	Input by S/T
1. Planning	Plan	Refer to Task Table		●
2. Preparation		Ditto	●	●
a) Preparation of education materials	Education material	Ditto	●	●
b) Coordination with schools	Meeting with teachers	Ditto	●	Support
c) Coordination with recycling companies	Meeting with the private sector	Ditto	●	Support
d) Coordination with NGO	Meeting with NGO	Ditto		●
3. Implementation of the plan	Implementation record	Ditto	●	Support
4. Drawing up a manual (draft)	Manual (draft)	Ditto	●	Support
5. Monitoring	Monitoring record	Ditto	●	●
6. Evaluation	Evaluation report	Ditto	●	●
7. Revision of manual (if necessary)	Compiling and printing	Ditto	●	●

Input Table

Input	Study Team	Counterpart
Personnel	• Main: MaK • Assistant: MAB • Support: ViO	Executing Unit integrated by C/P team of SEDUMA, OPB, FCP and CAPA.
Material	• Education material • Manual (draft) • Manual (final)	

Task Table

Activities	Tasks
1. Planning	Environmental education program
2. Preparation	
a) Environmental education tools	Preparation of education materials and complementary tools (draft): ● Selection of campaign mascot ● Education panels ● Póster, leaflets, etc.
	● Production of education video (Production of an educational video of about 12-15 minutes for the school community related to the SWM, wastewater and the coastal environment in general)
b) Coordination with schools	● Coordination with the Ministry of Education. ● Coordination with one or two schools by model project area. ● Student participation for writing of essays and making of illustrations on aspects of SWM, resources conservation and preservation of the aquatic environment.
c) Coordination with recycling companies	● Coordination with several recycling companies and the municipalities to implement recycling activities.
d) Coordination with NGOs	Coordination with NGO to promote environmental education, follow-up and monitoring of model project.
3. Implementation of the plan	● Training of teachers through workshops. ● Meetings and mini-workshops with the communities. ● Experimental class in schools ● Recycling activities in the private sector (tentative). ● Complementary and supporting activities (environmental days, cleansing activities, etc.)
4. Drawing up a manual (draft)	Preparation of educational manual for the school community and residents.
5. Monitoring	Visits to model project sites

6. Evaluation	Analysis and evaluation of environmental education activities.
7. Revision of manual (if necessary)	Compiling and printing

Actividades

1.	Promotion of environmental education program.
2.	Formulation of a training program for C/P personnel.
3.	Formulation of a training program for teachers.
4.	Preparation of training instruments and complementary materials.
5.	Meetings with school principals and teachers.
6.	Implementation of experimental classes.
7.	Commencement of recycling activities.

c. Work Schedule

Table S-1: Work Schedule for the Model Project of Environmental Education and Recycling Activities

Period	Activities
October~December (2003)	Preparation Stage • Selection of model project mascot • Student participation on essay writing and illustration making contest
January (2004)	Preparation • Selection of schools for the model project • Preliminary meetings with school principals/teachers of areas selected for the model project.
January~February (2004)	Activity Planning Stage • Meetings with C/P • Program for C/P training workshop • Program for teachers training workshop • Program for experimental lessons in schools • Preparation of evaluation format
February (2004)	Implementation of Model Project • Workshop for C/P training • Meeting with teachers • Workshop for teacher training
February (2004)	Implementation • Experimental classes in schools - Comodoro Manuel Azueta Elementary School (Chetumal) - Patria Elementary School (Chetumal) - Don Felipe Carrillo Puerto Elementary School (Felipe Carrillo Puerto)
March (2004)	Implementation of experimental classes in other schools by the C/P team and workshop for teachers - J. Jesús Cetina Salazar Elementary School (Chetumal) (1st week) - Lic. Andrés Quintana Roo Elementary School (Chetumal) (2nd week) - Vicente Kau Chan Elementary School (Mahahual) (end of March) - Workshop for teachers (3rd week)
April ~ June (2004)	Implementation of workshops for teachers in other schools and experimental classes (by the C/P team) • 5 elementary schools of Chetumal (Melchor Ocampo, Nicolás Bravo, Fernando Figueroa Guardia, Forjadores de Quintana Roo, Telesecundaria Justo Sierra Mendez) • 4 elementary schools of Felipe Carrillo Puerto (Tiburcio May Uh, Jacinto Canek, Benito Juarez, Orlando Martínez Debeza) • Other schools of the municipalities of Othón P. Blanco, Felipe Carrillo Puerto and Solidaridad.
March~June (2004)	Monitoring and Evaluation • Monitoring by C/P • Evalution by S/T • Site visit to model project areas (tentative)

S.2 Diagnosis

Recycling of materials separated from the solid waste flow, is sustainable when there is market of those materials. In the state, there are motivations and knowledge on the benefit that the recycling brings toward the environment. However, practices of recycling activities are few at the state and municipal level.

This is mainly for two reasons: a) existence of few companies that process recyclable materials; b) lack of implementation of separate collection by the municipality and solid waste separation at source.

Among few enterprises devoted to recycling activities can be mentioned ECOCE, located in the north part of Quintana Roo and a cardboard sheet manufacturer located in Chetumal, which buy PET bottles and paper/cardboard materials respectively.

Nowadays, no recycling program is auto-financial at municipal level. Few recycling activities are subsidized by the taxpayers or subscribers to some services of local waste haulage companies. Collection type, length of the collection routes, topography, transport system and the separation grade or required classification, they show a great influence on the costs of the program.

After analysis of the composition of domestic solid waste, where 15% of generated waste consist of paper and cardboard, and considering the existence of one cardboard sheet manufacturer and some paper and other material storing centers in the city of Chetumal that would receive newspapers, it was decided to begin a paper recycling program at elementary schools called "Hagamos un buen papel" ("Lets make a good role (paper)").

The C/P team of SEDUMA, CAPA, the municipalities of Othon P. Blanco and Felipe Carrillo Puerto with the support of related institutions will have the responsibility of giving the continuation to the recycling activity program to be begun in the elementary schools, to continue the workshops for teachers and later on to develop the experimental classes in all the participant schools of the environmental education and the recycling activity program.

This model project of environmental education was designed considering the possibility to verify if the developed activities were appropriate and/or convenient, and the results will be reflected in the M/P. The model project of environmental education and recycling activities was formulated jointly by the C/P and the S/T, with the commitment by the C/P to continue and follow the implementation of workshops for teachers and later development of experimental classes in elementary schools with the purpose of multiplying the habits guided

toward the minimization of solid waste and paper recycling as the first step and then to continue with a global recycling at the municipality level..

In the following Table model project activities are described:

Table S-2: Activity Plan for Model Project

No	Item	Activity	Remarks	Respon-sibility
1	Tools for environmental education	• Design of mascot • Preparation of education booklet, education panels, poster, leaflets,	Design by the C/P and the S/T. Production and materials provided by the S/T	C/P S/T
		• Production of educational video	Planning by the C/P and the S/T. Production of video by the S/T	C/P S/T
2	Student participation	• Making of essays and illustrations by students.	Participation of 17 schools of the Study Area selected by the C/P. Production of materials by S/T	C/P, with the support of S/T
3	Environmental Education program	• Training to C/P through workshops	Organized and implemented by the S/T	S/T
		• Training to teachers through workshops	Organized and implemented by the C/P with the support of the S/T	C/P S/T
	Training	• Experimental lessons developed by teachers	Organized and implemented by schools with the support of the C/P and the S/T.	C/P S/T
4	Meetings	• Meeting with community leaders and residents.	Conducted by C/P with the support of the S/T.	C/P S/T
5	Visit to model project sites (tentative)	• Visit and impressions of model project areas.	Participation of institutions, residents, teachers, students, journalists, municipality staff, etc.	C/P
6	Monitoring	Monitoring of schools engaged on paper recycling activities.	By the C/P (Executing Unit of SEDUMA, CAPA, OPB, FCP, etc.	C/P
7	Evaluation	Evaluation of model project	To be evaluated on June 2004	S/T

S.3 Implementation

The implementation plan for the model project of environmental education was formulated jointly by the C/P and the S/T.

The model project was carried out over a period of approximately one month, from end of January to end of February, 2004, followed by monitoring of paper recycling program, continuation of other workshops and experimental classes in school of the Study Area.

Two workshops were carried out in the model project, essentially to transmit ideas, knowledge and abilities regarding environmental education related to solid waste and wastewater management. The main policy of carrying out the workshops was the taking of a participative approach where the participants share their knowledge and experiences among them, being themselves the lecturers and audience to feel as the owners of the project. A great importance was given to "facilitators" and teachers training, since appropriate behaviors reinforce the sustainability. The workshops were carried out according to the following steps:

Step	Facilitator	Receive training
1	Study Team (S/T)	Counterpart (C/P)
2	C/P	Teachers
3	Teachers	Students Other teachers Parents

At the beginning of March 2004, after the implementation of workshops and experimental classes, a paper recycling program began through Comodoro Manuel Azueta and Patria schools.

Previous to the commencement of the program, a contact was made with a cardboard sheets company which requires papers and cardboard for the production of roofing sheets. Between the company and the school principal a letter of commitment was exchanged, where the first one committed to collect periodically newspapers from the school and the school to bring newspapers to the school with the support of the students.

The newspaper gathered by the schoolchildren should be collected periodically. The activities will be periodically monitored by C/P team composed of SEDUMA, the municipality of Othon P. Blanco and CAPA's staff.

Work schedule and activities of the Environmental Education Model Project, developed jointly by the S/T and C/P team during January and February of 2004, and the activities developed by the C/P from March to June of 2004 are shown below:

Table S-3: Work Schedule (January~June 2004) for Environmental Education Model Project

No.	School	Place	Activity	Implementation	Agreement	Remarks
				Date	Date	
	Workshop for the C/P	Chetumal	Workshop	30 January	—	Hotel Pricipe
	1st. Workshop for Teachers	Chetumal	Workshop	11 February	—	Hotel Principe
1	Comodoro Manuel Azueta	Chetumal	Experimental class	18 February	24 February	Cardboard Sheet factory Chetumal
2	Patria	Chetumal	Experimental class	20 February	24 February	Cardboard Sheet factory Chetumal
3	Don Felipe Carrillo Puerto	Chetumal	Experimental class	26 February	—	
4	Lic. Andrés Quintana Roo	Chetumal	Experimental class	16 March	16 March	Metales y Fierros del Sureste
5	J. Jesús Cetina Salazar	Chetumal	Experimental class	17 March	17 March	Metales y Fierros del Sureste
6	Vicente Kau Chan	Mahahual	Experimental class	30 March		
	2nd. Workshop for Teachers	Chetumal	Workshop	26 March	—	Establishment of CAPA
7	Nicolas Bravo	Subt. Lopez	Experimental class	27 April	—	
8	Fernando Figueroa Guardia	Chetumal	Experimental class	28 April	Agreement	
9	Melchor Ocampo	Chetumal	Experimental class	4 May		
10	Melchor Ocampo	Chetumal	Experimental class	6 May		
11	Forjadores de Quintana Roo	Chetumal	Experimental class	11 May		
12	Telesecundaria J. Sierra Méndez	Subt. Lopez	Experimental class	—		
	3rd. Workshop for Teachers	Chetumal	Workshop	21 May	—	
13	Tiburcio May Uh	FCP	Experimental class	27 May		
14	Jacinto Canek	FCP	Experimental class	28 May		
15	Benito Juarez (morning shift)	FCP	Experimental class	1 June		
16	Orlando Martínez Debeza	FCP	Experimental class	2 June		
17	Benito Juarez (afternoon Shift)	FCP	Experimental class	3 June		
18	Moisés Saez	FCP	Experimental class	7 June		
	4th. Workshop for Teachers		Workshop	10 June	—	
	Otras actividades	Xcalak	Environmental education	21 April		By the C/P

S.4 Results

S.4.1 Summary of Results

Summary of the Project	Results
Global goal Environmental education and recycling activities are implemented.	1. The strategy and the measures proposed in the M/P for environmental education and recycling activities are on-going. 2. Increase of knowledge and interest on SWM aspects and recycling among students.
Purpose of the Project 1. The children that will be the main actors of the next generation take knowledge of the importance of the recycling and the conservation of resources. 2. The model project gives origin to the conservation of resources through recycling and protect the aquatic environment.	1. Activities in schools a. Workshops on SWM and wastewater for teachers were carried out in the Study Area. b. Following the workshops imparted to teachers, they carried out experimental classes in schools with students of higher grades. 2. other activities related to environmental education program
Products 1. Communication improvement for environmental education activities between related institutions within the state and municipality sphere. 2. A recycling system focused to schools was established.	1. Formation of an Executing Unit integrated by SEDUMA, OPB and CAPA personnel, and the commitment of this Unit to follow the environmental education model project and the recycling activities. 2. The personnel of C/P (OPB, FCP, CAPA and SEDUMA) were trained in environmental education through work sessions and workshops. 3. Trained personnel of C/P in turn, trained elementary school teachers to carry out experimental classes with students of higher grades. 2. Implementation of experimental classes on environmental education in schools. 4. Implementation of recycling activities in elementary schools. 5. Participation of the private sector (recycling company) for paper recycling activities. 6. Commitment of the Executing Unit for follow-up of the model project of environmental education and recycling activities at state level.

Contributions

The working team for environmental education program was led by Mr. Masaharu Kina of JICA Study Team with the assistance of Maria Antonieta Bocanegra. The environmental education program and education materials (educational booklet on solid waste and wastewater management, booklet with compositions and illustrations by students, educational video, educational panels, poster and leaflets) were planned and designed entirely with the joint participation of the C/P Team integrated by Mr. Jose Mcliberty and its staff (SEDUMA), Mr. Gonzalo Vidana and its staff (OPB) and Mr. Jorge Jimenez and its staff (CAPA).

Amigos del Sian Ka'an (ONG) participated in the implementation of workshops and environmental education activities. The participation of Amigos del Sian Ka'an has been important in order to reach the objectives of the model project of environmental education.

JICA finances the production of the following education materials

1) Poster (1,000 units)
2) Education panels (10 units)
3) Educational booklet (1,000 copies)
4) Booklet with students works (1,000 copies)
5) Leaflets (1,000 units)
6) Education video 1 lot (30 copies)

All editorial materials and video used in environmental education activities (workshops, experimental classes and other related activities) were received with great acceptance by the recipient group.

It is necessary to mention that the educational video was transmitted by a state television channel (Channel 7 MAS) during several days in educational and children programs.

S.4.2 Results of workshops and experimental class implemented in the first phase

a. Training Workshop for the Counterpart by the S/T

Participants of the training workshop carried out by the S/T included 15 persons from the Secretariat of Urban Development and Environment (SEDUMA), the Department of Ecology of the Municipality of Othón P. Blanco and Commission of Potable Water and Sewerage (CAPA). All the participants were extremely motivated during the whole course of the workshop, indicating their interest in sharing knowledge and learning to improve their skills at the institutional level, and in their professional and personal lives. Participants actively took part in all workshop activities, making the participatory approach of sharing knowledge and experiences. Both the C/P and S/T showed complete and absolute satisfaction with the results of this workshop.

b. Training Workshop for Teachers and Invited Personnel by the C/P

The training workshop for teachers was organized by the C/P team. 19 teachers of the following elementary schools participated in workshop: Comodoro Manuel Azueta, Patria, J. Jesús Cetina Salazar, and Lic. Andrés Quintana Roo located in the city of Chetumal, Don Felipe Carrillo Puerto (morning and afternoon shifts) of Felipe Carrillo Puerto and Vicente Kau Chan of Mahahual community. The participants were very enthusiastic from the beginning, due to the interactive program and other approaches used by the C/P facilitators, who were well prepared for their respective roles.

The results obtained in this workshop were very satisfactory and greatly accepted by the participant side. The teachers recognized the efforts of the C/P facilitators and the S/T, a fact that can be appreciated in the evaluation results and in their commitment in the framework of this model project for environmental education.

It is of great importance to follow-up on the commitment acquired by the C/P by enforcing the pilot program for environmental education in the three participant schools and in the rest

of the schools of the capital district. The program should apply the same methodology used, that is to say, making multiplier agents (teachers), so that these teachers in turn transfer the knowledge to the rest of the teachers and students.

c. Experimental Classes or Trial Lessons

After the training to the teachers, continuity was given to the program activities as scheduled with the preparation, by school teachers, of experimental classes or trial lessons at Comodoro Manuel Azueta, Patria and Don Felipe Carrillo Puerto (morning and noon shifts) schools.

Each school, with the support of the C/P and the S/T, planned an activity program with students, especially of 5th and 6th grades. In Patria school also children of the first grades participated in the experimental class.

It can be mention that, in all schools, parents participated jointly with the students in the development of the experimental class.

Teachers and students participation were excellent in the three schools. In the three cases, teachers used participatory techniques that involved the students and parents. Some of these techniques were round-table discussions, a waste classification workshop, manual activities, etc. The program in every participating school was conducted by the students themselves. In Comodoro Manuel Azueta School, a mother participated in the round-table discussion conducted by the students. In Patria School,

the mother showed the same enthusiasm as the students during the activity of recycled paper making.

The teacher staff of the three schools demonstrated a great enthusiasm and interest in the development and execution of the experimental classes, raising equally the interest in the students and motivating them to be an essential part in the changes required to improve SWM in the community.

The participation of schoolteachers in the three trial lesson programs allowed them to share methodologies and techniques that enriched their methodological tools. This undoubtedly will contribute to the transferring and sharing of knowledge beginning with the experimental class. However, to be more effective, trained teachers should continue the program with the rest of the students and administrative personnel of the school. Parents can also be incorporated in the program, since SW issues and environmental conservation should be approached from the first teaching years.

Following the activities of environmental education, after the finalization of the experimental classes, a paper recycling program was started with the participation of schools and private companies. Up today, the Comodoro Azueta and Patria schools collected approximately 1,460 Kg and 960 Kg respectively , during the period of April to June of 2004. Cetina Salazar, Andres Quintana Roo and Forjadores de Quintana Roo schools are also participating actively in the paper that recycling program.

S.4.3 Follow-up and monitoring of Model Project of Environmental Education and Recycling Activities

Activities, follow-up and monitoring made by the C/P team are shown below

Activities, follow-up and monitoring made by the C/P team are shown below

Date	Munic.	Description	Remarks
March 16	Othón P. Blanco	*Lic. Andrés Quintana Roo. elementary school* Implementation of experimental class "I really want my environment clean"	Organized by: SEDUMA, Municipality of OPB and CAPA Site: Andrés Quintana Roo elementary school Time: 8:30 to 14:10 65 students from the third, fourth and fifth grade and 14 parents and 8 teachers were involved in the activities. An agreement was signed between Metales y Fierros de Sureste and the school's principal Mr. Juan de la Cruz Vela Acosta. Through this agreement, the company is engaged to recover every Friday, newspapers that students of the fourth and fifth grade bring to the school

March 17	Othón P. Blanco	*J. Jesús Cetina Salazar. elementary school* Implementation of experimental class "I really want my environment clean"	Organized by: SEDUMA, Municipality of OPB and CAPA Site: J. Jesús Cetina Salazar elementary school Time: from 8:30 to 11:10 83 students from the fifth and sixth grade plus 16 relatives and 11 teachers were involved during the development of the activities. An agreement was sign between the company Metales y Fierros de; Sureste and the school's principal professor Tiburcio Pat A, through this agreement, the company is engaged to recover one day a week the news paper gathered by the students at the school facilities.
March 19	Othón P. Blanco	Opening ceremony of "Space for Water Culture	Organized by: CAPA. Place: Payo Obispo zoo facilities Time: 13:30 to 14:30 As a part of the activities, the OPB mayor, deliver educational material prepared by the C/P and S/T to students of Melchor Ocampo elementary school. 
March 26	Othón P. Blanco	Implementation of the 2nd. workshop for teachers "lets make a good paper"	Organized by: SEDUMA, Municipality of OPB and CAPA Place: CAPA facilities Time: 8:00 to 17:00  21 teachers attended the workshop from the following schools: 1. Nicolás Bravo elementary school 2. Melchor Ocampo elementary school (morning shift) 3. Melchor Ocampo elementary school (evening shift) 4. Forjadores de Quintana Roo elementary school 6. Fernando Figueroa Guardia elementary school

March 30	Othón P. Blanco	Mahahual Telesecundaria school Implementation of experimental class "I really want my environment clean"	Organized by: SEDUMA, Municipality of OPB and CAPA Participant: Ministry of Tourism Cooperating agency: Amigos del Sian Ka'an Place: Mahahual Telesecundaria school The experimental class was carried out at Mahahual community, it last for two days and 27 students from Kau Chan elementary school and Telesecundaria school participated in the activities.
March 31	Othón P. Blanco	Implementation of Environmental Education activities in Mahahual	Organized by: Amigos del Sian Ka'an Amigos del Sian Ka'an (NGO) coordinated a series of environmental education activities such as theater representation and film projection.
April 1	Othón P. Blanco	Beach cleansing activity	Organized by: SEMARNAT, Municipality de OPB, SEDUMA and CAPA Cooperating agency: Amigos de Sian Ka'an. Invited institution: SEDETUR The experimental classes in Mahahual culminated with a beach cleansing activity, where 27 students of the elementary school and telesecundaria participated in the event.
April 27	Othón P. Blanco	*Nicolás Bravo elementary school* Implementation of experimental class "I really want my environment clean"	Organized by: SEDUMA, Municipality of OPB and CAPA Time: 8:00 to 14:00 Place: Nicolás Bravo elementary school The workshop count with the participation of 24 students from the fifth and sixth grade, 4 teachers and 6 parents.
April 28	Othón P. Blanco	*Fernando Figueroa Guardia elementary school* Implementation of experimental class "I really want my environment clean".	Organized by: SEDUMA, Municipality of OPB and CAPA Place: Fernando Figueroa Guardia elementary school Time: 8:00 to16:00 The C/P invited the school authorities to join the paper recycling activity; however, the school was not interested to assume responsibility for the recycling program.
April 28	Othón P. Blanco	*Visit to schools which participated in paper recycling activity*	The enthusiastic participation of Comodoro Manuel Azueta school caused that students overpass the amount of collected paper in other schools. However, due to the lack of an appropriate storing of the collected paper, the school principal instructed to the students to collect paper only once a week.
			The participation of Patria elementary school has been constant, although the amount of paper gathered has been small quantity.
			In Andrés Quintana Roo elementary school, the school principal was committed to impulse the recycling program in coordination with teachers. However, there is a lack of organization and commitment among the teachers.

			In Jesús Cetina Salazar elementary school was observed lack of diffusion and promotion to the program. So far nothing has been gathered.
May 3	Othón P. Blanco	*Visits to schools of Felipe Carrillo Puerto.*	Visits to schools in FCP were carried out in order to invite them to participate in the 3rd. workshop on environmental education for teachers: 1. Jacinto Canek (morning shift) 2. Benito Juárez (morning shift) 3. Benito Juárez (afternoon shift) 4. Tiburcio May Uh 5. Orlando Martínez Debeza 6. Moisés Sáenz
May 4	Othón P. Blanco	*Melchor Ocampo elementary school (afternoon shift).* Implementation of experimental class "I really want my environment clean"	Organized by: SEDUMA, Municipality of OPB and CAPA Place: Melchor Ocampo elementary school (afternoon shift) Time: 14:00 to 17:00
May 6	Othón P. Blanco	*Melchor Ocampo elementary school (morning shift)* Implementation of experimental class "I really want my environment clean"	Organized by: SEDUMA, Municipality of OPB and CAPA Due to the lack of motivation and interest from the school authorities there was lack of coordination and preparation for the experimental class.
May 11	Othón P. Blanco	*Forjadores de Quintana Roo elementary school* Implementation of experimental class "I really want my environment clean"	Organized by: SEDUMA, Municipality of OPB and CAPA Place: Forjadores de Quintana Roo elementary school Time: 7:30 to 12:00 The participation of both students and teachers was very enthusiastic. The school principal signed an agreement with a recycling company (Metales y Fierros del Sureste) where both parts were committed to collect and gather the newspaper once a week.
May 21	Felipe Carrillo Puerto	Implementation of the 3rd. workshop for teachers "lets make a good paper" in Felipe Carrillo Puerto	Organized by: SEDUMA, CAPA, Municipality of FCP and Municipality of OPB Invited institution: Shool Supervision Office 6 Time: 8:30 to 3:00 Place: Municipality building of FCP 

			Participating schools: 1. Jacinto Canek (morning shift) 2. Moisés Sáenz 3. Benito Juárez (morning shift) 4. Benito Juárez (afternoon shift) 5. Tiburcio May Uh 6. Orlando Martínez Debeza This municipality has not carried out the paper recycling program because in the municipality there are no recycling companies or recycling gathering centers.
May 27	Felipe Carrillo Puerto	*Tiburcio May Uh elementary school* Implementation of experimental class "I really want my environment clean"	Organized by: teachers Place: Tiburcio May Uh elementary school Time: 7:00 to 12:00 33 students of 5th grade participated in the experimental class. The activity was implemented during school hours.
May 28	Felipe Carrillo Puerto	*Jacinto Canek elementary school* Implementation of experimental class "I really want my environment clean"	Organized by: Teachers Place: Jacinto Canek elementary school Time: 7:00 to 12:00 28 students of 4th grade participated in the experimental class.
June 1	Felipe Carrillo Puerto	*Benito Juárez elementary school (morning shift)* Implementation of experimental class "I really want my environment clean"	Organized by: Teachers Place: Benito Juárez elementary school (morning shift) Time: 7:00 to 12:00
June 2	Felipe Carrillo Puerto	*Orlando Martínez Debeza elementary school* Implementation of experimental class "I really want my environment clean"	Organized by: Teachers Place: Orlando Martínez Debeza elementary school Time: 7:00 to 12:00
June 3	Felipe Carrillo Puerto	*Benito Juárez elementary school (afternoon shift)* Implementation of experimental class "I really want my environment clean"	Organized by: Teachers. Time: 13:00 to 17:00 Place: School Benito Juárez elementary school (afternoon shift)
June 5	Othón P. Blanco	*World Environment Day*	In Payo Obispo Zoo was carried out an event due to the World Environmental Day. The event was organized by the municipality of Othon P. Blanco was attended by JICA Study Team.
June 7	Othón P. Blanco	*Moisés Sáenz elementary school*	Organized by: Teacher. Place: Moisés Sáenz elementary school Time: 7:00 to 12:00

<table>
<tr><td></td><td></td><td>Implementation of experimental class “I really want my environment clean”</td><td>In the experimental class participated 34 students from the 5th grade.</td></tr>
<tr><td>June 15</td><td>Othón P. Blanco</td><td>Visit to participant schools in the recycling program</td><td>The Patria elementary school keeps promoting the program. The authorities estimated that approximately 800 kg of newspaper and cartons have been collected, starting three months ago, from the signing of the agreement with the company (March 17th). Teachers and the school principal have discussed the possibility of using the money obtained from the payment of recycled paper for painting the school shield.

The principal of J. Jesús Cetina Salazar elementary school informed that during the first week, 115 Kg was gathered from 120 children of fifth and sixth grade. The program was extended in all the school and at present paper is collected every day.

The Forjadores de Quintana Roo elementary school has gathered so far 90 Kg.</td></tr>
<tr><td>June 15</td><td>Othón P. Blanco</td><td>Visit to the company: Metales y Fierros del Sureste and Fábrica de Láminas de Cartón de Chetumal.</td><td>Visits to both companies were carried out in order to know the exact amount of recycled paper delivered and collected by schools.
The amounts reported were the following:

Manuel Azueta elementary school
<table><tr><td>Week</td><td>Kg</td></tr><tr><td>1st week</td><td>607</td></tr><tr><td>2nd week</td><td>215</td></tr><tr><td>3rd week</td><td>375</td></tr><tr><td>4th week</td><td>595</td></tr><tr><td>5th week</td><td>24</td></tr><tr><td>6th week</td><td>20</td></tr><tr><td>Total</td><td>1836</td></tr></table>
Patria elementary school
<table><tr><td>Week</td><td>Kg</td></tr><tr><td>1st week</td><td>153</td></tr><tr><td>2nd week</td><td>42</td></tr><tr><td>3rd week</td><td>136</td></tr><tr><td>4th week</td><td>253</td></tr><tr><td>Total</td><td>584</td></tr></table></td></tr>
<tr><td>Junio 17th</td><td>Othón P. Blanco</td><td>Visita a Escuelas participantes en el Programa de Reciclaje</td><td>In Andrés Quintana Roo elementary school the recycling program is not totally active. Due to end of school courses for the summer vacation, teachers are busy concentrating in school duties.
The authorities of the school agreed to continue the recycling program after the vacation period.
Teachers have discussed the possibility of using the money from selling the newspaper to buy didactic material needed for school use.</td></tr>
<tr><td>June 18</td><td>Othón P. Blanco</td><td>Visit to Comodoro Manuel Azueta elementary school</td><td>The S/T visited the school principal to encourage the recycling program initiated successfully in the school.
The school principal showed an enthusiastic attitude and able to continue with the activities.
The S/T invited the schoolchildren to participate in a guided visit to a paper sheet factory for June 24th with the purpose of watching the paper recycling process.</td></tr>
<tr><td>June 18</td><td>Othón P. Blanco</td><td>Visit to Patria elementary school</td><td>The S/T and the school principal met with the purpose to know updated information and results on paper recycling.

The S/T invited the school to participate in a guided visit to a paper sheet factory. The date for the visit was decided by August</td></tr>
</table>

			19th.
June 24	Othon P. Blanco	*Forjadores of Quintana Roo elementary school* Delivery of paper to the recycling company	The school delivered the collected paper to the recycling company "Metales y Fierros de Sureste". The students delivered 218 Kg to the company. 
June 24	Othon P Blanco	Visit to the recycling paper factory.	29 students from Comodoro Manuel Azueta school and 25 students from Forjadores de Quintana Roo school visited the recycling paper factory (Láminas de Cartón de Chetumal).  

Summary of the results	
Positive aspects	• The established program for Environmental Education Model Project was carried out completely. • The C/P organized additional environmental education activities which enriched and complemented the Model Project. • The Model Project was a complementary activity for the school education program. • The recycling activities program encouraged the children to contribute for waste minimization through recycling. • The students, teachers and school authorities were interested and enthusiastic regarding the project. • With the implementation of the Model Project of Environmental Education and Recycling Activities, the C/P formed a Working Team where the institutions can share their experiences and enrich the actions. • There are two recycling paper centers at Chetumal city. • Education materials such as the video, education panels, education booklet, booklet with student works, posters and leaflets for the Model Project were matched to the social and economic conditions of Quintana Roo State. Through the education materials, children were identified with their reality.
Negative aspects	• The C/P doesn't have enough material, human and financial resources to implement the Model Project in the whole state in the future. • There is little participation of the community and parents. • There is no large paper, glass, plastic or aluminum recycling companies in Quintana Roo state.

S.5 Evaluation

Follow-up and monitoring of environmental education activities were carried out by the C/P team of SEDUMA, CAPA and the municipality of Othon P. Blanco, during the period of March to June of 2004.

a. Efficiency

The participation of the C/P, the S/T and the school community in workshops has been the main contribution in the environmental education model project. This model project has been focused to facilitate and to outline some proposals which allow linking a community needs with a feasible project at short time (demonstration), and medium term (actions); what will allow to implement and to strengthen new strategies of the model project expansion. In that sense workshops have been developed with concrete proposals considering: a school activity of environmental conservation including educational aspects and environmental sanitation; a demonstrative activity related with solid waste management and wastewater; and an educational activity promoting the use of recyclable materials. This participation, in addition to the preparation of didactic and supporting materials (educational booklet, students' booklet, educational panels, poster, leaflets and educational video) carried out by the C/P and the S/T that were used to implement the environmental education activities, it was the key to achieve the expected effect.

On the other hand, the funds given by JICA were used efficiently by the importance of the achieved products and in short time.

b. Effectiveness

It can say that the purpose of the model project has been achieved successfully since it has begun with a great interest the environmental education model project and recycling activities.

It is expected that at the medium term to become a culture that would be part of the community for resources protection and preservation of the aquatic environment of the coastal area of Quintana Roo state.

The results of the workshop for teachers carried out by the C/P have motivated the school communities to carry out experimental classes related to solid waste management and wastewater and to implement recycling activities.

Regarding the waste minimization through solid waste management and recycling, the strategy of the M/P demonstrated its effectiveness.

c. Impact

It is still early to measure the impact of the model project at municipal/state level. However, the model project has generated very positive effects at institutional level and the schools where the training workshops and experimental classes were implemented.

d. Relevance

The recycling activities are associated to several aspects of economic, financial, social, cultural and environmental nature, smaller costs in waste collection, transport and final disposal, and consequently contributing to resources conservation and protection of the aquatic environment, tourist promotion, employment generation and improvement of the life in the coastal area of the State.

e. Sustainability

SEMARNAT, as SEDUMA, CAPA, the municipalities and the communities have an environmental responsibility and action to manage the solid waste and wastewater in the State. In every organization structure of related institutions has an administrative unit associated to the solid waste management. However, coordination among them is weak; therefore, the establishment of an executing unit was proposed to carry out the model project of environmental education and recycling activities.

The enforcement of this unit and the implementation of the M/P can be a mechanism to achieve the sustainability of the model project of environmental education and recycling activities.

The participation and cooperation of the community in recycling activities will be extremely important for the achievement of the objectives and the sustainability of the project.

f. Evaluation of capacity building for environmental education and recycling activities (self-evaluation)

The results of self-evaluation made by the C/P team after the implementation of the model project of environmental education and recycling activities are shown below:

Evaluation :	Very good	4	Good	3	Average	2	Poor	1

No.	Item	OPB	CAPA	SEDUMA
1	Knowledge and methods			
a.	Understanding of the objective of environmental education	4	4	4
b.	Understanding of tecniques and methodologies used for environmental education training (making of education materials and workshops)	4	4	4
c.	Understanding of techniques and methodologies learned	4	4	4
d.	Level of effectiveness of the implemented techniques and methodologies	3	4	4
2	Technique and Action			
a.	It can implement training workshops on environmental education in schools and communities.	3	4	4
b.	It carries out the follow up of paper recycling in schools.	2	3	4
c.	It carries out environmental education and/or recycling activities in other areas.	3	3	3
d.	Knowledge of effective methods and techniques to elaborate manuals and information and supporting materials for environmental education programs.	3	4	4
e.	The materials used in the workshops were appropriate.	4	4	4
3	Responsibility and attitude (of the institutions)			
a.	It carries out periodic visits to schools where the recycling program is implemented.	3	4	3
b.	It carries out meetings and activities to promote recycling program in other municipality schools.	3	3	2
c.	It uses methods and comprehensible educational instruments for children and residents of the community.	3	4	3
d.	It supports the teachers in experimental classes	3	4	3
3	The private sector (participant companies in recycling program)			
a.	The company picks up the paper gathered in the schools according the agreement signed between the parts (school-company).	2	3	3
b.	Generally, the Company is fulfilling the agreement with the schools.	2	3	2
4	Schools where paper recycling program are carried out			
a.	The teachers, authorities and students have understood the necessity of the environmental education and recycling activities.	3	4	4
b.	The enthusiasm of the recycling program is increasing.	4	3	3
c.	Diffusion of the strategies proposed in the workshops.	4	4	4
d.	The school carries out the paper recycling program.	2	3	2
e.	Follow up of recycling activities is carried out by the involved institutions.	2	3	3
f.	There is parent participation.	2	3	2
	Points (total 84 points)	62	75	69
	Points (percentage)	74	89	82

Of a total of 84 points (100%) all those interviewed overcame 70% of the capacity. With regard to the environmental education and recycling activities implemented it can conclude that:

- The recycling program is contributing for the preservation of the aquatic environment in the coastal area of Quintana Roo State.

- The C/P team follow the activities of environmental education through training workshops, experimental classes and paper recycling activities in elementary schools.
- Formation of multiplier agents has settled down to develop recycling program.
- It has been possible to diffuse what they learned in environmental education workshops to other groups in schools and in communities.
- It has been carried out other activities related to environmental education program in the communities.
- The impact of environmental education and recycling activities in the community has been very positive.

S.6 Conclusions and Recommendations

a. Conclusions

- The strategy and proposal measures in the P/M are on going.
- With the implementation of the Model Project of Environmental Education and Recycling Activities, the C/P formed a Working Team where the institutions can share their experiences and to enrich the actions and impact of the project in the State.
- The working team (Executing Unit of Environmental Education) has carried out the short term program of environmental education activities (training workshops for teachers, experimental classes and other activities related) successfully.
- The school community is incorporating the waste minimization practices through paper recycling activities.
- Coordination among the private companies, schools and the institutions is still weak.

b. Recommendations

- To conform and consolidate in permanent form the Executing Unit being SEDUMA the coordinating organism.
- To implement a monitoring system for environmental education program and recycling activities.
- To incorporate in a permanent way the Ministry of Education participation in the Executing Unit.
- To promote community and parents participation in recycling activities.

- To invite the private sector to participate in solid waste minimization activities.
- To foment and institutionalize recycling activities at state level.
- To monitor the recycling activities between the private companies and schools.
- To obtain incentives and finances to reinforce the environmental education activities with the participation and support of the private sector.