6. IMPLEMENTATION SCHEDULE AND COST ESTIMATE

SUPPORTING REPORT
ON
IMPLEMENTATION SCHEDULE AND COST ESTIMATE

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SUPPORTING REPORT
ON
IMPLEMENTATION SCHEDULE AND COST ESTIMATES

1. General

The objectives of this sector are to prepare the implementation schedule for two (2) plans; the Master Plan and the First Stage Project, and cost estimation for three (3) plans; the Basic Plan, the Master Plan and the First Stage Project.

2. Construction Plan

2.1 Terms and Conditions

Workable Days and Working Hour

In this planning, workable days and working hours are estimated as follows:

- 255 days are deemed to be workable and is equivalent to 70% of a year, excluding Sundays (52 days), national holidays (16 days) and rainy days (42 days). Unworkable rainy days are taken to be 3.5 days per month on an average based on the records/1 of similar works executed in recent years.
- Working hours in a day are set at eight hours in accordance with the circumstances in this country.

Availability of Materials and Equipment

The main construction materials to be used in the construction works are structural steel, cement, reinforcing bars, sand, brick, stone (gravel, rubble), wooden materials, concrete pipes, and others. Most of these materials are locally available, except structural steel.

/1: Informe Final II Etapa del Sistema de Alcantarillado Pluvial de la Ciudad de Asuncion, 1985.

A cement plant in the suburbs produces only one type of normal portland cement at present. Reinforcing bars are produced from imported steel ingots in lengths of 14 m at maximum and in diameters of 6 to 32 mm. Gravel, rubble and other stone materials are produced in quarries near Asuncion City in required sizes. Precast concrete pipes are locally produced in various diameters, the biggest of which is 2,500 mm, by using ordinary portland cement. All precast concrete pipes are reinforced with reinforcing bars, except those of 500 mm in internal diameter and smaller.

Construction equipment such as bulldozer, buckhoe, crane, dump truck, compactor, etc., will be used in the construction works of the project and they may have to be imported.

2.2 Construction Methods

The construction works of the project consist of (1) River Improvement Works, (2) Drainage Facility Works, and (3) Detention Facility Works. They are further divided into a number of specific works as mentioned hereunder.

(1) River Improvement Works

The works include excavation of channels, revetment (retaining wall type), groundsill, box culvert, invert, maintenance road, retarding basin, and bridge works.

(2) Drainage Facility Works

This consists of pipings, box culvert, open channel, manhole, gutter and inlet, and outlet works.

(3) Detention Facility Works

This comprises works on storage in public compounds, works on storage in house lot, and infiltration facility works.

The process of work of the above items and the work efficiency of main equipment used are studied hereinafter.

River Improvement Works

The works are principally conducted from downstream to upstream partly from one side of the river to the other, switching the existing river flow. Due to the work volume, it is necessary that the construction be made at several work sites simultaneously.

(1) Earthwork for Widening of Channel

Excavation for widening and/or deepening the existing channel is done by bulldozer (10-ton) or buckhoe (0.6 m^3), and spoiled soils loaded by buckhoe or loader (1.3 m^3) will be used for the embankment or transported by dump truck (8-ton) to the nearest dumpsite where a bulldozer (10-ton) is in operation for spreading.

(2) Revetment Work

The construction process of the revetment work is in the following order:

- Excavation for temporary waterway.
- Excavation for masonry work.
- Measuring and preparation of dewatering equipment.
- Wet masonry work (piling up of rubbles with mortar) and backfilling with ripraps.
- Backfilling with sand.
- To the other side (switching waterway to the front side of the constructed revetment), after finishing one side.

The excavation is made by a combination of buckhoe (0.3-0.6 m^3) and dump trucks (8-ton). Sand backfill is compacted by tamping rammers and stone materials are provided by trucks (8-ton) from the nearest quarry. Spoiled soils are treated as same as earthwork for widening of channel, and wet masonry work is done mostly by manual labor.

(3) Box Culvert Work

The construction process of the box culvert is similar to the revetment work, but due to the requirement of switching the existing river flow to as near the structure position as possible, a box culvert section has to be divided into two sections and constructed in two stages in most cases. Thus, the construction procedure is in the following order:

- Excavation for temporary waterway.
- Excavation for the structure (1st section).
- Measuring and preparation of dewatering equipment.
- Placing the base leveling concrete.
- Reinforcing bar and formworks (bottom slab).
- Concrete-placing (bottom slab).
- Reinforcing bar and formworks (side wall and top slab).
- Concrete-placing (side wall and top slab).
- Curing of concrete (1st stage is over).
- To the other side (switching waterway into the constructed box culvert).

Earthworks are the same as in the revetment works. Ready-mix concrete is provided in truck-mounted mixers (3-6 m^3) from local batching plants, and placed using concrete pump (50-60 m^3/hr) or truck-mounted crane (10-20 ton). It is desirable that a truck-mounted crane (10-20 ton) be used in the handling of materials and equipment.

(4) Replacement Bridges Work

Bridge structures are constructed at the same time with the revetment works. Superstructure is thereafter erected to its full floor system in most cases, but for bridges on major streets with heavy traffic, half-by-half erection method by switching traffic is adopted. Earthwork and concrete work are the same as in the box culvert work.

Pile foundation, if necessary, is done using a pile driver and in most cases, popular drop hammer with a ram weighing more than 1.0 ton is assumed.

(5) Other Works

Groundsill works is similar to revetment works. A bulldozer, dump trucks and vibration roller are assumed in the filling of embankment and the maintenance road works. Invert is made up of wet masonry placed wall to wall of revetment and the construction method is similar to the revetment work.

Drainage Facility Works

The drainage facility works are in most cases done on the streets; therefore, trench timbering method is adopted to provide as much wide road space as possible for pedestrians or vehicles to pass through the site.

(1) Piping Work

The process of piping work is as follows:

- Excavation of trench.
- Trench timbering.
- After excavation, placing sand for base.
- Pipe laying and coupling one by one.
- Filling and compaction using sand and excavated soil.
- Restoration of pavement.

Excavation is performed by a buckhoe (0.3-0.6 m^3) and dump trucks (8-ton). Filling and compaction is by tamping rammers.

(2) Box Culvert Work

The same excavation and filling processes as in piping work are adopted.

Base foundation has two layers, rubble and levelling concrete. Reinforcing bars and formworks are similar to the box culvert work in the river channel works.

(3) Revetment Work for Open Channel

The excavation and filling method is the same as that in the pipe work. As for the wet masonry work, the same method as described in the river channel works is applied.

(4) Other Works

In the pipe conduit construction process, manhole is constructed in a similar way as in box culverts and the inlet is constructed in accordance with the progress of the connecting conduit construction. The construction method of inlet is not equipment-oriented but mostly by manpower, because of the shallow base elevation and small size. Outlet is reinforced with wet masonry to prevent erosion of the riverside and scouring of the riverbed, and the construction is similar to the invert work described under other works in the river channel works.

Detention Facility Works

(1) Storage Facility Work

The storage facility consists of two types. One is made in public area with wide horizontal range and shallow depth, and the other is made in house lot with storage tank connected by drain pipe.

In the construction method for the facility in public area, many construction materials are not necessary, except drain pipes, gutters and inlet. Construction is easily done either by scooping surface soil with bulldozer or by manual labor.

(2) Infiltration Facility Works

Infiltration facilities consist of inlet blocks and infiltration trenches. The materials are concrete inlet blocks, perforated pipes, porous sheets, sand and gravel. The structure size is small and construction is made mostly by manual labor, but use of a small-sized buckhoe is advisable.

Work Efficiency of Main Equipment

Capacities and work efficiencies of the main construction equipment are as follows:

(1) Buckhoe (0.6 m^3)

Excavation quantity per one hour (Vs) is estimated by the following formula:

$$Vs = 3{,}600 \times q \times E / C = 42\ (m^3/hr) \text{ for common earth}$$
$$= 27\ (m^3/hr) \text{ for hard earth}$$

where;

q : excavation quantity per one cycle (= 0.59 m^3)
E : work efficiency factor (= 0.40)
C : time required in one cycle of loading (= 35 sec)

Assuming that consecutive five hours are utilized, the excavation quantity per day is, therefore, 42 m^3/hr x 5 hrs = 210 m^3/day for common earth, or 135 m^3/day for hard earth.

(2) Dump Truck (8-Ton)

Soil shipping capacity by one dump truck is calculated by the following formula:

$$Vs = 60 \times q \times E / C = 5.9\ (m^3/hr)$$

where;

q : loading quantity per one dump truck (= 4.4 m^3)
E : work efficiency factor (= 0.9)
C : time required in one round trip (= 5.3 LB + A = 42.5 min.)

where, L is the distance to and from the dump site which is assumed as 5 km; B is traffic congestion factor (= 1.0); and A is efficiency factor (= 18).

Assuming that consecutive six hours are utilized, shipping capacity per day is 5.9 m^3/hr x 6 hrs = 35.4 m^3/day.

(3) Bulldozer (10-Ton)

Removable soil quantity by one bulldozer is calculated as follows:

$$Vo = 60 \times q \times E / C = 68 \ m^3/hr$$

where;

q : 1.24 (m^3/cycle)
E : 0.40
C : 0.037 x 5.00 m + 0.25 = 0.435

Assuming that consecutive five hours are utilized, removal capacity per day is 68 m^3/hr x 5 hrs = 340 m^3/day.

(4) Loader (1.3 m^3)

Loading quantity by one wheel loader is calculated as follows:

$$Vi = 3{,}600 \times q \times E / C = 43 \ (m^3/hr)$$

where;

q : 1.06 (m^3)
E : 0.45
C : 40 (min)

Assuming consecutive six hours are utilized, loading capacity per one day is 43 m^3/hr x 6 hrs = 258 m^3/day.

2.3 Implementation Plan for the Master Plan

Since it is difficult to decide the timing of project implementation for each basin in the Master Plan at this point, the implementation schedule was given by the following concepts, apart from the technical consideration taking the project work volume and the construction methods mentioned in 2.2.

The Project consists of a number of sub-projects, so that it is practically infeasible to complete all the sub-projects in a shorter period of time. The target year of the subject Project is 2005; therefore, project implementation is scheduled for a period of 20 years between 1986 and 2005. Since the extent of flood damage differs widely in each basin, simultaneous execution of construction may not be advisable because of the almost unavoidable delay in reaping the benefits. Therefore, priority for project implementation should be given to the sub-projects covering the heavy inundation areas and the major highways for the earliest possible execution. Hence, the above-said 20-year construction period is divided into two, 10-year for the first phase and 10-year for the second phase of construction.

(1) Sub-Projects for 1986-1995 Execution

Priorities are placed on the three basins of Itay (upper stream area of Aviadores del Chaco Avenue), Mburicao and Lambare in accordance with the principles mentioned in Subsection 7.5 of the Main Report. To balance the expenditures in the former and latter 10-year periods, only drainage system improvement works will be provided for these river channels in the former 10 years, and the detention facilities required will be installed in the latter 10 years.

Out of the above-mentioned three basins, flood damage over the Itay and the Mburicao river basins are more severe than those in Lambare as studied in 2.4 of the sector on Inundation and Flood Damage. It is, therefore, advisable to provide improvement works for these two basins prior to Lambare.

(2) Sub-Projects for 1996-2005 Execution

During this 10-year period, river improvement works and drainage facilities will be provided for the remaining basins. Detention facilities will be installed for the above-mentioned three river basins to cope with the incremental runoff discharge.

The basins covered by the former 10-year construction period and those by the latter 10-year period are marked off in Fig. 6-1. The Implementation Schedule of this Project is shown in Fig. 6-2.

2.4 Implementation Plan for the First Stage Project

Construction Period

This project is planned to be executed for several years because of its work volume. A suitable construction period of execution is fixed at 4 years due to the findings of the study mentioned below.

(1) Construction Period by Target Year

The river improvement and drainage facilities installation for the three rivers of Mburicao, Itay and Lambare are scheduled to be completed by the year 1995 in conformity to the implementation schedule for the Master Plan as mentioned elsewhere in 2.3. In case this project is implemented with financial assistance from a foreign source, the execution of the construction works cannot be commenced by the end of the year 1989 due to the three (3) years required for the preparation of loan application and the procurement of the contractor, i.e., the completion of the feasibility study will be in early 1987, and then it will take 12 months for loan commitment and agreement, 6 months for contracting engineering services, 12 months for detailed design and tender document, and 6 months for pre-construction phase.

Therefore, only six (6) years is available for the completion of the river and drainage facilities improvement works in the above three rivers.

When the six years is proportionately divided according to the ratio of the base construction costs allocated to the respective works of the three rivers (21,500 million Guaranies for Mburicao and Itay, and 8,300 million Guaranies for Itay, as shown in Table 6-15 of 3.5, Construction Cost for the Master Plan), it is estimated that four (4) years is adequate for the construction period of this project.

(2) Construction Period from Economic Viewpoint

The sooner the completion of construction, the lesser the chance of damage caused by floods. Therefore, the soonest possible completion period is desirable. However, when the construction cost is considered, completion of the works in a too short period makes the cost higher. Therefore, there must be a certain construction period economically justifiable depending on the work volume.

To find out the appropriate construction period, the estimation was made on the following assumptions:

- Direct cost does not vary in relation to the construction period.

- Price escalation is disregarded in this estimation.

- Indirect cost mainly generated from the expenses for temporary facilities and technical personnel varies in relation to the construction period.

The relationship between indirect cost and construction period is given in Fig. 6-3. The indirect cost index of various periods indicated in this figure was obtained by setting the unit index (100) at the construction period of 4 years. The figure shows that indirect cost decreases sharply in a 4-year construction period and it decreases very slowly in construction periods longer than 4 years. It is, therefore, concluded that 4 years is the most suitable construction period for this project.

Priority of Project Components

The project is scheduled to be divided into several construction components executed on annual or phased basis. The order of execution of the respective components are studied based on two concepts as described below:

(1) In full consideration of the investment efficiency, execution of the component with the higher priority is started disregarding adverse effects on the downstream basin which may be caused by an upstream channel improvement, unless the adverse effect is serious. (Case 1 based on Economic Consideration)

(2) Contrary to the foregoing, execution starts from the downstream to avoid shift of possible storm water damage. (Case 2 based on Technical Consideration)

The contents and combination of the respective construction components are summarized in Table 6-1, and the relationship of the execution order among the respective components, accumulated construction costs and accumulated benefits are presented in Table 6-2 and in Fig. 6-4. Fig. 6-4 shows the comparison of the above two procedures which clearly indicates that the expected benefit under procedure (1) comes considerably later than that under procedure (2).

The execution of this project is a matter of great urgency since the area is still suffering much from damage caused by annual floods. Therefore, the priority is given to procedure (1) which proves an earlier realization of much desired effects.

Implementation Plan

In the case where the implementation of proposed construction works is four (4) years starting in early 1990 and completing in 1993, it is desirable that the volume of work be divided annually as evenly as possible. On the other hand, since the preparatory work including mobilization is conducted in the first year, the volume of work to be implemented in the first year is planned to be less than that of the other years. Accordingly, taking the priority fixed for the project components into consideration, the conclusion as tabulated below was reached after going over the annual construction cost. Also shown below are the benefits derived from the implementation of the annual works. (Refer to Table 6-2 and Fig. 6-4.)

Year	Construction Component	Construction Cost (¢ Million)	Benefit (¢ Million)
First Year (1990)	Improvement works of the drainage system along Artigas, Espana and Mariscal Lopez avenues and construction of retarding basin. (Component C, A, B and M)	2,859	688
Second Year (1991)	Improvement works of the dainage system along Madame Lynch Avenue. (Component E and F)	5,271	605
Third Year (1992)	Improvement works of Mburicao River channel and improvement works of the drainage system along Ayala Avenue. (Component G, I, J, O and H)	4,774	508
Fourth Year (1993)	Improvement works of river channels of tributaries and provision of the related drainage facilities in Mburicao and Itay river basins and remaining works. (Component K and L)	3,293	307

Technical Consideration for Implementation Plan

As to the implementation plan mentioned above, it is necessary that the construction method be examined in terms of work efficiency and/or procurability of equipment, labor and construction materials, because of the work volume and the target year. From this point of view, the construction method is deemed to be suitable, and poses no potential execution problem, due to the findings of the study described hereunder.

(1) Work Volume

The total approximate work volume of the main work items are as follows:

Work Item	Unit	River	Drainage Facility	Total
Excavation	m^3	950,000	300,000	1,250,000
Earth Filling	m^3	70,000	120,000	190,000
Earth Spoil	m^3	850,000	180,000	1,030,000
Revetment	m^3	65,600	25,800	91,400
Groundsill	pc.	39	-	39
Bridge	pc.	48	-	48
Box Culvert	m	2,700	6,200	8,900
Piping	m	-	6,000	6,000

The breakdown of the annual work volume is given in Table 6-3.

(2) Construction Material

Assuming a construction period of 4 years, the quantity of main construction materials such as concrete, reinforcing bar, stone, and concrete pipe to be procured monthly is, on the average, as follows:

- Concrete (95,000 m^3/4 years) = 2,159 m^3/mo.
- Reinforcing Bar (7,500 tons/4 years = 170 tons/mo.
- Stone (142,000 ton/4 years) = 3,227 tons/mo.
- Concrete Pipe (5,980 m/4 years) = 136 m/mo.

The above quantities may be provided by the respective suppliers in Asuncion City or its vicinity.

(3) Labor and Equipment

About 1,200 laborers per day on an average are to be needed in the execution of the project, provided that a four-year construction period is assumed. The labor need varies with the period of construction and the number of needed laborers fluctuate month by month or year by year in accordance with the work volume, but the deviation rate is less than 20% monthly and 30% yearly. On the other hand, the potential laborers in Asuncion City are estimated at 16,300/1, which is more than 10 times as much laborers as needed in the construction execution; therefore, no serious labor problem is anticipated. Skilled laborers and special workers may be employed from outside of Paraguay.

As for the construction equipment, most number of major heavy equipment is in full-time constant use. In certain years, some number of equipment must be added up due to the work volume, but the number is not much. In any case, equipment can be cost effective, provided that the construction be made in the construction period of 3 to 5 years, which is approximately equivalent to depreciation life of most heavy equipment. Table 6-4 lists the main construction equipment and their units in consideration of the construction methods described in 2.2.

The construction schedule and work section for the proposed plan of the First Stage Project are shown in Figs. 6-5 and 6-6, respectively.

/1: Population of Asuncion City = 457,000
Economically Active Population Rate (male age 15-65) = 29.7%
Economically Active Population (457,000 x 0.297) = 135,800
Unemployment Rate = 12%
Potential Laborer (135,800 x 0.12) = 16,300

3. Cost Estimate

3.1 Terms and Conditions

All costs for the cost estimate are based on prices as of August 1986, the currency exchange rate is fixed at US$1.00 = 650 Guaranies = ¥155. The cost estimate was carried out on an assumption that the project will be implemented on contract basis.

3.2 Unit Prices of Labor, Construction Materials, Equipment, land acquisition and house evacuation.

For the estimation of the construction cost, data on prices of labor, materials and construction equipment, including information on house evacuation and land acquisition were collected from local government offices, contractors, suppliers, and others. A further description is given below:

Labor Cost

Labor cost consists of wages and allowances. Wages per eight hours of labor by work category are shown in Table 6-5. Allowances comprising social security system benefits, vacation and sick leave benefits, bonus, family allowances, etc., are estimated as 45% of the labor wage.

Construction Materials

Unit prices of construction materials such as cement, sand, gravel, rubble, reinforcing bars, concrete pipes, etc., required for the construction are shown in Table 6-6.

Construction Equipment Operating Cost

Operating cost per working hour of construction equipment is based on CIF Asuncion price of the respective equipment. This operating cost is estimated for the elements of depreciation cost; administration cost including interest, tax and insurance; repair cost including spare parts, maintenance cost, cost of tire and/or cable consumption, cost of fuel and lubricant; and cost of consummable materials.

Land Acquisition Cost and House Evacuation Compensation

For project implementatin, land acquisition and house evacuation are likely necessary. The cost of land used in the estimation is presented in Fig. 6-7.

According to the data obtained, cost of land to be acquired varies with the location and degree of land utilization. In the Centro Basin (B-3), the cost of land is the highest and it becomes lower as the distance from the center of the city becomes farther. The cost of land for residential areas in Asuncion City is somewhere between 3,000 Guaranies to 20,000 Guaranies per square meter, and the lowest is 1,500 Guaranies per square meter in the suburbs where houses are sparsely scattered.

In the river improvement works, house evacuation is needed for the widening of the river channel, 7.2 million Guaranies per house is adopted as an average for the house evacuation compensation.

3.3 Unit Construction Cost for Work Items

Unit construction cost for each of the work items for river improvement works, drainage facility works, and detention facility works as mentioned in 2.2 were estimated as shown in Tables 6-7, 6-8, and 6-9, respectively.

In this study, the unit construction cost for each of the work items consists from the direct unit construction cost, which includes labor, material and equipment operating costs as mentioned in 3.2, and the indirect unit construction cost, which includes costs of preparatory works, miscellaneous works, temporary facilities, contractor's overhead and profit, tax, etc. Indirect unit construction cost is assumed at 30% of the direct unit construcion cost.

3.4 Construction Cost for the Basic Plan

Calculation Method of Construction Cost

Considering the number of alternative plans of Basic Plan, the calculation method for cost estimation of river improvement works and drainage facility works were simplified as mentioned below, while it was done by multiplying the quantities of works by the unit construction cost obtained in the foregoing for detention facility works.

(1) River Improvement Works

For the purpose of estimating the construction cost of the river improvement works, a relationship curve between discharge and construction cost on each river basin in the planning area was first prepared, from estimating the construction cost depending on certain discharges as shown in Table 6-10. By using this relationship curve, the construction cost of any alternative plan for each basin can be obtained when the design discharge of the alternative is set (refer to Fig. 6-8).

(2) Drainage Facility Works

The construction cost for each runoff discharge in every basin was estimated by multiplying the drainage area of each basin with the construction cost per unit area (ha) corresponding to each runoff discharge obtained by multiplying unit construction costs with quantities in accordance with the runoff discharge in the model basins as stated in 5.2.4 of the sector on River and Drainage Planning, as given in Table 6-11. To apply the relationship between the construction cost per unit area and the discharge in the model basin to the other basins, the relationship among runoff coefficient and return period which are the major components of the discharge and construction cost per unit area was estimated as shown in Fig. 6-9.

Base Construction Cost of Alternative Plans

As discussed in the sector on River and Drainage Planning, three (3) cases are taken up for consideration as alternatives, and out of the three, Case II and Case III have two divisions each for studying the respective regulation ratio of river channel/drainage facilities and detention facilities in the optimum combination of the control facilities.

Their estimated base construction costs (including the cost of land acquisition, house evacuation and engineering services, and physical contingency) are tabulated below and their breakdown is shown in Table 6-12.

Study Case	Construction Cost (G Million)			
	River	Drainage Facilities	Detention facilities	Total
Case I	60,140	160,800	-	220,940
Case II-1	56,590	156,370	16,580	229,540
Case II-2	47,890	147,660	49,850	245,400
Case III-1	56,590	156,340	12,730	225,660
Case III-2	47,890	147,660	38,490	234,040

Base Construction Cost of Optimum Basic Plan

In the selected Optimum Plan, seventeen (17) basins are planned to have the combination of storm water control facilities of Study Case I and the remaining basins will have the combination under Study Case III. The total base construction cost is estimated at 228,760 million Guaranies, as shown in Table 6-13.

3.5 Construction Cost for the Master Plan

Calculation Method of Construction Cost

Calculation methods of construction cost for the river improvement, detention facility works and Study Case I (Overall Restoration) of drainage facility works are in the same manner as the Basic Plan formulation, but the construction cost for both study case II (trouble spot improvement) and III (Improvement

Along Trunk Roads) is estimated by multiplying the obtained quantities of works by the unit construction cost.

Base Construction Cost of Alternative Plans

As explained in the sector on River and Drainage Planning, three (3) cases with three divisions each on 2, 3 and 5-year return periods were taken up for the alternative study of the Master Plan. The base construction costs under each case were estimated as summarized below and their breakdown is shown in Table 6-14.

(Unit: ₲ Million)

Study Case	Return Period 2-Year	3-Year	5-Year
Case I-1	140,430	166,720	188,000
Case I-2	173,320	204,740	238,190
Case I-3	161,320	190,140	220,790
Case II-1	46,070	55,090	64,980
Case II-2	70,020	84,160	101,300
Case II-3	63,850	76,740	92,260
Case III-1	18,410	22,260	26,950
Case III-2	32,090	38,810	47,460
Case III-3	28,760	34,820	42,520

Construction Cost for Fund Requirement of Proposed Storm Drainage System Improvement Project

Out of the foregoing alternative plans, Case II-2 (combination of river channel improvement and installation of drainage facilities in combination with detention facilities) was selected as the Optimum Plan for the Mburicao, Itay (upstream of Aviadores del Chaco Avenue), and Lambare basins, and Case II-1 (combination of river channel and drainage facilities) for the remaining basins.

The base construction cost for the proposed storm drainage system improvement project is estimated at 59,890 million Guaranies. Taking the Implementation Schedule into consideration, the base construction cost of the Sub-Project for 1986-1995 execution is 29,810 million Guaranies and that for 1996-2005 execution is

30,080 million Guaranies. The cost breakdown is shown in Table 6-15.

On the contrary, when the price contingency in addition to the above base construction cost is considered, the construction cost for fund requirement cost is estimated at 107,720 million Guaranies on the following assumptions:

- that the said base construction cost is almost equally allocated per year during project implementation in the year 2005;
- that the said base construction cost is divided into foreign currency and local currency portions of 60% and 40%, respectively; and
- that the annual escalation rate of 10% for the local currency portion is applied to the price contingency, while it is disregarded for the foreign currency portion.

3.6 Construction Cost for the First Stage Project

Calculation of Construction Cost

Cost estimation for the First Stage Project was worked out by multiplying the quantities of works estimated on the basis of the preliminary design with the unit construction cost obtained in 3.3 in this sector.

Base Construction Cost of Alternative Plans

The base construction costs of alternative plans for the First Stage Project as studied in the sector on River and Drainage Planning were estimated as shown in Table 6-16.

Construction Cost for Fund Requirement of Proposed First Stage Project

The base construction cost for the proposed First Stage Project is estimated at 21,520 million Guaranies, comprising 13,110 million Guaranies of foreign currency (F.C.) portion and 8,410 million Guaranies of local currency (L.C.) portion, including the cost of civil works, land acquisition, house evacuation, engineering services and physical contingency of 10% of the sum of the above items.

The construction cost for fund requirement was also estimated at 27,500 million Guaranies; 13,110 million Guaranies of foreign currency portion, 14,400 million Guaranies of local currency portion, adding the price contingency at the annual rate of 10% for local currency portion to the above base construction cost.

The breakdown of construction cost for fund requirement is shown in Table 6-17, and the annual disbursement schedule is presented in Table 6-18.

Maintenance and Administration Costs

The maintenance and administration costs consist of labor cost, operation cost of construction machinery, equipment and vehicles, and other miscellaneous expenses. For the annual maintenance and administration costs for facilities, the amount of 83 million Guaranies is estimated all during the entire project life.

TABLES

Table 6-1 COMPONENT OF CONSTRUCTION WORKS

Component	Mburicao River Basin	Itay River Basin
A. Artigas Avenue	Construction of one bridge.	-
B. Espana Avenue	Construction of one bridge and two routes of drainage facilities.	Construction of one groundsill and two routes of drainage facilities.
C. Mariscal Lopez Avenue	Construction of one bridge and two routes of drainage facilities.	Construction of two bridges and one route of drainage facilities.
D. Ayala Avenue	Construction of two routes of drainage facilities.	Construction of three routes of drainage facilities.
E. Madame Lynch (I)	-	River improvements of Itay River (up to confluence with Madame Lynch River) and Madame Lynch River (up to Mariscal Lopex Avenue).
F. Madame Lynch River (II)	-	River improvement of Madame Lynch River (between Mariscal Lopez Avenue and Ayala Avenue).
G. River Channel (I)	River improvement of Mburicao River (between Artigas Avenue and Espana Avenue).	-
H. River Channel (II)	-	River improvements of Itay River (between confluence points with Madame Lynch River and Orilla River) and Orilla River (up to Ayala Avenue).
I. River Channel (III)	River improvement of Mburicao River (between Espana Avenue and Mariscal Lopez Avenue).	-
J. River Channel (IV)	River improvement of Mburicao River (between Mariscal Lopez Avenue and Ayala Avenue).	-
K. River Channel (V)	River improvement of three tributaries and construction of three routes of drainage facilities.	River improvement of four tributaries and construction of four routes of drainage facilities.
L. Drainage Facilities	Construction of five routes of drainage facilities.	-
M. Retarding Basin	-	Construction of retarding basin.

Table 6-2 . ACCUMULATED COST AND BENEFIT THROUGH REARRANGEMENT OF IMPLEMENTATION ORDER OF CONSTRUCTION COMPONENTS

Order of Priority	Construction Component	Accumulated Cost/1 (¢ million)	Accumulated Benefit (¢ million)
CASE 1 (Based on Economic Consideration)			
1	C. Mariscal Lopez Avenue	559	310
2	A. Artigas Avenue	655	342
3	B. Espana Avenue	2,353	688
4	M. Retarding Basin	2,859	688
5	E. Madame Lynch Avenue (I)	6,642	1,070
6	F. Madame Lynch Avenue (II)	8,130	1,293
7	G. River Channel (I)	8,986	1,327
8	I. River Channel (III)	9,114	1,331
9	J. River Channel (IV)	9,222	1,363
10	D. Ayala Avenue	12,106	1,693
11	H. River Channel (II)	12,904	1,801
12	K. River Channel (V)	15,896	2,016
13	L. Drainage Facilities	16,197	2,108
CASE 2 (Based on Technical Consideration)			
1	A. Artigas Avenue	96	33
2	G. River Channel (I)	956	67
3	M. Retarding Basin	1,461	67
4	B. Espana Avenue	3,159	412
5	E. Madame Lynch Avenue (I)	6,943	794
6	H. River Channel (II)	7,734	902
7	I. River Channel (III)	7,862	906
8	C. Mariscal Lopez Avenue	8,421	1,216
9	F. Madame Lynch Avenue (II)	9,905	1,439
10	J. River Channel (IV)	10,013	1,471
11	D. Ayala Avenue	12,904	1,801
12	K. River Channel (V)	15,896	2,016
13	L. Drainage Facilities	16,197	2,108

/1 The above construction cost includes only costs of civil works, land acquisition and house evacuation.

Table 6-3 ANNUAL WORK VOLUME FOR PROPOSED PLAN OF FIRST STAGE PROJECT

Work Item	Unit	1st Yr (1990)	2nd Yr (1991)	3rd Yr (1992)	4th Yr (1993)	Total
1. River Improvement Works						
Excavation	m^3	310,000	322,900	202,000	112,700	947,000
Revetment	m^3	4,000	12,100	26,100	23,400	65,600
Invert	m^3	300	-	730	1,440	2,470
Groundsill	pc.	-	4	15	20	39
Box culvert	m	40	2,481	-	142	2,663
Bridge	pc.	4	7	11	26	48
2. Drainage Facility Works						
Excavation	m^3	96,600	-	137,200	66,900	300,700
Box culvert	m	675	-	4,420	1,135	6,230
Piping	m	1,170	-	450	4,360	5,980
Open Channel	m	5,510	-	1,050	180	6,740

Table 6-4. REQUIRED MAIN CONSTRUCTION EQUIPMENT FOR FIRST STAGE PROJECT

Equipment	Capacity	Unit
Backhoe	0.6 m^3	14
Bulldozer	11 tons	3
Wheel Loader	1.2 m^3	20
Dump Truck	8 tons	50
Pile Driver	1.0 ton Ram	1
Truck-Mounted Crane	10-20 tons	5
Tired Roller	8-20 tons	2
Tandem Roller	10-12 tons	2
Vibrating Roller	2.5 tons	8
Plate Compactor	80 kg	80
Asphalt Finisher	2.5 m class	2
Portable Concrete Mixer	0.3 m^3/bach	12

Table 6-5. LABOR WAGE

Work Category	Wage Per Eight-Hour Day (¢)
Common Labor	2,400
Skilled Labor	3,100
Driver	2,900
Operator	3,300
Foreman	3,600

Table 6-6. PRICES OF CONSTRUCTION MATERIALS

Material	Unit	Price (¢)
Cement	50 kg/bag	2,630
Sand	m^3	1,800
Gravel	m^3	5,100
Rubble	m^3	3,300
Reinforcing bar	kg	340
Wooden Material	m^3	40,000
Ready mixed concrete (100 kg/cm^2)	m^3	25,100
" (150 ")	m^3	28,700
" (210 ")	m^3	32,600
Manhole Cover	pc	50,000
Light Oil	litre	140
Gasoline	litre	240
Asphalt Mixture	kg	120
Concrete Pipe (150mm Dia.)	linear m	1,400
" (200mm Dia.)	"	2,400
" (300mm Dia.)	"	8,400
" (400mm Dia.)	"	10,000
" (500mm Dia.)	"	11,700
" (600mm Dia.)	"	21,700
" (700mm Dia.)	"	25,000
" (800mm Dia.)	"	29,200
" (900mm Dia.)	"	33,400
" (1000mm Dia.)	"	38,300
" (1200mm Dia.)	"	50,800
" (1400mm Dia.)	"	66,700
" (1600mm Dia.)	"	82,500
" (1800mm Dia.)	"	105,800
" (2000mm Dia.)	"	128,900
" (2200mm Dia.)	"	150,300
" (2500mm Dia.)	"	178,000

Table 6-7. UNIT CONSTRUCTION COST FOR RIVER IMPROVEMENT WORKS

Work Item	Unit	Unit Construction Cost F.C (us$)	L.C.(₡)	Total(₡)
Excavation of earth by machinery	m^3	0.64	52	468
Excavation of softrock by machinery	m^3	0.99	80	724
Excavation of earth by manpower	m^3	0	1,514	1,514
Excavation of softrock by manpower	m^3	0	2,251	2,251
Embankment	m^3	0.37	54	295
Backfill of earth by manpower	m^3	0.22	1,082	1,225
Disposal of excavated earth	m^3	0.93	120	725
Revetment	m^3	14.39	15,930	24,744
Gravel backfilling for revetment	m^3	4.07	3,807	6,453
Invert	m^3	14.39	14,654	24,008
Wet mansory for groundsill	m^3	14.39	14,654	24,008
Gabion for groundsill	m^3	21.82	9,973	24,156
Box culvert	m^3	99.43	22,700	87,330
Sodding	m^2	0	1,339	1,339
Maintenance road	m^2	0.80	1,110	1,630
Bridge	m^2	234.26	61,353	213,622

Table 6-8 (1/2). UNIT CONSTRUCTION COST FOR DRAINAGE FACILITY WORKS

Work Item	Unit	Unit Construction Cost F.C (us$)	L.C.(₵)	Total(₵)
Excavation of earth by machinery	m3	0.64	52	468
Excavation of softrock by machinery	m3	0.99	80	724
Excavation of earth by manpower	m3	0	1,514	1,514
Excavation of softrock by manpower	m3	0	2,251	2,251
Backfill of earth by machinery	m3	0.85	832	1,385
Backfill of earth by manpower	m3	0.22	1,082	1,225
Disposal of excavated earth	m3	0.93	120	725
Trench Timbering	m2	0.35	1,748	1,975
Concrete Cover for open Channel	m3	68.83	33,700	78,440
Asphalt Pavement	m2	20.76	4,165	17,660
Store Pavement	m2	0.41	847	1,114
Revetment for open channel and outlet	m3	14.39	15,930	24,744
invert for open channel	m3	14.39	14,654	24,008
Gravel backfilling for revetment of outlet	m3	4.07	3,807	6,453
Inlet and Gutter (Independent Type)	pc	873.31	407,709	975,360
Inlet (Continuous Type)	m	198.22	100,417	229,260
Manhole				
A(Pipes of 50 to 70cm dia.)	pc	420.24	174,644	447,800
B(Pipes of 80 to 100cm dia.)	pc	607.26	254,351	649,070

Table 6-8 (2/2). UNIT CONSTRUCTION COST FOR DRAINAGE FACILITY WORKS

Work Item	Unit	Unit Construction Cost		
		F.C (us$)	L.C.(₡)	Total(₡)
C(Pipes of 120 to 140cm dia.)	pc	896.34	374,589	957,210
D(Pipes of 160 to 180cm dia.)	pc	1,103.73	460,915	1,178,340
E(Pipes of 200 to 250cm dia.)	pc	1,385.77	579,850	1,480,600
F(Boxcalvert)	pc	148.06	51,361	147,600
Pipe-laying				
500mm in diameter	m	16.53	6,295	17,040
600mm "	m	23.32	8,792	23,950
700mm "	m	30.09	11,292	30,850
800mm "	m	36.89	13,781	37,760
900mm "	m	42.33	15,726	43,240
1000mm "	m	47.78	17,673	48,730
1200mm "	m	63.25	22,328	63,440
1400mm "	m	80.25	29,308	81,470
1600mm "	m	98.50	35,845	99,870
1800mm "	m	124.80	45,120	126,240
2000mm "	m	151.33	54,065	152,430
2200mm "	m	177.84	62,914	178,510
2500mm "	m	219.32	77,440	220,000
Box culvert "	m^3	94.80	30,180	91,800

Table 6-9. UNIT CONSTRUCTION COST FOR DETENTION FACILITY WORKS

Work Item	Unit	Unit Construction Cost (¢)
Storage in Public Compounds	ha	20,000,000
Storage in House Lots	m^3	61,000
Infiltration Trench	m	8,700

Table 6-10. (1/5) CONSTRUCTION COST FOR CERTAIN DISCHARGE IN THE RIVER IMPROVEMENT WORKS

Basin No.	River Name	Sub-Basin No.	Discharge (m^3/s)	Construction Cost (¢ million)
B-2	Jardin		- No Improvement -	
B-4	Jaen		35	210
			50	340
			65	410
			80	445
B-6	Salamanca	1	10	25
			15	83
			20	118
			25	142
B-7	Zanja Moroti	1	- No Improvement -	
		2	20	375
			30	520
			40	685
			50	850
B-8	Ferreira	1	- No Improvement -	
		2	45	320
			70	370
			95	430
			120	505
B-10	Las Mercedes	1	25	90
			40	245
			55	410
			70	535
B-12	Bella Vista		- No Improvement -	
B-14	Mburicao	1	25	90
			50	130
			75	160
			100	190
		2	40	65
			75	370
			110	520
			145	670
		3	40	400
			60	620
			80	770
			100	925

Table 6-10. (2/5) CONSTRUCTION COST FOR CERTAIN DISCHARGE IN THE RIVER IMPROVEMENT WORKS

Basin No.	River Name	Sub-Basin No.	Discharge (m^3/s)	Construction Cost (₡ million)
B-14 (Cont.)		4	140	90
			170	390
			200	685
			230	975
		5	20	-
			30	105
			40	185
			50	225
		6	150	350
			200	570
			250	800
			300	1,010
B-15	Ycua Carrillo	1	25	30
			35	240
			45	455
			55	670
		2	40	215
			70	940
			100	1,100
			130	2,250
B-16	Santa Rosa	1	30	350
			45	730
			60	1,200
			75	1,660
B-17	Tres Puentes Cue	1	15	220
			45	635
			75	960
B-18	Itay	1	100	2,000
			180	3,700
			260	5,075
			340	8,150
		2-1	150	1,440
			220	1,840
			290	2,360
			360	2,940

Table 6-10. (3/5) CONSTRUCTION COST FOR CERTAIN DISCHARGE IN THE RIVER IMPROVEMENT WORKS

Basin No.	River Name	Sub-Basin No.	Discharge (m^3/s)	Construction Cost (₡ million)
B-18 (Cont.)		2-2	100	228
			130	270
			160	320
			190	466
		3-1	20	158
			30	206
			40	256
			50	317
		3-2	20	337
			30	418
			40	500
			50	593
		4	40	680
			55	792
			70	893
			85	980
		5	50	353
			70	412
			90	472
			110	506
		6	150	320
			300	1,030
			450	1,720
			600	2,260
		7-1	40	345
			80	550
			120	680
			160	760
		7-2	20	165
			30	218
			40	271
			50	322
		7-3	10	30
			15	125
			20	203
			25	263

Table 6-10. (4/5) CONSTRUCTION COST FOR CERTAIN DISCHARGE IN THE RIVER IMPROVEMENT WORKS

Basin No.	River Name	Sub-Basin No.	Discharge (m^3/s)	Construction Cost (₡ million)
B-18 (Cont.)		8	150	365
			300	755
			450	1,080
			600	1,430
		10	210	560
			340	1,070
			470	1,370
			600	1,670
B-19	Lambare	1	30	106
			50	196
			70	260
			90	298
		2	20	270
			25	310
			50	520
			65	675
		3	200	60
			230	330
			260	470
			290	1,050
		4	150	1,175
			210	1,220
			270	1,295
			330	1,400
		5	- No Improvement -	
		6	- No Improvement -	
		7	200	590
			290	635
			380	700
			470	780
B-21	Villa Elisa	1	30	102
			40	138
			50	174
			60	211

Table 6-10. (5/5) CONSTRUCTION COST FOR CERTAIN DISCHARGE IN THE RIVER IMPROVEMENT WORKS

Basin No.	River Name	Sub-Basin No.	Discharge (m^3/s)	Construction Cost (¢ million)
B-21 (Cont.)		3	90	155
			120	240
			150	315
			180	395
B-22	Nemby	1	30	273
			50	425
			70	800
			90	1,090
B-23	San Lorenzo	1	60	375
			100	585
			180	1,130
			260	1,460
		2-1	10	80
			50	350
			90	610
			130	840
		2-2	10	55
			50	247
			90	357
			130	750
		2-3	10	-
			50	130
			90	253
			130	342
B-24	Tayazuape	1	80	390
			100	469
			120	555
			140	664
		3	140	1,080
			170	1,240
			200	1,428
			230	1,625
B-26	Zeballos Cue	1	10	8
			15	14
			20	19
B-27	Paso Cai	1	30	165
			50	263
			70	316
			95	408

Table 6-11. CONSTRUCTION COST PER UNIT AREA FOR DRAINAGE FACILITY WORKS IN THE MODEL BASIN

Return Period	Runoff Coefficient (%)	Construction Cost per Unit Area (¢ million)
10-year	40	6.3
	60	7.9
	80	9.6
5-year	40	5.2
	60	7.1
	80	8.5
2-year	40	4.6
	60	5.8
	80	6.8

Table 6-12 (1/5). CONSTRUCTION COST OF ALTERNATIVES FOR BASIC PLAN (CASE I)

(Unit: ¢ Million)

Basin Number	Name of Basin or River	River	Drainage Facilities	Total
1. Basins with River Channel				
B-2	Jardin	-	620	620
B-4	Jaen	590	2,530	3,120
B-6	Salamanca	230	1,320	1,550
B-7	Zanja Moroti	860	1,610	2,470
B-8	Ferreira	890	3,210	4,100
B-10	Las Mercedes	780	2,030	2,810
B-12	Bella Vista	-	750	750
B-14	Mburicao	5,800	15,860	21,660
B-15	Ycua Carrillo	1,720	3,920	5,640
B-16	Santa Rosa	1,120	2,380	3,500
B-17	Tres Puentes Cue	2,540	2,480	5,020
B-18	Itay	25,170	36,820	61,990
B-19	Lambare	7,530	26,470	34,000
B-21	Villa Elisa	1,000	8,090	9,090
B-22	Nemby	1,420	3,200	4,620
B-23	San Lorenzo	5,880	15,060	20,940
B-24	Tayazuape	3,930	5,780	9,710
B-26	Zeballos Cue	20	960	980
B-27	Paso Cai	660	3,680	4,340
	Sub-Total	60,140	136,770	196,910
2. Basins without River Channel /1				
B-1	Varadero	-	3,220	3,220
B-3	Centro	-	7,390	7,390
B-5	Tacumbu	-	1,150	1,150
B-9	Villa Universitaria	-	2,270	2,270
B-11	Mariscal Lopez	-	650	650
B-13	Tablada	-	1,020	1,020
B-20	Valle Apua	-	8,330	8,330
	Sub-Total	-	24,030	24,030
	Total	60,140	160,800	220,940

Note: /1 Only drainage facilities are applied to these basins because the cost is absolutely less than that of combination with detention facilities.

Table 6-12 (2/5). CONSTRUCTION COST OF ALTERNATIVES FOR BASIC PLAN (CASE II-1)

(Unit: ¢ Million)

Basin Number	Name of Basin or River	River	Drainage Facilities	Detention Facilities	Total
1. Basins With River Channel					
B-2	Jardin	-	600	110	710
B-4	Jaen	570	2,460	270	3,300
B-6	Salamanca	210	1,300	180	1,690
B-7	Zanja Moroti	800	1,580	100	2,480
B-8	Ferreira	840	3,110	490	4,440
B-10	Las Mercedes	730	1,970	230	2,930
B-12	Bella Vista	-	730	60	790
B-14	Mburicao	5,350	15,040	1,690	22,080
B-15	Ycua Carrillo	1,540	3,800	430	5,770
B-16	Santa Rosa	1,030	2,300	400	3,730
B-17	Tres Puentes Cue	2,280	2,420	410	5,110
B-18	Itay	23,870	35,730	2,960	62,560
B-19	Lambare	6,860	25,680	3,380	35,920
B-21	Villa Elisa	930	7,840	1,130	9,900
B-22	Nemby	1,360	3,100	420	4,880
B-23	San Lorenzo	5,770	14,560	2,280	22,610
B-24	Tayazuape	3,800	5,610	1,410	10,820
B-26	Zeballos Cue	20	940	60	1,020
B-27	Paso Cai	630	3,570	570	4,770
	Sub-Total	56,590	132,340	16,580	205,510
2. Basins Without River Channel /1					
B-1	Varadero	-	3,220	-	3,220
B-3	Centro	-	7,390	-	7,390
B-5	Tacumbu	-	1,150	-	1,150
B-9	Villa Universitaria	-	2,270	-	2,270
B-11	Mariscal Lopez	-	650	-	650
B-13	Tablada	-	1,020	-	1,020
B-20	Valle Apua	-	8,330	-	8,330
	Sub-Total	-	24,030	-	24,030
	Total	56,590	156,370	16,580	229,540

Note: /1 Only drainage facilities are applied to these basins because the cost is absolutely less than that of combination with detention facilities.

Table 6-12 (3/5). CONSTRUCTION COST OF ALTERNATIVES FOR BASIC PLAN (CASE II-2)

(Unit: ¢ Million)

Basin Number	Name of Basin or River	River	Drainage Facilities	Detention Facilities	Total
1. Basins With River Channel					
B-2	Jardin	-	570	360	930
B-4	Jaen	540	2,290	860	3,690
B-6	Salamanca	190	1,230	570	1,990
B-7	Zanja Moroti	720	1,500	280	2,500
B-8	Ferreira	750	2,910	1,560	5,220
B-10	Las Mercedes	540	1,840	720	3,100
B-12	Bella Vista	-	670	230	900
B-14	Mburicao	4,880	14,360	5,340	24,580
B-15	Ycua Carrillo	1,120	3,550	1,390	6,060
B-16	Santa Rosa	820	2,150	1,250	4,220
B-17	Tres Puentes Cue	1,730	2,260	1,320	5,310
B-18	Itay	20,880	33,190	9,390	63,460
B-19	Lambare	4,860	23,830	7,920	36,610
B-21	Villa Elisa	750	7,310	3,610	11,670
B-22	Nemby	1,200	2,900	1,340	5,440
B-23	San Lorenzo	4,990	13,590	7,240	25,820
B-24	Tayazuape	3,400	5,230	4,480	13,110
B-26	Zeballos Cue	10	920	190	1,120
B-27	Paso Cai	510	3,330	1,800	5,640
	Sub-Total	47,890	123,630	49,850	221,370
2. Basins Without River Channel /1					
B-1	Varadero	-	3,220	-	3,220
B-3	Centro	-	7,390	-	7,390
B-5	Tacumbu	-	1,150	-	1,150
B-9	Villa Universitaria	-	2,270	-	2,270
B-11	Mariscal Lopez	-	650	-	650
B-13	Tablada	-	1,020	-	1,020
B-20	Valle Apua	-	8,330	-	8,330
	Sub-Total	-	24,030	-	24,030
	Total	47,890	147,660	49,850	245,400

Note: /1 Only drainage facilities are applied to these basins because the cost is absolutely less than that of combination with detention facilities.

Table 6-12 (4/5). CONSTRUCTION COST OF ALTERNATIVES FOR BASIC PLAN (CASE III-1)

(Unit: ₡ Million)

Basin Number	Name of Basin or River	River	Drainage Facilities	Detention Facilities	Total
1.	Basins With River Channel				
B-2	Jardin	-	600	60	660
B-4	Jaen	570	2,450	180	3,200
B-6	Salamanca	210	1,300	110	1,620
B-7	Zanja Moroti	800	1,580	80	2,460
B-8	Ferreira	840	3,100	330	4,270
B-10	Las Mercedes	730	1,970	150	2,850
B-12	Bella Vista	-	730	50	780
B-14	Mburicao	5,350	15,040	1,180	21,570
B-15	Ycua Carrillo	1,540	3,790	390	5,720
B-16	Santa Rosa	1,030	2,310	280	3,620
B-17	Tres Puentes Cue	2,280	2,420	380	5,080
B-18	Itay	23,870	35,730	2,590	62,190
B-19	Lambare	6,860	25,680	2,460	35,000
B-21	Villa Elisa	930	7,830	870	9,630
B-22	Nemby	1,360	3,110	290	4,760
B-23	San Lorenzo	5,770	14,550	1,760	22,080
B-24	Tayazuape	3,800	5,610	1,100	10,510
B-26	Zeballos Cue	20	940	40	1,000
B-27	Paso Cai	630	3,570	430	4,630
	Sub-Total	56,590	132,310	12,730	201,630
2.	Basins Without River Channel /1				
B-1	Varadero	-	3,220	-	3,220
B-3	Centro	-	7,390	-	7,390
B-5	Tacumbu	-	1,150	-	1,150
B-9	Villa Universitaria	-	2,270	-	2,270
B-11	Mariscal Lopez	-	650	-	650
B-13	Tablada	-	1,020	-	1,020
B-20	Valle Apua	-	8,330	-	8,330
	Sub-Total	-	24,030	-	24,030
	Total	56,590	156,340	12,730	225,660

Note: /1 Only drainage facilities are applied to these basins because the cost is absolutely less than that of combination with detention facilities.

Table 6-12 (5/5). CONSTRUCTION COST OF ALTERNATIVES FOR BASIC PLAN (CASE III-2)

(Unit: ¢ Million)

Basin Number	Name of Basin or River	River	Drainage Facilities	Detention Facilities	Total
1. Basins With River Channel					
B-2	Jardin	-	560	230	790
B-4	Jaen	540	2,290	580	3,410
B-6	Salamanca	190	1,220	380	1,790
B-7	Zanja Moroti	720	1,500	260	2,480
B-8	Ferreira	750	2,910	1,050	4,710
B-10	Las Mercedes	540	1,840	470	2,850
B-12	Bella Vista	-	680	180	860
B-14	Mburicao	4,880	14,360	3,740	22,980
B-15	Ycua Carrillo	1,120	3,550	1,230	5,900
B-16	Santa Rosa	820	2,150	900	3,870
B-17	Tres Puentes Cue	1,730	2,260	1,190	5,180
B-18	Itay	20,880	33,190	8,230	62,300
B-19	Lambare	4,860	23,830	5,770	34,460
B-21	Villa Elisa	750	7,310	2,770	10,830
B-22	Nemby	1,200	2,900	950	5,050
B-23	San Lorenzo	4,990	13,590	5,550	24,130
B-24	Tayazuape	3,400	5,230	3,490	12,120
B-26	Zeballos Cue	10	930	130	1,070
B-27	Paso Cai	510	3,330	1,390	5,230
	Sub-Total	47,890	123,630	38,490	210,010
2. Basins Without River Channel /1					
B-1	Varadero	-	3,220	-	3,220
B-3	Centro	-	7,390	-	7,390
B-5	Tacumbu	-	1,150	-	1,150
B-9	Villa Universitaria	-	2,270	-	2,270
B-11	Mariscal Lopez	-	650	-	650
B-13	Tablada	-	1,020	-	1,020
B-20	Valle Apua	-	8,330	-	8,330
	Sub-Total	-	24,030	-	24,030
	Total	47,890	147,660	38,490	234,040

Note: /1 Only drainage facilities are applied to these basins because the cost is absolutely less than that of combination with detention facilities.

Table 6-13. CONSTRUCTION COST OF PROPOSED STORM WATER CONTROLO SYSTEM FOR BASIC PLAN

(Unit: ¢ Million)

Basin Number	Name of Basin or River	River	Drainage Facilities	Detention Facilities	Total
B-1	Varadero	-	3,220	-	3,220
B-2	Jardin	-	620	-	620
B-3	Centro	-	7,390	-	7,390
B-4	Jaen	550	2,480	440	3,470
B-5	Tacumbu	-	1,150	-	1,150
B-6	Salamanca	230	1,320	-	1,550
B-7	Zanja Moroti	710	1,590	310	2,610
B-8	Ferreira	820	3,140	850	4,810
B-9	Villa Universitaria	-	2,270	-	2,270
B-10	Las Mercedes	570	1,980	460	3,010
B-11	Mariscal Lopez	-	650	-	650
B-12	Bella Vista	-	750	-	750
B-13	Tablada	-	1,020	-	1,020
B-14	Mburicao	3,810	14,860	3,240	21,910
B-15	Ycua Carrillo	1,130	3,530	1,320	5,980
B-16	Santa Rosa	920	2,190	620	3,730
B-17	Tres Puentes Cue	2,540	2,480	-	5,020
B-18	Itay	21,290	34,450	8,280	64,020
B-19	Lambare	5,780	24,010	7,780	37,570
B-20	Valle Apua	-	8,330	-	8,330
B-21	Villa Elisa	1,000	8,090	-	9,090
B-22	Nemby	1,420	3,200	-	4,620
B-23	San Lorenzo	5,880	15,060	-	20,940
B-24	Tayazuape	3,930	5,780	-	9,710
B-26	Zeballos Cue	20	960	-	980
B-27	Paso Cai	660	3,680	-	4,340
	Total	51,260	154,200	23,300	228,760

Table 6-14 (1/9). CONSTRUCTION COST OF ALTERNATIVES FOR MASTER PLAN (RETURN PERIOD: 2-YEAR)

(Unit: ₡ Million)

Basin Number	Name of Basin or River	Case I-1	Case I-2/2	Case I-3/2
1.	Basins With River Channel			
B-2	Jardin	440	540	500
B-4	Jaen	2,220	2,470	2,350
B-6	Salamanca	1,110	1,240	1,180
B-7	Zanja Moroti	1,700	1,780	1,760
B-8	Ferreira	3,050	3,910	3,580
B-10	Las Mercedes	1,820	2,100	1,990
B-12	Bella Vista	550	650	630
B-14	Mburicao	14,260	16,590	15,230
B-15	Ycua Carrillo	2,930	3,920	3,730
B-16	Santa Rosa	2,330	3,120	2,760
B-17	Tres Puentes Cue	2,820	3,490	3,370
B-18	Itay	37,160	41,580	40,060
B-19	Lambare	23,410	30,130	27,170
B-21	Villa Elisa	6,490	8,630	7,900
B-22	Nemby	3,110	4,250	3,740
B-23	San Lorenzo	14,430	19,410	17,820
B-24	Tayazuape	4,950	9,510	8,280
B-26	Zeballos Cue	700	980	890
B-27	Paso Cai	3,100	5,170	4,530
	Sub-Total	126,580	159,470	147,470
2.	Basins Without River Channel/1			
B-1	Varadero	2,350	2,350	2,350
B-3	Centro	1,630	1,630	1,630
B-5	Tacumbu	840	840	840
B-9	Villa Universitaria	1,660	1,660	1,660
B-11	Mariscal Lopez	480	480	480
B-13	Tablada	740	740	740
B-20	Valle Apua	6,150	6,150	6,150
	Sub-Total	13,850	13,850	13,850
	Total	140,430	173,320	161,320

Note: /1 Only drainage facilities are applied to these basins in all the study cases, because the cost is absolutely less than that of the combination with detention facilities.

/2 Costs have been estimated on the assumption that the runoff discharge under the land use condition as of 1984 is confined by drainage system and the incremental discharge for future urbanization up to 2005 by detention facilities.

Table 6-14 (2/9) CONSTRUCTION COST OF ALTERNATIVES FOR MASTER PLAN (RETURN PERIOD: 3-YEAR)

(Unit: ₡ Million)

Basin Number	Name of Basin or River	Case I-1	Case I-2/2	Case I-3/2
1. Basins With River Channel				
B-2	Jardin	500	610	560
B-4	Jaen	2,560	2,870	2,730
B-6	Salamanca	1,260	1,400	1,340
B-7	Zanja Moroti	1,920	2,010	1,970
B-8	Ferreira	3,330	4,270	3,910
B-10	Las Mercedes	2,100	2,340	2,220
B-12	Bella Vista	620	730	700
B-14	Mburicao	16,220	18,900	17,330
B-15	Ycua Carrillo	4,030	4,720	4,500
B-16	Santa Rosa	2,650	3,510	3,110
B-17	Tres Puentes Cue	3,220	3,800	3,690
B-18	Itay	47,670	50,430	48,640
B-19	Lambare	26,050	35,090	31,320
B-21	Villa Elisa	7,300	10,780	9,750
B-22	Nemby	3,620	5,110	4,470
B-23	San Lorenzo	16,450	22,320	20,420
B-24	Tayazuape	7,470	13,490	11,920
B-26	Zeballos Cue	800	1,090	1,000
B-27	Paso Cai	3,470	5,790	5,080
	Sub-Total	151,240	189,260	174,660
2. Basins Without River Channel/1				
B-1	Varadero	2,640	2,640	2,640
B-3	Centro	1,820	1,820	1,820
B-5	Tacumbu	940	940	940
B-9	Villa Universitaria	1,860	1,860	1,860
B-11	Mariscal Lopez	540	540	540
B-13	Tablada	840	840	840
B-20	Valle Apua	6,840	6,840	6,840
	Sub-Total	15,480	15,480	15,480
	Total	166,720	204,740	190,140

Note: /1 Only drainage facilities are applied to these basins in all the study cases, because the cost is absolutely less than that of the combination with detention facilities.

/2 Costs have been estimated on the assumption that the runoff discharge under the land use condition as of 1984 is confined by drainage system and the incremental discharge for future urbanization up to 2005 by detention facilities.

Table 6-14 (3/9) CONSTRUCTION COST OF ALTERNATIVES FOR MASTER PLAN (RETURN PERIOD: 5-YEAR)

(Unit: ₡ Million)

Basin Number	Name of Basin or River	Case I-1	Case I-2/2	Case I-3/2
1.	Basins With River Channel			
B-2	Jardin	560	660	630
B-4	Jaen	2,820	3,260	3,090
B-6	Salamanca	1,390	1,550	1,480
B-7	Zanja Moroti	2,170	2,300	2,250
B-8	Ferreira	3,650	4,810	4,380
B-10	Las Mercedes	2,030	3,030	2,850
B-12	Bella Vista	670	810	780
B-14	Mburicao	19,240	22,540	20,510
B-15	Ycua Carrillo	4,660	5,330	5,100
B-16	Santa Rosa	2,960	4,070	3,610
B-17	Tres Puentes Cue	3,990	4,480	4,320
B-18	Itay	54,060	62,040	59,770
B-19	Lambare	28,700	38,150	34,130
B-21	Villa Elisa	8,060	11,700	10,610
B-22	Nemby	4,090	5,800	5,040
B-23	San Lorenzo	18,580	26,300	23,880
B-24	Tayazuape	8,630	16,720	14,610
B-26	Zeballos Cue	880	1,210	1,110
B-27	Paso Cai	3,840	6,410	5,620
	Sub-Total	170,980	221,170	203,770
2.	Basins Without River Channel/1			
B-1	Varadero	2,910	2,910	2,910
B-3	Centro	2,010	2,010	2,010
B-5	Tacumbu	1,030	1,030	1,030
B-9	Villa Universitaria	2,050	2,050	2,050
B-11	Mariscal Lopez	580	580	580
B-13	Tablada	920	920	920
B-20	Valle Apua	7,520	7,520	7,520
	Sub-Total	17,020	17,020	17,020
	Total	188,000	238,190	220,790

Note: /1 Only drainage facilities are applied to these basins in all the study cases, because the cost is absolutely less than that of the combination with detention facilities.

/2 Costs have been estimated on the assumption that the runoff discharge under the land use condition as of 1984 is confined by drainage system and the incremental discharge for future urbanization up to 2005 by detention facilities.

Table 6-14 (4/9) CONSTRUCTION COST OF ALTERNATIVES FOR MASTER PLAN (RETURN PERIOD: 2-YEAR)

(Unit: ¢ Million)

Basin Number	Name of Basin or River	Case II-1	Case II-2/2	Case II-3/2
1. Basins With River Channel				
B-2	Jardin	50	50	50
B-4	Jaen	940	980	960
B-6	Salamanca	170	190	180
B-7	Zanja Moroti	580	590	580
B-8	Ferreira	1,640	1,810	1,760
B-10	Las Mercedes	320	440	410
B-12	Bella Vista	130	160	150
B-14	Mburicao	6,050	6,600	6,330
B-15	Ycua Carrillo	940	2,160	1,730
B-16	Santa Rosa	620	1,280	1,100
B-17	Tres Puentes Cue	1,090	1,840	1,560
B-18	Itay	17,920	21,270	20,060
B-19	Lambare	8,430	14,610	13,040
B-21	Villa Elisa	430	2,230	1,760
B-22	Nemby	640	1,590	1,350
B-23	San Lorenzo	2,820	5,830	5,670
B-24	Tayazuape	1,950	4,790	4,110
B-26	Zeballos Cue	10	180	130
B-27	Paso Cai	390	2,470	1,970
	Sub-Total	45,120	69,070	62,900
2. Basins Without River Channel/1				
B-1	Varadero	440	440	440
B-3	Centro	-	-	-
B-5	Tacumbu	130	130	130
B-9	Villa Universitaria	20	20	20
B-11	Mariscal Lopez	230	230	230
B-13	Tablada	130	130	130
B-20	Valle Apua	-	-	-
	Sub-Total	950	950	950
	Total	46,070	70,020	63,850

Note: /1 Only drainage facilities are applied to these basins in all the study cases, because the cost is absolutely less than that of the combination with detention facilities.

/2 Costs have been estimated on the assumption that the runoff discharge under the land use condition as of 1984 is confined by drainage system and the incremental discharge for future urbanization up to 2005 by detention facilities.

Table 6-14 (5/9) CONSTRUCTION COST OF ALTERNATIVES FOR MASTER PLAN (RETURN PERIOD: 3-YEAR)

(Unit: ₡ Million)

Basin Number	Name of Basin or River	Case II-1	Case II-2/2	Case II-3/2
1.	Basins With River Channel			
B-2	Jardin	60	60	60
B-4	Jaen	1,090	1,180	1,130
B-6	Salamanca	210	230	220
B-7	Zanja Moroti	650	660	660
B-8	Ferreira	1,840	2,020	1,960
B-10	Las Mercedes	390	500	460
B-12	Bella Vista	160	180	170
B-14	Mburicao	7,520	8,890	8,400
B-15	Ycua Carrillo	1,160	2,560	2,050
B-16	Santa Rosa	760	1,710	1,470
B-17	Tres Puentes Cue	1,260	2,220	1,870
B-18	Itay	21,790	25,060	23,730
B-19	Lambare	9,420	15,670	14,030
B-21	Villa Elisa	540	2,930	2,380
B-22	Nemby	840	2,070	1,760
B-23	San Lorenzo	3,540	7,550	7,320
B-24	Tayazuape	2,330	6,550	5,560
B-26	Zeballos Cue	10	240	180
B-27	Paso Cai	430	2,790	2,240
	Sub-Total	54,000	83,070	75,650
2.	Basins Without River Channel/1			
B-1	Varadero	520	520	520
B-3	Centro	-	-	-
B-5	Tacumbu	150	150	150
B-9	Villa Universitaria	20	20	20
B-11	Mariscal Lopez	250	250	250
B-13	Tablada	150	150	150
B-20	Valle Apua	-	-	-
	Sub-Total	1,090	1,090	1,090
	Total	55,090	84,160	76,740

Note: /1 Only drainage facilities are applied to these basins in all the study cases, because the cost is absolutely less than that of the combination with detention facilities.

/2 Costs have been estimated on the assumption that the runoff discharge under the land use condition as of 1984 is confined by drainage system and the incremental discharge for future urbanization up to 2005 by detention facilities.

Table 6-14 (6/9) CONSTRUCTION COST OF ALTERNATIVES FOR MASTER PLAN (RETURN PERIOD: 5-YEAR)

(Unit: ¢ Million)

Basin Number	Name of Basin or River	Case II-1	Case II-2/2	Case II-3/2
1.	Basins With River Channel			
B-2	Jardin	60	60	60
B-4	Jaen	1,260	1,380	1,320
B-6	Salamanca	240	260	250
B-7	Zanja Moroti	790	790	790
B-8	Ferreira	2,050	2,290	2,210
B-10	Las Mercedes	520	940	880
B-12	Bella Vista	160	190	180
B-14	Mburicao	9,420	11,000	10,390
B-15	Ycua Carrillo	1,580	3,350	2,720
B-16	Santa Rosa	890	2,080	1,800
B-17	Tres Puentes Cue	1,440	2,580	2,180
B-18	Itay	26,190	30,460	28,820
B-19	Lambare	10,030	18,110	16,070
B-21	Villa Elisa	660	3,660	2,970
B-22	Nemby	980	2,410	2,040
B-23	San Lorenzo	4,310	9,380	9,090
B-24	Tayazuape	2,680	7,370	6,270
B-26	Zeballos Cue	10	280	200
B-27	Paso Cai	490	3,490	2,800
	Sub-Total	63,760	100,080	91,040
2.	Basins Without River Channel/1			
B-1	Varadero	560	560	560
B-3	Centro	-	-	-
B-5	Tacumbu	170	170	170
B-9	Villa Universitaria	20	20	20
B-11	Mariscal Lopez	310	310	310
B-13	Tablada	160	160	160
B-20	Valle Apua	-	-	-
	Sub-Total	1,220	1,220	1,220
	Total	64,980	101,300	92,260

Note: /1 Only drainage facilities are applied to these basins in all the study cases, because the cost is absolutely less than that of the combination with detention facilities.

/2 Costs have been estimated on the assumption that the runoff discharge under the land use condition as of 1984 is confined by drainage system and the incremental discharge for future urbanization up to 2005 by detention facilities.

Table 6-14 (7/9) CONSTRUCTION COST OF ALTERNATIVES FOR MASTER PLAN (RETURN PERIOD: 2-YEAR)

(Unit: ¢ Million)

Basin Number	Name of Basin or River	Case III-1	Case III-2/1	Case III-3/1
1. Basins With River Channel				
B-2	Jardin	-	-	-
B-4	Jaen	-	-	-
B-6	Salamanca	-	-	-
B-7	Zanja Moroti	-	-	-
B-8	Ferreira	-	-	-
B-10	Las Mercedes	20	150	100
B-12	Bella Vista	-	-	-
B-14	Mburicao	3,420	4,590	4,300
B-15	Ycua Carrillo	-	-	-
B-16	Santa Rosa	350	1,070	870
B-17	Tres Puentes Cue	-	-	-
B-18	Itay	10,320	15,080	13,870
B-19	Lambare	4,300	11,200	9,620
B-21	Villa Elisa	-	-	-
B-22	Nemby	-	-	-
B-23	San Lorenzo	-	-	-
B-24	Tayazuape	-	-	-
B-26	Zeballos Cue	-	-	-
B-27	Paso Cai	-	-	-
	Sub-Total	18,410	32,090	28,760
2. Basins Without River Channel*				
B-1	Varadero	-	-	-
B-3	Centro	-	-	-
B-5	Tacumbu	-	-	-
B-9	Villa Universitaria	-	-	-
B-11	Mariscal Lopez	-	-	-
B-13	Tablada	-	-	-
B-20	Valle Apua	-	-	-
	Sub-Total	-	-	-
	Total	18,410	32,090	28,760

Note: /1 Costs have been estimated on the assumption that the runoff discharge under the land use condition as of 1984 is controlled by drainage system and the incremental discharge for future urbanization up to 2005 by detention facilities.

Table 6-14 (8/9) CONSTRUCTION COST OF ALTERNATIVES FOR MASTER PLAN (RETURN PERIOD: 3-YEAR)

(Unit: ¢ Million)

Basin Number	Name of Basin or River	Case III-1	Case III-2/1	Case III-3/1
1. Basins With River Channel				
B-2	Jardin	-	-	-
B-4	Jaen	-	-	-
B-6	Salamanca	-	-	-
B-7	Zanja Moroti	-	-	-
B-8	Ferreira	-	-	-
B-10	Las Mercedes	20	160	110
B-12	Bella Vista	-	-	-
B-14	Mburicao	4,380	6,590	6,070
B-15	Ycua Carrillo	-	-	-
B-16	Santa Rosa	550	1,400	1,160
B-17	Tres Puentes Cue	-	-	-
B-18	Itay	12,630	18,840	17,310
B-19	Lambare	4,680	11,820	10,170
B-21	Villa Elisa	-	-	-
B-22	Nemby	-	-	-
B-23	San Lorenzo	-	-	-
B-24	Tayazuape	-	-	-
B-26	Zeballos Cue	-	-	-
B-27	Paso Cai	-	-	-
	Sub-Total	22,260	38,810	34,820
2. Basins Without River Channel				
B-1	Varadero	-	-	-
B-3	Centro	-	-	-
B-5	Tacumbu	-	-	-
B-9	Villa Universitaria	-	-	-
B-11	Mariscal Lopez	-	-	-
B-13	Tablada	-	-	-
B-20	Valle Apua	-	-	-
	Sub-Total	-	-	-
	Total	22,260	38,810	34,820

Note: /1 Costs have been estimated on the assumption that the runoff discharge under the land use condition as of 1984 is controlled by drainage system and the incremental discharge for future urbanization up to 2005 by detention facilities.

Table 6-14 (9/9) CONSTRUCTION COST OF ALTERNATIVES FOR MASTER PLAN (RETURN PERIOD: 5-YEAR)

(Unit: ¢ Million)

Basin Number	Name of Basin or River	Case III-1	Case III-2/1	Case III-3/1
1.	Basins With River Channel			
B-2	Jardin	-	-	-
B-4	Jaen	-	-	-
B-6	Salamanca	-	-	-
B-7	Zanja Moroti	-	-	-
B-8	Ferreira	-	-	-
B-10	Las Mercedes	30	210	160
B-12	Bella Vista	-	-	-
B-14	Mburicao	5,590	8,710	8,050
B-15	Ycua Carrillo	-	-	-
B-16	Santa Rosa	740	1,660	1,390
B-17	Tres Puentes Cue	-	-	-
B-18	Itay	15,020	22,950	21,040
B-19	Lambare	5,570	13,930	11,880
B-21	Villa Elisa	-	-	-
B-22	Nemby	-	-	-
B-23	San Lorenzo	-	-	-
B-24	Tayazuape	-	-	-
B-26	Zeballos Cue	-	-	-
B-27	Paso Cai	-	-	-
	Sub-Total	26,950	47,460	42,520
2.	Basins Without River Channel			
B-1	Varadero	-	-	-
B-3	Centro	-	-	-
B-5	Tacumbu	-	-	-
B-9	Villa Universitaria	-	-	-
B-11	Mariscal Lopez	-	-	-
B-13	Tablada	-	-	-
B-20	Valle Apua	-	-	-
	Sub-Total	-	-	-
	Total	26,950	47,460	42,520

Note: /1 Costs have been estimated on the assumption that the runoff discharge under the land use condition as of 1984 is controlled by drainage system and the incremental discharge for future urbanization up to 2005 by detention facilities.

Table 6-15 CONSTRUCTION COST OF PROPOSED STORM WATER CONTROL SYSTEM FOR MASTER PLAN

(Unit: ₡ Million)

Basin Number	Name of Basin or River	River	Drainage Facilities	Detention Facilities	Total
1. Sub-Projects for 1986-1995 Execution					
B-14	Mburicao	2,500	4,190	-	6,690
B-18	Itay (Upstream of Aviadores del Chaco Avenue)	10,430	4,420	-	14,850
B-19	Lambare	3,440	4,830	-	8,270
	Sub-Total	16,370	13,440	-	29,810
2. Sub-Projects for 1996-2005 Execution					
B-1	Varadero	-	520	-	520
B-2	Jardin	-	60	-	60
B-3	Centro	-	-		-
B-4	Jaen	410	680	-	1,090
B-5	Tacumbu	-	150	-	150
B-6	Salamanca	160	50	-	210
B-7	Zanja Moroti	560	90	-	650
B-8	Ferreira	730	1,110	-	1,840
B-9	Villa Universitaria	-	20	-	20
B-10	Las Mercedes	370	20	-	390
B-11	Mariscal Lopez	-	250	-	250
B-12	Bella Vista	-	160	-	160
B-13	Tablada	-	150	-	150
B-14	Mburicao	-	-	1,330	1,330
B-15	Ycua Carrillo	610	550	-	1,160
B-16	Santa Rosa	640	120	-	760
B-17	Tres Puentes Cue	1,050	210	-	1,260
B-18	Itay (Downstream of Aviadores del Chaco Avenue	3,530	-	4,680	8,210
B-19	Lambare	-	-	4,180	4,180
B-20	Valle Apua	-	-	-	-
B-21	Villa Elisa	540	-	-	540
B-22	Nemby	840	-	-	840
B-23	San Lorenzo	3,540	-	-	3,540
B-24	Tayazuape	2,330	-	-	2,330
B-26	Zeballos Cue	10	-	-	10
B-27	Paso Cai	430	-	-	430
	Sub-Total	15,750	4,140	10,190	30,080
	Total	32,120	17,580	10,190	59,890

Table 6-16. CONSTRUCTION COST OF ALTERNATIVES FOR FIRST STAGE PROJECT

(Unit: ¢ Million)

Alternative Plan	River Channel	Diversion Channel	Retarding Basin	Drainage Facilities	Total
A-1	70	-	-	29	99
A-2	-	-	-	242	242
B-1	603	-	-	1,941	2,544
B-2	349	-	-	3,215	3,564
B-3	573	-	-	2,032	2,605
B-4	573	-	-	1,982	2,555
B-2 & B-3	191	-	-	3,306	3,497
B-2 & B-4	191	-	-	3,256	3,447
C-1	295	-	-	928	1,223
C-2	169	-	-	1,218	1,387
D-1	112	-	-	-	112
D-2	187	-	-	-	187
E-1	2,763	-	-	-	2,763
E-2	2,190	710	-	-	2,900
E-3	2,529	838	-	-	3,367
F-1	1,497	-	-	-	1,497
F-2	1,350	-	290	-	1,640
F-3	1,412	-	110	-	1,522
F-2 & F-3	1,265	-	400	-	1,665

Table 6-17. CONSTRUCTION COST OF PROPOSED PLAN FOR FIRST STAGE PROJECT

(Unit: ¢ thousand)

Work Item	Unit	Quantity/1	F.C.	L.C.	Total
1. Civil Works					
River Improvement Works					
- Excavation	m3	947,600	395,140	163,008	558,148
- Backfilling of Earth	m3	71,900	10,425	77,787	88,212
- Embankment	m3	27,100	6,475	1,449	7,924
- Spoil	m3	848,600	510,692	101,286	611,978
- Revetment	m3	65,600	615,453	1,047,413	1.662,866
- Gravel Backfilling for Revetment	m3	36,690	97,098	139,683	236,781
- Invert	m3	2,470	23,057	36,123	59,180
- Box Culvert	m	2,663	2,733,760	1,258,663	3,992,423
- Groundsill	pc.	39	10,524	12,690	23,214
- Bridge	pc.	48	689,187	267,416	956,603
- Sodding	m2	28,200	-	37,749	37,749
- Maintenance Road	m2	37,950	19,809	42,117	61,926
Sub-Total			5,111,620	3,185,385	8,297,005
Drainage Facilities					
- Excavation	m3	300,700	147,229	252,959	400,188
- Backfilling of Earth	m3	116,600	43,288	109,920	153,208
- Spoil	m3	184,100	110,781	21,972	132,753
- Box Culvert	m	6,230	1,475,932	722,789	2,198,721
- Piping	m	5,980	475,231	262,598	737,829
- Open Channel	m	6,740	546,802	657,944	1,204,746
- Manhole	pc.	124	48,682	30,163	78,845
- Inlet (Independent Type)	pc.	278	457,403	356,486	813,889
- Inlet (Continuous Type)	m	3,550	157,808	113,336	271,144
- Outlet	pc.	24	10,096	16,953	27,049
- Restoration of Pavement	m2	55,170	306,871	12,002	426,873
Sub-Total			3,780,123	2,665,122	6,445,245
Total of 1			8,891,743	5,850,507	14,742,250
2. Compensation					
House Evacuation	pc.	77	-	568,800	568,800
Land Acquisition	m2	163,800	-	885,946	885,946
3. Engineering Services	l.s.		3,022,000	342,200	3,364,200
Total of 1, 2 and 3			11,913,743	7,647,453	19,561,196
4. Physical Contingency (10% of Total of 1 to 3)	l.s		1,191,374	764,745	1,956,119
Total of 1 to 4			13,105,117	8,412,198	21,517,315
5. Price Contingency (None for F.C.; 10% for L.C.)	l.s		-	5,985,140	5,985,140
Grand Total			13,105,117	14,397,338	27,502,455

Note: The quantities of relative improvement works to secure the transportation alone the Artigas Avenue are also included.

Table 6-18 ANNUAL DISBURSEMENT SCHEDULE FOR FIRST STAGE PROJECT

(Unit: ₵ million)

Item	1988		1989		1990		1991		1992		1993		Grand Total		
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	Total
1. River Improvement Works	-	-	-	-	567	253	3,228	1,686	652	653	665	593	5,112	3,185	8,297
2. Drainage Facility Works	-	-	-	-	1,080	959	-	-	1,802	1,084	898	623	3,780	2,665	6,445
3. House Evacuation	-	-	-	-	-	-	-	158	-	173	-	238	-	569	569
4. Land Acquisition	-	-	-	-	-	-	-	198	-	411	-	277	-	886	886
5. Engineering Services	467	52	467	52	522	60	522	60	522	60	522	60	3,022	342	3,364
Total of 1 to 5	467	52	467	52	2,169	1,271	3,750	2,103	2,975	2,380	2,085	1,790	11,914	7,647	19,561
6. Physical Contingency (10% of Total of 1 to 5)	47	5	47	5	217	127	375	210	298	238	209	179	1,191	765	1,956
Total of 1 to 6	514	57	514	57	2,386	1,399	4,125	2,313	3,273	2,618	2,294	1,968	13,105	14,397	21,517
7. Price Contingency (None for F.C.; 10% for L.C.)	-	12	-	19	-	649	-	1,413	-	2,021	-	1,871	-	5,985	5,985
Total	514	69	514	76	2,386	2,047	4,125	3,726	3,273	4,639	2,294	3,840	13,105	14,397	27,502

FIGURES

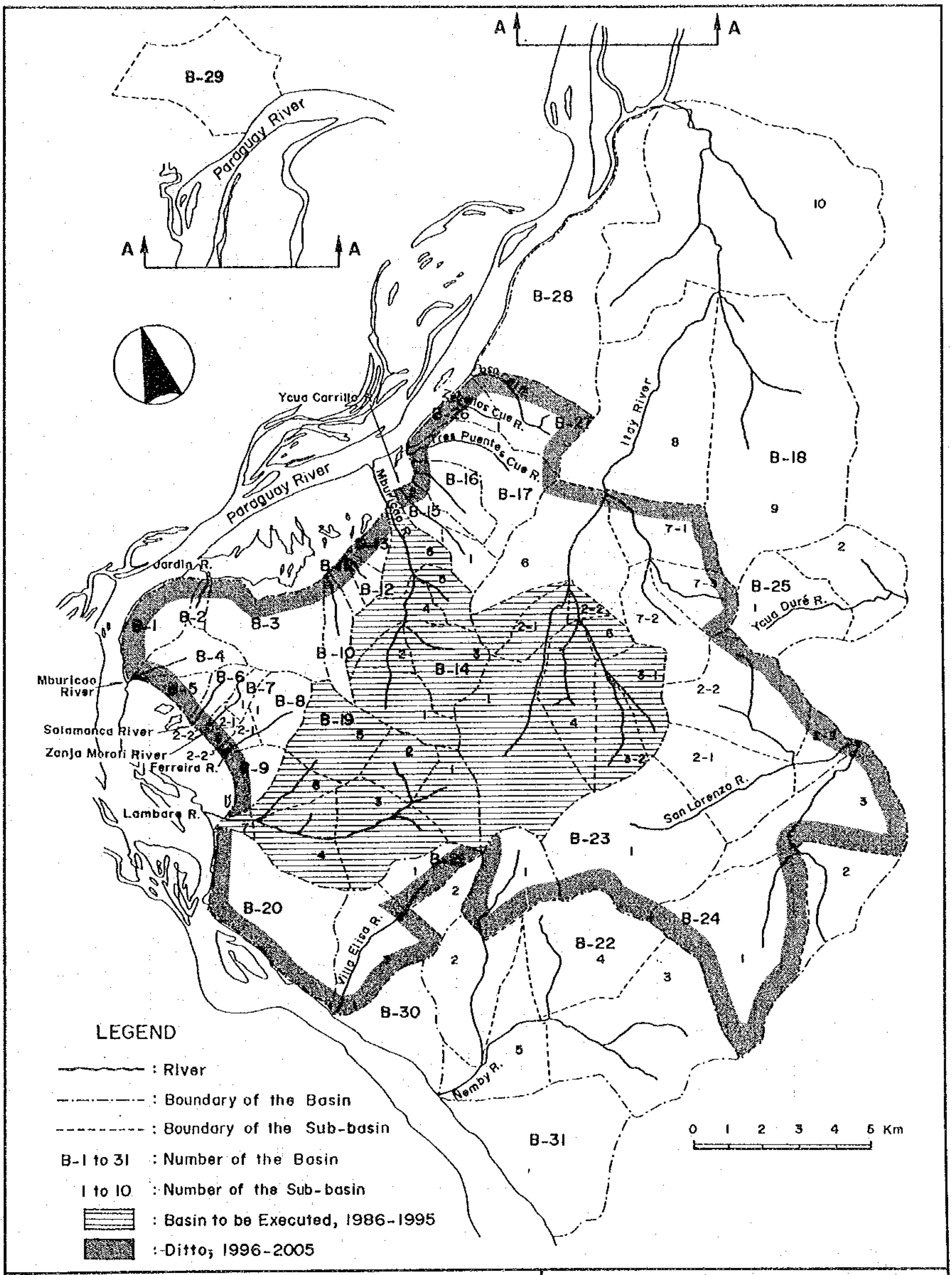


Fig. 6-1 BASINS FOR CONSTRUCTION OF THE MASTER PLAN

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

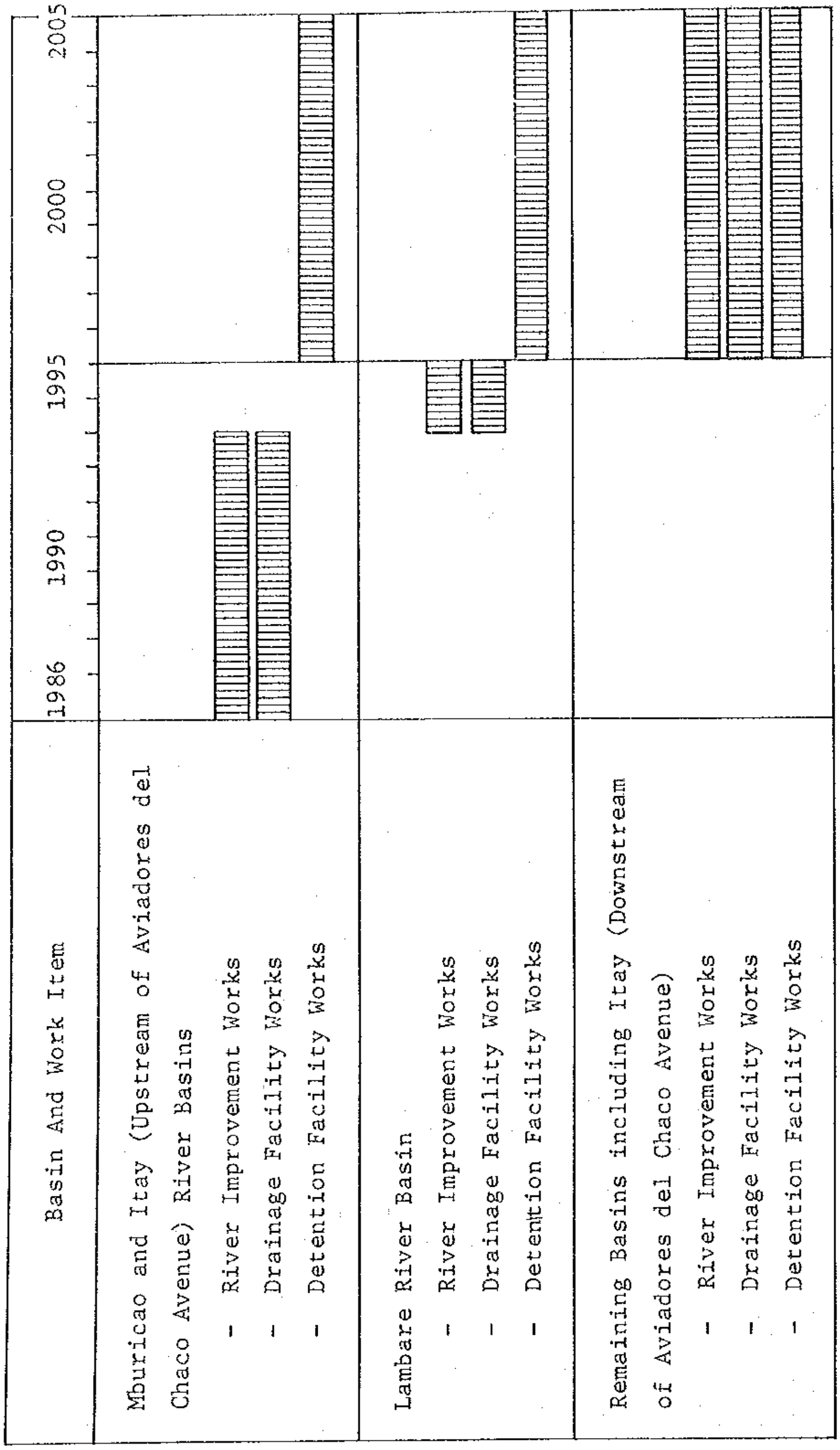


Fig. 6-2 IMPREMENTATION SCHEDULE FOR THE MASTER PLAN

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

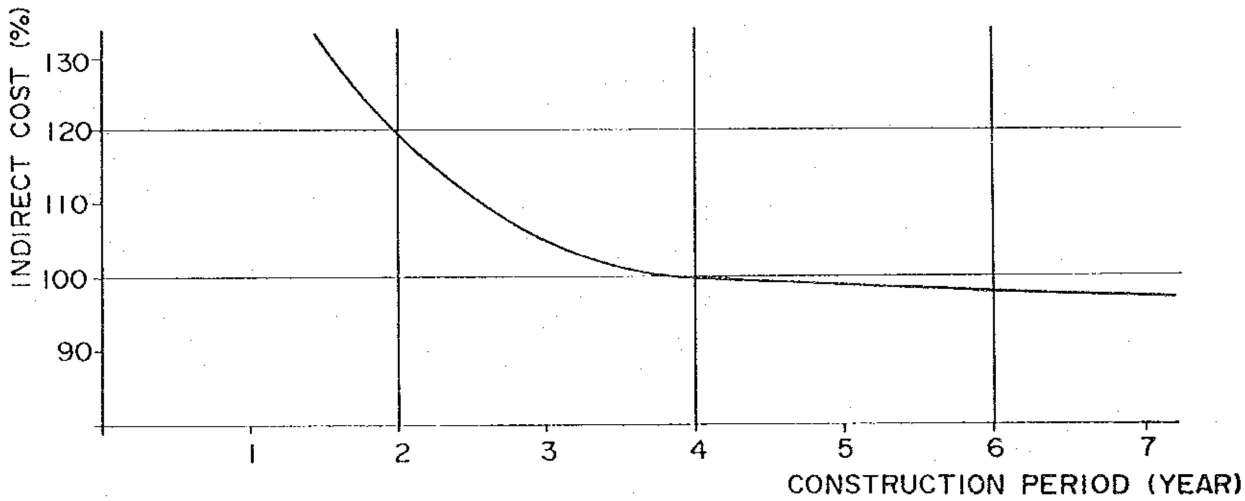


Fig. 6-3 RELATION BETWEEN CONSTRUCTION PERIOD AND COST

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

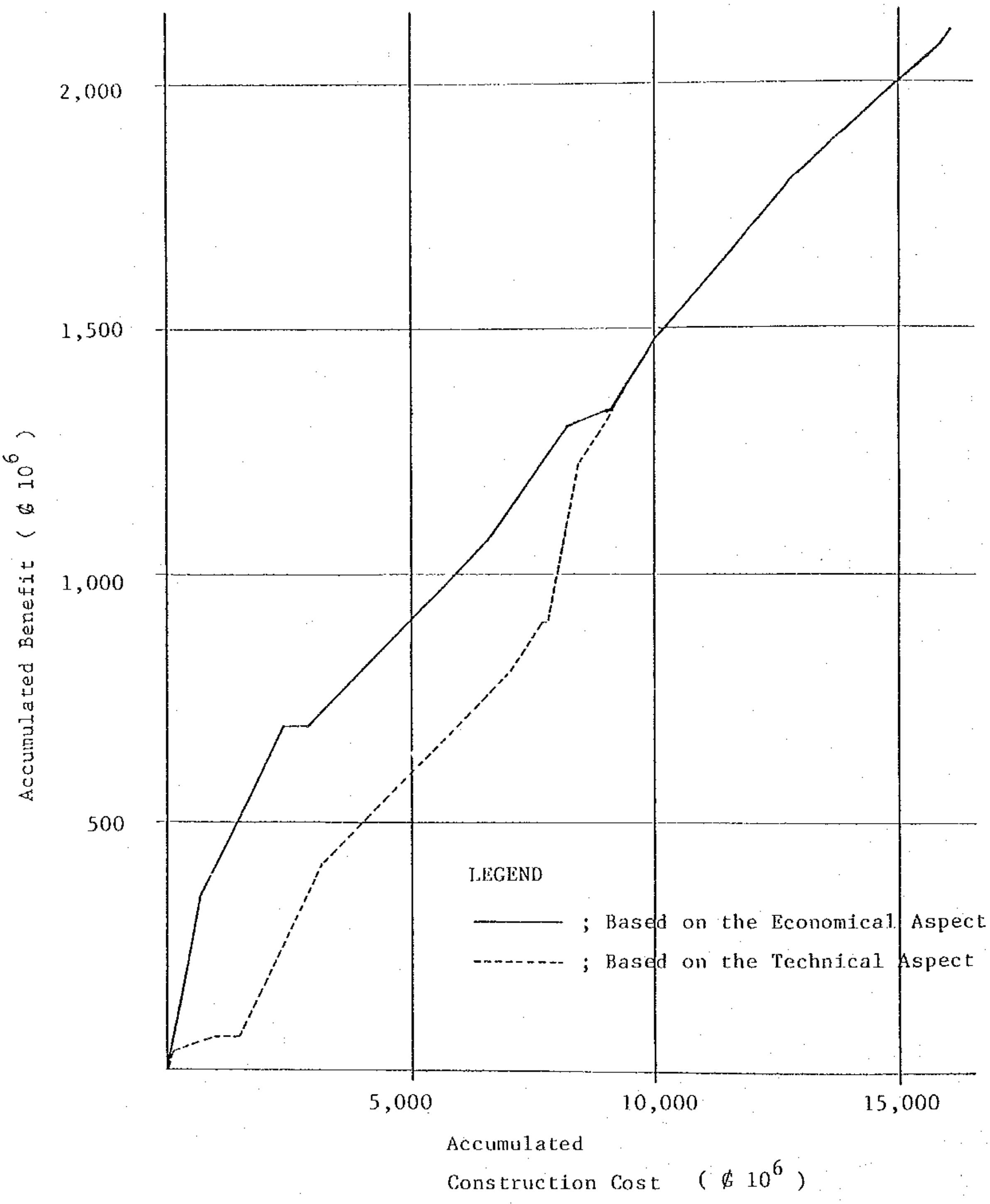


Fig. 6-4 ACCUMULATED CONSTRUCTION COST AND BENEFIT FOR FIRST STAGE PROJECT

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

Basin	Type	Location	Work Item	Quantity	1st Yr. (1990)	2nd Yr. (1991)	3rd Yr. (1992)	4th Yr. (1993)
		Mobilization and Preparatory Works						
Mburicao River Basin	River	Mburicao River	Bridge	8 pc.				
			Revetment	15,970 m^3				
			Invert	730 m^3				
			Groundsill	7 pc.				
			Excavation	82,000 m^3				
		San Martin River	Bridge	4 pc.				
			Revetment	4,220 m^3				
			Invert	1,440 m^3				
			Boxculvert	142 m				
			Groundsill	3 pc.				
			Excavation	12,100 m^3				
		Santo Domingo River	Bridge	2 pc.				
			Revetment	1,180 m^3				
			Excavation	3,900 m^3				
		Jose Lambarde River	Bridge	2 pc.				
			Revetment	1,700 m^3				
			Groundsill	2 pc.				
			Excavation	4,700 m^3				
	Drainage	14-2	Piping	350 m				
		14-2	Boxculvert	2,020 m				
		14-3,4,6,7,9,12,13,14	Piping	4,020 m				
		14-6,13	Boxculvert	1,055 m				
		14-5,8,10,11	Piping	1,170 m				
		14-10	Boxculvert	515 m				
		14-14	Open Channel	180 m				
Itay River Basin	River	Retarding Basin	Excavation	310,000 m				
			Revetment	3,750 m^3				
		Itay River	Bridge	10 pc.				
			Revetment	12,760 m^3				
			Groundsill	11 pc.				
			Invert	300 m^3				
			Excavation	175,800 m^3				
		Madame Lynch River	Bridge	7 pc.				
			Revetment	12,100 m^3				
			Boxculvert	2,520 m				
			Groundsill	4 pc.				
			Excavation	278,100 m^3				
		Orilla River	Bridge	7 pc.				
			Revetment	7,400 m^3				
			Groundsill	5 pc.				
			Excavation	19,100 m^3				
		Santa Teresa River	Bridge	6 pc.				
			Revetment	4,530 m^3				
			Groundsill	1 pc.				
			Excavation	95,350 m^3				
		San Pablo River	Bridge	2 pc.				
			Revetment	1,750 m^3				
			Groundsill	1 pc.				
			Excavation	3,800 m^3				
	Drainage	18-1,2,3	Boxculvert	2,400 m				
		18-2	Piping	100 m				
		18-7,8	Boxculvert	160 m				
		18-4,5,6	Piping	340 m				
		18-8	Boxculvert	80 m				
		18-7,9,10	Open Channel	5,510 m				
		18-2,3	Open Channel	1,050 m				

Fig. 6-5 CONSTRUCTION SCHEDULE FOR PROPOSED PLAN OF FIRST STAGE PROJECT

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

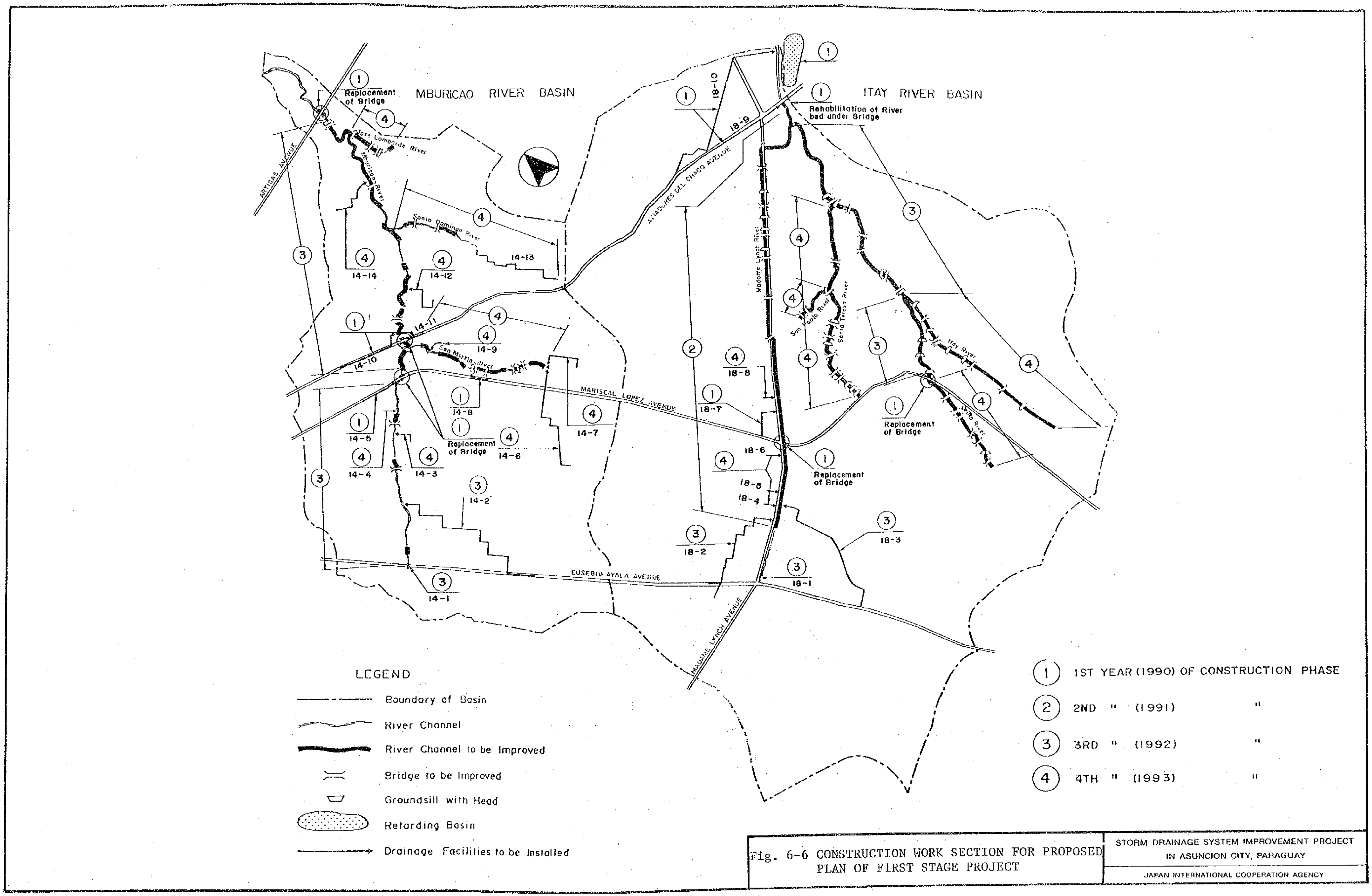


Fig. 6-6 CONSTRUCTION WORK SECTION FOR PROPOSED PLAN OF FIRST STAGE PROJECT

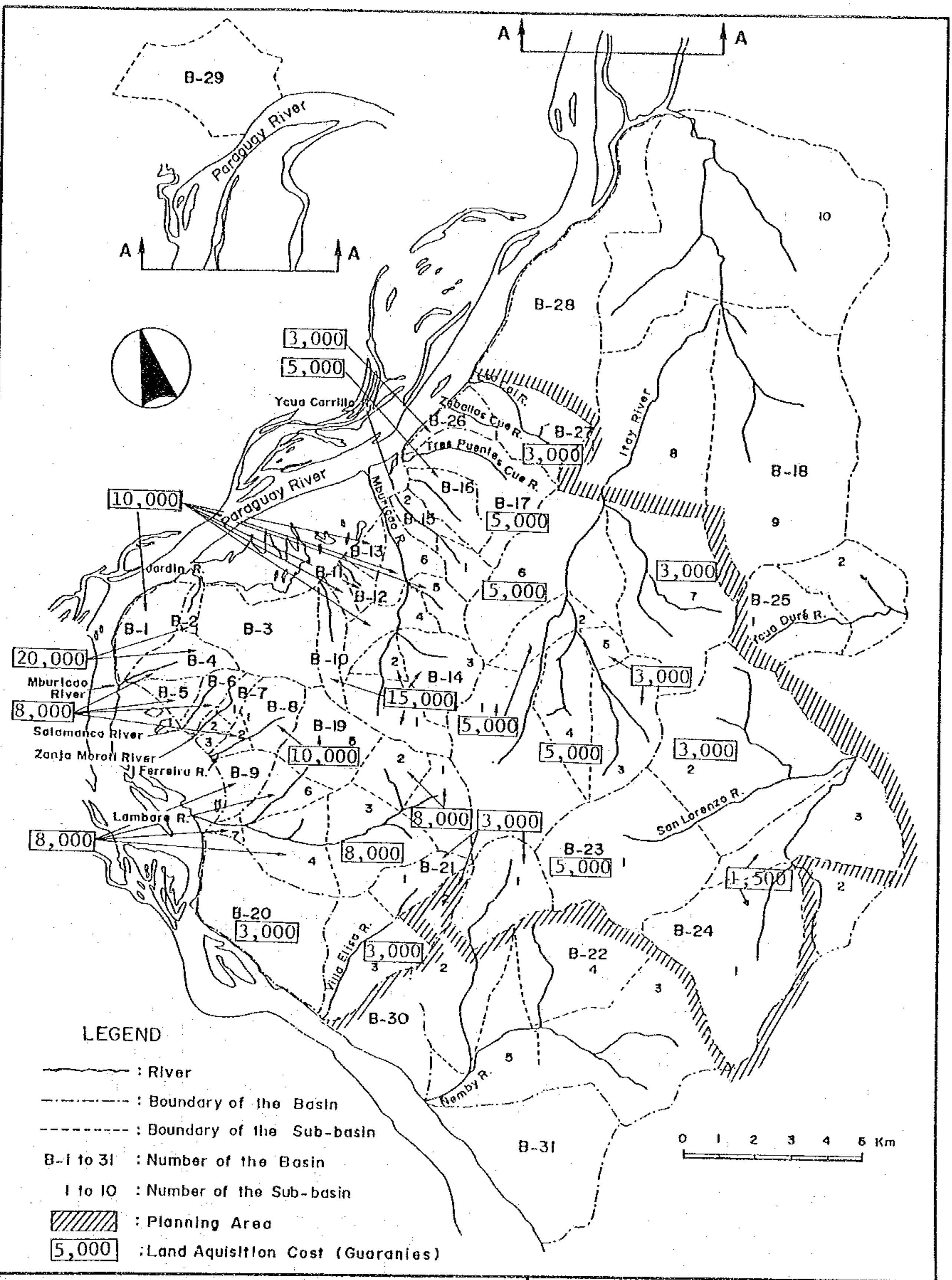


Fig. 6-7 LAND AQUISITION COST IN THE PLANNING AREA

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

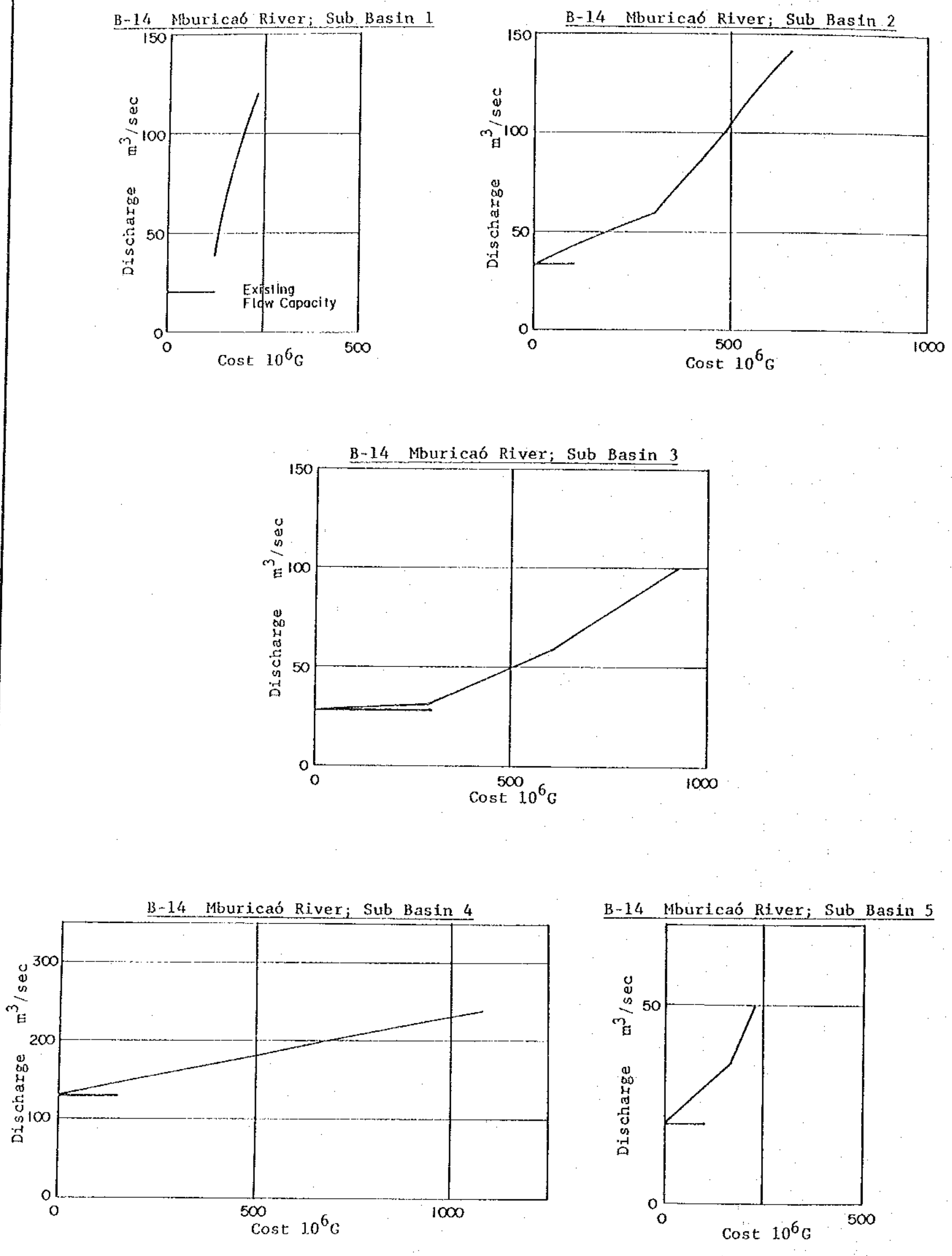
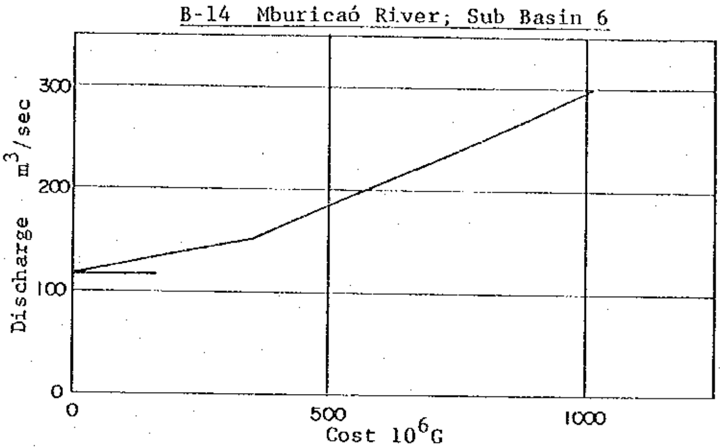


Fig. 6-8 (1/8) RELATIONSHIP CURVE BETWEEN DISCHARGE AND CONSTRUCTION COST OF RIVER IMPROVEMENT WORKS

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

B-14 Mburicaó River; Sub Basin 6



B-15 Ycuá Carrillo River; Sub Basin 1

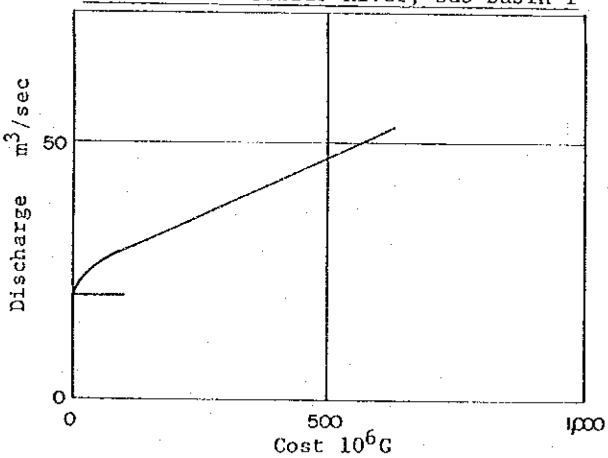
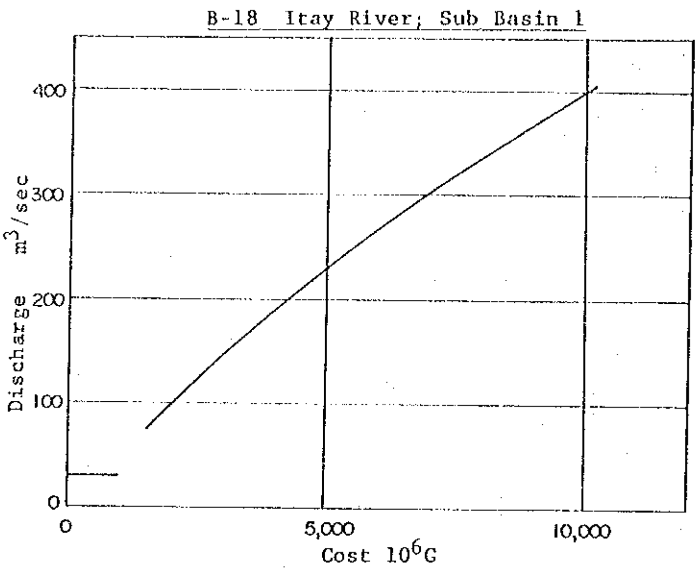
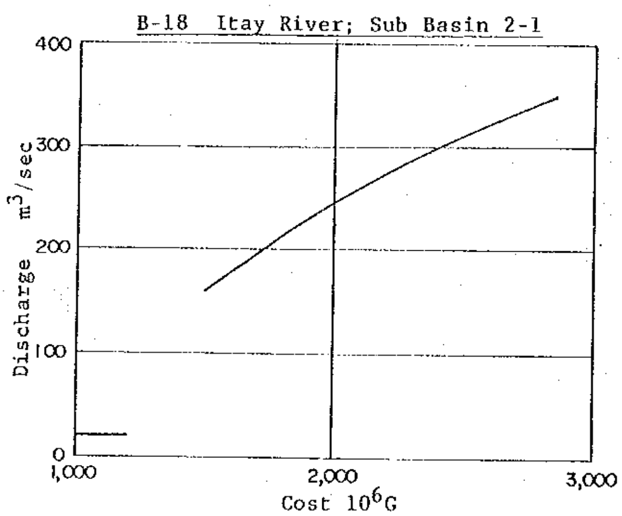


Fig. 6-8 (2/8) RELATIONSHIP CURVE BETWEEN DISCHARGE AND CONSTRUCTION COST OF RIVER IMPROVEMENT WORKS	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY





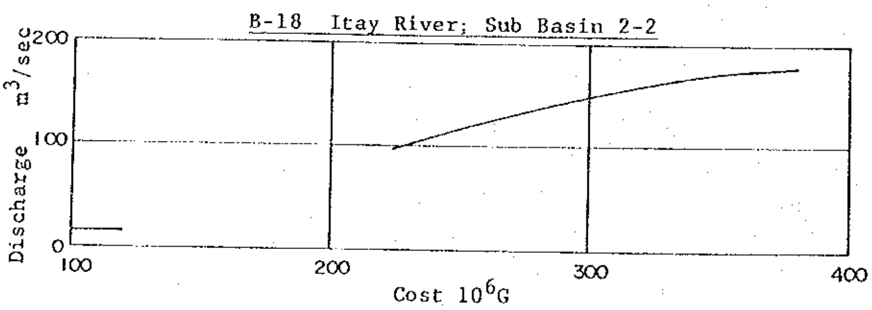
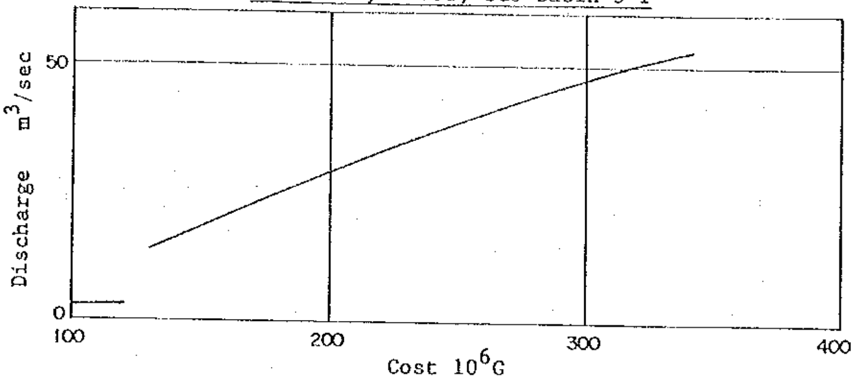


Fig. 6-8 (3/8) RELATIONSHIP CURVE BETWEEN DISCHARGE AND CONSTRUCTION COST OF RIVER IMPROVEMENT WORKS

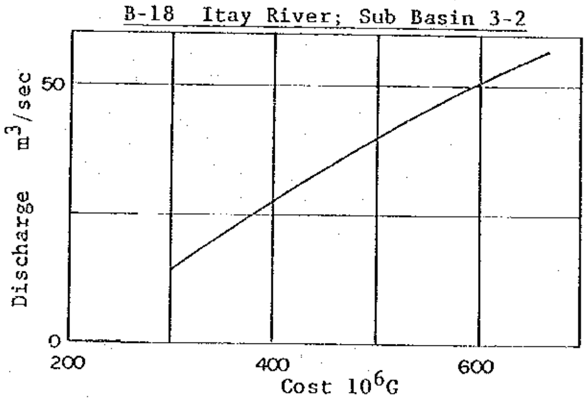
STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

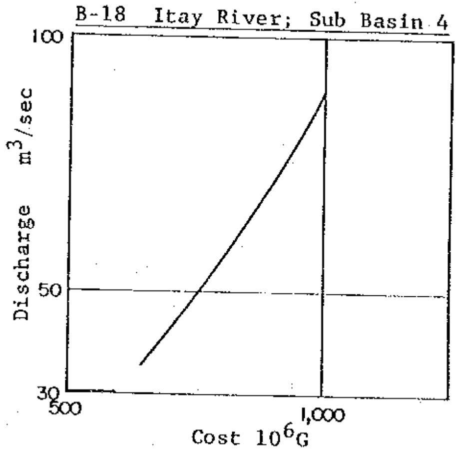
B-18 Itay River; Sub Basin 3-1



B-18 Itay River; Sub Basin 3-2



B-18 Itay River; Sub Basin 4



B-18 Itay River; Sub Basin 5

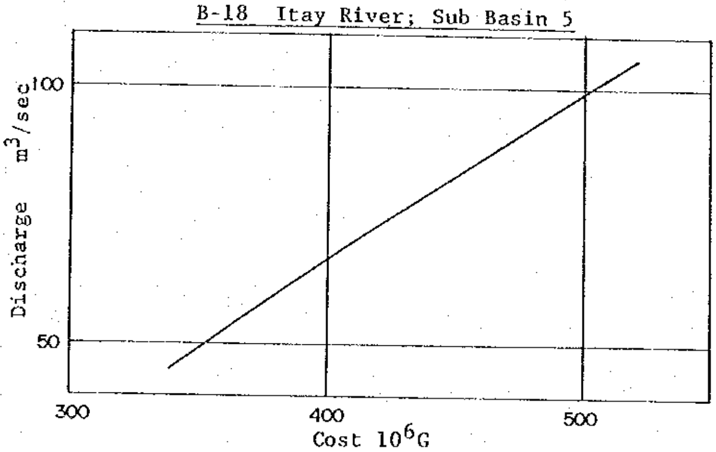
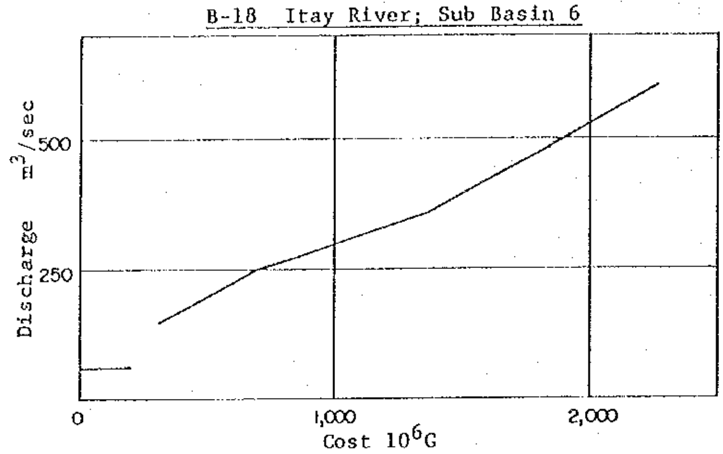


Fig. 6-8 (4/8) RELATIONSHIP CURVE BETWEEN DISCHARGE AND CONSTRUCTION COST OF RIVER IMPROVEMENT WORKS

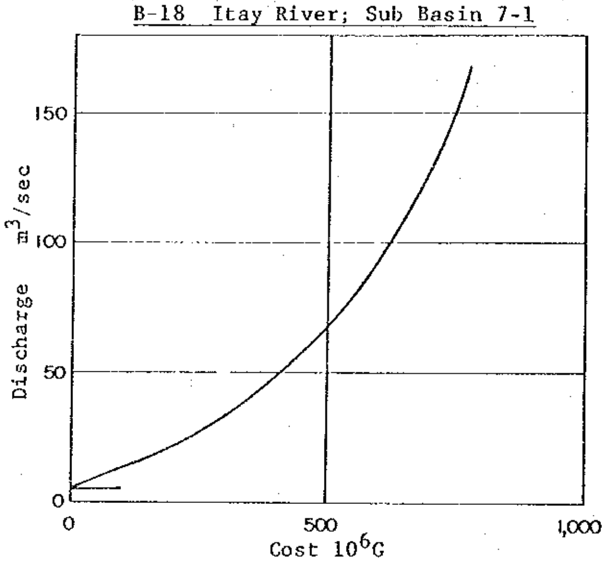
STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

B-18 Itay River; Sub Basin 6



B-18 Itay River; Sub Basin 7-1



B-18 Itay River; Sub Basin 7-2

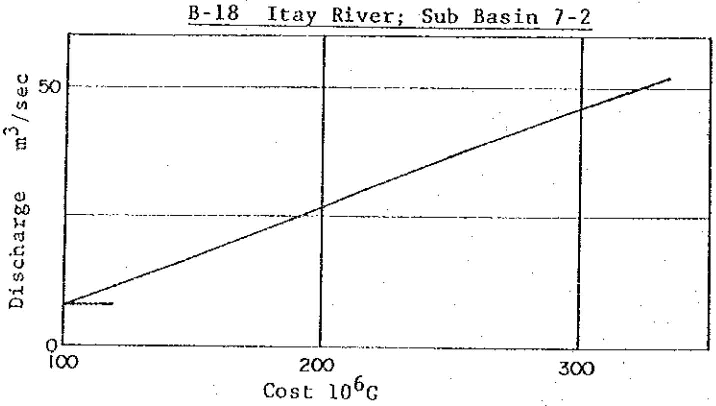
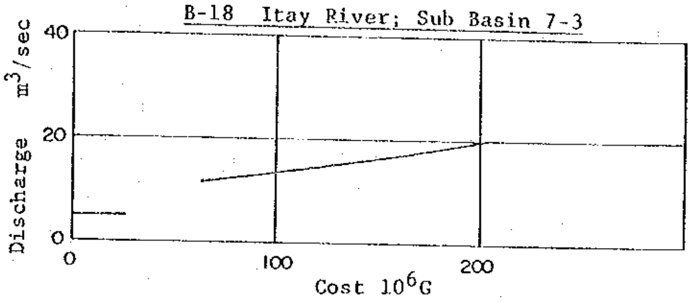
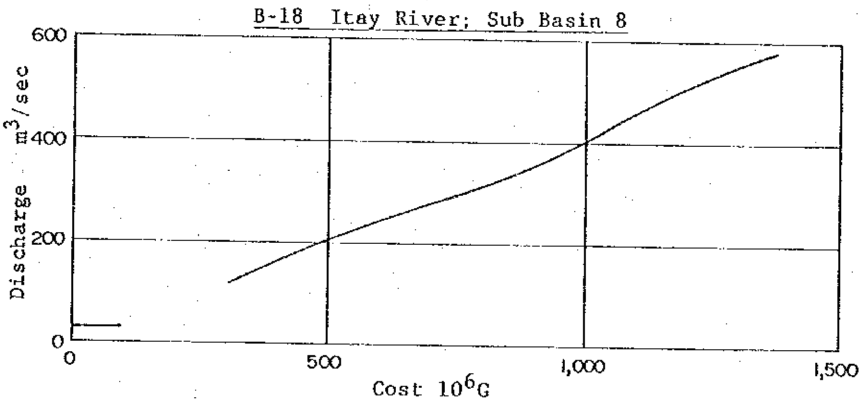


Fig. 6-8 (5/8) RELATIONSHIP CURVE BETWEEN DISCHARGE AND CONSTRUCTION COST OF RIVER IMPROVEMENT WORKS	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY





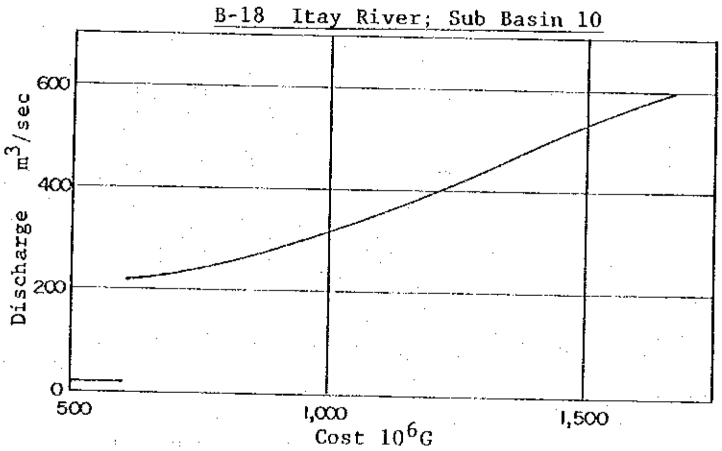
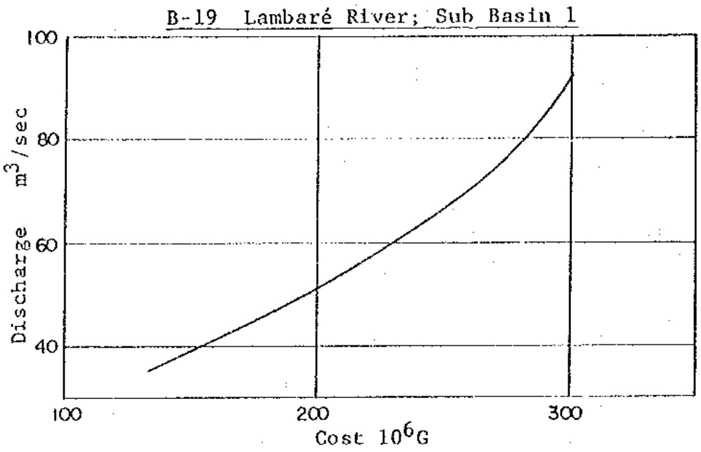
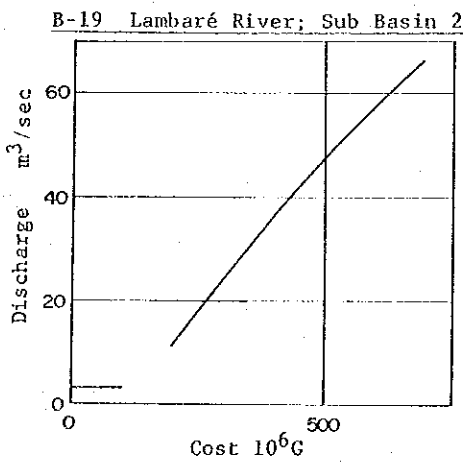


Fig. 6-8 (6/8) RELATIONSHIP CURVE BETWEEN DISCHARGE AND CONSTRUCTION COST OF RIVER IMPROVEMENT WORKS

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY





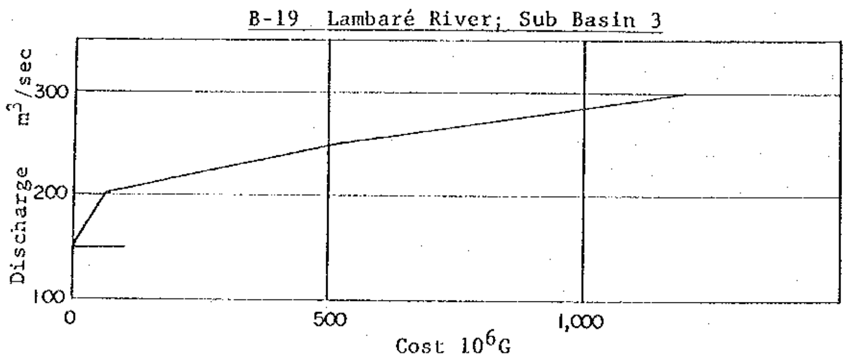
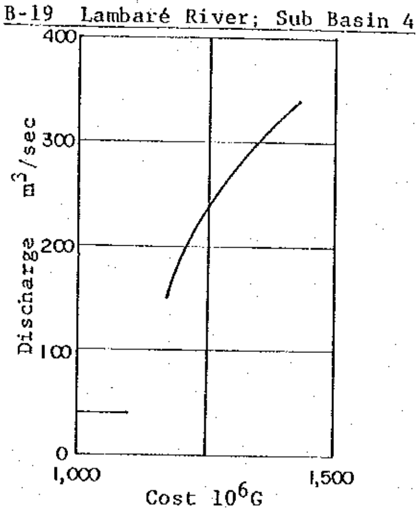


Fig. 6-8 (7/8) RELATIONSHIP CURVE BETWEEN DISCHARGE AND CONSTRUCTION COST OF RIVER IMPROVEMENT WORKS	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY



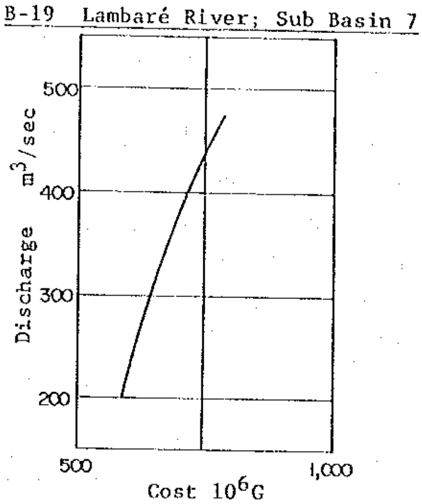


Fig. 6-8 (8/8) RELATIONSHIP CURVE BETWEEN DISCHARGE AND CONSTRUCTION COST OF RIVER IMPROVEMENT WORKS	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY

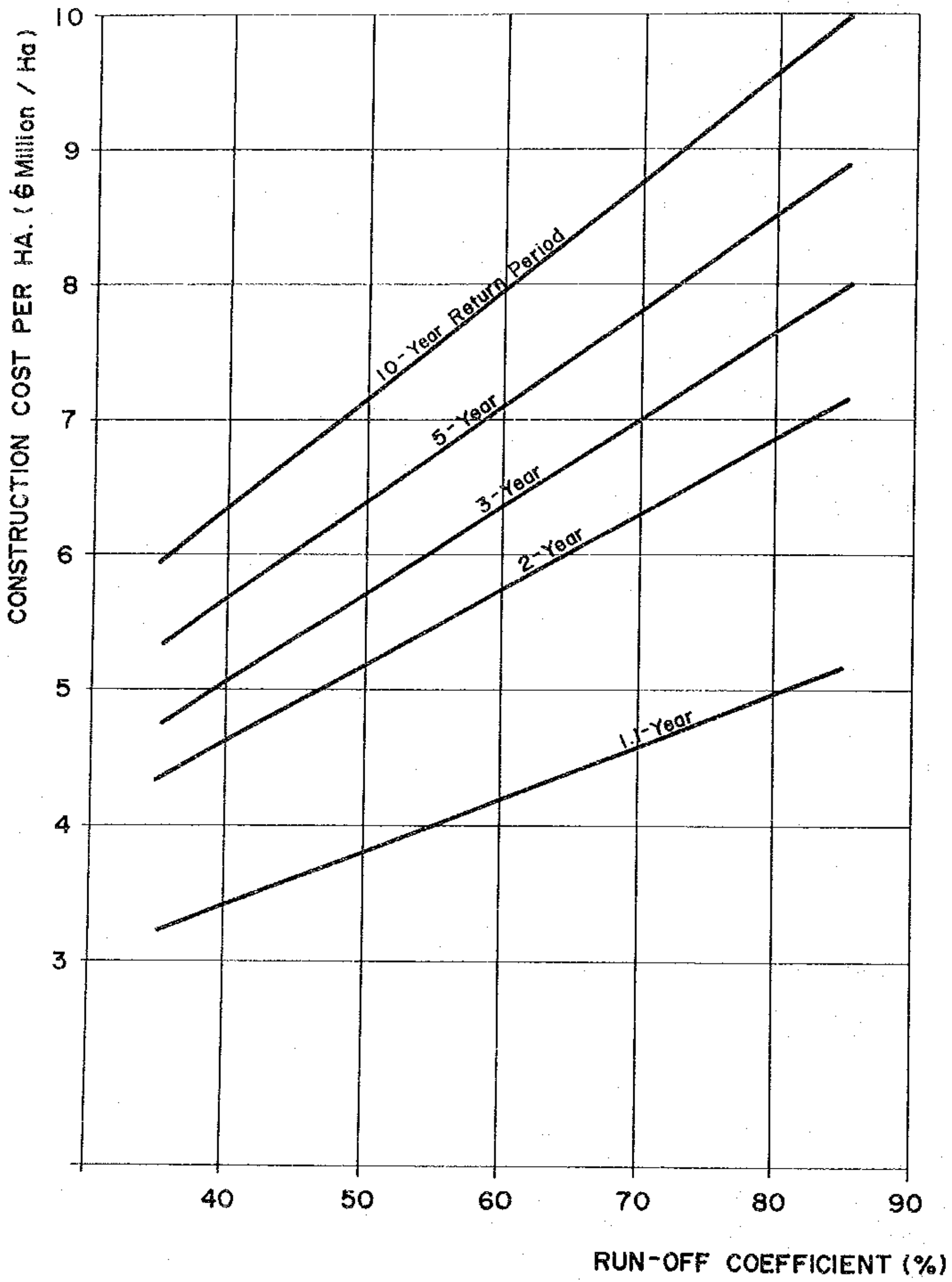


Fig. 6-9 CONSTRUCTION COST PER UNIT AREA OF DRAINAGE FACILITY WORKS

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

7. PROJECT EVALUATION

SUPPORRING REPORT
ON
PROJECT EVALUATION

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SUPPORTING REPORT
ON
PROJECT EVALUATION

1. General

Economic and financial studies were conducted for the Master Plan and the First Stage Project, which have been formulated on the bases of 2005's and 1995's land use patterns, respectively, to solve the major problems caused by inundating and running water on the roads and in the residential areas. The basic conditions for the studies are as follows:

(1) Calculation of all costs and benefits are based on the price level of August, 1986;

(2) Currency exchange rates are US$1.00 = ₲650 = ¥155.

(3) Project life (for economic evaluation) is fixed at 50 years, considering the life expectancy of the facilities to be installed for the project.

2. Economic Evaluation

2.1 Conditions for Calculation of Economic Cost

The economic costs of the project are nominal figures that duly reflect the true economic value of goods and services involved. These costs were used only for the economic evaluation of the project.

Based on the estimated financial costs, the economic costs were calculated under the following conditions.

(1) Economic Construction Cost

Transfer items such as taxes and duties imposed on construction materials and equipment, including government subsidy, should be excluded from the elements of financial cost. In accordance with the present taxation system of Paraguay, it is assumed that about 15% of taxes and duties are involved in the financial construction cost.

(2) Land Acquisition and Compensation Cost

Land has to be acquired for project implementation, and its economic value is considered to correspond to the productivity foregone by the project. The land to be acquired is not so wide and it is located on the riverside that is left almost unused, so that land acquisition cost is not taken into account.

Some of the residents along the river course will be resettled due to widening of the river channel, but compensation cost, one of the transfer items, will be deducted from the financial cost.

(3) Cost for Engineering Services

The cost for engineering services required for the construction, which should duly reflect its true value, is also included in the economic evaluation.

(4) Physical Contingency

Physical contingency is estimated at 10% of the total of the economic construction cost and the engineering service cost.

(5) Price Contingency

Price contingency or escalation is not included in the economic cost.

2.2 Methodology and Conditions for Calculation of Project Benefit

Project benefit is defined as the difference in damage by storm water between the with- and without-the-project situations. Hence, the damages with and without new storm water control system have to be estimated to quantify the project benefit in monetary terms, though it must be recognized that the estimates are subject to a considerable degree of uncertainty.

Damages caused by storm water in the planning area can be classified into three categories; namely,

(1) Damage due to traffic interruption by storm water, including augmentation of travel cost of vehicles affected by detouring and speed-down, as well as loss of productivity of people who may lose their time assigned for economic activities.

(2) Damage due to submergence by storm water, which is inflicted on the assets mainly consisting of private houses and their household effects.

(3) Indirect damage, including maintenance cost for pavements and vehicles, requirements for road clearing, deterioration of sanitary conditions, negative aesthetic effects of flooding, etc.

Estimation of Storm Water Damage

(1) Damage Due to Traffic Interruption

Traffic volume on main roads has been estimated basically from the results of the Urban Transport Study in Asuncion Metropolitan Area undertaken by JICA, while that on the streets concerned was obtained through an actual research carried out during the study period.

The augmentation of travel cost of vehicles affected and the loss of productivity of people on these vehicles were calculated in monetary terms on the following assumptions:

- In the main roads (asphalt pavement), all the cars and buses detour for 5 km at the speed of 5 km/hr, though it is presumed that some of the affected vehicles have to standby due to the limited traffic capacity of roads.

- All the cars and buses passing through the streets (stone pavement) are to detour for 2 km at the speed of 5 km/hr.

- Actual traffic interruption time is longer than the inundation time by 50% before and after the inundation.

- Unit running and time costs of cars and buses are those estimated by the Urban Transport Study of Metropolitan Asuncion Area, as tabulated hereunder:

Vehicle	Running Cost (¢/km)		Time Cost (¢/hr)
	Asphalt	Stone	
Cars	28.8	41.5	176
Buses	78.4	161.6	451

- In other areas of the trouble spots, there must be some traffic damages such as detouring and speed-down due to running water on the roads. Since detailed data for these spots are not available, the damage is assumed to be 10% of the estimated traffic damage of the major trouble spots.

- Hourly per capita productivity is estimated at ¢358/hr and ¢342/hr from the GDP in the metropolitan area and its economically active population (EAP) in 2005 and 1995, respectively (refer to Table 7-1.)

- The number of EAP taking cars and buses affected is assumed at 2 persons/car and 30 persons/bus on an average.

Thus, the damage (Dt) due to traffic interruption that is subject to change depending on rainfall volume is the sum of the incremental cost of vehicles by detouring (Dd) plus the loss of productivity of EAP (Dp) as presented below:

$$Dt = Dd + Dp$$

Dd and Dp can be calculated by the following equation:

$$Dd = Tv \times (Rc + Tc) \times Id$$
$$Dp = Pv \times Pp \times Lt$$

where,

Tv : Traffic volume of detouring
Rc : Running cost of vehicles (per km)
Tc : Time cost of vehicles (per hr)
Id : Incremental distance by detouring (km)
Pv : EAP taking vehicles (persons)
Pp : Per capita productivity (per hr)
Lt : Loss of time for economic activities (hr)

(2) Damage Due to Submergence by Storm Water

Inundation water inflicts a direct damage on assets consisting of private houses and household effects. The value of these assets has been estimated on the basis of the number of houses in 2005 and 1995 which may increase in accordance with the progress of urbanization.

To calculate the damage on houses and household effects, the following conditions were assumed:

- The values of houses were estimated at ₡16.0 million per high class house and ₡7.2 million per middle house and ₡2.4 million based on the construction cost of houses in the planning area, while the values of household effects were assumed to be 30% thereof.

- Inundation water depths are given through the hydrological study as presented in Table 7-2. The submergence depth is obtained by deducting 20 cm from the inundation depth because the floor elevation of a house is usually raised or higher than the road surface by that much.

- Damage rates of submerged assets are the same as those applied to the past JICA study in the central-south America because no related data was available. (Refer to Table 7-3.)

The damage (Ds) due to submergence of houses and household effects caused by storm water that is subject to change depending on rainfall intensity can be calculated by multiplying the value of submerged assets (Va) by the damage rate (Dr), i.e., Ds = Va x Dr.

(3) Indirect Damage

The indirect damage is assumed to correspond to 15% of the total of the above-referred damages.

Average Annual Benefit

The total damage by one rainfall is the sum of (Dt) and (Ds) plus the indirect damage as explained. Since short-term rainfall records are not available in the study area, the relation between damage and daily rainfall has been identified for several cases by applying different daily rainfalls.

Rainfalls for the past 29 years, 1950 to 1961 and 1969 to 1985, have been well recorded and those of more than 30 mm are summarized in Table 7-4. (Damages apparently occur with the rainfall of more than 30 mm.) These data were applied to the relation curve to calculate the annual damage of each year, and the average annual damage was obtained by dividing the total amount of damage by 29 years.

Calculation of the average annual damage in the with-the-project situation was also carried out to estimate the average annual benefit, which is the difference in damage between the situations with and without the project.

2.3 Master Plan

Economic viability was examined by means of calculating the internal rate of return (IRR) for two representative river basins having different features, Mburicao and Ferreira river basins, to identify the optimum scale through comparative studies on the following three (3) cases:

Case I : Overall restoration -- complete provision of all necessary storm water drainage along the entire river channels and drainage ditches in the basins concerned.

Case II : Trouble spot improvement -- improvement works at trouble spots that are habitually affected by flood damage in the basins concerned.

Case III: Improvement along trunk roads -- improvement works at the habitually damaged spots along the important trunk roads consisting of Artigas, España, M.A.C. Lopez, Ayala, Fernando de la Mora, General Santos and Madame Lynch.

(Artigas, España, M.A.C. Lopez and Ayala avenues run in the Mburicao river basin, but no important trunk road goes in the Ferreira river basin. Therefore, economic studies on this case has been conducted only for Mburicao river basin.)

The project scale of the Master Plan has been determined to be of a 3-year return period basis through the social and financial considerations. In this section, however, the economic viability is examined not only for this project scale but for other scales as well to justify the project on comparative terms.

2.3.1 Economic Cost

The economic costs of the Master Plan are estimated for each study case in accordance with the conditions described in Section 2.1, as tabulated below:

Case Study	Project Scale in Return Period	Economic Cost (million G)	
		Mburicao	Ferreira
Case I	1.1 years	9,436	2,045
	2.0 years	14,255	2,565
	3.0 years	16,219	2,805
	5.0 years	19,151	3,060
Case II	1.1 years	2,578	889
	2.0 years	5,152	1,140
	3.0 years	6,414	1,274
	5.0 years	8,028	1,432
Case III	1.1 years	1,481	-
	2.0 years	2,878	-
	3.0 years	3,702	-
	5.0 years	4,711	-

2.3.2 Project Benefit

Traffic Interruption

Major interruption spots in the representative river basins are shown in Figs. 7-1 and 7-2, and the traffic volume consisting of cars and buses are shown in Table 7-5 for each major spot with the inundation duration time thereof.

Assets Submergence

Storm water inundates three major areas in Mburicao river basin; namely, (1) upstream of Artigas Avenue, (2) the vicinity of the crossing point of Generalisimo Franco Avenue and Mburicao River, and (3) the vicinity of the intersection of Eusebio Ayala and Republic Argentina avenues. It also inundates two spots in Ferreira river basin; (1) the lowermost stream of Ferreira River and (2) the crossing point of Jose Felix Bogado Avenue and Ferreira river channel. For convenience, these areas and spots are hereinafter referred to as MI-1, MI-2, MI-3, FI-1 and FI-2. Aside from these areas, these river basins are dotted with small inundation areas.

In the above inundation areas co-exist high, middle and low class houses at the following shares:

Unit: %

Reference No.	High Class	Middle Class	Low Class
MI-1	5	85	10
MI-2	5	90	5
MI-3	5	85	10
FI-1	-	50	50
FI-2	10	70	20

In preparing relation curves between the submergence depth and the value of assets as shown in Fig. 7-3, reference is made to the results of cross-sectional survey for river channels and the topographic maps. Areas of MI-3 and FI-2 are considered to represent other small inundation areas in Mburicao and Ferreira, respectively, because they are in similar situations.

Average Annual Benefit

The relationship between damage and daily rainfall in Mburicao and Ferreira are given in Table 7-6 and in Fig. 7-4. The average annual benefits calculated for the project scales of 1.1, 2, 3, and 5-year return periods in the manner as described in 2.2 are summarized in the following table and the relationship between average annual benefit and project scale is shown in Fig. 7-5. (Since no important trunk road exists in Ferreira river basin, the benefit has not been calculated.)

Study Case	Project Scale in Return Period	Annual Benefit (million G)	
		Mburicao	Ferreira
Case I	1.1 years	321	76
	2.0 years	703	165
	3.0 years	739	173
	5.0 years	762	178
Case II	1.1 years	299	72
	2.0 years	657	156
	3.0 years	691	164
	5.0 years	712	169
Case III	1.1 years	202	-
	2.0 years	441	-
	3.0 years	462	-
	5.0 years	475	-

2.3.3 Internal Rate of Return (IRR)

The economic viability of the project is assessed by means of calculating the internal rate of return (IRR), which is equivalent to "r" in the following formula:

$$\sum_{i=1}^{n} \frac{Ci}{(1+r)^i} = \sum_{i=1}^{n} \frac{Bi}{(1+r)^i}$$

where,

- Ci : Cost in the i-th year
- Bi : Benefit in the i-th year
- r : Annual discount rate
- n : Project life (year)

Calculation of IRRs of the Master Plan is based on the assumption that construction period lasts for five (5) years in which the construction cost accrues equally for each year, and that the annual operation and maintenance cost is 2% of the total construction cost.

The IRRs have been calculated for several project scales, i.e., 1.1, 2, 3, and 5-year return period bases. The results are shown in Fig. 7-6 and tabulated hereunder:

Case Study	Project Scale in Return Period	Internal Rate of Return (%) Mburicao	Ferreira
Case I	1.1 years	-	0.0
	2.0 years	1.9	4.1
	3.0 years	1.2	3.7
	5.0 years	0.2	3.2
Case II	1.1 years	10.2	6.1
	2.0 years	11.2	12.2
	3.0 years	9.1	11.4
	5.0 years	7.2	10.2
Case III	1.1 years	12.3	-
	2.0 years	13.9	-
	3.0 years	11.0	-
	5.0 years	8.5	-

2.3.4 Selection and Justification of the Optimum Plan

Justification of projects from the economic viewpoint is dependent on whether or not the IRR exceeds the opportunity cost of capital (OCC) in the country concerned, but it is generally difficult to estimate accurately the opportunity cost or the marginal productivity of capital because of its frequent fluctuation.

As a matter of practice in international banking facilities, an IRR of 10 to 12% has been accepted as the cut-off point. In this context, both Case II and Case III may be acceptable, while Case I which shows a very low IRR has much difficulty in implementing the project. This kind of project should cover an area as large as possible from the social requirements, so that Case II should be adopted because the IRRs of these tow cases indicate no significant difference.

The determined project scale (3-year return period basis) in Case II shows IRRs of 9.1% and 11.4% for the Mburicao and the Ferreira river basins, respectively, which show an enough economic viability to put it into implementation, judging from the rather low IRRs of other infrastructure projects that have been accepted by the international banking facilities. It is, therefore, concluded from the viewpoints of economic viability and social requirements that the plan of trouble spot improvement (Case II) should be formulated on the 3-year return period basis as the optimum plan.

2.4 First Stage Project

The First Stage Project has been formulated against the design runoff discharge of a 3-year return period covering only the Mburicao and the Itay river basins to solve the flooding problems at the trouble spots therein. The design runoff discharge has been estimated by the runoff analysis under the land use patterns as of 1995. The calculation of benefit was thus based on the traffic volume and the assets to be situated in 1995.

2.4.1 Economic Cost

The economic cost estimated in line with the conditions described in Section 2.2 is 17,486 million Guaranies in total, including 5,436 million Guaranies and 12,050 million Guaranies in the Mburicao and the Itay river basins, respectively. The annual disbursement of the economic cost during the construction period is presented in Table 7-7.

2.4.2 Project Benefit

Traffic Interruption

The location of traffic interruption spots in the Mburicao river basin is the same as that of the Master Plan Study (refer to Fig. 7-1). Major interruption spots in the Itay river basin are shown in Fig. 7-6 with reference numbers. The traffic volume in 1995 is summarized in Table 7-8 for each major spot with the inundation duration time thereof.

Assets Submergence

Storm water inundates the same areas in Mburicao river basin as described in Subsection 2.3.2 and three areas in Itay river basin; namely, (1) along Aviadores del Chaco Avenue about 2 km to the west of Madame Lynch, (2) along Madame Lynch River, and (3) along the main channel of Itay River. These areas are referred to as MI-1, MI-2, MI-3, II-1, II-2 and II-3, respectively, for convenience. Aside from these areas, there are other small inundation areas.

In the above inundation areas co-exist high, middle and low class houses at the following shares:

Unit: %

Reference No.	High Class	Middle Class	Low Class
MI-1	-	80	20
MI-2	-	90	10
MI-3	2	65	33
II-1	20	30	50
II-2	2	50	48
II-2	-	-	100

The relationship curve between the submergence depth and the value of assets is presented for each area in Fig. 7-8. Areas of MI-3 and II-3 are considered to represent other small inundation areas in Mburicao and Ferreira, because they are in similar situations.

Average Annual Benefit

The relationship between damage and daily rainfall in the Mburicao and the Itay river bains are presented in Table 7-9 and in Fig. 7-9. The average annual benefits with the project on the 3-year return period basis is estimated at 2,108 million Guaranies in total which consists of 599 million Guaranies and 1,509 million Guaranies in the Mburicao and the Itay river basins, respectively.

2.4.3 Internal Rate of Return (IRR)

The economic viability of the First Stage Project was examined by the internal rate of return (IRR) to judge on whether or not the project will be put into implementation. The IRRs were calculated for the Mburicao and the Itay river basins based on the cost-benefit flow of Table 7-10 with with the following results:

Mburicao River Basin	:	11.2 %
Itay River Basin	:	11.8 %
First Stage Project	:	11.6 %

2.4.4 Justification of the Project

In general, international banking facilities regard IRRs of 10 to 12% as the cut-off point, and infrastructure projects like this project are accepted even with low IRRs. In this context, this project showing an IRR of 11.6% can be assessed to have enough economic viability for implementation.

2.5 Socio-Economic Impacts

Project implementation could exert favorable influences on not only the planning area but also the whole nation. The favorable impacts are summarized as follows:

(1) The trunk roads leading to international and national highways and to the international airport will be released from traffic interruption due to inundation. Therefore, international and nationwide circulation of commodities will be secured resulting in the stabilization of the people's living condition in the whole country.

In the Mburicao and the Itay river basins, the target area of the First Stage Project, are located many important roads which connect Asuncion City and other major cities, as follows:

- Artigas Avenue: extends to Poso Colorado City through Mariano R. Alonso City after connecting with Route 9.
- España (Generalisimo Franco, General Genes, Aviadores del Chaco) Avenue: extends to Aregua City through the International Airport and Luque City.
- Mariscal Lopez Avenue: connected at San Lorenzo City to Route 1 which reaches up to Stroesner City.
- Eusebio Ayala Avenue: connected to Route 1 and Route 2 at San Lorenzo City, as well as to Mariscal Lopez Avenue.
- Madame Lynch Avenue: links the above-said important roads as a lateral circumferencial road.

(2) Speedy and safe drainage of storm water will enhance social welfare through the improvement of sanitary conditions in the areas where houses suffer from inundation.

Some of the habitually inundated portions in the Mburicao and the Itay river basins are as follows:

- The upper portion from the bridge at the crossing point of Mburicao River and Artigas Avenue.

- The upper portion from Caido Bridge at the crossing point of Mburicao River and Generalisimo Franco Avenue.

- Along Madame Lynch Avenue, especially in the area of Grupo Habitacional Aeropuerto.

- The vicinity of the intersection between Boggiani Avenue and Eusebio Ayala Avenue.

(3) A number of engineers, technicians, laborers, etc., will be required for the project implementation, so that the increase of employment opportunities can be expected at least during the construction period.

3. Study on Financial Aspects

3.1 Revenue of CORPOSANA

CORPOSANA (La Corporacion de Obras Sanitarias) is a government corporation responsible for the services of potable water supply, storm drainage and sewage, and hence considered to be the key organization for the implementation of this project. These services produce revenue as discussed below, which is alloted for operation and maintenance of the related facilities, administration, amortization of loan and financial source for new projects.

(1) Potable Water Supply

The connections for potable water supply has reached 80,665 with 443,700 beneficiaries as of 1984. The water treatment plant has a production capacity of 240,000 m^3/day, and the annual consumption volume in 1984 amounts to 50.6 MCM.

The tariff system is in principle dependent on the type of meter which is classified according to the diameter of pipe. Basic water charge for one month (30 days) has been fixed for each type of meter based on the designated consumption volume, and a different tariff is applied to the excess water volume.

The water charge is calculated at approximately G100/m^3. The annual revenue from this sector reached 2,484 million Guaranies in 1984, which accounts for 84% of the total annual revenue.

(2) Storm Water Drainage

The present storm water drainage system which was constructed through the loan from the Inter-American Development Bank (IDB) covers 710 ha in the central commercial area in Asuncion. For the maintenance and amortization of the loan, CORPOSANA collects charges from the residents in the metropolitan area. The charges are determined in proportion to the value of real estates, as well as on the location of houses, as follows:

Location	Value of Real Estate	Rate of Charge
In Designated Area	More than ₲2 million	0.3 %
	Less than ₲2 million	0.2 %
Outside Above Area	(no classification)	0.1 %

The charges collected through the storm drainage sector totalled 372 million Guaranies in 1984, corresponding to 13% of the total revenue.

(3) Sanitary System

The sanitary system in Asuncion and the surrounding areas consists of collection pipes and branch pipes, 745 km and 386 km in total length, respectively. The beneficiaries of 71,059 living in an area of 4,737 ha are charged at the rate of 5% of their potable water charge for maintenance of the system. Its 1984's annual revenue was 99 million Guaranies, which accounts for 3% of the total revenue.

3.2 Financial Consideration for Project Implementation

3.2.1 Master Plan

The most reliable financial source for project implementation is considered to be the revenue from the storm drainage sector of CORPOSANA, because at present this revenue overcomes the cash outflow composed of amortization of the IDB loan and payment of its loan interest with a resultant positive balance (refer to Table 7-11). The total surplus fund (positive balance) from 1987 to 2005 is estimated at 25,602 million Guaranies at the annual average of 1,347 million Guaranies.

On the other hand, the total cost amounts to 107,717 million Guaranies, and the annual average is 5,669 milliom Guaranies. If all the said surplus fund is allocated for the implementation of this project, the expenditure will be about 4.2 times as much as the financial capacity with a difference 4,322 million Guaranies per annum on the average.

Assuming that the foreign currency portion of the project cost is covered by a loan with an interest rate of 3.5% and a repayment period of 30 years including a 10-year grace period, and that the local currency portion is loaned at the interest rate of 15% per annum for a repayment period of 10 years, the total expenditure would reach 192,699 million Guaranies, while the surplus fund during the loan amortization period will accumulate to 142,797 million Guaranies, resulting in a negative balance of 49,902 million Guaranies in total. However, this difference is possibly supplemented in various ways such as subsidy or financial assistance from the central government, loan from the private sector, and financial assistance on a grant basis from international lending agencies.

3.2.2 First Stage Project

The total cost of the First Stage Project is estimated at 27,502 million Guaranies, consisting of 13,105 million and 14,397 million Guaranies in the foreign and the local currency portions, respectively.

Assuming that the foreign currency portion of the project cost is covered by a loan with an interest rate of 3.5% and a repayment period of 30 years including a 10-year grace period, the amortization and the local currency portion would be 36,907 million Guaranies with an annual average of 1,025 million Guaranies. The total expenditure, including the operation and maintenance cost during the amortization period, would then amount to 42,264 million Guaranies. The loan amortization schedule is presented in Table 7-12.

The most reliable financial source for project implementation is the revenue from the storm drainage sector of CORPOSANA, as described in Subsection 3.2.1 (refer to Table 7-11). The amount possible to be earmarked for the project implementation is estimated at 2,387 million Guaranies on an annual average during the same period given above.

The financial source overcomes the expenditure by 43,666 million Guaranies in total and 1,213 million Guaranies on an annual average, as shown in Table 7-13. Hence, it follows that the First Stage Project can be implemented within the financial capacity of CORPOSANA.

TABLES

Table 7-1. CALCULATIN OF PER CAPITA PRODUCTIVITY OF ECONOMICALLY ACTIVE POPULATION

Item	Estimated Value		Remarks
	1995	2005	
1. GDP/1 in Paraguay ($x10^9$ Guaranies)	4,963.8	3,024.0	Calculated on the basis of GDP in 1984 estimated by the Central Bank of Paraguay and prediction of futher growth rate made by the Technical Planning Secretariat
2. GRP/2 in Metropolitan Area ($x10^9$ Guaranies)	1,935.9	1,179.4	39% of 1. This percentage is calculated from the data of National Census in 1982.
3. Population in Metropolitan Area ($x10^3$)	1,647.2	1,048.9	Estimated by JICA Team.
4. E.A.P./3 in Metropolitan Area ($x10^3$)	617.7	393.3	37.5% of 3. This percentage is also calculated from the data of National Census in 1982
5. Per Capita Productivity of E.A.P. ($x10^3$)	3,134.0	2,998.7	2./4.
6. Hourly Productivity (Guarany)	357.8	342.3	5./365 days/24 hrs.

NOTE /1: Gross Domestic Products
/2: Gross Regional Products
/3: Economically Active Population

Table 7-2. INUNDATION DEPTH

Return Period (years)	Inundation Depth (m)							
	/1 MI-1	/2 MI-2	/3 MI-3	/4 FI-1	/5 FI-2	/6 II-1	/7 II-2	/8 II-3
In 2005								
1.1	0.3	0.0	0.3	0.4	0.4	-	-	-
2.0	0.8	0.2	0.4	1.1	0.6	-	-	-
3.0	1.2	0.4	0.5	1.2	0.7	-	-	-
5.0	1.6	0.8	0.6	1.4	0.8	-	-	-
10.0	1.9	1.1	0.8	1.6	0.9	-	-	-
30.0	2.0	1.3	1.1	1.8	1.0	-	-	-
In 1995								
1.1	0.3	0.0	0.3	-	-	0.3	0.5	0.3
2.0	0.8	0.2	0.4	-	-	0.4	0.8	0.5
3.0	1.2	0.4	0.5	-	-	0.5	1.0	0.7
5.0	1.6	0.8	0.6	-	-	0.6	1.2	0.9
10.0	1.8	1.0	0.8	-	-	0.8	1.3	1.2
30.0	1.9	1.2	1.0	-	-	0.9	1.4	1.4

NOTE
/1 : Upstream of Arigas Ave.
/2 : Vicinity of the crossing point of Generalisimo Franco Ave. and Mburicao River.
/3 : Vicinity of the intersection of Eusebio Ayala and Repulbic Argentina Avenues.
/4 : Down-most stream of Ferreira River
/5 : Crossing point of Jose Felix Bogado Ave. and Ferreira River
/6 : Along Aviadores del Chaco Ave. about 2 km in the west of Madame Lynch River.
/7 : Along Madame Lynch River.
/8 : Along the main channel of Itay River.

Table 7-3. DAMAGE RATES

Submergence Depth (m)	Houses	Household Effects
0.01 to 0.25	0.078	0.050
0.25 to 0.50	0.151	0.115
0.50 to 0.75	0.192	0.167
0.75 to 1.00	0.226	0.215
1.00 to 1.25	0.258	0.262
1.25 to 1.50	0.292	0.307
1.50 to 2.00	0.341	0.373

Table 7-4.(1/2) DIALY RAINFALL RECORDS
(more than 30 mm)

1950			1951			1952			1953			1954		
No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)
1.	JAN. 1	63.0	1.	JAN.10	37.7	1.	JAN.10	31.9	1.	JAN. 7	56.2	1.	JAN. 1	36.0
2.	JAN. 8	69.1	2.	JAN.17	33.3	2.	JAN.21	60.6	2.	JAN.26	45.8	2.	JAN.12	70.9
3.	JAN.12	60.9	3.	JAN.23	75.0	3.	FEB. 1	36.1	3.	MAR.22	116.3	3.	JAN.17	80.4
4.	JAN.17	50.6	4.	FEB. 5	52.3	4.	FEB. 4	30.5	4.	APR. 6	62.3	4.	JAN.18	78.4
5.	MAR.27	75.5	5.	FEB.12	82.6	5.	FEB.15	51.1	5.	APR.13	80.5	5.	FEB.13	89.0
6.	MAR.28	33.4	6.	FEB.20	164.8	6.	FEB.24	133.4	6.	MAY 1	190.0	6.	FEB.27	36.5
7.	APR. 8	65.7	7.	FEB.21	37.4	7.	MAR.28	37.2	7.	MAY 8	85.7	7.	APR.25	68.6
8.	MAY 29	38.0	8.	MAR.10	60.0	8.	MAR.29	80.2	8.	MAY 23	38.4	8.	APR.26	110.3
9.	JUN. 1	38.0	9.	MAR.13	50.7	9.	MAY 24	40.0	9.	JUN.29	42.2	9.	MAY 2	52.2
10.	JUN. 4	54.5	10.	MAR.21	32.8	10.	MAY 26	52.6	10.	SEP.19	44.1	10.	MAY 16	30.9
11.	JUN.22	59.9	11.	MAY 24	46.2	11.	JUL.12	50.3	11.	OCT. 1	43.8	11.	MAY 28	188.9
12.	OCT. 4	35.5	12.	OCT.10	51.8	12.	OCT.17	68.3	12.	OCT.24	97.0	12.	JUN.12	93.8
13.	OCT. 7	35.4	13.	NOV.13	36.7	13.	OCT.30	72.2	13.	OCT.30	33.1	13.	JUL.11	34.3
14.	NOV. 5	43.1	14.	DEC. 4	39.3	14.	NOV. 7	61.1	14.	NOV.27	46.4	14.	OCT. 8	88.6
15.	NOV. 9	30.2	15.	DEC. 9	56.2	15.	NOV.18	76.1						
16.	DEC. 2	95.7				16.	DEC.16	35.3						
17.	DEC. 3	78.0												

1955			1956			1957			1958			1959		
No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)
1.	JAN.13	49.5	1.	JAN. 4	93.2	1.	JAN. 7	32.8	1.	FEB.16	118.1	1.	JAN. 2	34.3
2.	JAN.16	38.0	2.	JAN.18	46.0	2.	JAN.23	87.3	2.	FEB.23	53.3	2.	JAN. 3	38.8
3.	MAR.15	32.3	3.	JAN.25	51.3	3.	JAN.27	34.5	3.	MAR.28	77.1	3.	FEB. 6	124.4
4.	MAR.19	58.1	4.	MAR.13	33.1	4.	JAN.31	40.2	4.	APR.30	131.2	4.	FEB.11	39.3
5.	MAR.28	66.4	5.	MAR.17	59.1	5.	FEB. 5	73.6	5.	JUL.14	32.1	5.	FEB.13	43.0
6.	MAR.29	34.3	6.	MAR.20	56.7	6.	FEB.23	34.2	6.	SEP.22	95.7	6.	MAR.16	49.2
7.	APR.14	66.0	7.	MAR.22	42.5	7.	MAR. 8	40.5	7.	SEP.23	70.0	7.	APR. 3	79.2
8.	MAY 4	33.6	8.	MAR.26	38.7	8.	APR.13	35.8	8.	OCT.10	38.8	8.	APR. 6	47.7
9.	MAY 13	76.4	9.	MAR.30	42.0	9.	APR.24	41.5	9.	NOV. 8	45.8	9.	APR. 9	118.7
10.	JUN.30	44.5	10.	APR. 4	36.7	10.	APR.28	67.7	10.	DEC. 1	52.1	10.	APR.22	108.8
11.	OCT. 8	34.9	11.	APR. 6	61.8	11.	MAY 5	43.5	11.	DEC. 7	48.3	11.	MAY 9	40.0
12.	DEC.20	45.6	12.	APR.21	70.4	12.	MAY 24	31.3	12.	DEC.12	38.2	12.	MAY 30	32.4
			13.	MAY 30	35.2	13.	JUN. 1	86.1	13.	DEC.13	100.5	13.	SEP.24	38.0
			14.	JUL. 2	35.0	14.	JUN.26	50.4				14.	NOV.10	68.9
			15.	SEP. 8	38.2	15.	JUL.13	34.0				15.	NOV.16	48.8
			16.	OCT. 7	35.6	16.	AUG.17	39.7				16.	NOV.28	41.6
			17.	OCT.13	57.2	17.	SEP.18	46.2				17.	NOV.29	40.8
			18.	OCT.16	43.5	18.	OCT. 9	35.2				18.	DEC. 6	47.1
			19.	DEC. 5	80.5	19.	DEC.28	46.0				19.	DEC.15	131.8
			20.	DEC.21	52.3							20.	DEC.17	51.8
												21.	DEC.21	36.4

1960			1961			1969			1970			1971		
No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)
1.	JAN.29	38.3	1.	JAN. 5	30.0	1.	JAN. 6	89.0	1.	JAN.14	32.7	1.	JAN. 3	30.0
2.	FEB.16	89.1	2.	FEB. 7	43.9	2.	JAN. 7	89.6	2.	JAN.24	30.2	2.	JAN. 7	72.0
3.	APR. 3	37.7	3.	FEB.22	49.7	3.	JAN. 9	79.5	3.	FEB.12	36.3	3.	JAN. 9	69.4
4.	APR.15	47.6	4.	MAR. 4	43.0	4.	FEB.17	34.0	4.	MAR.15	66.4	4.	JAN.10	65.4
5.	JUN.10	31.7	5.	MAR.12	36.7	5.	MAR.26	37.3	5.	MAR.20	38.0	5.	JAN.11	37.0
6.	JUN.13	49.3	6.	MAR.25	83.1	6.	APR. 1	36.4	6.	MAR.31	37.7	6.	JAN.30	34.0
7.	AUG.24	40.5	7.	MAR.31	38.5	7.	APR.10	35.2	7.	MAY 18	97.7	7.	FEB.13	34.3
8.	SEP. 7	49.2	8.	APR.12	47.6	8.	APR.19	34.7	8.	JUN. 9	37.0	8.	FEB.22	43.7
9.	OCT.18	55.4	9.	APR.13	68.7	9.	APR.27	44.2	9.	AUG.20	45.4	9.	FEB.23	42.8
10.	OCT.21	44.5	10.	APR.22	78.7	10.	MAY 12	49.5	10.	SEP.18	39.3	10.	MAR.11	71.5
11.	OCT.24	42.7	11.	MAY 6	56.0	11.	MAY 25	53.0	11.	SEP.24	31.5	11.	MAY 1	33.1
12.	OCT.25	33.8	12.	JUN. 9	54.0	12.	SEP.27	39.7	12.	SEP.27	47.2	12.	MAY 22	36.8
13.	NOV. 3	93.0	13.	OCT.13	35.2	13.	SEP.28	50.0	13.	OCT.31	38.0	13.	JUN. 4	38.0
14.	NOV.13	53.0	14.	OCT.18	78.1	14.	OCT. 3	38.7	14.	DEC.23	38.4	14.	JUL.28	84.8
15.	NOV.24	33.2	15.	NOV. 9	115.5	15.	OCT. 4	34.6				15.	AUG. 8	33.3
16.	DEC.31	44.2	16.	NOV.19	53.8	16.	NOV. 7	48.3				16.	AUG.22	54.7
			17.	NOV.24	63.1	17.	NOV.20	61.3				17.	OCT. 9	57.6
			18.	DEC.23	74.0	18.	NOV.25	60.8				18.	NOV. 8	50.4
												19.	DEC. 1	57.7

Table 7-4.(2/2) DAILY RAINFALL RECORDS
(more than 30 mm)

1972			1973			1974			1975			1976		
No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)
1.	JAN.17	45.0	1.	FEB.11	38.4	1.	JAN.25	57.5	1.	JAN. 9	34.7	1.	JAN. 5	43.0
2.	JAN.20	72.3	2.	MAR. 7	60.2	2.	JAN.29	38.5	2.	MAR.29	37.4	2.	JAN.26	38.2
3.	FEB. 1	34.9	3.	MAR.18	65.9	3.	JAN.30	39.0	3.	MAR.31	67.4	3.	JAN.30	74.1
4.	FEB.13	34.7	4.	JUN.30	40.1	4.	FEB. 3	44.3	4.	APR. 1	34.9	4.	MAR.20	32.2
5.	FEB.18	36.2	5.	AUG.11	32.0	5.	FEB.20	30.2	5.	APR. 7	105.8	5.	APR. 9	54.8
6.	MAR. 9	87.6	6.	OCT. 4	33.4	6.	FEB.28	51.2	6.	JUN.28	36.5	6.	APR.18	32.0
7.	APR. 2	82.6	7.	OCT. 5	68.2	7.	MAR.21	53.8	7.	SEP. 9	70.6	7.	OCT.16	45.2
8.	APR.25	33.9	8.	OCT.22	51.9	8.	MAR.30	45.6	8.	OCT.16	33.4	8.	NOV. 4	34.4
9.	JUN. 2	54.2	9.	NOV. 7	38.0	9.	MAY 11	56.6	9.	NOV. 8	60.1			
10.	JUN. 5	36.5	10.	NOV.23	65.2	10.	MAY 17	60.8	10.	NOV.22	46.2			
11.	JUN.10	40.0	11.	DEC. 4	35.0	11.	MAY 23	50.9	11.	DEC. 6	51.2			
12.	JUN.15	35.8				12.	MAY 24	48.4	12.	DEC. 8	36.6			
13.	SEP.19	41.6				13.	AUG. 3	78.4	13.	DEC.13	43.3			
14.	OCT.13	57.0				14.	AUG.27	45.2						
15.	OCT.12	65.0				15.	OCT. 3	51.2						
16.	OCT.29	103.2				16.	OCT.15	155.2						
17.	OCT.30	87.0				17.	NOV.11	49.6						
18.	DEC. 3	51.2				18.	NOV.26	82.4						
19.	DEC.28	30.7				19.	DEC.27	55.2						
20.	DEC.31	67.4												

1977			1978			1979			1980			1981		
No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)
1.	MAY 5	34.0	1.	FEB.19	53.5	1.	JAN.27	34.5	1.	JAN. 7	55.6	1.	JAN.17	57.2
2.	MAY 6	49.5	2.	FEB.20	34.4	2.	FEB. 8	30.7	2.	JAN.23	100.0	2.	JAN.20	33.9
3.	JUN.19	78.8	3.	FEB.28	32.8	3.	MAR. 7	54.4	3.	FEB. 4	77.6	3.	FEB. 8	34.1
4.	JUN.20	47.2	4.	JUN.17	34.1	4.	APR. 2	78.7	4.	MAR. 1	73.6	4.	FEB. 9	59.2
5.	OCT.24	30.0	5.	JUL. 1	80.4	5.	APR. 3	34.8	5.	APR. 7	39.5	5.	FEB.12	88.0
6.	NOV.21	30.6	6.	SEP.13	44.2	6.	APR.12	82.1	6.	APR.30	43.8	6.	FEB.14	43.6
7.	NOV.23	34.4	7.	OCT. 8	49.6	7.	MAY 11	72.6	7.	MAY 9	71.0	7.	APR.22	67.3
8.	DEC. 5	51.2	8.	OCT.26	54.8	8.	MAY 22	87.4	8.	MAY 19	42.3	8.	APR.26	49.4
9.	DEC. 6	66.2	9.	OCT.31	97.0	9.	AUG. 9	78.1	9.	MAY 20	44.3	9.	JUN. 5	30.6
			10.	NOV.20	47.2	10.	AUG.16	34.7	10.	JUN.18	34.6	10.	NOV.18	31.0
						11.	AUG.17	51.3	11.	AUG. 4	70.7	11.	NOV.29	36.5
						12.	SEP. 8	45.7	12.	AUG.21	44.2	12.	DEC.14	56.2
						13.	SEP. 9	31.5	13.	SEP.27	37.6	13.	DEC.20	82.0
						14.	SEP.12	46.9	14.	OCT.29	39.5			
						15.	OCT.29	41.2	15.	NOV.20	38.6			
						16.	NOV. 7	63.0	16.	NOV.28	71.4			
						17.	NOV.17	77.2	17.	DEC.10	37.9			
						18.	NOV.21	42.0						
						19.	NOV.30	53.5						

1982			1983			1984			1985		
No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)	No.	Date	Rain(mm)
1.	FEB.21	35.6	1.	JAN.25	35.6	1.	FEB.18	52.0	1.	FEB.11	34.7
2.	MAR.16	35.4	2.	FEB. 7	60.2	2.	JAN.27	42.0	2.	APR.15	68.0
3.	APR.13	35.0	3.	FEB.15	126.4	3.	MAR. 1	37.0	3.	APR.27	35.4
4.	JUN. 3	35.5	4.	MAR.17	46.6	4.	MAR.16	31.8	4.	MAY 18	50.4
5.	JUN.14	67.0	5.	APR.18	68.2	5.	MAR.28	69.0	5.	JUL.30	71.7
6.	SEP.11	31.0	6.	APR.23	35.5	6.	APR.16	89.4	6.	SEP.14	45.6
7.	SEP.25	30.0	7.	APR.28	81.0	7.	APR.17	78.5	7.	OCT.15	33.5
8.	SEP.25	57.0	8.	MAY 9	62.5	8.	MAY. 9	35.8			
9.	NOV. 3	34.7	9.	MAY 10	51.2	9.	OCT.13	31.5			
10.	NOV.19	193.7	10.	MAY 22	34.2	10.	NOV.11	44.5			
11.	NOV.21	57.6	11.	JUL.26	42.3	11.	NOV.23	48.2			
12.	DEC.14	38.8	12.	SEP. 5	31.0	12.	DEC. 5	43.3			
13.	DEC.16	56.3	13.	SEP.16	40.2	13.	DEC.27	32.8			
14.	DEC.21	52.2	14.	OCT.16	37.0	14.	DEC.30	32.5			
			15.	NOV.18	45.2						

Table 7-5. ESTIMATED TRAFFIC VOLUME AND INUNDATION DURATION AT THE TROUBLE SPOTS AS OF 2005

Trouble Spot No.	No. of Vehicles (Per Hour)		Inundation Duration (min.) Return Period					
	Car	Bus	1.1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	30-Yr
Mburicao River Basin								
MT-1	1,668	206	10	30	35	65	75	110
MT-2	495	66	30	60	70	95	120	165
MT-3	1,029	93	30	60	65	95	125	165
MT-4	1,832	397	40	60	85	120	140	190
MT-5	1,521	418	20	30	40	65	75	110
MT-6	758	104	0	0	0	15	25	45
MT-7	1,127	125	45	90	110	140	170	230
MT-8	1,706	397	20	45	60	75	100	160
MS-1	536	55	10	30	35	65	75	110
MS-2	245	70	10	30	40	65	75	110
MS-3	781	-	10	30	40	65	75	110
MS-4	632	55	30	60	65	95	120	165
MS-5	475	19	50	90	110	140	170	230
MS-6	578	-	45	90	110	140	170	230
MS-7	90	-	10	30	40	65	75	110
Ferreira River Basin								
FT-1	1,875	182	35	65	75	100	125	165
FS-1	484	53	20	30	40	55	75	100
FS-2	198	-	30	50	60	90	110	150
FS-3	236	130	0	10	20	35	40	55
FS-4	72	53	30	55	65	95	120	155

NOTE : Refer to Figs. 7-1 and 7-2 for the location of trouble spots.

Table 7-6.(1/3) DAMAGE ESTIMATE FOR EACH RAINFALL AS OF 2005
(In the Whole River Basin)

Unit: ¢ million

River Basin	Damage Item	Return Period 1.1-yr	2-yr	3-yr	5-yr	10-yr	30-yr
MBURICAO	1. Damage due to Traffic Interruption	29.6	54.9	70.8	102.1	124.5	178.5
	1) Incremental Travel Cost	4.8	9.2	11.8	17.1	20.8	29.6
	2) Loss of Productivity	24.8	45.7	59.0	85.0	103.7	148.9
	2. Damage due to Submergence	6.2	20.7	36.0	62.9	127.6	234.5
	3. Indirect Damage (15%)	5.4	11.3	16.0	24.8	37.8	62.0
	4. Total	41.2	86.9	122.8	189.8	289.9	475.0
FERREIRA	1. Damage due to Traffic Interruption	5.9	11.1	13.2	17.9	22.5	29.7
	1) Incremental Travel Cost	1.1	2.1	2.4	3.3	4.2	5.5
	2) Loss of Productivity	4.8	9.0	10.8	14.6	18.3	24.2
	2. Damange due to Submergence	2.3	8.8	11.8	16.0	23.1	38.5
	3. Indirect Damage (15%)	1.2	3.0	3.8	5.1	6.8	10.2
	4. Total	9.4	22.9	28.8	39.0	52.4	78.4

Table 7-6.(2/3) DAMAGE ESTIMATE FOR EACH RAINFALL AS OF 2005
(At the Trouble Spots)

Unit: ¢ million

River Basin	Damage Item	Return Period 1.1-yr	2-yr	3-yr	5-yr	10-yr	30-yr
MBURICAO	1. Damage due to Traffic Interruption	26.9	49.9	64.3	92.8	113.2	162.3
	1) Incremental Travel Cost	4.4	8.4	10.7	15.5	18.9	26.9
	2) Loss of Productivity	22.5	41.5	53.6	77.3	94.3	135.4
	2. Damage due to Submergence	6.2	20.7	36.0	62.9	127.6	234.5
	3. Indirect Damage (15%)	5.0	10.6	15.0	23.4	36.1	59.5
	4. Total	38.1	81.2	115.3	179.1	276.9	456.3
FERREIRA	1. Damage due to Traffic Interruption	5.4	10.1	12.0	16.3	20.4	27.0
	1) Incremental Travel Cost	1.0	1.9	2.2	3.0	3.8	5.0
	2) Loss of Productivity	4.4	8.2	9.8	13.3	16.6	22.0
	2. Damange due to Submergence	2.3	8.8	11.8	16.0	23.1	38.5
	3. Indirect Damage (15%)	1.2	2.8	3.6	4.8	6.5	9.8
	4. Total	8.9	21.7	27.4	37.1	50.0	75.3

Table 7-6.(3/3) DAMAGE ESTIMATE FOR EACH RAINFALL AS OF 2005 (Along the Trunk Roads)

Unit: ¢ million

River Basin	Damage Item	Return Period					
		1.1-yr	2-yr	3-yr	5-yr	10-yr	30-yr
MBURICAO	1. Damage due to Traffic Interruption	26.9	49.9	64.3	92.8	113.2	162.3
	1) Incremental Travel Cost	4.4	8.4	10.7	15.5	18.9	26.9
	2) Loss of Productivity	22.5	41.5	53.6	77.3	94.3	135.4
	2. Damage due to Submergence	-	-	-	-	-	-
	3. Indirect Damage (15%)	4.0	7.5	9.6	13.9	17.0	24.3
	4. Total	30.9	57.4	73.9	106.7	130.2	186.6

Table 7-7. ANNUAL DISBURSEMENT OF ECONOMIC PROJECT COST

Unit: ¢ million

Work Item	1988		1989		1990		1991		1992		1993		Total		
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	Total
1. Civil Works															
River Channel	-	-	-	-	567	130	3,228	949	652	457	665	404	5,112	1,940	7,052
Drainage Facilities	-	-	-	-	1,080	653	-	-	1,802	651	898	395	3,780	1,699	5,479
Sub-total	-	-	-	-	1,647	783	3,228	949	2,454	1,108	1,563	799	8,892	3,639	12,531
2. Physical Contingency (10%)	-	-	-	-	165	78	323	95	245	111	156	80	889	364	1,253
3. Engineering Services	514	57	514	57	574	66	574	66	574	66	574	66	3,324	378	3,702
Total	514	57	514	57	2,386	927	4,125	1,110	3,273	1,285	2,293	945	13,105	4,381	17,486

NOTE F.C.: Foreign currency portion
L.C.: Local currency portion

Table 7-8. ESTIMATED TRAFFIC VOLUME AND INUNDATION DURATION AT THE TROUBLE SPOTS AS OF 1995

Trouble Spot No.	No. of Vehicles (Per Hour)		Inundation Duration (min.)					
			Return Period					
	Car	Bus	1.1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	30-Yr
Mburicao River Basin								
MT-1	1,467	196	10	30	35	60	70	100
MT-2	436	63	30	55	65	90	110	155
MT-3	876	89	30	55	60	90	115	155
MT-4	1,770	378	35	55	80	110	130	175
MT-5	1,386	398	20	30	35	60	70	100
MT-6	749	99	0	0	0	15	25	40
MT-7	992	119	45	85	100	130	160	215
MT-8	1,676	393	20	40	55	70	95	150
MS-1	323	53	10	30	35	60	70	100
MS-2	238	50	10	30	35	60	70	100
MS-3	768	0	10	30	35	60	70	100
MS-4	631	61	30	55	60	90	110	155
MS-5	395	17	45	85	100	130	160	215
MS-6	560	0	45	85	100	130	160	215
MS-7	75	0	10	30	35	60	70	100
Itay River Basin								
IT-1	1,291	175	40	70	80	110	135	180
IT-2	2,013	420	80	170	190	210	230	270
IT-3	854	408	90	170	200	220	250	290
IS-1	230	63	40	70	80	110	135	180
IS-2	171	33	70	160	180	190	210	290

NOTE : Refer to Figs. 7-1 and 7-7 for the location of trouble spots.

Table 7-9. DAMAGE ESTIMATE FOR EACH RAINFALL AS OF 1995
(At the Trouble Spots)

Unit: ¢ million

DAMAGE ITEM	Return Period					
	1.1-yr	2-yr	3-yr	5-yr	10-yr	30-yr
MBURICAO RIVER BASIN						
1. Damage due to Traffice Interruption	24.2	44.0	56.0	80.8	99.4	141.1
1) Incremental Travel Cost	4.0	7.4	9.2	13.3	16.3	23.2
2) Loss of Productivity	20.2	36.6	46.8	67.5	83.1	117.9
2. Damage due to Submergence	5.6	17.7	29.7	53.9	88.4	147.7
3. Indirect Damage (15%)	4.5	9.3	12.9	20.2	28.2	43.3
4. Total	34.3	71.0	98.6	154.9	216.0	332.1
ITAY RIVER BASIN						
1. Damage due to Traffice Interruption	37.8	76.8	88.1	98.0	111.4	138.6
1) Incremental Travel Cost	5.2	10.6	12.1	13.4	15.3	19.1
2) Loss of Productivity	32.6	66.2	76.0	84.6	96.1	119.5
2. Damange due to Submergence	26.2	73.6	128.7	225.6	579.6	1,185.9
3. Indirect Damage (15%)	9.6	22.6	32.5	48.5	103.7	198.7
4. Total	73.6	173.0	249.3	372.1	794.7	1,523.2

Table 7-10. COST-BENEFIT FLOW FOR FIRST STAGE PROJECT

Unit: ¢ million

Year	Economic Cost				Benefit
	Consulting Services	Construction	Operation & Maintenance	Total	
1	571	-	-	571	-
2	571	-	-	571	-
3	640	2,673	-	3,313	-
4	640	4,595	14	5,249	688
5	640	3,918	38	4,596	1,293
6	640	2,598	58	3,296	1,801
7	-	-	71	71	2,108
8	-	-	71	71	2,108
9	-	-	71	71	2,108
10	-	-	71	71	2,108
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41	-	-	71	71	2,108
42	-	-	71	71	2,108
43	-	-	71	71	2,108
44	-	-	71	71	2,108
45	-	-	71	71	2,108
46	-	-	71	71	2,108
47	-	-	71	71	2,108
48	-	-	71	71	2,108
49	-	-	71	71	2,108
50	-	-	71	71	2,108
Total	3,702	13,784	3,234	20,720	96,534

Table 7-11. FUTURE SURPLUS FUND OF CORPOSANA'S DRAINAGE SECTOR

Unit: ₡ million

Year	Revenue /1	Expenditure /2			Surplus Fund	Accumulation
		Interest	Repayment	Total		
1987	720.9	108.3	271.5	379.8	341.1	341.1
1988	829.0	91.3	302.4	393.7	435.3	776.4
1989	953.4	65.2	302.4	367.6	585.8	1,362.2
1990	1,096.4	44.6	104.3	148.9	947.5	2,309.7
1991	1,151.2	41.7	104.3	146.0	1,005.2	3,314.9
1992	1,208.8	39.8	104.3	144.1	1,064.7	4,379.6
1993	1,269.2	35.9	104.3	140.2	1,129.0	5,508.6
1994	1,332.7	32.9	95.5	128.4	1,204.3	6,712.9
1995	1,399.3	30.6	82.7	113.3	1,286.0	7,998.9
1996	1,469.3	28.4	77.2	105.6	1,363.7	9,362.6
1997	1,542.8	26.4	77.2	103.6	1,439.2	10,801.8
1998	1,619.9	24.4	78.8	103.2	1,516.7	12,318.5
1999	1,700.9	22.6	61.9	84.5	1,616.4	13,934.9
2000	1,785.9	21.3	61.9	83.2	1,702.7	15,637.6
2001	1,875.2	20.1	61.9	82.0	1,793.2	17,430.8
2002	1,969.0	18.9	61.9	80.8	1,888.2	19,319.0
2003	2,067.5	17.6	61.9	79.5	1,988.0	21,307.0
2004	2,170.9	16.4	61.9	78.3	2,092.6	23,399.6
2005	2,279.4	15.2	61.9	77.1	2,202.3	25,601.9
2006	2,393.4	13.9	61.9	75.8	2,317.6	27,919.5
2007	2,513.1	12.7	61.9	74.6	2,438.5	30,358.0
2008	2,638.8	11.4	61.9	73.3	2,565.5	32,923.5
2009	2,770.7	10.2	61.9	72.1	2,698.6	35,622.1
2010	2,909.2	9.0	61.9	70.9	2,838.3	38,460.4
2011	3,054.7	7.7	61.9	69.6	2,985.1	41,445.5
2012	3,207.4	6.4	61.9	68.3	3,139.1	44,584.6
2013	3,367.8	5.3	61.9	67.2	3,300.6	47,885.2
2014	3,536.2	4.0	61.9	65.9	3,470.3	51,355.5
2015	3,713.0	2.8	61.9	64.7	3,648.3	55,003.8
2016	3,898.7	1.5	61.9	63.4	3,835.3	58,839.1
2017	4,093.6	0.3	30.9	31.2	4,062.4	62,901.5
2018	4,298.3	-	-	-	4,298.3	67,199.8
2019	4,513.2	-	-	-	4,513.2	71,713.0
2020	4,738.9	-	-	-	4,738.9	76,451.9
2021	4,738.9	-	-	-	4,738.9	81,190.8
2022	4,738.9	-	-	-	4,738.9	85,929.7
2023	4,738.9	-	-	-	4,738.9	90,668.6
2024	4,738.9	-	-	-	4,738.9	95,407.5
2025	4,738.9	-	-	-	4,738.9	100,146.4
2026	4,738.9	-	-	-	4,738.9	104,885.3
2027	4,738.9	-	-	-	4,738.9	109,624.2
2028	4,738.9	-	-	-	4,738.9	114,363.1
2029	4,738.9				4,738.9	119,102.0
2030	4,738.9				4,738.9	123,840.9
2031	4,738.9				4,738.9	128,579.8
2032	4,738.9				4,738.9	133,318.7
2033	4,738.9				4,738.9	138,057.6
2034	4,738.9				4,738.9	142,796.5

NOTE /1 : Annual inrease rates are assumed to be 15% until 1990, 5% from 1991 to 2020 and 0% after 2021.

/2 : Amotization for the loan of IDB, etc.

Table 7-12. LOAN AMORTIZATION SCHEDULE OF THE FOREIGN CURRENCY PORTION

Unit: ¢ million

Year	Disbursement	Repayment	Accumulation	Interest	Total
1987	0.0	0.0	0.0	0.0	0.0
1988	514.0	0.0	514.0	18.0	18.0
1989	514.0	0.0	1,028.0	36.0	36.0
1990	2,386.0	0.0	3,414.0	119.5	119.5
1991	4,125.0	0.0	7,539.0	263.9	263.9
1992	3,273.0	0.0	10,812.0	378.4	378.4
1993	2,294.0	0.0	13,106.0	458.7	458.7
1994	0.0	0.0	13,106.0	458.7	458.7
1995	0.0	0.0	13,106.0	458.7	458.7
1996	0.0	0.0	13,106.0	458.7	458.7
1997	0.0	0.0	13,106.0	458.7	458.7
1998	0.0	25.7	13,106.0	458.7	458.7
1999	0.0	51.4	13,080.3	457.8	509.2
2000	0.0	170.7	13,028.9	456.0	626.7
2001	0.0	377.0	12,858.2	450.0	827.0
2002	0.0	540.6	12,481.3	436.8	977.4
2003	0.0	655.3	11,940.7	417.9	1,073.2
2004	0.0	655.3	11,285.4	395.0	1,050.3
2005	0.0	655.3	10,630.1	372.1	1,027.4
2006	0.0	655.3	9,974.8	349.1	1,004.4
2007	0.0	655.3	9,319.5	326.2	981.5
2008	0.0	655.3	8,664.1	303.2	958.5
2009	0.0	655.3	8,008.8	280.3	935.6
2010	0.0	655.3	7,353.5	257.4	912.7
2011	0.0	655.3	6,698.2	234.4	889.7
2012	0.0	655.3	6,042.9	211.5	866.8
2013	0.0	655.3	5,387.6	188.6	843.9
2014	0.0	655.3	4,732.3	165.6	820.9
2015	0.0	655.3	4,077.0	142.7	798.0
2016	0.0	655.3	3,421.7	119.8	775.1
2017	0.0	655.3	2,766.4	96.8	752.1
2018	0.0	629.6	2,111.1	73.9	703.5
2019	0.0	603.9	1,481.5	51.9	655.8
2020	0.0	484.6	877.6	30.7	515.3
2021	0.0	278.4	393.0	13.8	292.1
2022	0.0	114.7	114.7	4.0	118.7

Table 7-13. FINANCIAL STATUS OF CORPOSANA'S DRAINAGE SECTOR IN IMPLEMENTING THE FIRST STAGE PROJECT

Unit: ¢ million

Year	Surplus Fund /1	Expenditure For The First Stage Project				Balance
		F.C. /2	L.C. /3	O/M /4	TOTAL	
1987	341.1	-	-	-	.0	341.1
1988	435.3	18.0	69.2	-	87.2	348.1
1989	585.8	36.0	76.1	-	112.1	473.7
1990	947.5	119.5	2,047.5	-	2,167.0	-1,219.5
1991	1,005.2	263.9	3,726.2	42.8	4,032.9	-3,027.7
1992	1,064.7	378.4	4,638.8	49.6	5,066.8	-4,002.1
1993	1,129.0	458.7	3,839.6	71.2	4,369.5	-3,240.5
1994	1,204.3	458.7	-	83.1	541.8	662.5
1995	1,286.0	458.7	-	87.3	546.0	740.0
1996	1,363.7	458.7	-	91.7	550.4	813.3
1997	1,439.2	458.7	-	96.3	555.0	884.2
1998	1,516.7	484.4	-	101.1	585.5	931.2
1999	1,616.4	509.2	-	106.2	615.4	1,001.0
2000	1,702.7	626.7	-	111.5	738.2	964.5
2001	1,793.2	827.0	-	117.1	944.1	849.1
2002	1,888.2	977.4	-	123.0	1,100.4	787.8
2003	1,988.0	1,073.2	-	129.2	1,202.4	785.6
2004	2,092.6	1,050.3	-	135.7	1,186.0	906.6
2005	2,202.3	1,027.4	-	142.5	1,169.9	1,032.4
2006	2,317.6	1,004.4	-	149.6	1,154.0	1,163.6
2007	2,438.5	981.5	-	157.1	1,138.6	1,299.9
2008	2,565.5	958.5	-	165.0	1,123.5	1,442.0
2009	2,698.6	935.6	-	173.3	1,108.9	1,589.7
2010	2,838.3	912.7	-	182.0	1,094.7	1,743.6
2011	2,985.1	889.7	-	191.1	1,080.8	1,904.3
2012	3,139.1	866.8	-	200.7	1,067.5	2,071.6
2013	3,300.6	843.9	-	210.7	1,054.6	2,246.0
2014	3,470.3	820.9	-	221.2	1,042.1	2,428.2
2015	3,648.3	798.0	-	232.3	1,030.3	2,618.0
2016	3,835.3	775.1	-	243.9	1,019.0	2,816.3
2017	4,062.4	752.1	-	256.1	1,008.2	3,054.2
2018	4,298.3	703.5	-	268.9	972.4	3,325.9
2019	4,513.2	655.8	-	282.3	938.1	3,575.1
2020	4,738.9	515.3	-	296.4	811.7	3,927.2
2021	4,738.9	292.1	-	311.2	603.3	4,135.6
2022	4,738.9	118.7	-	326.8	445.5	4,293.4
TOTAL	85,929.7	22,509.5	14,397.4	5,356.9	42,263.8	43,665.9

NOTE /1: Refer to Table 7-11.
/2: Amortization for the foreing currency portion
/3: Expenses in the local currency portion
/4: Operation and maintenance cost

FIGURES

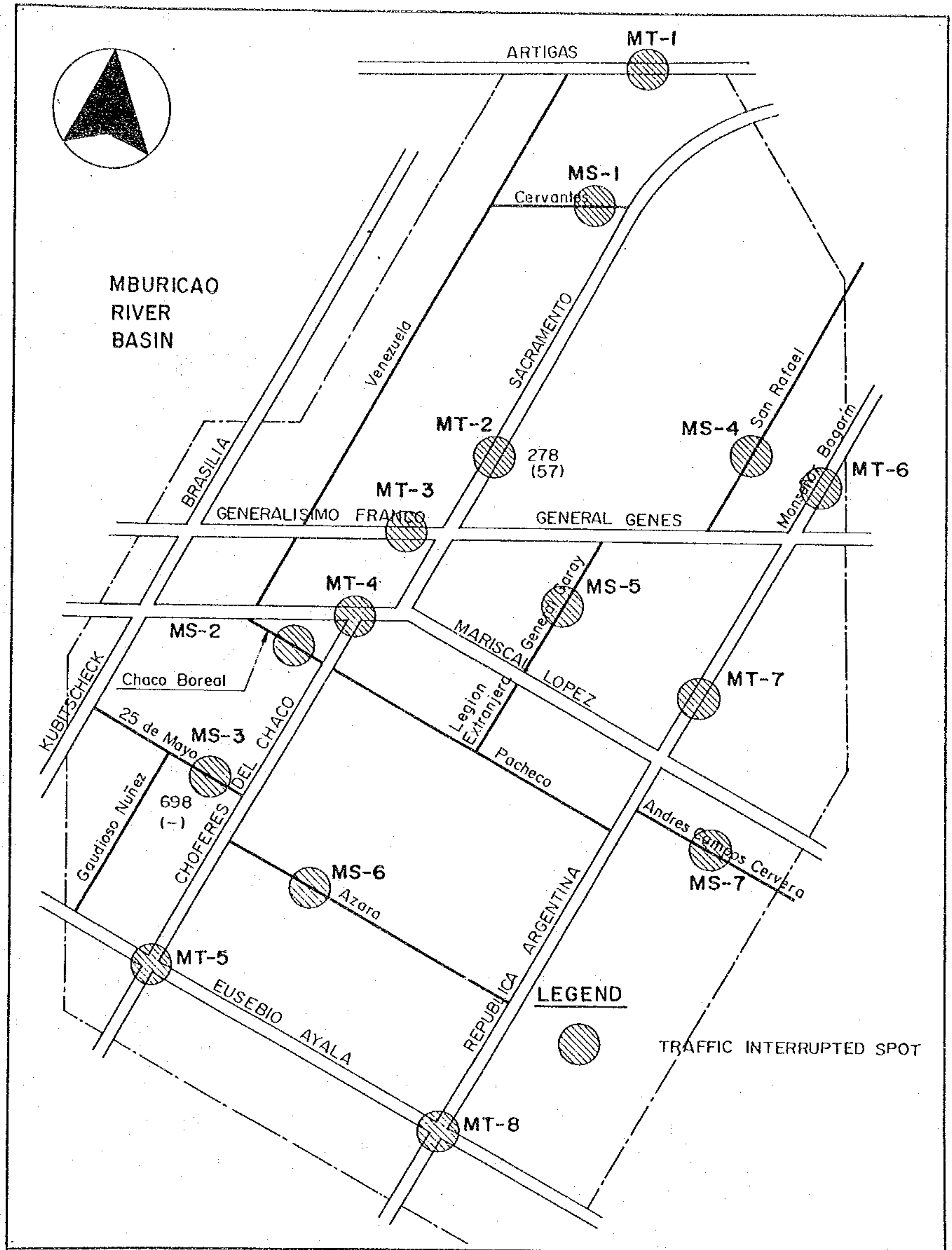

Fig. 7-1. LOCATION OF MAJOR TRAFFIC INTERRUPTION SPOTS IN MBURICAO RIVER BASIN

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

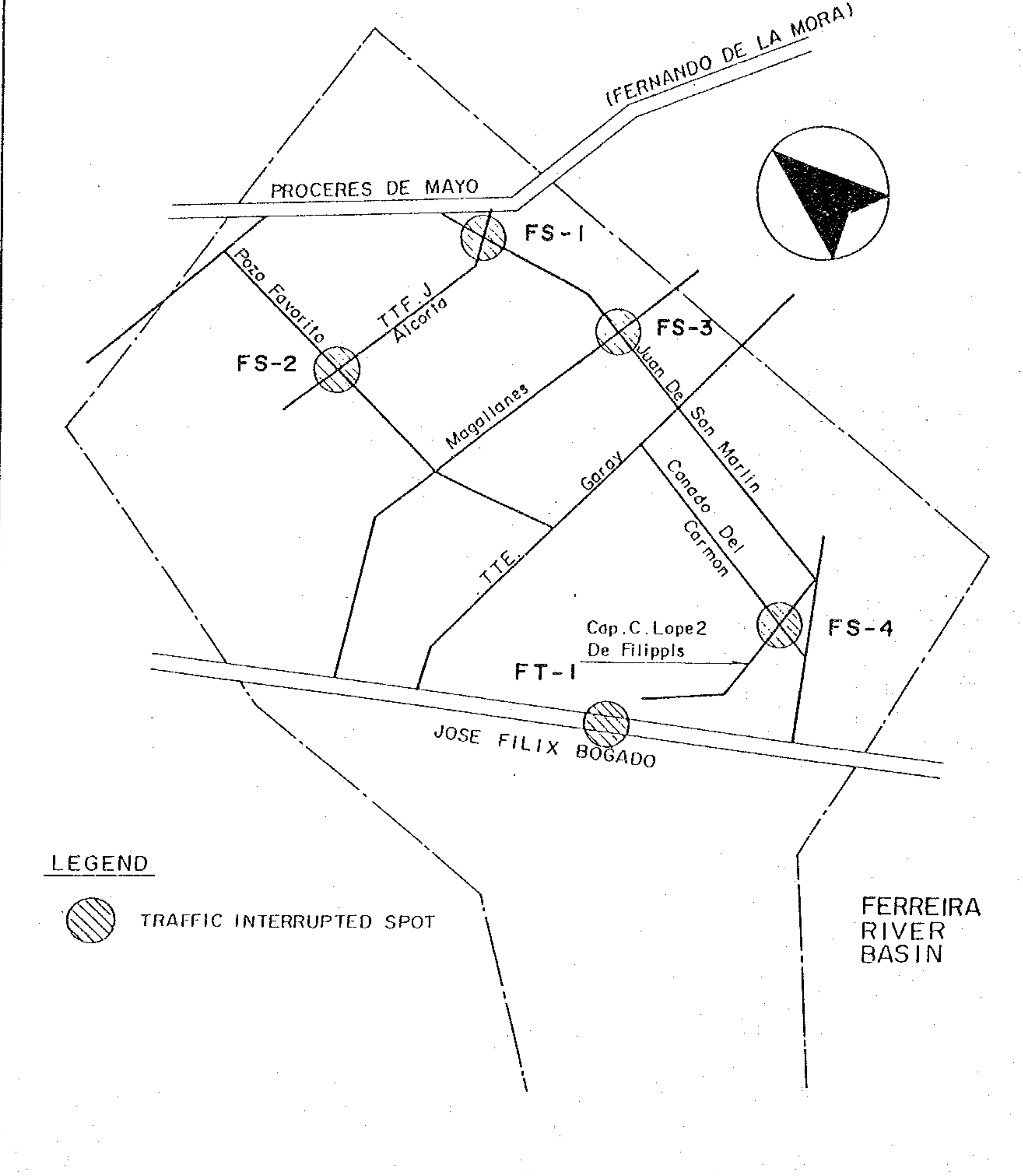

Fig.7-2. LOCATION OF MAJOR TRAFFIC INTERRUPTION SPOTS IN FERREIRA RIVER BASIN

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

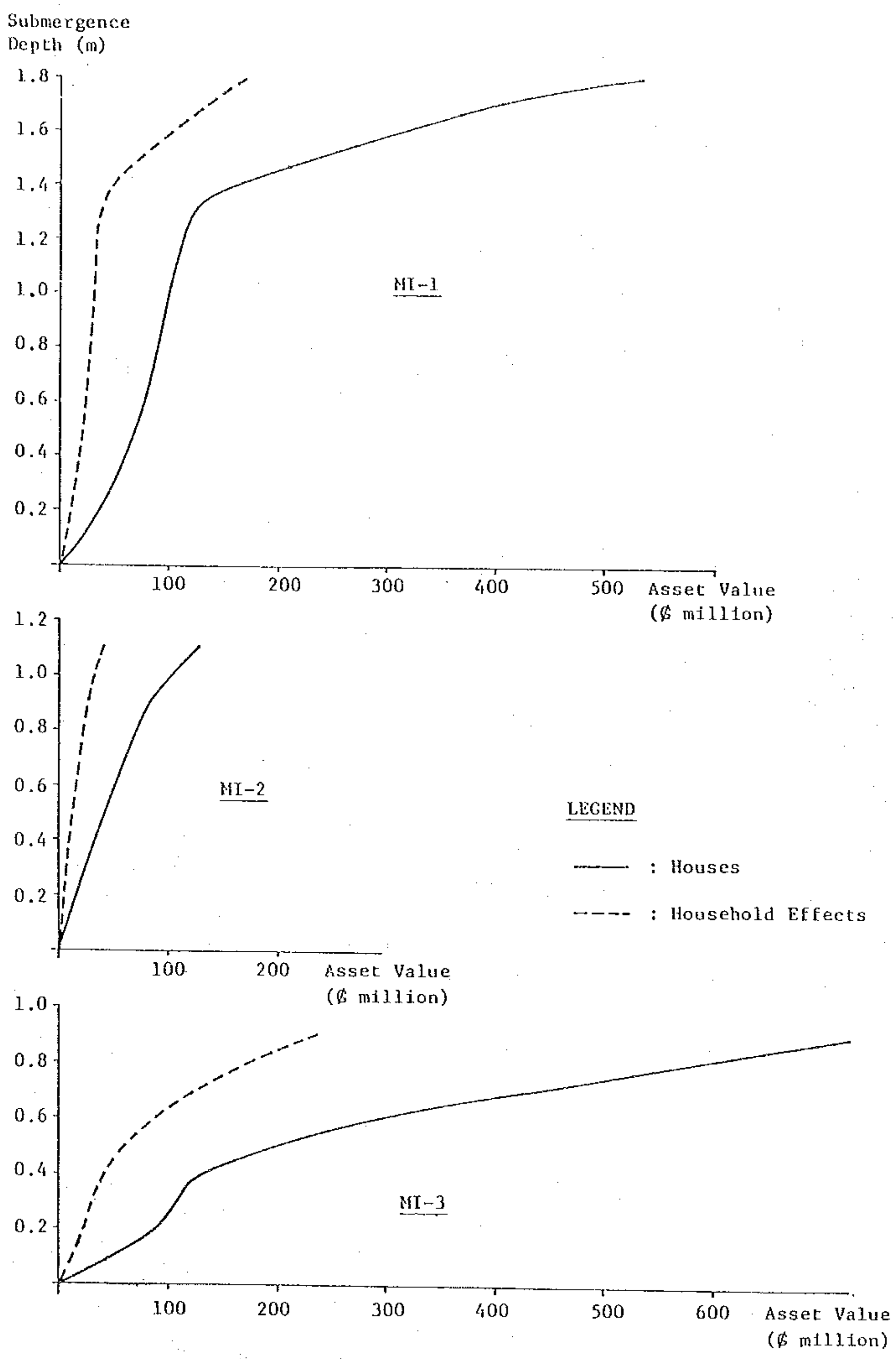

Fig. 7-3.(1/2) RELATION CURVES BETWEEN SUBMERGENCE DEPTH AND ASSETS VALUE AS OF 2005 (MBURICAO)

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

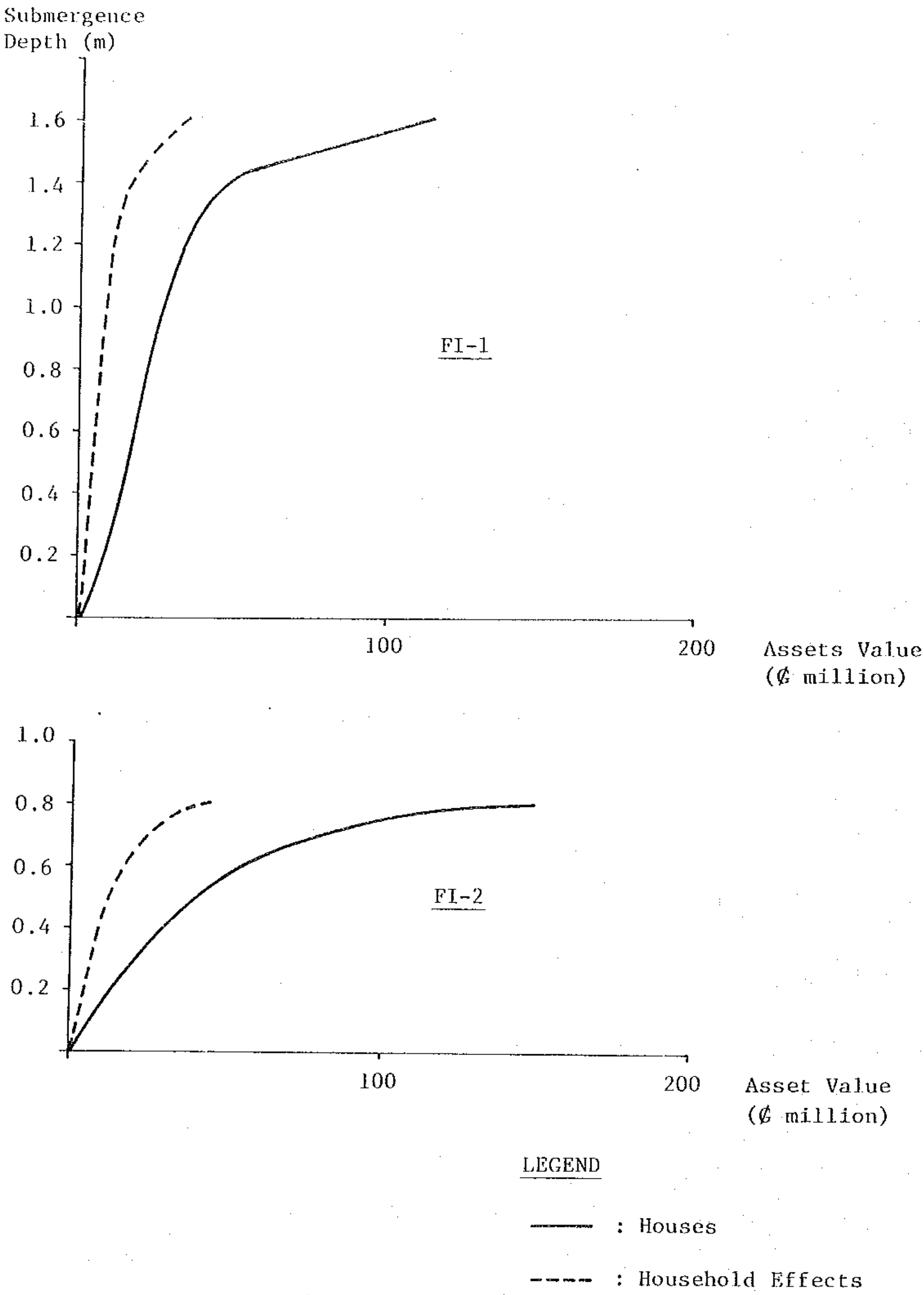

Fig. 7-3.(2/2) RELATION CURVES BETWEEN SUBMERGENCE DEPTH AND ASSETS VALUE AS OF 2005 (FERREIRA)	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY

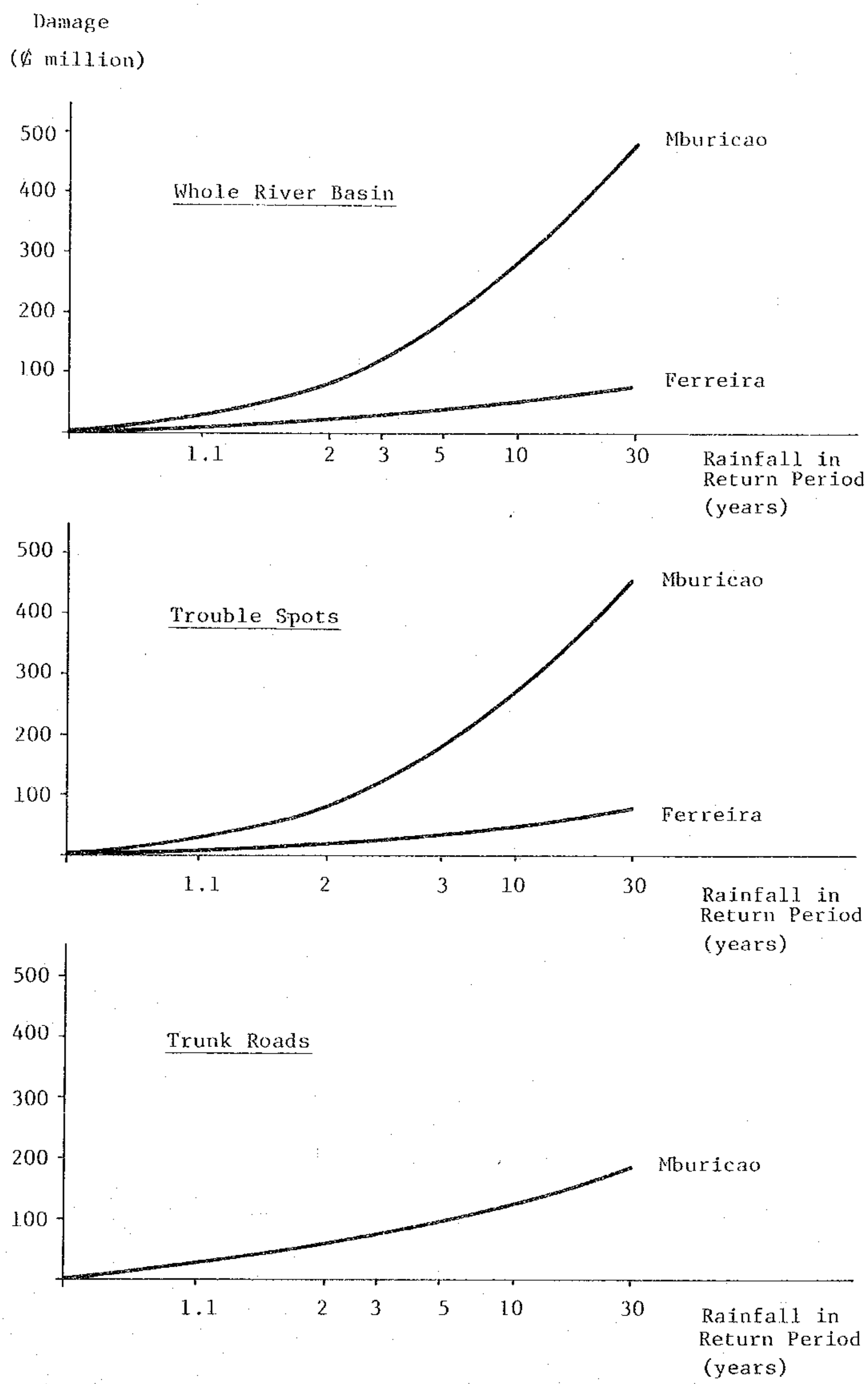

Fig. 7-4. RELATION CURVES BETWEEN DAMAGE AND RAINFALL AS OF 2005	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY

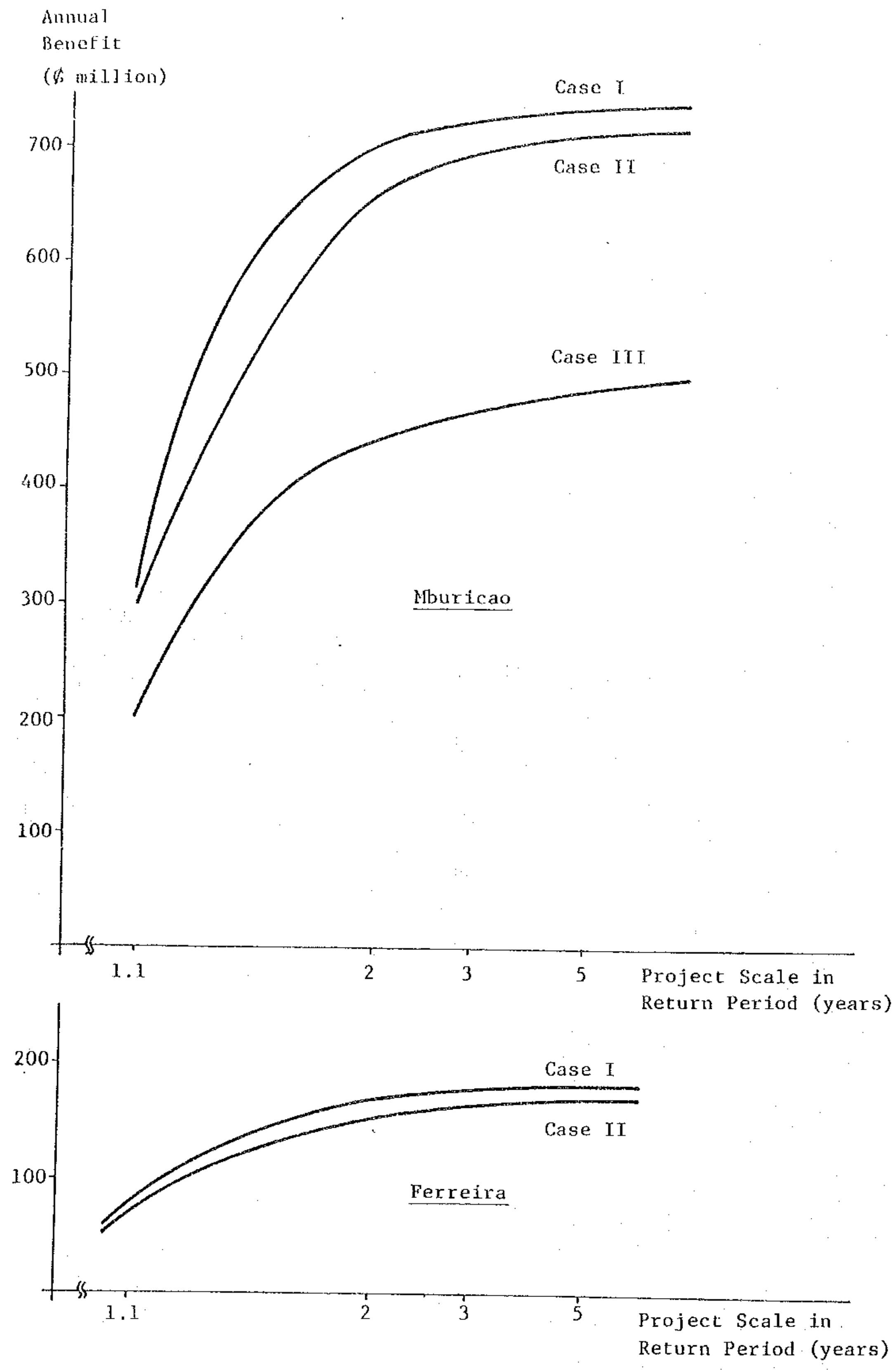

Fig. 7-5. RELATION CURVES BETWEEN ANNUAL BENEFIT AND PROJECT SCALE AS OF 2005	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY

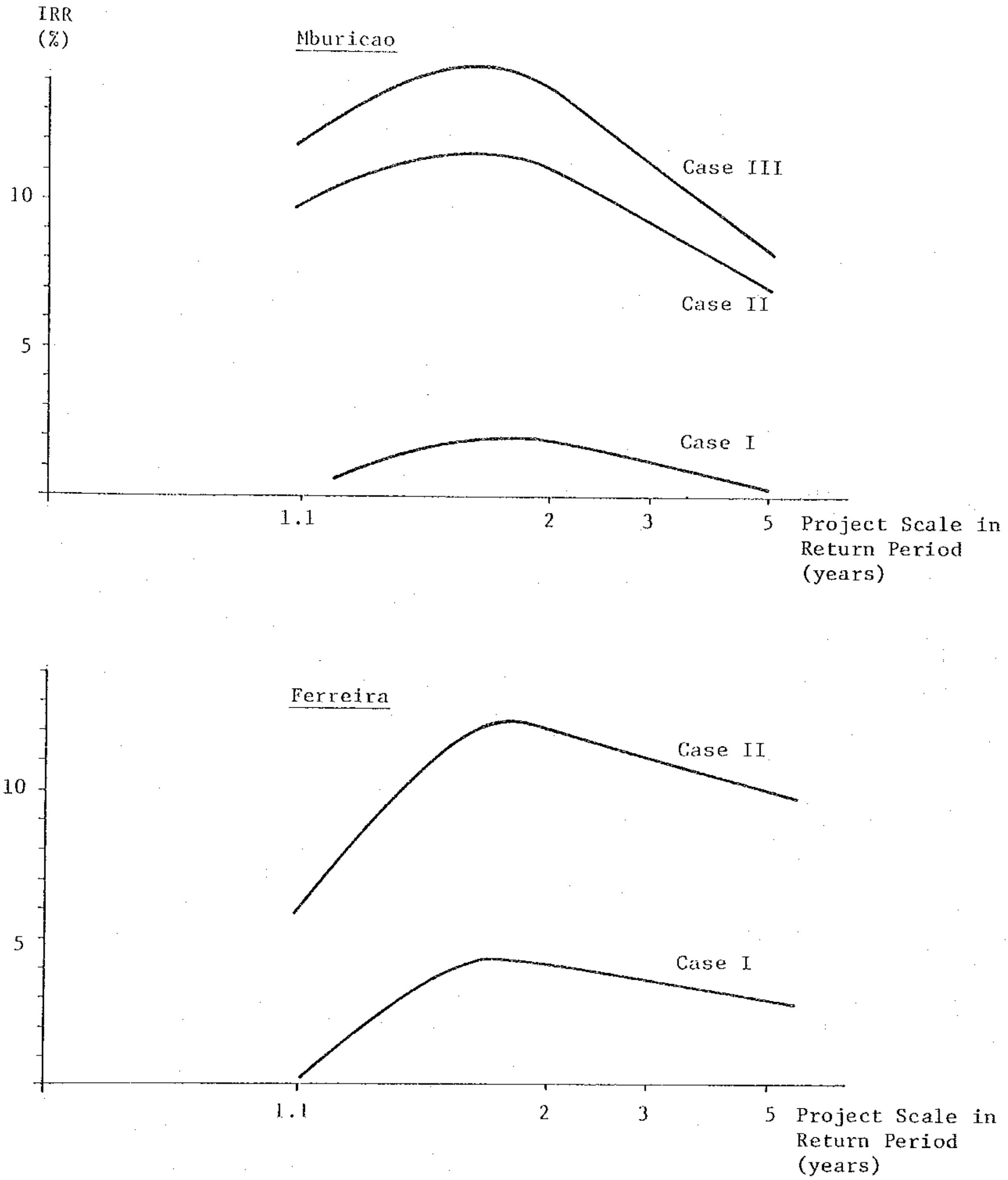

Fig. 7-6. RELATION CURVES BETWEEN IRR AND PROJECT SCALE

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

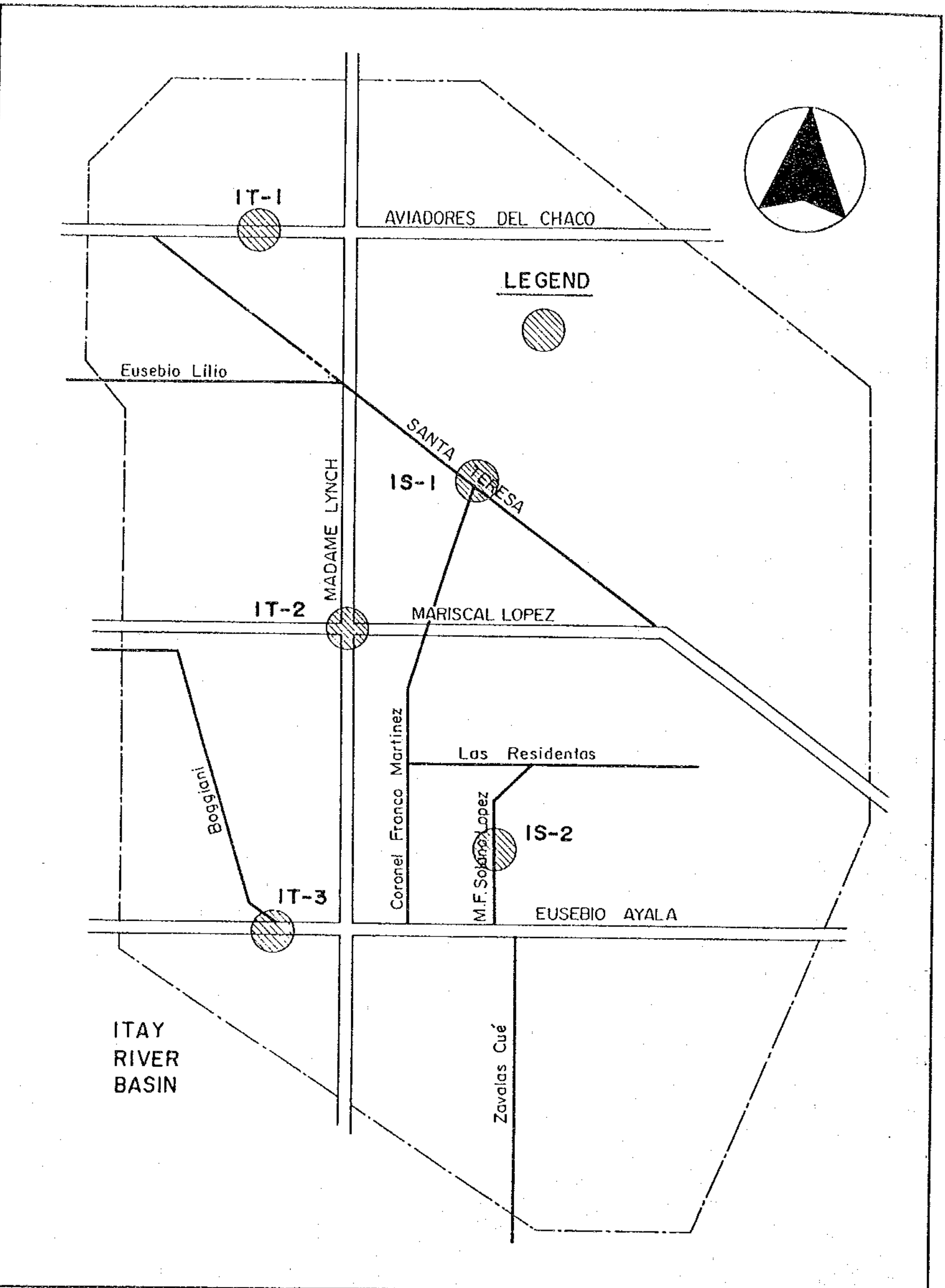

Fig. 7-7. LOCATION OF MAJOR TRAFFIC INTERRUPTION SPOTS IN ITAY RIVER BASIN

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

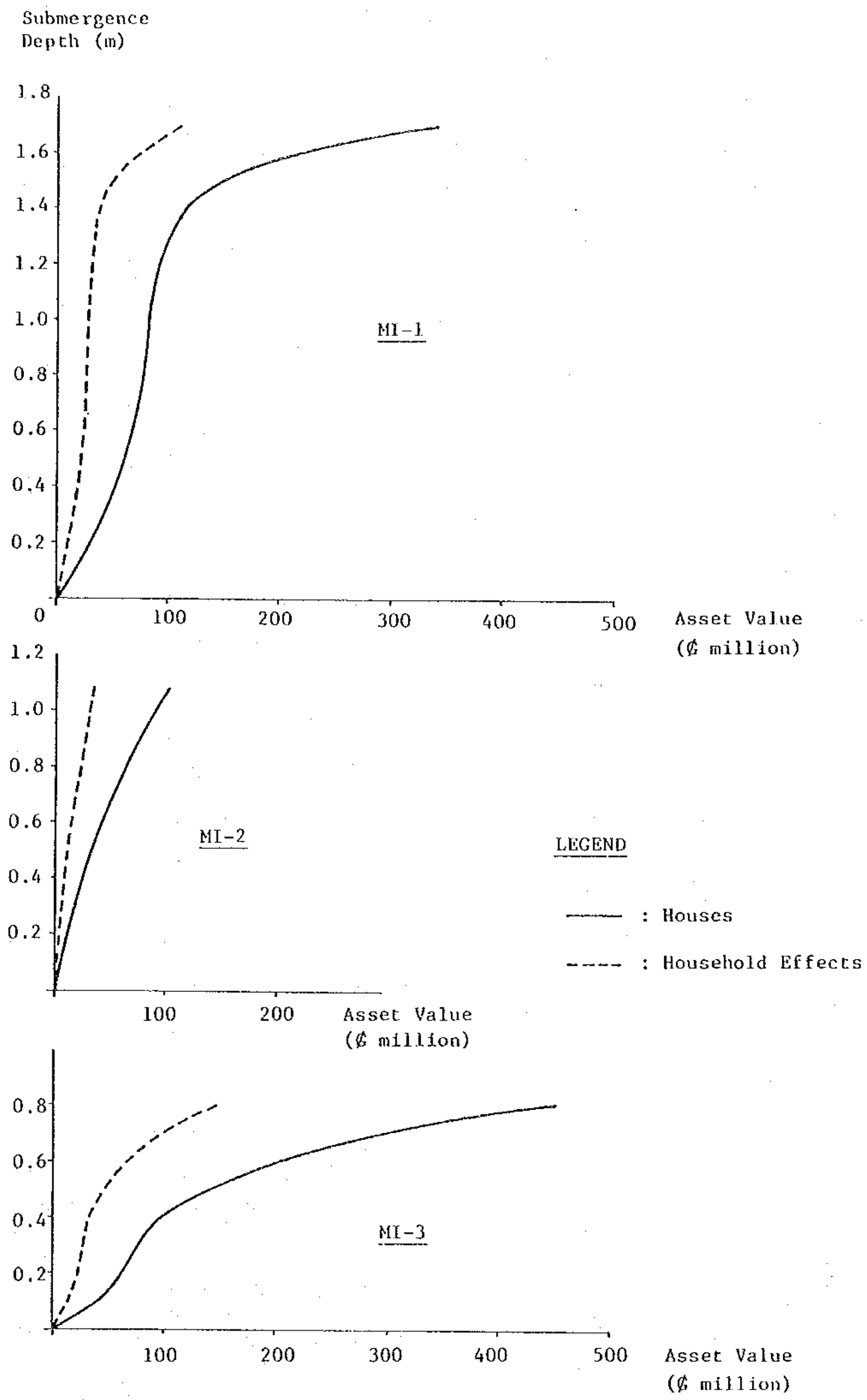

Fig. 7-8.(1/2) RELATION CURVES BETWEEN SUBMERGENCE DEPTH AND ASSETS VALUE AS OF 1995 (MBURICAO)	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY

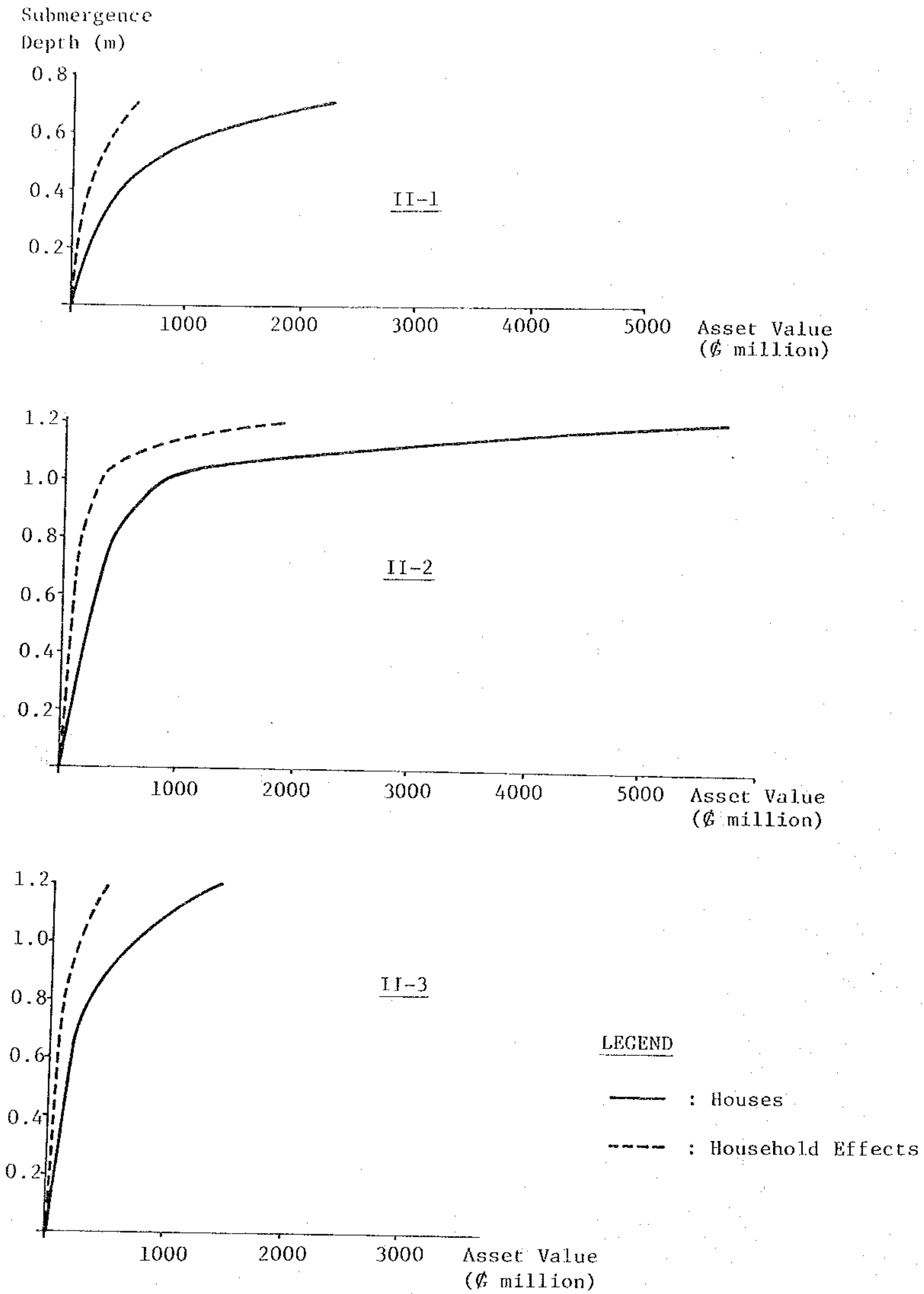

Fig. 7-8.(2/2) RELATION CURVES BETWEEN SUBMERGENCE DEPTH AND ASSETS VALUE AS OF 1995 (ITAY)

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

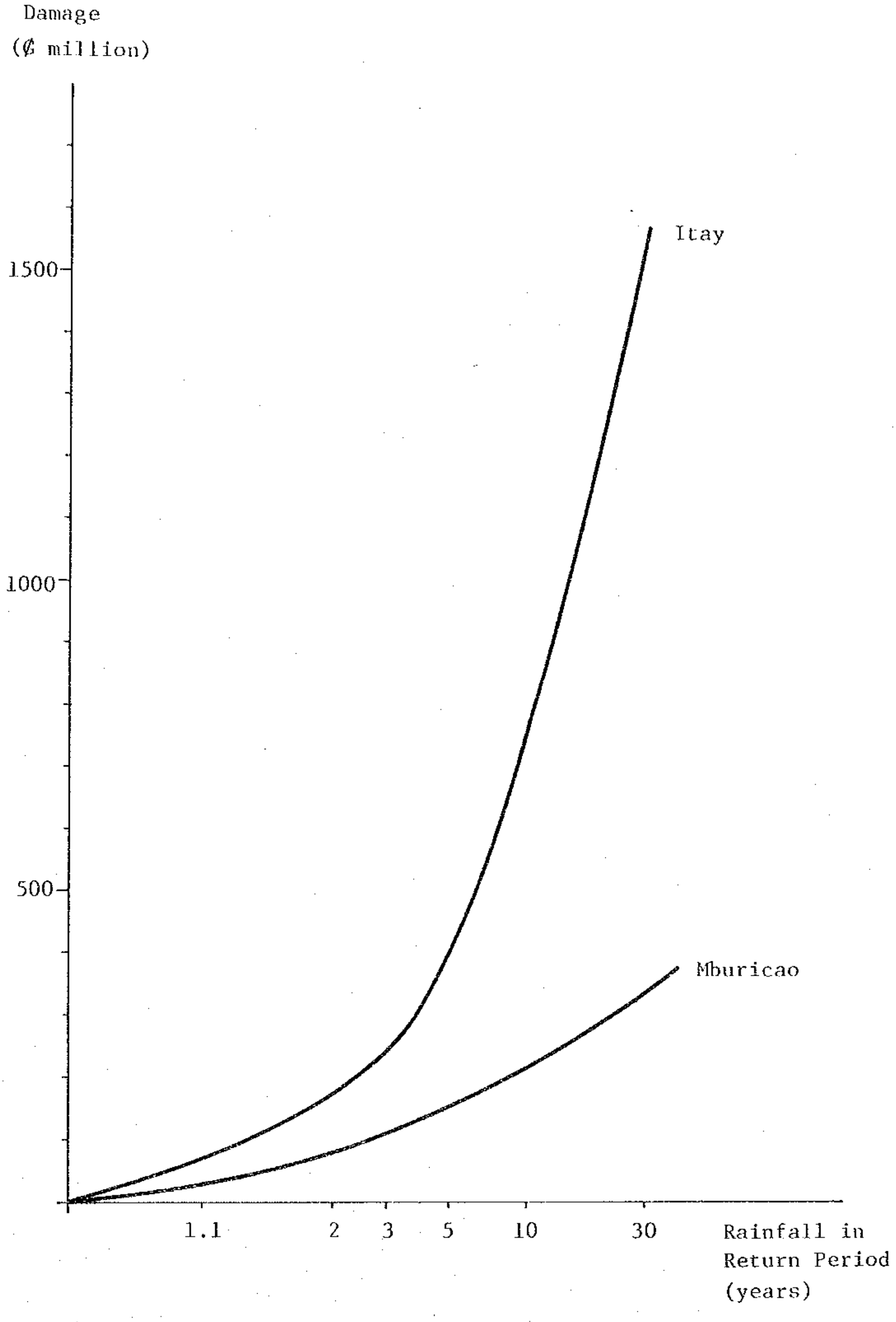

Fig. 7-9. RELATION CURVES BETWEEN DAMAGE AND RAINFALL AS OF 1995

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

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8. ORGANIZATION AND MANAGEMENT

SUPPORTING REPORT
ON
ORGANIZATION AND MANAGEMENT

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SUPPORTING REPORT
ON
ORGANIZATION AND MANAGEMENT

1. General

1.1 National Government Organization

In the administrative structure of the Government of the Republic of Paraguay are ministries. Two (2) of these ministries are likely to undertake water management such as flood control and drainage, water supply and sewerage. They are the Ministry of the Interior (Interior) and the Ministry of Health and Social Welfare (Salud Publica y Bienestar Social).

Presently, the two ministries do not directly execute any relevant project themselves, but the former supervises CORPOSANA (Corporacion de Obras Sanitarias) and the latter directs the activities of SENASA (Servicio Nacional de Sanitarias). CORPOSANA and SENASA are undertaking projects on water supply and sewerage system in the entire country.

The administrative structure of the Government of Paraguay including the ministries may be presented as in Fig. 8-1.

1.2 Local Government Organization

Asuncion City

Asuncion City is the capital of the Republic of Paraguay. It has an autonomous form of government and thus, enjoying exclusive jurisdiction over matters related to its interests, assets and revenues and in matters of urban development, food supply, education and culture, health care and social welfare, traffic, tourism, and security (see Fig. 8-2).

Asuncion Metropolitan Area

The outskirts of Asuncion City are composed of several small communities that participate briskly in Asuncion's economic activities. Municipalities such as Luque, Lambare, Fernando de la Mora and San Lorenzo are completely integrated into Greater Asuncion, so that Asuncion City and its 10 outskirt municipalities decided in 1978 to form an inter-departmental association, named the "Asosiacion de Municipalidad de Asuncion y su Area Metropolitana" or AMUAM, with the common aspiration of socio-economic development. Apart from the municipalities mentioned above, the association includes Mariano Roque Alonso, Limpio, Nemby, San Antonio, Villa Elisa and Villa Hayes. The mayor of Asuncion City is the chairman of the association.

2. Existing Organization and Legislation for Storm Water Drainage

2.1 Organizational Setup

As far as the existing organization and management are concerned, the study concentrated on CORPOSANA which is the agency responsible for storm drainage services to Asuncion City and other cities. The history and main functions of CORPOSANA are briefly presented hereinafter.

CORPOSANA, an independent agency attached to the Ministry of the Interior but with its own administration, organization, and resources, was originally organized through Law 244 and Decree 9669 of 1954. The agency's original objective was to provide potable water and sewage services to Asuncion City. Subsequently, its functions and responsibilities were modified and amplified in 1958 under Law 166 to attend at water connections in Greater Asuncion. Soon afterwards, Law 713 of March 1962 authorized CORPOSANA to extend its functions in the construction and maintenance of sewers in Asuncion.

In March 1966, Law 1095 further amplified and changed CORPOSANA's objectives to promote, operate and maintain water supply and sewerage system in major towns with population of above 4,000 in the interior. Accordingly, CORPOSANA changed its name in the following year of 1967 to Corporacion de Obras Sanitarias by abandoning the suffix of "de Asuncion" to make it clear that it was no more serving only for Asuncion but nationwide to attend to services in the fields of city water supply and sewerage system.

In 1973, the restructuring of CORPOSANA took place under Law 405 and Decree 29697, so that its functions and responsibilities came to cover the water supply, sewerage and storm water drainage in Asuncion City and in major towns having the population greater than 4,000 in the interior.

CORPOSANA's management structure is divided into several divisions, each with specific functions, as shown in Fig. 8-3. The function on storm water drainage belongs to the Sewerage Division (Gerencia de Alcantarillado) as shown in Fig. 8-4. This division has been primarily attending at the operation and maintenance of both foul and storm sewerage systems within the City of Asuncion, and it is composed of around 60 personnel including one (1) division manager, six (6) professional staff and four (4) administrative staff. As to storm water, the Storm Drainage Section consisting of one section chief and one secretary manages the daily activities.

2.2 Laws and Regulations

Laws and regulations concerning water management are not firmly established in Paraguay. For some time in the recent past, the water law originally enacted in the neighboring country of Argentina has been used as the basis of Paraguay's own water management regulation. It is understood that drafting of Paraguay's independent law concerning water management is underway.

While legal care has been rather neglected on rivers and river water use, the Government of Paraguay has now come to be confronted by the problems arising from pollution of river water due, particularly, to the industrial wastes liberally flowing out of the chemical and pharmaceutical plants and factories that are operating through international licenses. Some concerned institutions like SENASA are seriously studying countermeasures to this kind of hazard to people's health through the formulation of relevant laws and regulations.

As to laws on storm water control system, CORPOSANA has been authorized under Law 902 to impose levies on the residents of the metropolitan area in connection with its undertaking the storm drainage system in the central part of Asunsion. The charges are determined in proportion to the value of real estate owned by a resident, as well as on the location of houses, as follows:

Location	Value of Real Estate	Rate of Charge
In Designated Area	More than Ø2 million Less than Ø2 million	0.3% 0.2%
Outside of Above Area	(No classification)	0.1%

3. Problems on Organization and Management of the Storm Water Drainage System

In this section, the study will focus on the problems related to the organization and management of the storm drainage system. CORPOSANA has been authorized under Law 405 and Decree 29697 to administer storm water control systems in this country, as mentioned hereinbefore. Although this agency makes every endeavor to fulfill this function, several problems have arisen in the study area.

These problems may be due to two causes: (1) lack of coordination among the agencies concerned, and (2) management responsibility of CORPOSANA itself. These causes are briefly described hereinafter.

Problems Due to Lack of Coordination

(1) Coordination with Road Improvement Projects

In the study area, it was observed that several drainage channels have been reclaimed for road construction resulting in the demolition of the storm water drainage system. The road improvement projects involve the construction or reconstruction of bridges across drainage channels, but the design criteria for such structures seldom provide for security from flooding caused by storm water. This condition will bring about not only conflict in executing storm water drainage plans but also flood hazard to existing storm water drainage systems.

(2) Coordination with Drainage Channel Improvement Projects by Other Agencies

Aside from CORPOSANA, other agencies including the private sector participate in storm water drainage improvement works. Since these works are partially and independently executed, adverse influences occur such as the increment of flood damage in other areas, especially the downstream reaches, because the design criteria for these works seldom satisfy the condition of security as mentioned above.

(3) Coordination with Land Development Projects

Since the urbanized area is expanding in proportion to the increase in population, unused areas including flood-prone areas are being converted into residential areas, so that flood damage in such areas may increase. Furthermore, land development in some areas is executed without provision of suitable control facilities thereby causing serious flood damage. Sometimes, a residential area is provided close to the riparian area, so that expansion of the river channel in case of channel improvement is hardly executed when required.

(4) Other Matters that Need Coordination

In the case of construction of storm water control facilities, replacement or rehabilitation works on existing facilities managed by other agencies such as electric transmission lines, sewage pipes, etc., need coordination among agencies concerned.

(5) Problems Expected in the Future

The problems currently occuring are expected to evolve in the future, so that the necessity of coordination in solving such problems are also encouraged. Besides, the necessity of coordination is emphasized in the following points.

In the future, several development projects may be executed resulting in the increment of flood discharge due to loss of permeable area. To cope with the increment of flood discharge, the proposed storm water drainage system will include detention facilities such as infiltration facilities and storage using public places and house lots. The installation of such facilities will require proper coordination among agencies concerned.

Problems Due to the Management Responsibility of CORPOSANA

(1) Delineation of the Area to be Managed

Although CORPOSANA is authorized to manage or administer storm water drainage systems, the boundaries of the area or stretch to be managed is not clear in relation to the existing drainage channels, so that the riparian areas are proliferating with facilities installed for some other purposes. This situation has brought about the deterioration of the flow capacity of existing drainage channels, resulting in the increment of flood damage.

(2) Investigation of Flood Damage Condition, and Formulation and Execution of the Project

The implementing agency should investigate the flood damage condition, and formulate/execute the suitable plan to cope with the condition.

Although a suitable plan for the storm water control system is proposed for the planning area in this study, the execution of the plan is not scheduled yet, so that the existing condition may persist.

(3) Maintenance and Rehabilitation Works

In connection with the maintenance of the storm water control system, the following condition can be seen in several drainage channels: garbage are dumped on the riverbed and houses are built on the riparian area. Such indiscriminate dumping of garbage will diminish the flow capacity of the drainage channels, so that floodwaters will easily overflow and thus increment flood damage.

When flood occurs, some facilities and structures are damaged. The prompt execution of rehabilitation works are needed not to obstruct the economic and social activities of the inhabitants.

Although this situation is expected to be improved through daily or periodic maintenance and rehabilitation works, such works may be insufficient to cope with the flooding problem in the study area.

(4) Collection of Flood Information and Provision of Flood Protection Works

During flood time, it is imperative to disseminate flood information to the area inhabitants to avoid flood damage. It is also necessary to arrange the relevant flood mitigation works for the current flood damage. Such activities are rearly executed in the study area.

(5) Problems Expected in the Future

As land is urbanized, houses and other structures may be constructed close to the riparian area. This will make it difficult to expand the drainage channel to cope with the increment of runoff discharge in the future.

The necessity of formulation and execution of the storm control project in the area not covered by this study is expected to be encouraged. Otherwise, flood damage will increase in parallel with the increment of assets in the area.

In connection with the problems at present, proper maintenance, flood protection and rehabilitation works will play important roles in preventing the increment of flood damage.

4. Necessary Organization and Laws on Storm Water Control

4.1 Necessary Organization

The necessary organization to cope with the problems mentioned in Section 3 may be divided into two (2) agencies: the Coordinating Group and the Implementing Agency, as hereinafter described.

4.1.1 Coordinating Group

Agencies Concerned in Storm Water Control Projects

Agencies having the following functions or responsibilities may be involved:

(1) Road management;
(2) House and building planning;
(3) City planning;
(4) Electric transmission line management; and
(5) Waste water management.

The agencies having the above functions or responsibilities may correspond to the following:

(1) Municipalities in the metropolitan area;
(2) Ministry of Public Works and Communications;
(3) National Administration of Energy (ANDE);
(4) National Administration of Telecommunications (ANTELCO); and
(5) National Sanitary Services (SENASA).

Aside from the above agencies, the Ministry of the Interior, which had administrative functions over the municipalities and CORPOSANA, should also be included as one of the agencies concerned.

Necessary Organization for the Coordination

Among the problems to be coordinated include various items that may categorized into two (2): problems that need to be discussed among several agencies concerned and the other problems that need to be resolved by only a few agencies.

In line with the above categories, the following coordinating groups may be necessary:

(1) Overall Coordinating Group

This group shall be organized to coordinate the overall items or problems related to the various agencies such as city planning, large-scale improvement projects and others.

To solve these problems, this group should be composed of representatives from all the agencies concerned. Since the items to be discussed seldom evolve, the group will convene only as necessary in accordance with the request of the members.

In the group, a secretariat consisting of a general affairs section, a technical section, a financial section, a legal section, etc., should be provided in CORPOSANA to deal with the issues that are brought out in meetings.

(2) Specific Problems Coordinating Group

This group is organized to coordinate the problems on storm water drainage that are expected to evolve through the daily activities. It should be composed of personnel who are familiar with such problems and be responsible to their solution. Some specific person should be assigned to take charge of the management of the group. It is also desirable that the group convene at least once a month or from time to time as the need arises.

As in the Overall Coordinating Group, a secretariat should also be provided.

4.1.2 Implementing Agency

The function of the implementing agency for the storm drainage system should basically cover the following items:

(1) Planning of the project;
(2) Project execution and maintenance;
(3) Flood prevention and rehabilitation works; and
(4) Preparation of finance, etc.

In this regard, the following sections should be created under the Implementing Agency:

(1) General Affairs Section

This section shall handle the miscellaneous affairs of the Implementing Agency in coordination with the other sections.

(2) Planning Section

This section shall be responsible for investigating flood damage condition, planning of storm water control projects in coordination with related urban development projects and other agencies concerned, and such other functions and responsibilities related to planning.

(3) Flood Prevention Section

This section shall be responsible for the works related to flood prevention such as flood prevention plan, flood damage precautions, preparation of emergency countermeasures against flood, etc.

(4) Construction, Maintenance and Rehabilitation Works Section

This section shall handle the construction and supervision works on storm water control projects and the installation of necessary facilities and structures, together with their maintenance to ensure their smooth operation and function. Rehabilitation works for damaged structures and facilities, etc., are also handled by this section.

(5) Financial Management Section

This section shall have the responsibility of preparation of funds necessary through loans from available financial sources, if needed, and the collection of tariff or imposition of levies, if necessary, from beneficiaries of the project.

(6) Legal Section

This section shall handle the drafting of necessary laws, rules and regulations, and attend to problems related to the storm water control system.

4.2 Necessary Laws and Regulations

The functions and responsibilities of the foregoing agencies can be consolidated by the enactment of laws and regulations. In this connection, the laws and regulations should be prepared for their creation, and it is also desirable for the related agencies such as municipalities, the MOPC, and others, to provide additional legislations or items in their own laws and regulations in cooperation with the implementing agency.

The items to be provided may be as follows:

Coordinating Groups

The necessary laws and regulations should include the following items:

(1) Purpose of the group;
(2) Composition and members of the group;
(3) Functions, responsibilities, and competence of the group;
(4) Position of the group in the governmental organization;
(5) Manner and frequency of conducting meetings; and
(6) Others.

Implementing Agency

The laws and regulations for the Implementing Agency should stipulate the following:

(1) Stretch and Facility to be Managed

Storm water control system consists of the drainage ditch, the drainage pipes, the drainage channel, rivers, and several detention facilities such as storage facilities and infiltration facilities. Since the management of some stretches and facilities may overlap in several agencies concerned, the designation of the stretch and facilities to be managed by the Implementing Agency is necessary.

(2) Function of Project Planning

The function of project planning should be made clear in the law to cope with problems on storm water control system in consideration of other related plans.

(3) Function of Execution of the Project

The agency shall execute the project through construction and supervision works.

(4) Function of Maintenance of the Project

The agency shall maintain the system to ensure its function through periodic maintenance activities.

(5) Function of Creating the Program of Emergency Countermeasures Against Flood

During flood time, the agency shall prepare the program of emergency countermeasures against flood to cope with flood damage. Besides, the agency shall be responsible for the dissemination of flood information and flooding condition to the other agencies concerned and the inhabitants.

(6) Function of Rehabilitation Works

The agency shall be responsible for rehabilitation works on drainage facilities damaged by flood.

(7) Function of Permission and Prohibition

The agency shall be authorized to give permission and/or prohibition in connection with the following activities:

- Occupancy of managed area;
- Construction, reconstruction and/or removal of structures on the managed area;
- Land excavation, banking, cutting or any other activities that may alter the configuration of the area; and
- Disposal of sewage in the managed area.

(8) Function of Collection of Management Funds

The agency shall be authorized to obtain the finances necessary for managing the storm water control system through subsidies from the national government, loans from financing agencies, or tariffs from beneficiaries.

Agencies Concerned

The following items should be stipulated in the laws, rules and regulations for the agencies concerned to secure the function of the storm water control system:

(1) Obligation in Urban Development

Urban development that may result in the increment of runoff discharge should be adjusted so as not to increase the flood damage potential in the developed area. For this purpose, it should be made obligatory for the execution body of the urban development project to provide countermeasures for the increment of flood damage potential, in consultation with the implementing agency.

(2) Obligation in Construction of Buildings and Houses

Construction of buildings and houses which will deteriorate the infiltration and detention capacity due to decrease of permeable area will result in the increment of runoff discharge. In case of construction of buildings and houses, it should be made obligatory to install necessary detention facilities so as to maintain the current runoff discharge condition of the area.

(3) Utilization of Public Places as Detention Facilities

Public places can be useful as detention facilities aside from their original purposes. The regulation for their use should be arranged so that the public places can be readily used as detention facilities.

4.3 Action Plan

The establishment of the storm water drainage system could hardly be promoted without any concrete action, even if the necessary organization, laws, rules and regulations are provided. In this connection, as action plan is herein presented for the full consideration of the agencies concerned including CORPOSANA to forward the establishment of the appropriate system. This action plan may be broadly categorized into short and long term plans, as shown in Table 8-1, to successfully accomplish this project.

5. Introduction of Organization and Management on Storm Water Control

5.1 Organization and Management in Japan

5.1.1 Institutional Setup on River Administration and Flood Prevention

Administrative Organization

The matters concerning countrywide water management is taken up at the cabinet level by the initiative of the Minister of Construction who presides over the Ministry of Construction, which is given the authority of coordination, as far as water administration is concerned, among other government agencies like the Prime Minister's Office, the Ministry of Health and Welfare, the Ministry of Agriculture, Forestry and Fisheries, the Ministry of International Trade and Industry, and the Ministry of Transportation.

The ministries mentioned above, except the Ministry of Construction and the Ministry of Health and Welfare, have some subordinate agencies in charge of water management, either directly or indirectly, according to the regional pecularities and the nature of water management, as shown in Fig. 8-5. The important assignment of water management duties among these ministries is stipulated in Table 8-2.

Coordinating Agency

The Ministry of Construction attends at coordination of inter-ministerial activities concerning water management and gives approval of their water utilization programs. In short, this Ministry has an overall responsibility for the countrywide coordination of water management works in Japan. This Ministry is comprised of the ministry proper, the auxillary organs which are mainly attending at research and survey activities, and the regional offices.

The ministry proper consists of the Minister's Secretariat and five bureaus, among which the River Bureau specializes at water management, river administration in particular, all over the country. This bureau has one department dealing with sabo and eight divisions dealing with general water development and management. Sabo Department is divided into two divisions: Sabo and Slope Conservation. The other divisions are: (1) Water Administration, (2) River Planning, (3) River Improvement, (4) Urban Rivers, (5) Development, (6) Seacost, (7) Disaster Prevention, and (8) General Affairs. The Organization Chart of the Ministry of Construction is shown in Fig. 8-6, with further breakdown of the River Bureau into many divisions and sections. The divisional functions of the River Bureau are explained in Table 8-3.

The responsibility assigned to the Ministry's regional offices that are located all over the country is the day-to-day water administration through various work offices dealing with survey, planning, design and project implementation. Local governments also attend at administration of small local rivers under the direction of the Ministry of Construction, while the ministry administers the larger rivers that may exert multifarious influences over a large area beyond prefectural boundaries.

Project Execution Agencies

At the ministerial level, only the Ministry of Construction and the Ministry of Agriculture, Forestry and Fisheries are the project executing agencies.

The former ministry operates through its River Bureau which is held responsible for planning, execution, operation and maintenance of the comprehensive river basin development projects along all the major river systems in Japan. Its scope of work covers flood prevention, water resources development, seacost preservation and environmental conservation. The Sabo Department was established in the River Bureau for the planning and execution of erosion control and lanslide prevention works along the large rivers.

The latter ministry, i.e., the Ministry of Agriculture, Forestry and Fisheries, assigns execution of reclamation projects for agricultural development and disaster prevention and restoration works accompanying such projects to the Agricultural Structure Improvement Bureau. As for the conservation of forests which serve as important retainers of water resources (rain water and snowfall) thus delaying flood runoff, such function is assigned to the Forestry Agency, also under the Ministry of Agriculture, Forestry and Fisheries. This agency also executes landslide prevention works for the purpose of forest conservation.

Other projects for development of water resources are undertaken by either the local governments or by private corporations. For instance, if a dam construction is solely meant for hydroelectric power generation, the project will be promoted and executed by a private firm under the guidance, supervision and, assistance if necessary, of the Ministry of International Trade and Industry. Likewise, the facilities for service water supply and sewage are provided by the prefectural as well as municipal governments, under the guidance, supervision and assistance of the Ministry of Health and Welfare.

5.1.2 Laws Related to Water Management

Flood Prevention

Laws related to water management in Japan can be broadly classified from their purpose into three major groups of flood prevention, water resources development and environmental conservation. The major laws related to water management are summarized in Table 8-4.

The River Act is the basic law for river administration in Japan which was enacted in 1896 and remained in force through minor revisions until 1964 when its contents and coverage were drastically amended and enlarged in order to make a comprehensive administration possible not only on the rivers but also for prevention of floods, high tides, water pollution, and all other water-related disasters. According to this law, all the rivers in Japan are classified into three classes, together with their specified management systems so as to facilitate a successful river administration. It further stipulates the rules and regulations concerning the construction of riparian works, the countermeasures in case of emergency, the usage of rivers, the coordination of water users' interests, and the construction of dams, among others.

Acts, rules, and regulations to meet with administrative purposes arising from time to time for water management have ensued on the basis of the River Act, among which two will deserve attention. The first one is the Flood Defense Act of 1948, which stipulates the flood fighting systems, the flood forecasting and warning systems, the dispatch of flood fighting troops, and the financial arrangements for such activities. The second is the Sabo Act of 1897 which concerns itself in erosion and sediment control works in upstream regions, the method of project cost allocation, and the conservation of the designated areas.

As for the areas of water management which are not covered by the River Law, there have been enacted three Acts, viz: the Seacoast Act of 1956, the Landslide Prevention Act of 1958, and the Act on Disaster Prevention due to Collapse of Steep Slope Land of 1969.

The first was enacted for the protection of coasts and its hinterlands from damage due to tidal waves, high tides, etc. The second mainly deals in damages caused by landslide and coal sludge collapse by stipulating the implementation procedures of landslide fighting works. The third is meant for protection of lives from disasters due to collapse of steep slopes by prescribing the necessary procedures for preventing such damage.

Water Resources Development

Among the laws meant for development of water resources through dam construction, the first that was enacted was the Specified Multipurpose Dam Act of 1957. This Act stipulates rules and conditions for the construction and control of multipurpose dams as distinguished from dams falling under the application of the River Law. It clarifies the rights to the use of water thus development so that smooth and due functioning of the multipurpose dam will be ensured.

Environmental Conservation

The Basic Act for Environmental Pollution Control is for an overall control of public nuisance such as pollution, noise, etc. Effluent disposal of harmful elements and prevention of hazards thereby is stipulated in the Water Pollution Control Act of 1970. Disposal of sewage is regulated by the Sewage Act which was enacted in 1958 in order to prevent deterioration of water quality in public water areas.

5.1.3 Storm Water Drainage System

Current Situation

Most of the major cities and towns in Japan have developed in and around flood-prone areas. As industrialization progressed, population in urban areas increased; thence, the urban area has been expanding rapidly.

The rapid urbanization has caused some serious problems. Runoff rate of watersheds increased and runoff hydrographs became sharp and rather fast after rains stop due to decrease in penetration/infiltration of rain into the ground and to the diminution of the natural detention/retention effects. The expansion of urban area is so fast that sewerage works cannot cope with the increased runoff. Furthermore, undertakings of sewerage and drainage works have created an adverse effect on drainage conditions.

In Japan, the urban sewerage and drainage works are undertaken by the respective divisions/offices of cities and municipalities that are responsible for sewerage and sanitation projects. Usually, a sewerage system is designed and constructed to drain both sewage and storm water by using common drains and channels. The sewerage system consists of such facilities as drains and channels to gather sewage and storm water. To cope with this development, mains to drain out the water to rivers and some treatment plants for sewage water have been constructed.

However, the expansion of sewerage and drainage works calls for the improvement of rivers in urban areas so as to safely carry storm water runoff drained into them. For a more effective supervision, the Ministry of Construction has categorized such rivers as urban rivers in its flood prevention works based on any of the following factors:

(1) The rivers flow through the urban area with a population of more than 30,000 in the densely inhabited district (DID);

(2) They flow through the urban area covered by Article 2 of the Urban Planning Act; or

(3) They flow through a large-scale development area of more than 100 ha.

However, the classification and management of rivers have remained as before, i.e., Class A, B and C falling under the juridiction and responsibility of the Ministry of Construction, the Prefectural Government, and the City Government, respectively.

Non-juridical rivers not belonging to either classes A, B, or C are under the management of specific agencies in the respective cities or prefectures, while the management of channels of small rivers with the catchment area of more than 2.0 km^2 falls under such city river division and the management of sewerage for an area of less than 2.0 km^2 falls under a city sewerage agency.

Under these circumstances, the Ministry of Construction prepared an improvement program of the urban rivers capable of coping with a flood caused by rainfall of 50 mm/hour by 1990 for the existing urban areas. Urban improvement projects are broadly classified into two (2) categories: the direct control program and the grant-in-aid program. Details of the projects to be implemented by 1985 are presented in Table 8-5.

Integrated Flood Control and Drainage Program

Among the projects aimed at alleviating flood and storm water damage, an integrated flood control and drainage program which had been highlighted as a powerful countermeasure against complicated problems on urban rivers was prepared in the early 1970's.

(1) Establishment of the Plan

In response to the inquiry by the Minister of Construction, the River Development Council, the attached body for guidance and supervision of flood control and water resources development, submitted an interim report in June 1977. The report cited the necessity of a unified body involving all related organizations and agencies to enable implementation of flood control works for urban rivers as well as urban storm drainage.

As the first step for its materialization, a preliminary conference on river basins was organized in October 1977 by the bureaus of the Ministry of Construction and the divisions/departments in the local goverments concerned in river administration, urban planning and land/housing.

Through the studies and deliberations, the following programs were prepared and submitted in May 1980 to the respective governors through the Deputy Minister of Construction.

a. Objective

The degree of safety in flood control shall be assured so as to cope with a flood caused by rainfall of 50 mm/hour in the succeeding ten (10) years.

b. Strategies

- The priority in implementing works shall be given to the improvement of the urban rivers designated in the integrated flood control and drainage program.

- A river basin management plan shall be prepared together with the above river improvement plan to maintain the basin's capability of detention and/or retention of storm water. The plan shall be contemplated in the related project to be undertaken by cities and municipalities located in the basin.

- Map of the past flooded area shall be put up in a public place to serve as guide in appropriate land use and prepare measures against floods.

- Advertisements and/or public hearings shall be held to make inhabitants well informed on flood.

Finally, councils for integrated flood control and drainage have been established for totally fourteen (14) urban river basins, and studies and discussions on optimum flood control and drainage plan have been carried out. As of August 1985, river basin management plans have been formulated for thirteen (13) river basins and maps of past flooded areas were already released for all the designated fourteen (14) basins.

(2) Individual Undertaking

Among the strategies indicated in the foregoing, maintaining the basin's capability of detention and retardation of storm water was emphasized in the river basin management. Measures to amplify the capability were enumerated as follows:

a. Land developers are obligated to prepare rain detention facilities such as provisional or permanent regulation pond and storage in residential area/open space.

b. Porous pavement in road construction and some storage facilities in a sewerage system are to be involved to a possible extent.

c. Delineation of land use between urban and conservation areas shall be made on account of the natural detention and retardation effects therein.

d. In planning a retarding pond, several suitable designs such as foresty area of storm water storage and multipurpose retarding basin shall also be considered.

e. Embankment works are to be properly controlled not to give an adverse effect on the flooding conditions.

Some examples which have been already applied in various places are hereunder presented together with surrounding conditions for actual implementation.

- Regulation Pond

In the Urban Planning Act, it is stipulated that a large-scale development shall be permitted or advised by the governor or the mayor on the basis of the detailed regulations relative to the enforcement of the Act concerning a storm water drainage plan. Furthermore, local governments have prepared their own Housing Lot Development Code to direct any housing project and to prevent disordered developments.

As the most effective measure, construction of a regulation pond is clearly stipulated in the Code. All developers shall shoulder any expense for the effects of construction. As of the end of 1978, about 2,000 regulation ponds have been constructed with the large-scale development works such as housing lots, industrial real estates and golf courses.

- Storm Water Storage

As for the existing urban area where the detention and retardation capabilities are exhausted, some storm water storage facilities have been proposed. This storage measure is to be applied to mainly public and governmental buildings or facilities.

Owing to the Storm Water Storage Project in which one-third of the installation cost of storage facilities was subsidized by the government, on-site detention, rooftop ponding, storage between houses, etc., have been executed since 1978. Simultaneously, small detention ponds have been employed in the urban sewerage system to reduce the storm water runoff discharge toward rivers. Design criteria for the detention ponds were prepared in 1981.

Not only surface storage but also underground storage was examined by the Public Corporation of Housing and Urban Development in cooperation with the Public Works Research Institute. The field examination conducted at a pilot area in Tokyo was to study functions and effects of facilities. A local government has also carried out a study on the combined use of an underground storage facility together with the regulation pond to aim at recharging groundwater as well as at controlling storm water runoff.

- Retardation

  Housing projects in lowlands along the river have taken an inherent retarding capacity and the houses themselves have been suffering from frequent inundation.

  Since the start of the Green Belt Project in 1973, reservation of open spaces in the lowland area has been promoted for use as retarding basin in a flood control plan or to serve as park or recreation area during no-flood time.

- Non-Structural Measures

  Advertisements such as placing maps of the past flooded area in a conspicuous place, public hearings, publications regarding the projects, etc., are necessary to obtain cooperation from inhabitants in the implementation of projects.

  Guidance and advices to the public including issuance of building codes and subdiuision regulations have been made to minimize damage potential of floods and effects of unavoidable developments in the flood-prone area.

Related Laws and Regulations

The principal laws for the integrated flood control and drainage plan are the River Act, the Sewerage Act, and the Urban Planning Act. All the projects on flood control and drainage have been carried out by the agencies, financed from a certain appropriation and operated/maintained by a certain body as specified in the said acts and their enforcement regulations. No act has been established nor put into operation prior to the integrated flood control and drainage program.

The program was actually drafted due to an urgency to implement a flood control project in the Tsurumi River Basin where the flood-prone area had been densely populated and rapidly urbanized resulting in the most serious flood damaged area. Some plans for flood plain management in the United States of America have been adopted and much modified to suit the conditions in Japan.

Aside from the structural measures described in the foregoing, some legislative means effective and applicable in Japan are hereunder presented.

(1) Land Use Regulations

Local government usually prepare regulations on land use. However, actual application of such legislations are quite difficult since most of the flood-prone areas have been already congested. Some applicable legislations are listed in Table 8-6.

(2) Flood Risk Map

River administrative bodies, the Ministry of Construction and local governments are no longer obligated by law to announce and/or issue the flood risk map to the public, becase such announcements may lower the value of real estates. However, such practice for few rivers are appreciated.

(3) Flood Proofing

In Japan, flood plain dwellers have been practicing by themselves some flood proofing measures such as elevated floor and embankment. Some local government subsidize the cost of such efforts based on the Building Code.

(4) Flood Insurance

This system was introduced from the United States of America while some disaster relief systems have long been employed in Japan. They are the flood fighting system and the farmer's mutual aid association. Flood insurance system itself has been employed by some insurance companies in recent years.

5.2 Organization and Management in the United States of America

5.2.1 Institutional Setup on River Administration and Flood Prevention

Administrative Organization

A network of the federal level agencies was established for water administration under the jurisdiction of the Office of the President, as shown in Fig. 8-7. The agencies sharing major responsibility for water administration are listed in Table 8-7, along with their jurisdictional functions and departmental affiliations. Judging from the extent of authority and jurisdictional function, the most important are (1) the Water Resources Council, (2) the Corps of Engineers, and (3) the Bureau of Reclamation.

Coordinating Agencies

The Water Resources Planning Act of 1965 brought into existence the Water Resources Council as an independent executive agency of the United States Government in view of encouraging conservation, development, and utilization of water and related land resources in a comprehensive and coordinated manner.

This Council is made up of the Council Members and the full-time staff. The Council Members comprise the heads of various federal departments concerned in development of water and related land resources, including the secretaries of the Department of Agriculture, the Department of Commerce, the Department of the Interior, the Department of Energy, the Department of Housing and Urban Development, the Department of Transportation, and the Department of the Army. The Administrator of the Environmental Quality Control, the chairmen and vice-chairmen of the river basin commissions, and the Chairman of the Tenessee Valley Wuthority (TVA) sit at the Council meetings as observers.

This Act also provides for the establishment of the river basin commissions which have the undermentioned functions:

(1) To serve as principal coordinating agency for plans for development of water and related land rersources;

(2) To prepare and keep updated the comprehensive and coordinated joint Federal-State plan for development of water and related land resources within the basin;

(3) To recommend the priorities for data collection and for investigation, planning, and project implementation;

(4) To foster and undertake such studies as are necessary in preparing the comprehensive plan; and

(5) To submit to the Water Resources Council, with its comprehensive plan, the recommendations for implementing the plan.

At present, there are seven river basin commissions in the United States. The Organization Chart fo the New England River Basin Commission is presented as their example in Fig. 8-8.

Project Execution Agencies

Among the Federal agencies concerned, the U.S. Army Corps of Engineers and the Bureau of Reclamation serve as the project executing agencies on the river basin basis. Tenessee Valley Authority is another agency equipped with the same project implementing power, but it operates exclusively in the Tenessee River Valley.

The Corps of Engineers is responsible for some portions of the long-range river basin planning for most of the large river systems of the United States, as against a limited geographical scope afforded to other agencies. The Corps' authority for resources development is bestowed by the Chief of Engineers to the Directorate of Civil Works, as shown in Fig. 8-9. As a rule, the Office of the Chief of Engineers (OCE) performs the staff supervision, the civil works function of OCE being supervised by the Director of Civil Works, with the support of other directorates and offices. Civil works functioning include the matters relating to planning, design, construction, operation and maintenance of rivers and harbors, waterway improvement for flood control, navigation, and shore protection projects or programs. The organization of the

Directorate of Civil Works is illustrated in Fig. 8-10. The bulk of the work assigned to the Chief of Engineers and the Civil Works Directorate is carried out by the field offices attached to the Directorate.

The Bureau of Reclamation was originally created by the Secretary of the Interior as the Reclamation Service in charge of carrying out reclamation works as provided for by the Reclamation Act of 1902, which authorized the Department of the Interior to locate, construct and maintain irrigation works with the proceeds of sales of public land in western states. Although the Bureau's responsibilities for water resources planning have since outgrown the originally granted function which was limited to irrigation, the Bureau's authority is still restricted to the seventeen western states. The Bureau is now involved in planning, design, construction, and operation of the water resources development projects serving for such purposes as irrigation, municipal and industrial water supply, hydroelectric power generation, flood control and navigation, as well as recreation and fish/widlife protection.

The Tennessee Valley Authority (TVA) was created as a regional resources development agency in 1933 in response to the then emerging concept of the unity of river system and the interrelationship among resource development approaches. The area of TVA's authority was geographically defined, not subject matter-wise as had been traditional in U.S. government organizations. TVA has wide power to acquire real estates necessary for projects, to construct dams, power houses, transmission lines, navigation facilities, etc., along the Tennessee River and its tributaries.

5.2.2 Laws Related to Water Management

In the United States of America, the laws related to flood prevention, water resources development, and environmental conservation have been enacted as required by the needs of the time. The related laws are listed in Table 8-8.

Flood Prevention

The first law of this kind enacted by the Federal Government was the River and Harbor Act of 1899 to authorize the construction of a low water channel of the Missouri River by the Army Corps of Engineers (COE). Since then, COE has been assuming the responsibility of implementing navigation projects in the district between the Mississippi and the southwest coast.

The Mississippi River inflicted in 1916 major flood damages on the neighboring areas, which prompted the Federal Government to enact the Flood Control Act in 1917. This Act was slightly amended in 1923 and drastically revised in 1928, after the same Mississippi River caused an extensive flood damage to its neighboring region. As this Act was subsequently revised in 1936, 1955, 1960 and 1972, the Federal Government's jurisdictional power and responsibilities for flood defense activities continued expanding. Watershed Protection and Flood Prevention Act was ratified in 1954, in view of assuring an effective flood prevention in the smaller-sized river basins in the country.

The Soil Conservation Act which was enacted in 1936 was meant for prevention of soil erosion and river bank scouring leading to aggravation or loss of agricultural lands. Under this Act, the Soil Conservation Service (SCS) was established under the jurisdiction of the Department of Agriculture.

The National Flood Insurance Act of 1968 endorsed the setting up of a program whereby the economic losses attributable to floods could be spread over a larger population base. Disaster Relief Act (1972) and Flood Disaster Protection Act (1973) helped extend the needed protection to the people suffering from flood disasters.

Water Resources Development

The Bureau of Reclamation (BOR) has been engaged mainly in implementation of water resources development projects in the thirteen western states, under the Reclamation Act (1902) and the Reclamation Project Act (1939).

In Tennessee State, the aforementioned Tennessee Valley Authority is managing the river basin development projects under the Tennessee Valley Authority Act of 1933, exclusively in the Tennessee Valley, in the same way as the Army Corps of Engineers, the Bureau of Reclamation, and the Soil Conservation Service are doing in other river basins.

Water Resources Planning Act which was ratified in 1965 made an integrated study and planning obligatory before implementing basin-wise multifarious riparian works including river water control on an comprehensive and coordinated basis. The preamble of this Act is quoted hereunder:

> "In order to meet the rapidly expanding demands for water throughout the Nation, it is hereby declared to be the policy of the Congress to encourage the conservation, development, and utilization of water and related land resources of the United States on a comprehensive and coordinated basis by the Federal Government, States, localities, and private enterprises with the cooperation of all affected Federal agencies, states, local governments, individuals, corporations, business enterprises, and others concerned."

This Act caused an establishment of the Water Resources Council (WRC), stipulated the provision for the establishment of the River Basin Commission, and also authorizes WRC to make grants available to the states for development planning of water and related land resources at the state level.

The recognition that water resources development, especially in the western part of the country, be reconsidered from the viewpoint of maximizing the utilization of the limited water resources caused the Water Resources Development Act to be enacted in 1974.

<u>Environmental Conservation</u>

The National Environmental Protection Act of 1972 was enacted to cope with environmental pollution due to development programs and, therefore, requires that the environmental consequences of major Federal actions be considered in the planning process. The management concerning conservation of water quality or prevention of its deterioration, however, is based upon the Federal Water Pollution Act and the Clean Water Act.

5.2.3 Storm Water Drainage System

Current Situation

Since 1936, the U.S. Army Corps of Engineers (COE) has been engaging in flood control and sabo projects. However, the past flood control works have been reviewed and evaluated for better undertakings in the 1960's. The following were pointed out through the study.

(1) Structural measures will not able to completely solve flood problems.

(2) Due to rapid development in the flood plain, it is becoming quite difficult to mitigate flood damage unless a huge investment will be made for construction of large-scale flood control structures.

(3) Therefore, many flood control works in flood plain areas cannot be economically justified.

In response to the above findings, the Task Force on Federal Flood Control Policy was organized consisting of COE, the Secretaries of Agriculture, HUD, TVA, and so on, to study a comprehensive flood control measure. In 1966, the task force submitted its report entitled "A Unified National Program for Managing Flood Losses, House Document No. 465."

The program set forth four (4) important policies on flood control plans and projects while the past structural measure was given a considerable position in a flood control plan. The policies are summarized as below:

(1) Many-sided and unified approach for identification of the flood problems; delineation of flood plain, unified methodology to determine flood frequency, collection of flood damage data, and investigation of flood plain use and urban hydrology;

(2) Coordinations and arrangements of various development plans in the flood plain areas;

(3) Promotion of flood insurance system; and

(4) Adjustments of flood control programs to socio-economic circumstances.

Although riverine flood plains include less than 7% of the Nation's total area, they are indicative of a widespread natural disaster affecting an estimated 22,000 communities.

Flood plains have been and continue to be under pressure for change to more intensive uses. Pressure to intensify flood plain uses is increasing as undeveloped land near urban areas has been becoming less abundant.

From the above situations, a flood plain management was emphasised to be a main issue among the policies. Basic strategy of flood plain management was placed on the non-structural flood control measures such as land use regulation, direction of housing development and promotion of flood insurance system.

Following to the program (House Document 465), the associated Executive Order 11296 was issued in August 1966 directing the Federal agencies to evaluate the flood disaster before funding construction of new buildings or purchase or disposal of lands, then the National Flood Insurance Act was enacted to enforce the order.

Flood Plain Management

There is wide variation in programs dealing with flood plain management. To realize a successful flood plain management, an emphasis should be placed on effective coordination and cooperative development of information and other related technical planning and construction assistance among levels of government and among agencies at the local, State and Federal.

Hereunder are the role of agencies at the Federal, State and local levels.

(1) Federal Role

Although the major responsibility for regulating flood plain use belongs to non-Federal, the program of the Federal Government are increasingly influencing flood plain management decisions either directly or indirectly.

As a whole the Federal Government has general interest in the alleviation or prevention of flood losses and associated disaster relief; wise use, conservation, and development of agricultural, mineral, and biological resources; utilization of waterways; and recreational and aesthetic opportunities of open space. Main programs and related agencies together with their main tasks are presented in Table 8-9.

The role of the Federal agencies is to develop consistent policies and activities, including those which may encourage and support the States in developing effective programs of their own, and to undertake information gathering technical planning, program criteria and construction services.

Further, the Federal agencies make actions to support Sate activities as follows:

a. Provide overall objectives and principles as guidelines for consistent State program development, recognizing that, until the states have acquired the capabilities, direct and widespread Federal guidance may be necessary;

b. Provide basic information and interpretative analysis for use by all State agencies and their programs;

c. Provide consistent program action, evaluation, and development criteria;

d. Provide consistent technical, planning, program criteria, and construction service response through action agencies;

e. Provide financial support for improving programs and capabilities to implement them at the State level within the limits of available resources; and

f. Work through the State in dealing with local entities to ensure consistent administration of flood plain management programs.

(2) State Role

Although the Federal Government continues to play its traditional coordinating role in interstate problems, the major intrastate coordination role belongs to the States.

The States are in a position to set strategy for coordination of management programs by establishment of state-wide standards and by procedures for aggregating local programs into subbasin and basin management programs.

A few States have vigorous and comprehensive flood plain management programs which recognize the full range of alternatives. Some States have enacted legislations that direct the State to step in, solve problems, and regulate areas if communities are not performing.

(3) Local Role

Since flood related problems can not be separated by municipal boundaries, local management should be supported by Federal, State and local standards. Within a limitation, communities and counties undertake the basic flood plain management role.

In spite of many limiting factors, hundreds of communities have adopted regulations in conjunction with mapping and flood information programs of Federal agencies, and some have responded to State programs.

For most flood plain management activities, the local government has the responsibility to initiate application to State and Federal agencies for participation in and assistance from the various programs. The local government must also enact and enforce land and water use regulations and in some cases maintain and operate structures on the flood plain.

Current Undertakings

In the course of embodiment of flood plain management, there have taken place some difficulties in the flood plain nearby the existing urban areas. High runoff ratio of storm water has still made it unavoidable to construct some flood control structures, and heavy urbanization and pressures to intensify development cannot allow to have land use regulations.

In accordance with the situation, heavy urbanization and high storm water runoff, a new component was added to the flood plain management, i.e., storm water management. The storm water management concentrates in controlling runoff discharge from the urban area by means of either increase of discharge carrying capacity or storage of excess runoff.

The measures for the above program are enumerated below:

(1) Improvement of Drainage Capacity

- Enclosed storm drain
- Ditch and open channel
- Debris removal
- Infiltration bed and dry well
- Porous pavement

(2) Storage of Excess Runoff

- Underground storage: tunnels and mined storage, in-line structure
- On-stream reservoir
- Ponding
- On-site detention/retention ponds
- Rooftop ponding
- Plaza and parking lot
- Open space and recreation areas
- Road embankment ponding
- Individual lot and property line swale

The above measures are to be employed together with usual flood plain management such as flood plain legislation, zoning, conservation, easement, etc.

As the examples of storm water management in the United States of America, two (2) systems are presented below:

(1) Maryland - National Capital Park and Planning Committee

A master plan of storm water management was formulated for the bi-country area: Montgomery and Prince Jones counties. In the study on the master plan, the committee prepared a manual of management and design criteria of several facilities.

In line with the management policy, some country ordinances were enacted such as building code, subdivision programs, zoning, storm water drainage and debris control, where agency responsibility or procedures for developers are defined.

(2) Tunnel and Reservoir Plan (TARP)

The Flood Control Coordinating Committee was reactivated in November 1970 by concerned officials of the State of Illinois, the Cook County, the Metropolitan Sanitary District of Greater Chicago, and the City of Chicago for the development of a plan to solve the waterway pollution and the increasing flood control problems of the Chicago Metropolitan Area. Specifically, the problems associated with the spillage of mixed sewage and storm water runoff to the waterways during every rainfall period from the area served by combined sewers are to be solved by the plan.

In the Tunnel and Reservoir Plan where the main structures are underground tunnels, storage reservoirs and pumping stations, the collection and conveyance of the sudden high volume surges of combined-sewer flows caused by heavy rains is accomplished through the use of large diameter tunnels located deep in the bedrock underlying Chicago. These tunnels are connected to surface collection systems by drop shafts which intercept the excess combined-sewer flow before it enters the waterway.

After interception the excessive volume of wastewater can be temporarily detained in storage reservoirs. After the storm event has dissipated, the stored flows can be conveyed to the treatment facilities for treatment and released to the waterways.

An organizational set-up for this TARP Project was done by placing the Metropolitan Sanitary District of Greater Chicago (MSDGC) as a principal implementing agency, and the United States Army Engineer District, the United States Environmental Protection Agency, the United States Department of Transportation, and the United States Department of Housing and Urban Development as cooperating agencies. Financing the project is mainly by MSDGC together with the subsidy of the Federal Government .

Related Laws and Regulations

In the Federal level, there have been principal laws, as described, to rule or direct the storm water drainage system. They are the Flood Control Act, the National Environmental Protection Act and the Flood Insurance Act. Based on the directions and guidelines stipulated in the acts, the States can issue ordinances and regulations to be applied to the regional storm water drainage plans.

Examples of the ordinances and regulations are shown in Table 8-10.

TABLES

Table 8-1. ACTION PLAN

Time Range	Authority in Charge: Coordinating Committee	CORPOSANA	Other Agencies Concerned
Current Situation	Preparation Stage	° Management of storm water drainage system. ° Taxation to beneficiaries.	° Project execution related to the storm water drainage system.
Short Term Plan	° Mobilization of Coordinating Committee. ° Recognition and coordination of the problems on storm water drainage system among the agencies concerned. ° Coordinating development projects related to storm water drainage system. ° Publication of flood risk map and limitation of land use.	° Consolidation of the organization. ° Land acquisition for First Stage Project. ° Execution of First Stage Project. ° Delineation of the stretch and area to be managed. ° Collection of flood data and preparation of flood risk map.	° Recognition of the importance of the storm water drainage system. ° Modification of the ongoing projects related to the storm water drainage system. ° Strengthening of the capacity for garbage collection and of inspection for illegal dumping of garbage.
Long Term Plan	° Coordination on the installation of the storm water drainage system. ° Instructions on the development of flood-prone area and the flood risk area.	° Land acquisition for the Master Plan. ° Execution of the Master Plan. ° Increment of the government subsidies for storm water drainage system and taxation to beneficiaries.	° Preparation of necessary regulations for land development. ° Approval of land development in coordination with the storm water drainage project.

Table 8-2 (1/2) CONTENTS OF WATER MANAGEMENT BY MINISTRIES IN JAPAN

Ministry	Functions and Responsibilities
MINISTRY OF CONSTRUCTION	- Formulation of Riparian Projects - Water control activities including flood control, riparian restoration works, etc. - Adjustment and approval of water utilization programs - Formulation and implementation of water resources development - Observation of water-level, discharge and precipitation - Conservation of water quality - Prevention of damages due to debris and sharply sloped terrain
PRIME MINISTER'S OFFICE	- Investigation and formulation of development plans in Hokkaido and Okinawa islands
Subordinate Agencies: - Hokkaido Development Agency - Environmental Agency - Okinawa Development Agency - National Land Agency	- Formulation of policies and long-term plans for water resources development as well as disaster prevention - Conservation of water quality and wild life - Ecological preservation
MINISTRY OF HEALTH AND WELFARE	- Assurance of purity of water supplied through water works - Conservation of water quality

Table 8-2 (2/2) CONTENTS OF WATER MANAGEMENT BY MINISTRIES IN JAPAN

Ministry	Functions and Responsibilities
MINISTRY OF AGRICULTURE, FORESTRY AND FISHERY Subordinate Agencies: - Food Agency - Forestry Agency - Fishery Agency	- Development and use of irrigation water - Drainage plan in minor river basins - Development of fisheries
MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY Subordinate Agency: - Agency of Natural Reserches and Energy	- Hydroelectric power - Assurance of industrial water - Regulation of drainage water (water quality conservation)
MINISTRY OF TRANSPORTION Subordinate Agency: - Meterological Agency	- Observation of rainfall and weather forecasting - Announcement of flood warnings

Table 8-3 (1/2) CONTENTS OF RIVER ADMINISTRATION BY DIFFERENT DIVISIONS OF THE RIVER BUREAU OF THE MINISTRY OF CONSTRUCTION

Division	Functions and Responsibilities
General Affairs	- Coordination within the River Bureau
Water Administration	- Drafting of laws and ordinances in connection with river administration - Issuance of water use permits - Administrative supervision of river and seacoasts
Planning	- Comprehensive planning for river and seacoast projects - Coordination of water resources development projects - Water quality and environmental problems - Technical cooperations in overseas countries
River Improvement	- Investigation into planning, implementation of construction and maintenance as well as management of river channels
Urban Rivers	- Investigation into planning and implementation of construction as well as management of urban rivers
Development	- Investigation into planning, construction and management of multipurpose dams - Enforcement of the Water Resources Development Public Corporation Act - Technical judgements regarding permission of water usage - Structural regulations for dams - Water resources development and natural environmental conservation

Table 8-3 (2/2) CONTENTS OF RIVER ADMINISTRATION BY DIFFERENT DIVISIONS OF THE RIVER BUREAU OF THE MINISTRY OF CONSTRUCTION

Division	Functions and Responsibilities
Seacoast	- Investigation into planning and execution of coastal conservation projects - Improvement and maintenance of seacoast
Disaster Prevension	- Estimation of expenditure on natural disaster rehabilitation projects for public utility facilities - Natural disaster prevention planning, natural disaster precautions, natural disaster emergency countermeasures and natural disaster rehabilitation
Sabo	- Coordination in the Sabo Department - Investigation into planning and implementation as well as direction and supervision of the Sabo works - Maintenance and management of Sabo facilities
Slope Conservation	- Investigation into planning and implementation for landslide prevention works, coal slagheap collapse prevention works - Maintenance of facilities mentioned above

Table 8-4 MAJOR ACTS RELATED TO WATER MANAGEMENT IN JAPAN

Name of the Law	Year of Enactment/Revision
River Act	1894, 1964
Sabo Act	1897
Flood Fighting Association Act	1908
Act on Reclamation of Public Water Surface Area	1921
Flood Fighting Act	1948
Act on Financial Aid for Relief Projects of Public Utilities	1951
Seacoast Act	1956
Specified Multipurpose Dam Act	1957
Sewerage Act	1958
Landslide Prevention Act	1958
Basic Act on Counter Measures Against Natural Disasters	1961
Act on Anti-erosion and Anti-flood Special Measures	1960
Flood Control Special Accounting Act	1960
Water Resources Development Promotion Act	1961
Water Resources Development Public Corporation Act	1961
Act on Financial Aid for Relief from Severe Natural Disasters	1961
Act on Disasters Prevention due to Collapse of Steep Slope Land	1969
Basic Act for Environment Pollution Control	1970
Water Pollution Control Act	1970
Act on Special Measures for the Reservoir Area Development	1973

Table 8-5 URBAN RIVER FLOOD MITIGATON PROJECT (NATIONAL, 1985)

Implementation	Description	Contents	No. of Project Locations
Project Under Direct Supervision	1. Comprehensive Flood Mitigation Project	Specific urban river basins are under rapid urban development, hence, the project aims to drastically decrease flood hazards. Measures of improvement are water detention in basin, retarding basins and river improvement.	6 rivers
	2. Riverbank Environment Improvement Project	Intake of uncontaminated river water; river channel improvement by dredging.	120 rivers
	3. Urban River Improvement Project	Improvement of rivers in big cities and in the suburbs.	392 rivers
Project By Subsidies (Prefecture Level)	1. Comprehensive Flood Mitigation Project	Water detention of basin, estabblishment of retardation functions as means of river improvement on urban rivers where development of basin is rapidly progressing and drastic decreasing in safety against flood.	14 rivers
	2. Urban Small River Improvement Project	River improvement project where basin population is over 300,000.	132 rivers
	3. Storm Charge Countermeasures Project	Same as No. 1	11 locations
	4. Land Subsidence Areas Along River Channel	Countermeasures to landside waters where excessive land subsidence is observed.	8 districts
	5. River Improvement as Countermeasures Against Earthquake	Construction of earthquake-proof river maintenance facilities in areas where earthquakes are anticipated.	4 districts
	6. Comprehensive River Improvement	Construction of embankment for prevention of inundation damage and for more effective land utilization.	2 rivers
	7. Urban River Flood Retardation Pond of Green Zone	Land acquisition for the proposed retarding basin.	19 ponds
	8. Multi-Purpose Retarding Basin	Combination of retarding basin and municipal facilities.	7 basins
	9. Regulating Reservoir for Flood Mitigation	Regulating reservoir for flood mitigation in connection with large scale housing lot development.	20 districts
	10. Urgent Improvement of Urban River Channels	To cope with rapid change of river basin, construction of regulating reservoir, diversion channel, etc.	5 rivers
	11. River Bank Environmental Improvement	Intake of uncontaminated river water; river channel improvement by dredging.	77 rivers and 48 districts
	12. Basin Storage and Infiltration	To give storage and infiltration functions to public compounds	19 locations
	13. Basin Development	Construction of retarding pond in urban development area.	1 river
	14. Detention Ponds	Improvement works for existing retarding ponds.	3 locations
	15. Super Embankment	Embankment of roads and housing lots in urbanized and lowland areas.	1 river
Project Subsidies (City and Municipality Level)	Improvement and Storm Water Storage in Small River Basins	Channel improvements and construction of storm water storage facilities.	698 rivers

Table 8-6 EXISTING LAND UTILIZATION LAWS AND REGULATIONS

	Title of Acts and Regulations	Preservation Measures (Status Quo)	Regulation Measures (Restrictions on Land Utilization Conversion)	Auxiliary Measures (Compensation for Preservation and Under Restriction Items)
ACTS				
1	Land Utilization Act	Designation of detailed grouping.	Designation of restricted areas.	Purchase of vacant land.
2	Urban Planning Act	Designation of urbanization regulation areas.	Regulations on location planning of urban facilities.	Prior procurement of construction lots.
3	Act on Adjustment Planning for Agriculture Development Region	Designation of adjustment planning for agriculture development region and zoning of land for agricultural use.	---	Promotion, subsidy and financing of projects.
4	Agricultural Land Law	---	Restriction on conversion permission of farmland.	---
5	Land Improvement Act	---	---	Guidance and assistance to land improvement project.
6	Forestry Act	Designation of privately owned forests under the regional forest plan.	Restriction on forest development.	---
7	Urban Green Belt Preservation Act	Designation of green preservation regions.	---	---
8	Productive Green Areas Act	Designation of productive green areas.	---	---
9	Housing Lot Grading Act	---	Designation of areas for development restrictions.	-
10	Building Standards Act	Designation of disaster danger zones.		
11	Local Tax Ordinances	---	---	Preferential measures such as special benefits on tax.
ORDINANCES				
1	Scenic Zone Ordinance	---	Designation of scenic zones. (Restrictions on housing lots and house construction)	---
2	Green Environment Growing Ordinance	---	Green environment agreement.	---
3	Building Standard Ordinance	---	Various restrictions on architecture.	---
4	City Tax Ordinance			Gradual tax cut on farmland and special land owners.
SUBDIVISION REGULATIONS AND CODES				
1	Housing Lot Development Code	Restriction by land development standards.	Restriction through various development standards and burden charges.	Acquisition for value of construction lots of public facilities.
2	Code for Preservation of Green Farmland	---	---	Grant in Aid difference between taxes on farmland and housing lot.
3	Code on Preservation of Natural Greenery and Greens on Mountain Slopes	---	---	Gradual cuts on city planning tax and fixed assets tax.
4	Guidance in Location of Disposal Site for Industrial Waste	---	Regulations on disposal and disposal site.	---
5	Restriction Code for Development in Scenic Zone	---	Restriction on permission of development and housing construction.	---
6	Guidance in Farmland Development Project	---	Restriction on work execution standards.	-

Table 8-7 (1/2) MAJOR FEDERAL AGENCIES AND THEIR RESPONSIBILITIES FOR WATER MANAGEMENT IN THE UNITED STATES OF AMERICA

Agency	Major Responsibilities
U.S. Water Resources Council	- Coordination/administration river planning - Grant-aids to states for planning - Coordination of river basin commissions
U.S. Department of Defense	
Corps of Engineers	- Navigation - Hydroelectric power generation - Municipal/industrial water supply - Water quality - Recreation
U.S. Department of the Interior	
Bureau of Reclamation	- Hydroelectric power generation - Municipal and industrial water supply - Irrigation - Flood plain management/navigation - Water quality - Recreation
Geological Survey	- Flood plain management - Water quality and quantity records
Heritage, Conservation and Recreation Service	- Preservation of cultural and historical values
Fish and Wildlife Service	- Fish and wildlife habitant values

Table 8-7 (2/2) MAJOR FEDERAL AGENCIES AND THEIR RESPONSIBILITIES FOR WATER MANAGEMENT IN THE UNITED STATES OF AMERICA

Agency	Major Responsibilities
U.S. Water Resources Council	- Coordination/administration river
U.S. Department of Agriculture	
Soil Conservation Service	- Flood plain management - Irrigation - Water quality - Recreation
U.S. Department of Energy	- Hydroelectric power generation
U.S. Department of Protection Agency	- Water quality - Food plain management - Financing/budgeting (grants)
Tennessee Valley Authority	- Navigation - Hydroelectric power generation - Municipal and industrial water supply - Flood plain management - Water quality - Recreation

Table 8-8. MAJOR ACTS RELATED TO WATER MANAGEMENT IN THE UNITED STATES OF AMERICA

Name of the Law	Year of Enactment/Revision
River and Harbor Act	1899
Reclamation Act	1902
Flood Control Act	1917, 1928, 1936, 1955, 1960
Tennessee Valley Authority Act	1933
Soil Conservation Act	1936
Reclamation Project Act	1939
Watershed Protection and Flood Prevention Act	1954
Water Resources Planning Act	1965
National Flood Insurance Act	1968
National Environmental Policy Act	1970
Federal Water Pollution Control Act	1972
Disaster Relief Act	1972
Flood Disaster Prevention Act	1973
Water Resources Development Act	1974
Clean Water Act	1977

Table 8-9. FEDERAL FLOOD PLAIN MANAGEMENT AND RELATED PROGRAMS BY AGENCY

Particulars	DOA	COE	DOC	PHS	CPD	DOI	DOT	FPC	SBA	TVA	WRC
1. Flood Insurance Studies*	*	*	*	-	*	*	-	-	-	*	-
2. Flood Plain Management Services	S	S	-	-	F	-	-	-	-	S	-
3. Flood Plain Information Studies and Reports											
Riverine	S	S	-	-	S	S	-	-	-	S	G
Coastal	I	S	S	-	S	S	-	-	-	-	G
4. Technical and Planning Services**											
Full Program	S	S	-	-	F	-	-	-	-	S	-
Program Elem.	G,S	S	S	-	S	S	I	I	-	S	G
5. Flood Modifying Construction	G,S	S	F	-	F	-	I	-	-	S	-
6. Flood Preparedness, Emergency, and Recovery	F,G	S	-	S	,G	S	S	-	G	-	-
7. Warning and Forecasting	-	-	S	-		-	-	-	-	-	-
8. Research	S	S	S	-		S	-	-	-	-	-
9. Open Space	S	-	-	-	G	G,S	-	-	-	-	-

* Administered by the Federal Insurance Administration through reimbursable technical studies by agency shown.

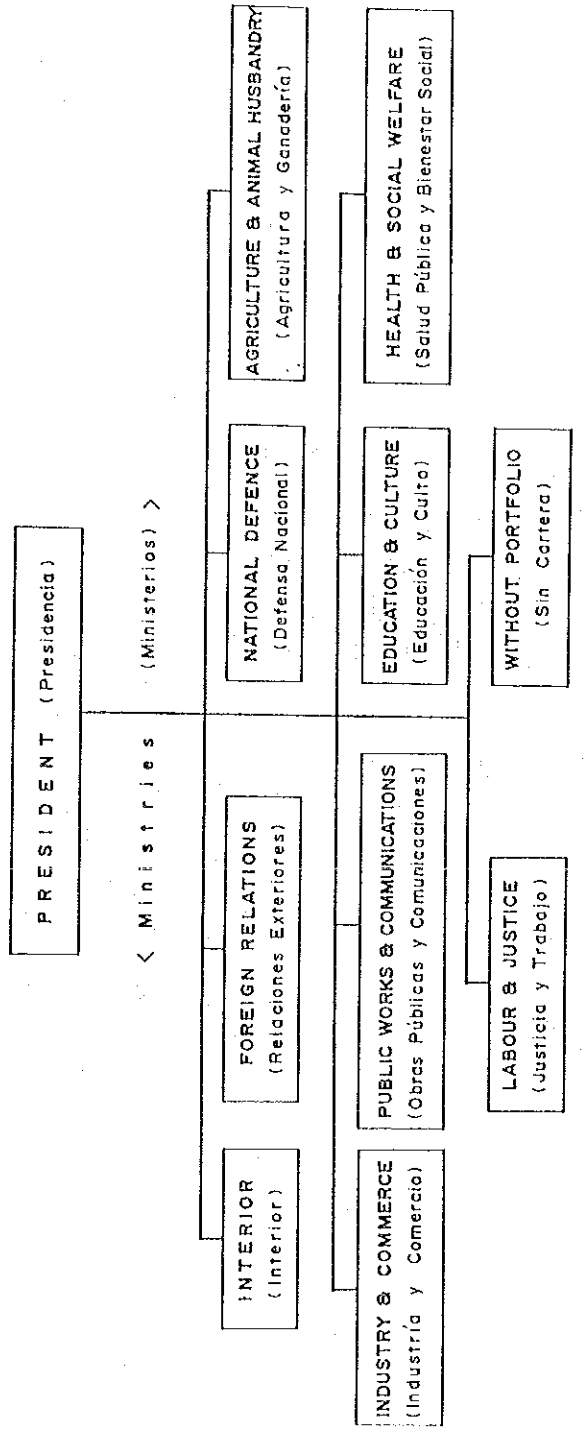
** Land and Water Resources.

DOA - Department of Agriculture
COE - Corps of Engineers, Department of the Army
DOC - Department of Commerce
PHS - Department of Health, Education, and Welfare
CPD - Community Planning and Development, Department of Housing and Urban Development
DOI - Department of the Interior
DOT - Department of Transportation
FDC - Federal Power Commission
SBA - Small Business Administration
TVA - Tennessee Valley Authority
WRC - Water Resources Council
S Staff and Funds
F Funds
G Grants
I Incidental

Table 8-10 ORDINANCES OR REGULATIONS FOR FLOOD PLAIN MANAGEMENT AND STORM WATER MANAGEMENT

City or State	Name of Ordinance or Regulation	Date Enacted	Summary of Contents
1. Naperville (Illinois)	Plumbing, Sewers and Water (Provision for Storm Runoff Control was added.)	1975-8-18	Applied to all the land use plan of more than 2.5 acres. Design discharge is of 100-year frequency.
2. Boulder (Colorado)	City Ordinances 72-74 (Modifications)	1969-8-5	Flood plain management: Flood flow areas - forbidding housing development Flood storage areas - forbidding housing development in the area with inundation of less than 2 feet deep.
		1973-7-17	Preparation of Master Plan; Flood Control Service Fee; Obligation to install on-site detention facility for new housing.
3. Arvada (Colorado)	City Ordinance (Modifications)	1970-10-8	Developers to be obligated to pay drainage fee or to construct drainage facilities.
		1972-2-21	Supplemental obligation to pay additional fee for storm water storage facilities.
4. Montgomery (Maryland)	Soil Erosion and Sedimentation Control Ordinance	1970	On-site detention; Preparation of master plan (by Maryland, National Capital Park and Planning Commission)
5. Denver (Colorado)	State Act	1969	Flood plain management (by Urban Drainage and Flood Control District)
6. Detroit (Michigan)	City Ordinance		Use of parking lot for on-site detention; 50% of storm runoff to be detained.
7. Fresno (California)	Drainage Fee Regulations	1969-4-8	Collection of drainage fee for development projects.
8. An-Urbar	Soil Erosion and Sedimentation Control Ordinance		Soil erosion control works for land development projects. Works: surface soil protection and energy dissipation of storm runoff.
9. Juliet (Illinois)	Ordinance for Detention of Storm Water Runoff		Application of on-site detention. Residential area: more than 10 acres; Non-Residential Area: more than 5 acres; All Developments: to have impermeable land which occupies more than 60% of total development area.
10. Chicago (Illinois)	Sewer Permit Ordinance	1969-7-10	Project scale: 100-year
11. Wille (Illinois)	Flood Damage Prevention Ordinance; Subdivision	1970	Land use regulation in flood plain. Building Code: forbidding construction below high water level. Compensatory Storage: equalizing volume between embankment and excavation.
12. Palatine	Ordinance Amending the Zoning Ordinance of the Village of Palatine, and Erosion and Sediment Contro Ordinance	1975-2-10	On-site detention. Individual House: more than 5 acres Combined House: more than 2 acres Non-Residential Area: more than 2 acres Soil erosion control. Soil surface treatment On-Site deterntion Drainage fee Energy dissipation

FIGURES



Note: Denominations in the parenthesis are the proper names in Spanish.

Fig. 8-1 ADMINISTRATIVE ORGANIZATION OF THE GOVERNMENT OF PARAGUAY

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

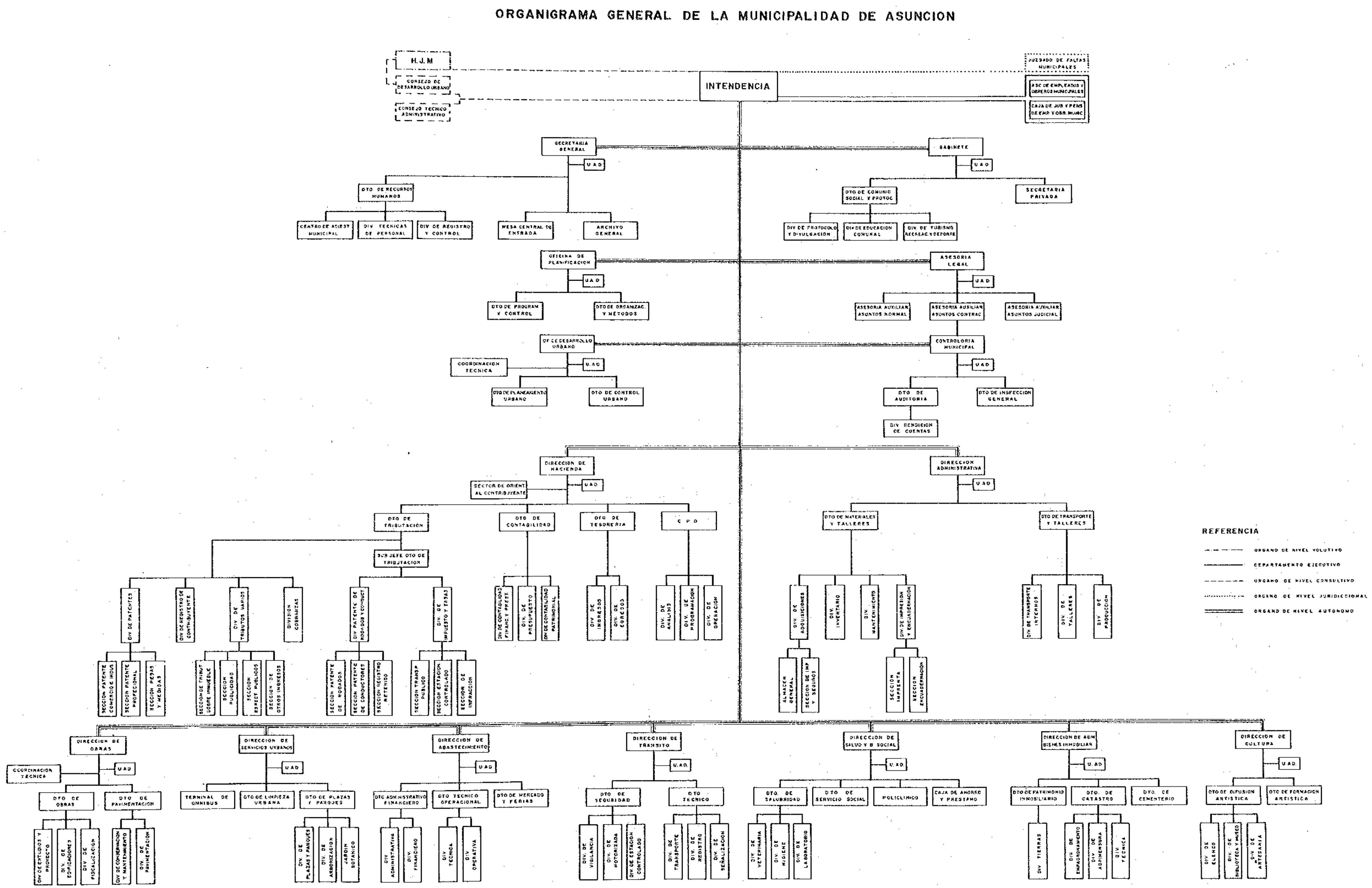


Fig. 8-2 ADMINISTRATIVE ORGANIZATION OF ASUNCION CITY

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

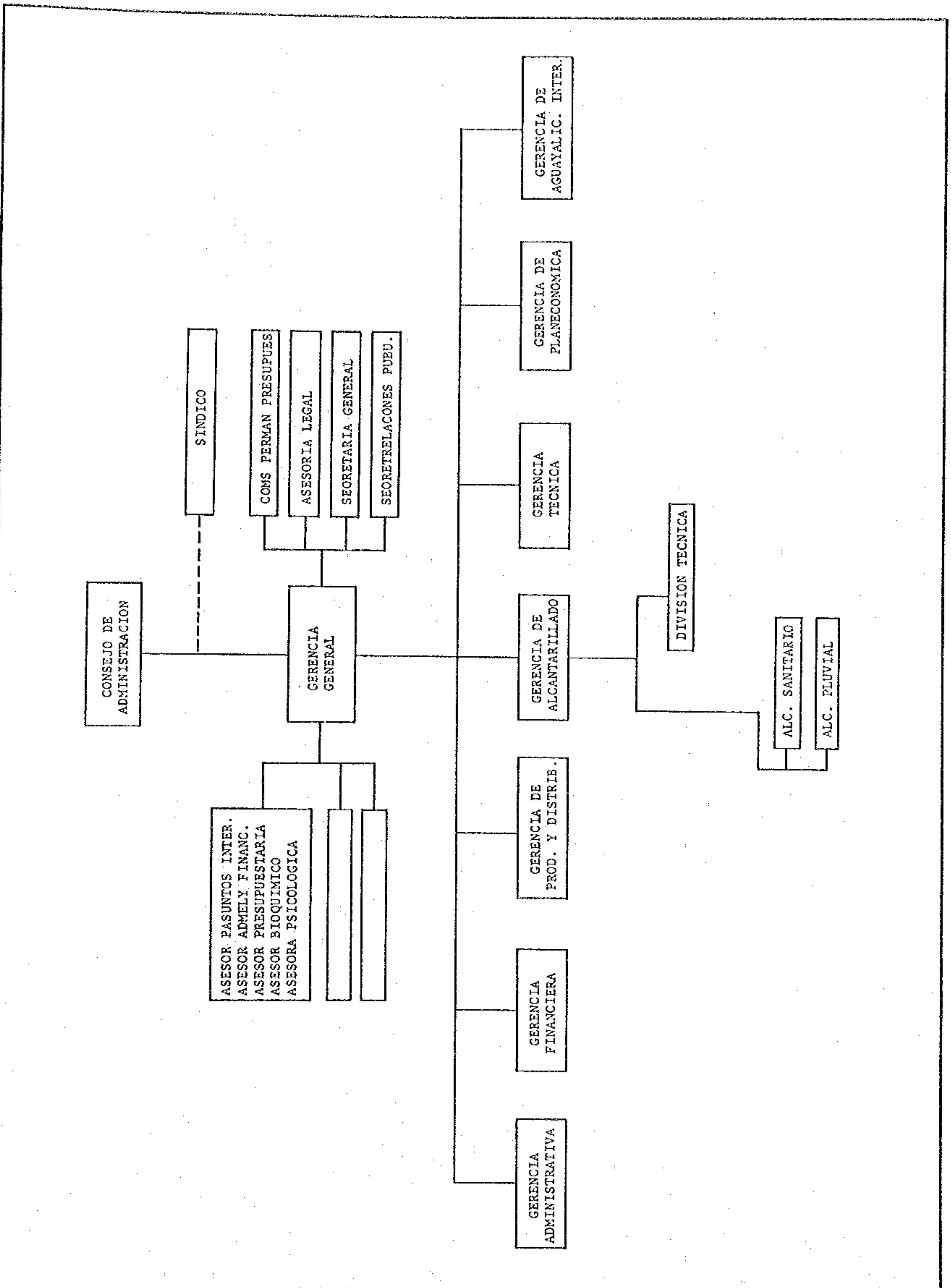


Fig. 8-3 ORGANIZATION CHART OF CORPOSANA	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY

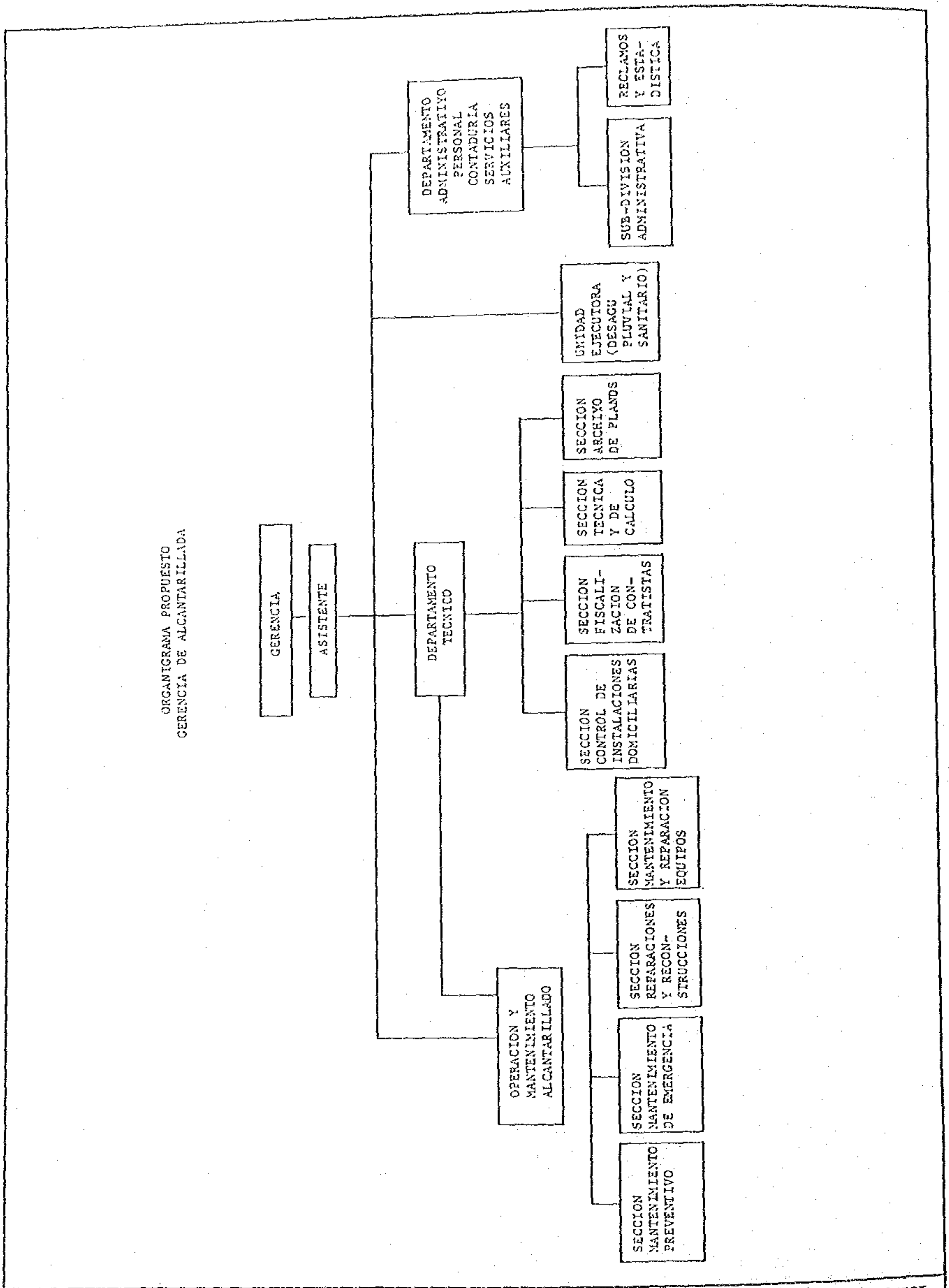


Fig. 8-4 ORGANIZATION CHART OF THE SEWERAGE DIVISION OF CORPOSANA

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

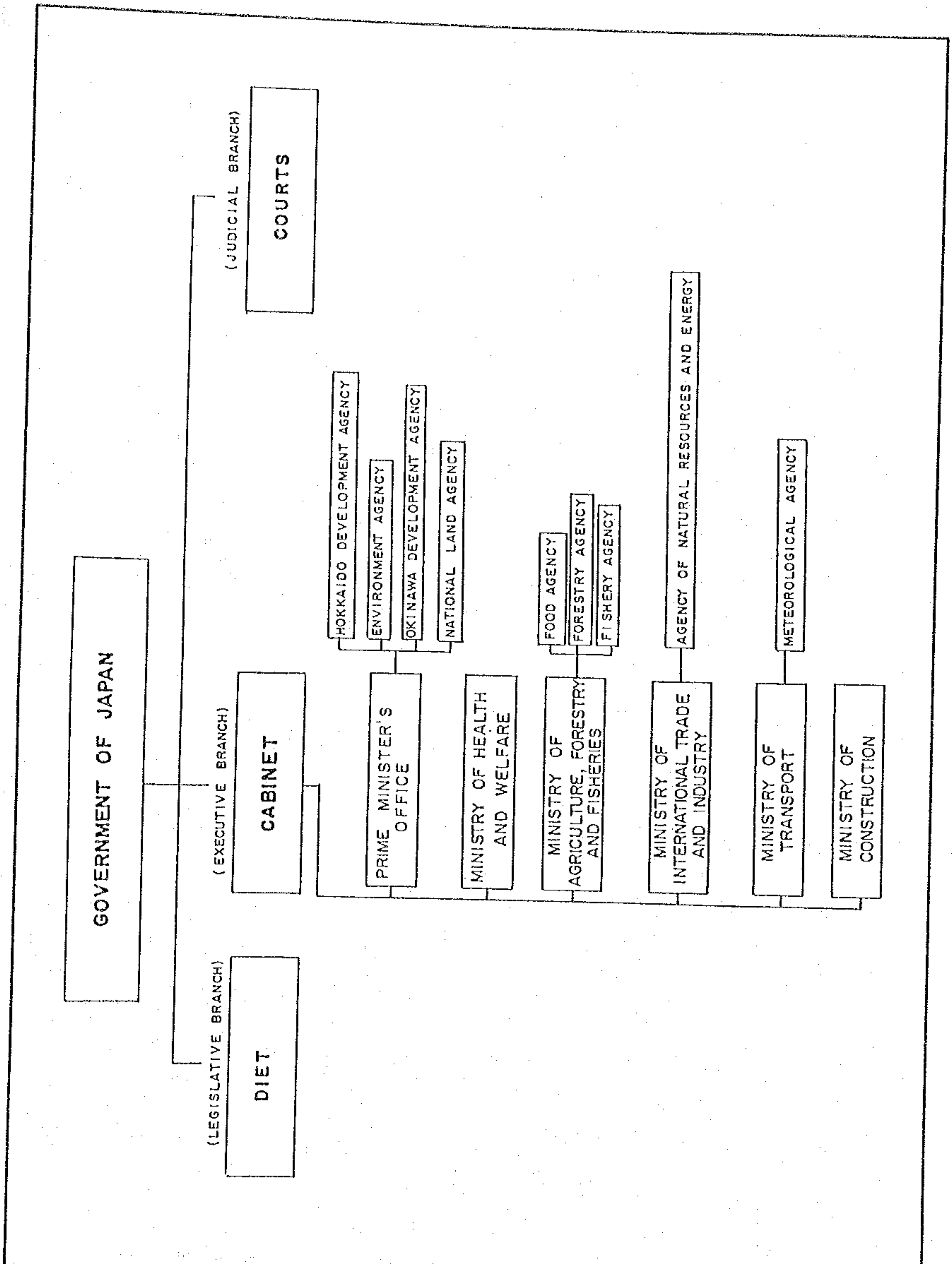


Fig. 8-5 ADMINISTRATIVE ORGANIZATION RELATED TO WATER MANAGEMENT IN JAPAN

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

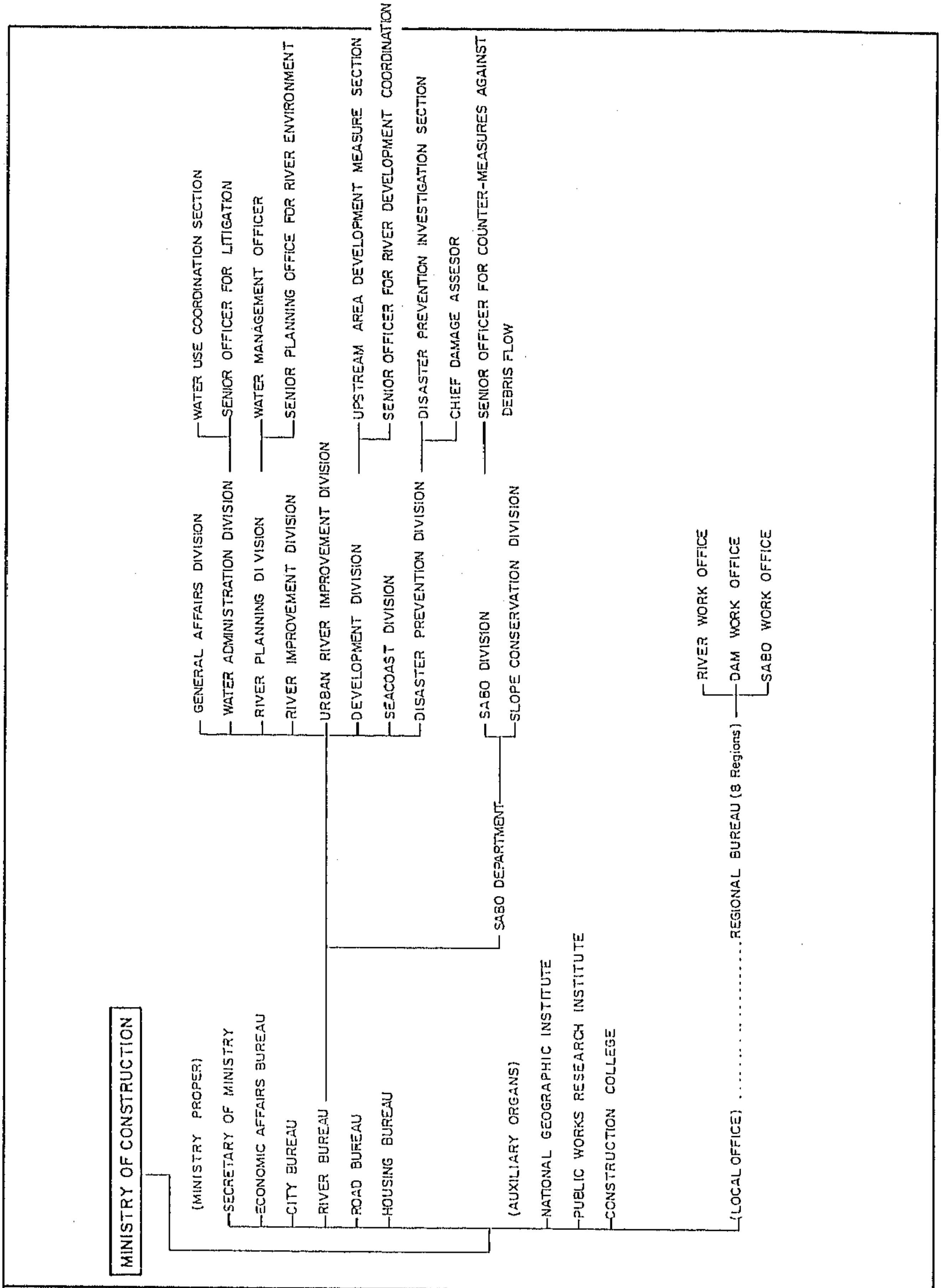


Fig. 8-6 ORGANIZATION CHART OF THE MINISTRY OF CONSTRUCTION WITH BREAKDOWN OF ITS RIVER BUREAU	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY

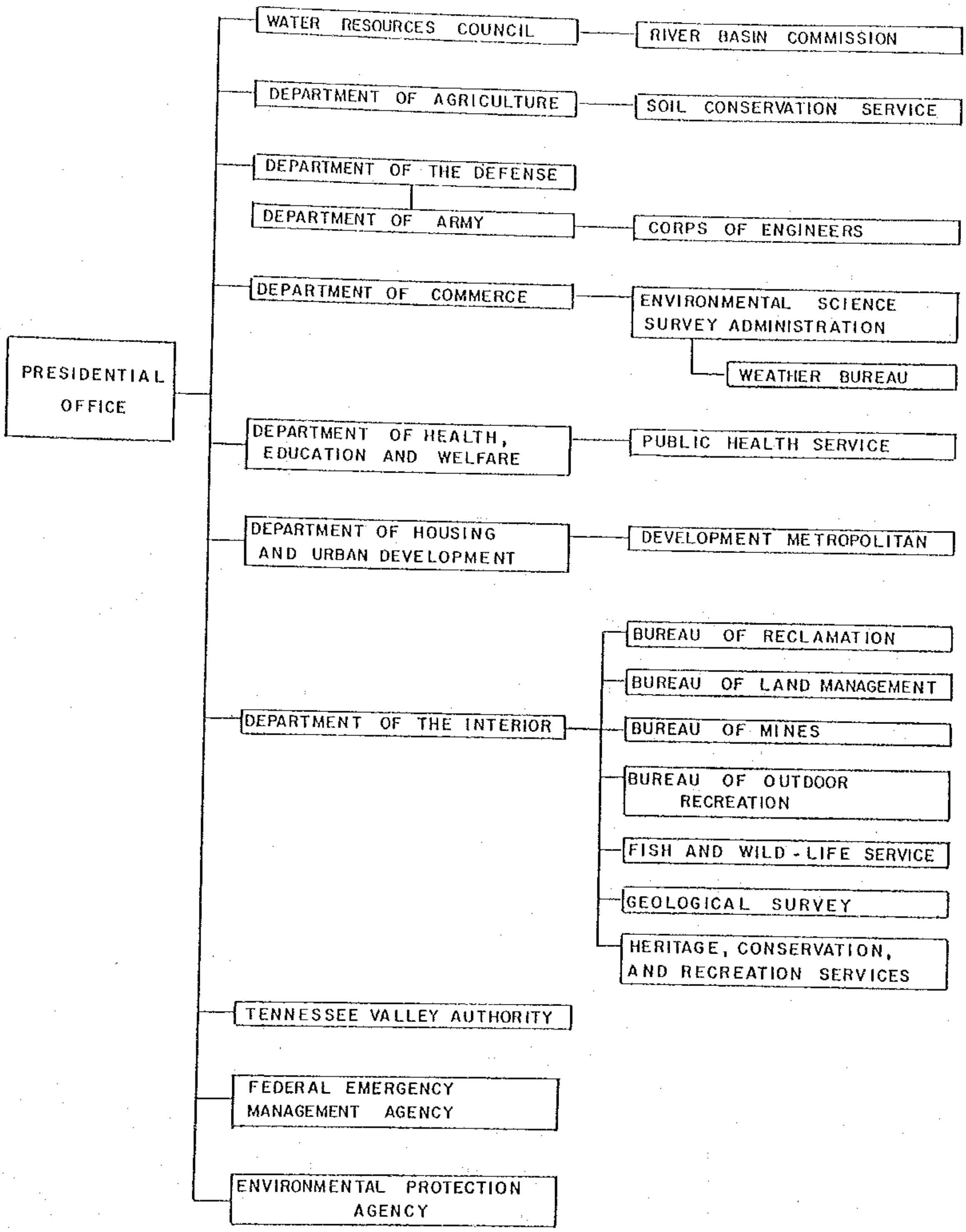


Fig. 8-7 ADMINISTRATIVE ORGANIZATION RELATED TO WATER MANAGEMENT IN USA	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY

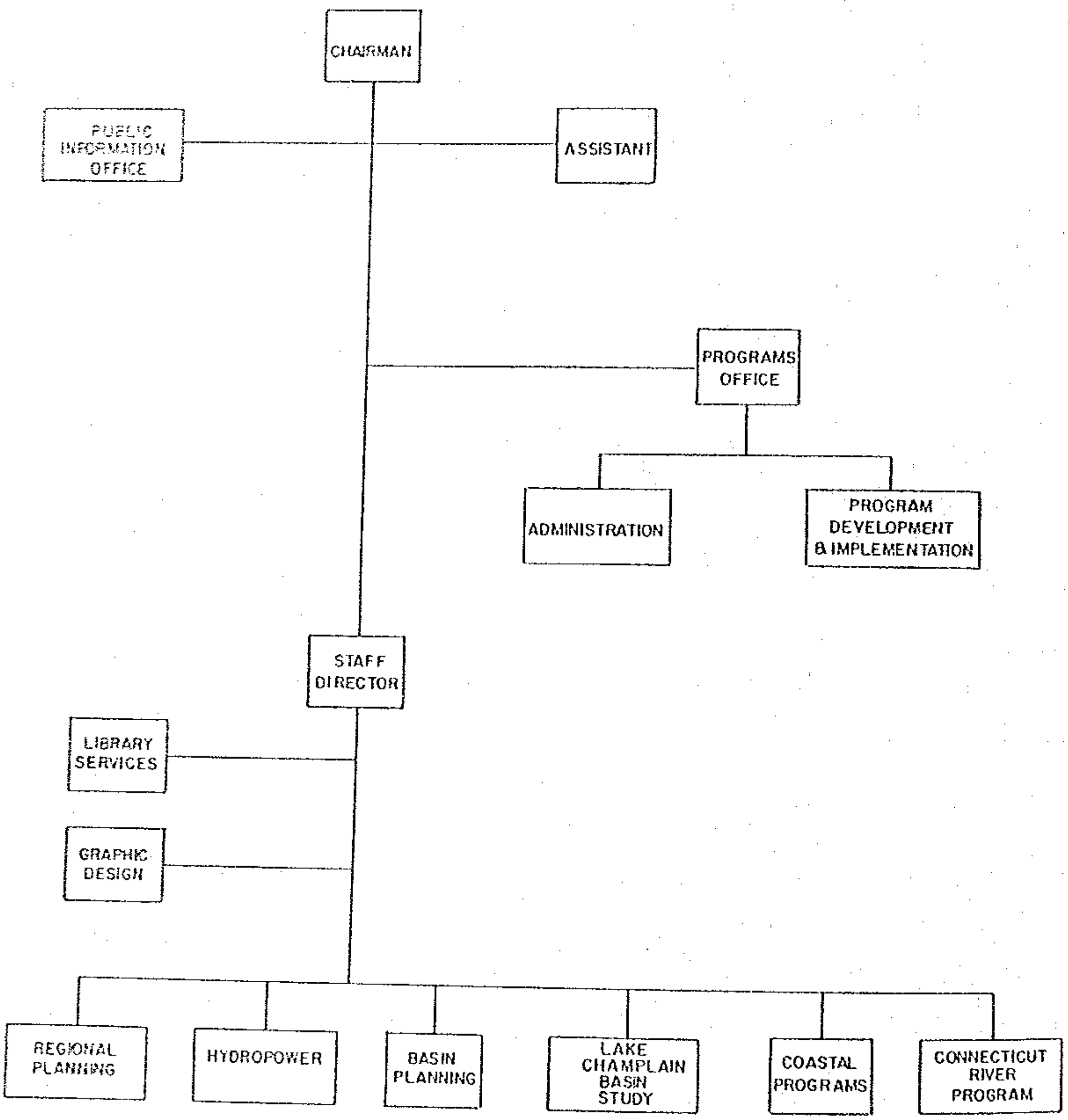


Fig. 8-8 ORGANIZATION CHART OF NEW ENGLAND RIVER BASIN COMMISSION	STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY JAPAN INTERNATIONAL COOPERATION AGENCY

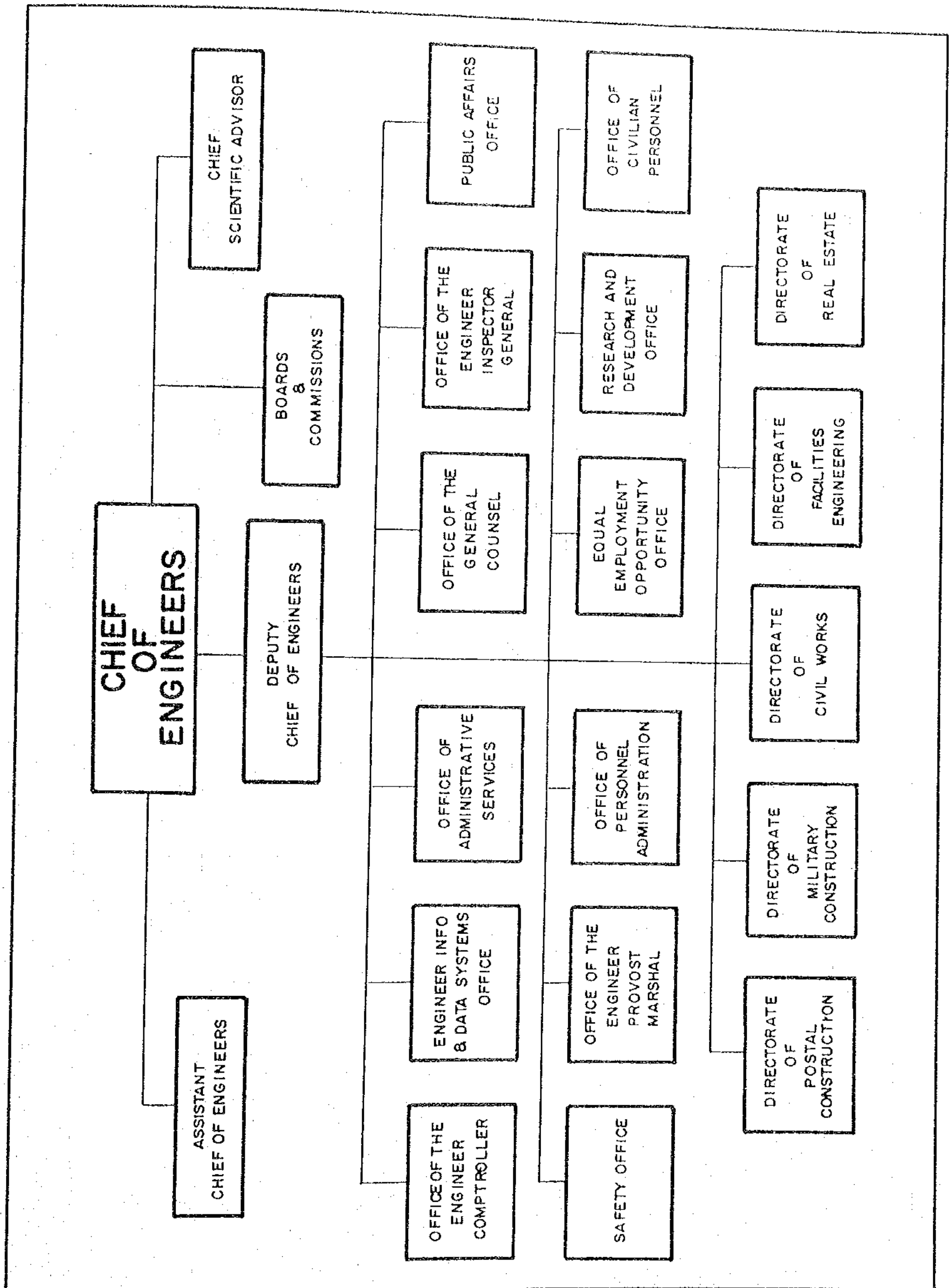


Fig. 8-9 ORGANIZATION CHART OF THE OFFICE OF THE CHIEF OF ENGINEERS

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

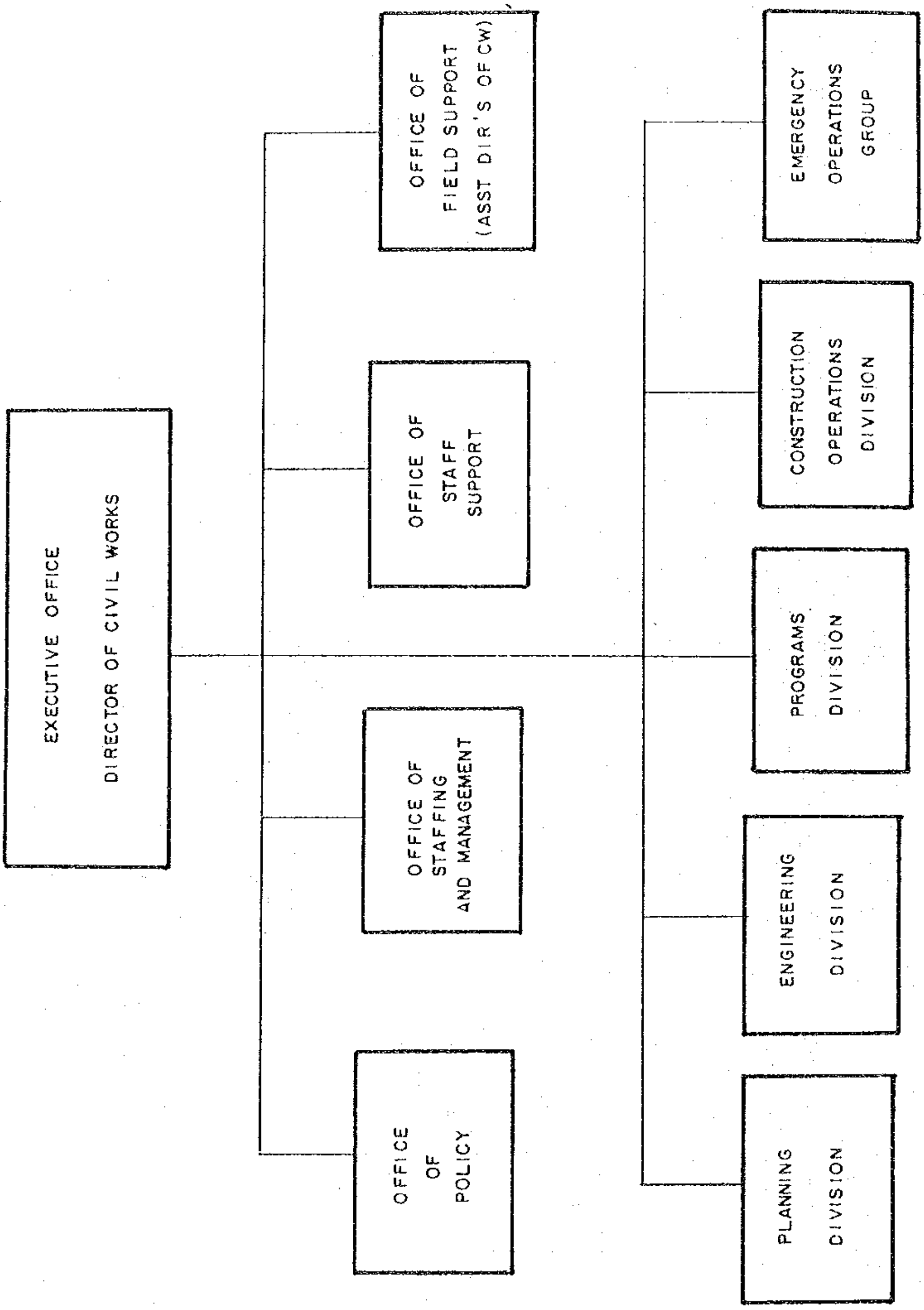


Fig. 8-10 ORGANIZATION CHART OF THE DIRECTORATE OF CIVIL WORKS

STORM DRAINAGE SYSTEM IMPROVEMENT PROJECT IN ASUNCION CITY, PARAGUAY

JAPAN INTERNATIONAL COOPERATION AGENCY

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