⑥ Promotion of duties concerning guidance and education of water quality engineers

- staging of seminars for water quality monitoring engineers
- testing for water quality monitoring engineer trainees

⑦ Promotion of duties for monitoring of water quality at water bodies and pollution sources

- selection of water quality monitoring points (pollution sources, rivers, lakes)
- establishment of collection water/analysis methods
- maintenance of analytical laboratory

⑧ Assurance of funding and personnel

8.4 Burdens for the Lake Ypacarai Basin Management Authority and Already Existing Organizations

It is premature yet to create a new institution which meets the outline in section 8.1, from the point of view of finances, personnel and existing agencies and their work contribution. A practical measure is thought to be to form Lake Ypacarai Basin Management Authority, based on the Ypacarai study team which consists of STP, INTN, SENASA, CORPOSANA, ICB and ANNP members. , We believe it would be advantageous to bolster this office with personnel and duties gradually so that in the future it can readily assume the administrative task of conserving the environment.

In the beginning, since it will be difficult to secure sufficient personnel and finances, it is desired to construct an agency which could assume only the duty of planning and coordination; and then, gradually, could transfer over functions and personnel from agencies closely related to water quality/environmental conservation; and, finally, could assume the full capacity of actual operations and work execution.

CHAPTER IX

CONSTRUCTION COSTS FOR THE WATER TREATMENT PLANTS

As explained in Chapter 2, the measures for water quality conservation are divided into two groups: "hard" measures which refer to the establishment of the treatment and purification facilities; "soft" measures which refer to the establishment of legislation and to the education and instruction of water quality conservation concepts. In the latter case, the costs are rather hard to determine, thus here one has attempted to calculate and present a summarized representative estimate of the costs concerning the former (in US$). However, in Paraguay, there is no authorized unit cost list relating to civil engineering operations, thus shown here is a standard monetary amount based on the necessary costs of construction for the experimental facilities for this present study and on the construction unit cost list of 1988.

9.1 Lagoons

The experimental facility, constituted by the oxidation pond set up at the Aregua butchery as a part of this study, has a treatment capacity of $6m^3$/day, and a BOD removal rate of 50%. It consists of three ponds in gradation of which the depth is m (total volume is $108m^3$) attached by a sedimentation pond and a screen as a pre-treatment facilities, and pump and sprinkler in order to create an aerobic state (Fig. S9.91).

In this way, the costs of construction of this lagoon (including an anaerobic pond) of which the structure is simple and doesn't require secondary facilities, is dependent on the volume. In turn, the lagoon's volume varies depending on the amount and quality of the raw water and on the standard water quality of the effluent following its treatment (refer to S-8 for a detailed explanation of this).

The total cost required for the construction of the experimental facilities is $4,960 and is detailed in Table S9.91. The unit price for the construction of the oxidation pond specified is approximately $50/m^3$.

Table S9.91 Details of the Construction Cost for an Oxidation Pond System

Items	Unit Price (US$)	Quantity	Amount (US$)	Remarks
Excavation	4	110 m^3	440	
Block	2	150 m^3	300	
Embankment	3	80 m^3	240	
Laying of Sewer Tile	6	5 m	30	
Waterproofing	4	150 m^2	600	Tar coating
Pump (1.5 HP)	830	3	2,500	for Aeration
Electric Supply			850	3 phases, 220V
Total			4,960	

Volume of Pond: 108m^3

9.2 Soil Absorption Treatment System

The domestic waste water experimental facility installed at the Aregua Police Station, as a part of this study, has a treatment capacity of 600ℓ/day, an osmotic rate of 7.8×10^{-3} cm/s, an outer diameter of 100mm, 2 perforated polyvinyl chloride pipes of 10m long, 1 septic tank of an approximate 3m^3 effective capacity, and 1 dividing receptacle (Fig. S9.92). In order to maintain the effectivity of soil purification, the PVC pipes will be used in a one-at-a-time rotating fashion.

The cost for the construction of this soil absorption treatment system is in proportion with the lenghth of the PVC pipes, and that lenghth depends on the amount of domestic waste water and the characteristics of the soil (osmotic rate) (detailed in S-8). Judging from the amount of domestic water used in an average city in Paraguay and from the characteristics of the soil distributed in the Lake basin, the lenghth of the PVC pipes needs to be 1 - 1.5m/per person, thus, for a family of 5, two pipes of 5~8m would be jlong required.

The total cost for the construction of this experimental facility is $410, and is itemized in Table S9.92. From these results, the unit cost of construction of this system is approximately $20/m, thus the cost for a family of 5 would be

$100-150. Therefore, to construct one system for a group of habitations would greatly reduce the cost.

Table S9.92 Details of the Construction Cost for a Soil Absorption Treatment System

Items	Unit Price (US$)	Quantity	Amount (US$)	Remarks
Excavation	4	30 m^3	120	
Block	2	20 m^3	40	
Laying of Pipe	6	30 m^3	180	PVC, ϕ = 100mm
Backfill	2	25 m	50	
Waterproofing	4	5 m^2	20	Tar coating
Total			410	

Effective Length of Trench: 20m^3

9.3 Raw Sewage Collection System by Cesspit Emptier

This system is presently implemented partially within cities in the Lake basin, however it is carried out by private companies, not by regional unit, but by establishment. Furthermore, the raw sewage collected is dumped into the rivers and open spaces untreated.

Here, as a domestic waste water treatment measure for those areas where soil absorption treatment is inappropriate due to the soil characteristics and the space, the collection method for raw sewage by cesspit emptier should be reestimated and the costs required should be calculated. Treatment for 3,000 people (600 households), sewage amount at 2ℓ/person/day, collection frequency at 1/2 months, a distance between the urban area and the treatment plant at 15km and a cesspit emptier capacity of 6,000ℓ, and considering the time required for collection and transport and the working hours for the operations staff, would absolutely require 4 cesspit emptiers. If the cesspit emptiers were brought from Japan, the cost per car would be $70,000 by CIF Asuncion.

Furthermore, in order to operate these cesspit emptiers annually, the cost required for the fuel , maintenance and insurance would come to $18,000-

$20,000 and that for personnel, counting the drivers (4), the assistants (2) and the laborers (12), would be $16,000-$18,000 (Table S9.93).

Table S9.93 Details of the Running Cost for the Raw Sewage Collection System by Cesspit Emptier

Items	Unit Price (US$)	Quantity	Amount (US$)	Remarks
Personnel Expenses				
Operator	5	960 MD	4,800	MD: Man×Day
Assistant	4	480 MD	1,920	
Labour	3	2,880 MD	8,640	
Car Maintenance Cost				
Fuel and Grease	3,600	4	14,400	
Repairs	360	4	1,440	
Insurance etc	500	4	2,000	
Total			33,200	per one year

for Four Cesspit Emptiers

In introducing the raw sewage collection system by cesspit emptier, it would be necessary to refurbish each house with the required type of storage tank. In addition, as the dumping of untreated collected matter directly into rivers and open spaces goes against any effort for environmental conservation, a new raw sewage treatment plant would have to be constructed.

9.4 River Basin Sewarage and Sewage Treatment Plant

The percentage of sewarage provision in the basin is extremely low, and explained in 4-2 is the reason why the outlook on future provision planning and main financial problems is bleak. CORPOSANA draws up the sewerage provision plans and the construction costs are well understood, however, in any case, there is still nothing yet resembling a basin sewerage proposal.

As stated in 1.1 and in 1.2, the urban area is rapidly growing in the basin, evidence of which can be seen especially in the Yuquyry River basin. Consequently, instead of refurbishing the urban sewage system, a better course of action would be the construction of a river basin sewerage system, as this would respond to the needs of the apparent future urbanization.

With this view in mind, an estimation was made of the summarized calculated cost of a plan based on the laying out of two arterial sewers on either side of the lake where the topographic position is the lowest and the construction of sewage treatment plants at the end of each (Fig. S9.93).

The length of the sewer on the east side of the lake would be 20km, extending from the southern tip of San Bernardino to the sewage treatment plant on the right bank at the lower reaches of the Salado River. The length of that on the west side would be 30km, extending from Ypacarai, through Aregua, to the sewage treatment plant to the north of Luque. With the topography along the route as it is, pump station would be in 10 places. In addition, the sewage treatment plant would be the same as that described in 9-1, an oxidation pond, of which the scale would be 8,000m^3, judging from the estimated treatment population.

The total cost of construction is estimated at $4,030,000, which is itemized in Table S9.94.

Table S9.94 Details of the Construction Cost for Sewerage and Terminal Treatment Plant for a Given River Basin

Items	Unit Price (US$)	Quantity	Amount (US$)	Remarks
Laying of Sewer Tile				ϕ = 250mm
Bedrock Area	85	20,000 m	1,700,000	
Sand and Gravel Area	30	30,000 m	900,000	
Treatment Plant	50	8,000 m^3	400,000	Lagoon
Pumping Station	10,000	10	100,000	
Other Expenses			690,000	30%
Total			4,030,000	

Population for Treatment: 3,000

It should be kept in mind that as for the work involved in the laying out of the pipe, earth pipes of a 250mm diameter would be buried in the ground, however the work cost varies greatly depending on the condition of the ground at the installation site. Furthermore, a separate necessity would be the cost of construction for the branch sewer linking the each house and each urban area to the arterial sewer.

9.5 Yuquyry River Flood Control Channel

The objective for this canal would be to reduce the pollant load flowng into the lake by having the excess flood water in the Yuquyry River directly pass into the Salado River. At the opening of the flood control channel, a diversion dum would be built and during the normal water level river water would pass through the normal waterways and enter the lake. Therefore, the installation of such a flood control channel would not effect the water level of the lake.

The location and structure of the flood control channel is illustated in Fig. S9.94. As for the body of the embankment, the grade of the slope would be 1:2 and an earth type, and upon the slope would be placed wire cylinders. The extension would be 8km and the diversion dam would be 5m wide and made of concrete.

The total for the summarized work costs would be approximately $5,400,000, which is itemized in Table S9.96. The principal portion of the work would be embankment work, thus depending on the unit cost involved, the total work cost could greatly vary. The on-site material available here, to give it a sandy compaction would require work, thus the unit cost for the embankment work, including material excavation and transportation, would be $10/m^3.

Table S9.95 Details of the Construction Cost for the Yuquyry River Flood Control Channel

Items	Unit Price (US$)	Quantity	Amount (US$)	Remarks
Diversion Dam				
Concrete Placing	40	55 m^3	2,200	
Mold	15	140 m^3	2,100	
Earth Levee				Length: 8 km
Enbankment	10	480,000 m^3	4,800,000	Mining, Transportation, Material etc.
Wire Cylinder	6.5	16,000 m	104,000	
Temporary Work			490,400	
Total			5,398,700	

9.6 Waste Water Treatment Plant for Vegetable Oil Refinery

Here is simply a presentation of the required $200,000 for the chemical treatment plant (presently out of operation) which was constructed for high density waste water by Capiata CAPSA in 1979.

This plant was designed to purify, up to 1,000ppm, waste water of a BOD density at 9,000ppm, thus has a treatment capacity of 5m3/h. The treatment procedure is as follows: the oil is separated and removed by a sulfate misture; neutralization by the addition of lime; coagulation and sedimentation by the addition of aluminum sulfate; the discharge of floating debris and the drying of sedimented jsludge.

The original plan calls for an oxidation pond to be directly affixed to this chemical treatment plant, however the plant at this time is without an oxidation pond.

CHAPTER X

SOCIOECONOMIC BENEFITS OF WATER QUALITY CONSERVATION MEASURES

As explained in Section 8.3, in order for water conservation measures to have the support of the population, and be effected without difficulty, it is imperative to demonstrate that the benefits of the measures will exceed the losses resulting if they are not implemented. However, this profit must include economic benefits not spread via the market (in other words, exterior effects).

Presently not enough facts exist for a cost/benefit analysis; therefore, this report can only expound on the socioeconomic benefits that will derive from the conservation measures.

The socioeconomic value of a safe quantity, quality and flow of water from lakes and rivers can be divided as in the following: ① useful function as resource for potable, industrial and agricultural water, ② useful function as a resource for a pleasant existence for people and animals (function as a resource for national territorial conservation without causing inundations and erosion and for a pleasant atmosphere at tourist and recreation spots).

Consequently, the benefits of conservation measures will come as a consequence of the maintenance of these two functions.

As Section 3.1 explained, the Lake and its basin have not been fully used on a wide scale, the basins' population is subject to an abundant spread of health hazards and the vital changes which occur in the ecological system are not met at the same rate by degradation of the environment. Accordingly, present profit from water quality conservation measures does not exceed the expenses, however for the next generations, the potential for profit is quite remarkable.

The following is a detailed explanation of the content of the benefits.

1) Reduction of costs for water purification and water waste treatment

If the water quality is improved in the lake and rivers, the cost for purification can be cut before the water is supplied for public use. Presently, CORPOSANA uses the Lake water as the city water source to supply only 1,095 houses in San Bernardino. However, as stated in 3.1, in 10 years, if the supply ratio reaches 8~10 times what it is now, the reduction in purification cost brought about by the improvement in water quality will amount to quite a large sum.

If the water quality worsens, complex treatment facilities will have to be established at pollution sources and garbage and pollution treatment, as well as dredging, will be necessary at marshes and rivers. Then, the facility maintenance and continuous operation cost, just as at purification sites, in proportion to the degradation of the water, will be quite large. Thus it is apparent that with an initial improved quality of water, all operations can be handled at a low cost.

2) Reduction in health care cost for inhabitants

In areas like Ypacarai, where there are no water works, the result from using wells contaminated by domestic effluence is an abundance of diseases in children. According to SENASA, 8.4% of the deaths from 1980-1982 were related to diarrhea or other bowel disorders. If water quality conservation measures were carried out and groundwater pollution ended, the detriments to health would be reduced and so would health care costs for inhabitants.

3) Reduction in animal health care cost and increase in product value

Cattle breeding is Ypacarai basin's principal industry, however pasturing animals experience weight loss in the winter season, and due to drinking contaminated water, develop diarrhea and lose even more weight. If there was an improvement in water quality, diarrhea problems in animals would cease, thus there would be a reduction in health care costs for animals and also in the time required to ship animals to the market, from a present 3-4 years to 2-3 years. In addition, the value of the products would increase greatly.

4) Increase in farm income due to river water use as irrigation

Presently, there are areas in the basin where the river water can no longer be used for irrigation, due to industrial effluence influx. If the river water quality was improved and then used for irrigation, even small scale farms which cannot afford the excavation for deep wells, could rest assured of being able to yield a large amount of profitable produce like strawberry and an increase in their incomes.

5) Increase in tourist recreation area income

The value of tourist recreation areas which base themselves on the presence of water bodies is determined by the scenery and surely the amount and quality of the water. Water quality conservation measures not only improve the quality of the water but also recycle the water amount which results in an appreciation of the value of the area. By the way, research done in America showed an increase in visitors and an extension in their stays in areas of improved water quality.

An increase in tourists and long-term stays naturally bring about an increase in the income of these areas. In America, the breakdown of tourists' expenditures is 48.2% for parking and yacht and boat use, 22.4% for souvenirs, 15.8% for lodging and 9.1% for restaurants.

6) Appreciation in land value surrounding water bodies

With an improvement in water quality, the environment surrounding the water improves as well, thus bringing about a high assessment of residential and tourist recreation areas and then an appreciation in land prices. In this region, already landowners understand water quality improvement as an increase of their assets.

7) Prevention against decrease in farm production

According to a survey done in India, surface soil run-off at 1cm/year resulted in a decrease in corn production from 100kg/ha, in the first year to 52kg/ha in the second year and to 51kg/ha in the third year (FAO report). According to these numbers, in the Ypacarai basin, water quality conservation, as a prevention against surface run-off, could save 150-300 tons of corn in one year, if implemented.

8) Increase in fuel resources

Recently in Paraguay, resulting from an increase in the use of propane gas and electricity, use of wood materials for fuel has not grown. However, wood materials are an extremely important fuel resource for daily life and for brick, pottery and bread factories. In 1986, the nation's

consumption rate was: domestic, 1,224,106 tons and industrial production, 1,518,691 tons. Moreover, for the Paraguay iron works at full capacity, even the charcoal use amount could equal a present 20%.
Recommendations for forestry operations as water quality conservation measures have been raised, however the wood materials resulting from this could also answer the demand for fuel resources as mentioned above.

CHAPTER X I

FURTHERING THE WATER QUALITY CONSERVATION PLAN

11.1 Yearly Plan

In order to implement the water conservation plan without losing time it is necessary to consider the many types of measures outlined in 9.3. For that very reason this report has examined the conditions in which these measures will be applied.

1) Application of the techniques of water treatment and purification

In order to establish water treatment and purification facilities, if the acquisition of land, the water quality standard for discharge and the cost sharing system legalities are not settled, the execution is bound to be quite problematic. Consequently, the establishment of legislations comes first, however, it is somewhat possible to eatablish the facilities, depending on the proper application of present legislation. For example, concerning operational suspension or existing drainage treatment facilities which require repair, the direction of the future funcions would be possible if the administrative agency possessed enough guidance potential.

In a sense, if legislation is not fixed for the establishment of environmental conservation which assures a large capacity for natural purification and of the public water body, for the determination of the necessary monitoring specialists and their related duties, and for the land use regulations, excution is going to be extremely difficult. However, before setting up legislation, selection must be made of the zones requiring conservation, and land use plans which would prove effective for water quality conservation must be designed. Furthermore, the prohibition of dumping garbage and polluted matters into the lake and rivers, and the campaign for forest and swamp protection can be effected without having to wait for the implementaion of legislation. Therefore, even the sense of the administrative agency's enthusiasm should be made apparent as early on as possible.

2) Formulating legislation

Chapter 6 points out the legislation necessary for water conservation. To implement this legislation, information must be collected upon which a coherent legislative structure can be erected. That legislation, in turn, will help to unify the population and the institutions, as well as establish systems of support and penalty.

3) Instruction and education

All sectors of society must understand and support the idea of water conservation for it to move ahead. Therefore, instruction and education of all proposed activities must remain a priority.

4) Bolster the administrative agency

As Chapter 8 explained, the central administrative agency should have the functions and powers to oversee water quality control throughout the basin. First, though, all existing organizations must be told of the need for this new agency, its functions and proposed powers.

Presently, there is no proposed length of time for water conservation measures to achieve their goals. However, if we take into account that after ten years palpable results will not be available, the most appropriate time frame is approximately 20 years. Considering that in the year 2011 (within 20 years) Paraguay will celebrate the bicentennial of its independence, this seems to be a good year to envision for success of the proposed goals.

Incidentally, in Japan, lake quality environmental standards (general items) were established in 1971 by the Environment Agency and their effects, 15 years later, were only perceived at 50 of the 115 places.

Fig. S9.111, as stated above, is the yearly plan, having been devised according to the established accomplishment date of 2011 and upon consideration of the context of various measures and the required time.

11.2 Financial Resource Planning

Getting financing from the national budget in order to implement conservation measures for Lake Ypacarai and its basin as proposed in Fig. S9.111 is difficult. Implementing installations for water treatment and purification can be assisted by international economic aid. Nevertheless, resources to assist in compiling information, monitoring and carrying out activities of diffusion should be supported principally by internal resources.

Methods for the procurement of funding are the following: ① introduction of new tax regulations, ② using the profit from any operations, ③ introduction of tax breaks for those contributors who bear the cost of facility establishment. However, ① is found to be the most effective in assuring a long-term financial resource.

Today, in any country, it is common sense that the contributor to pollution bear his/her proper cost burden according to the contribution amount (pollution contributor burden principle). Therefore, new taxation regulations based on this principle would easily win the people's support and , it is thought, constitute the best method in finance procurement for the conservation operations.

Investigation needs to be carried out in order to determine the index of the tax and to understand how to balance the relationship between the index size and the amount.

As a tax index, specially-fixed water quality item establishment is the most rational, however it is necessary to prescribe measurement, seasonal, land point and check methods, which is a fairly cumbersome task. Accordingly, it is very common and convenient to index the effluence amount (or usable water amount) and the amount of products manufactured. However, as that amount is not verified for the factories and businesses in the lake basin, the relationship between these amounts and the pollution discharge amount (there are big differences depending on the type of enterprise) is also not known, all work has to begin first by trying to understand these amounts.

FIGURES

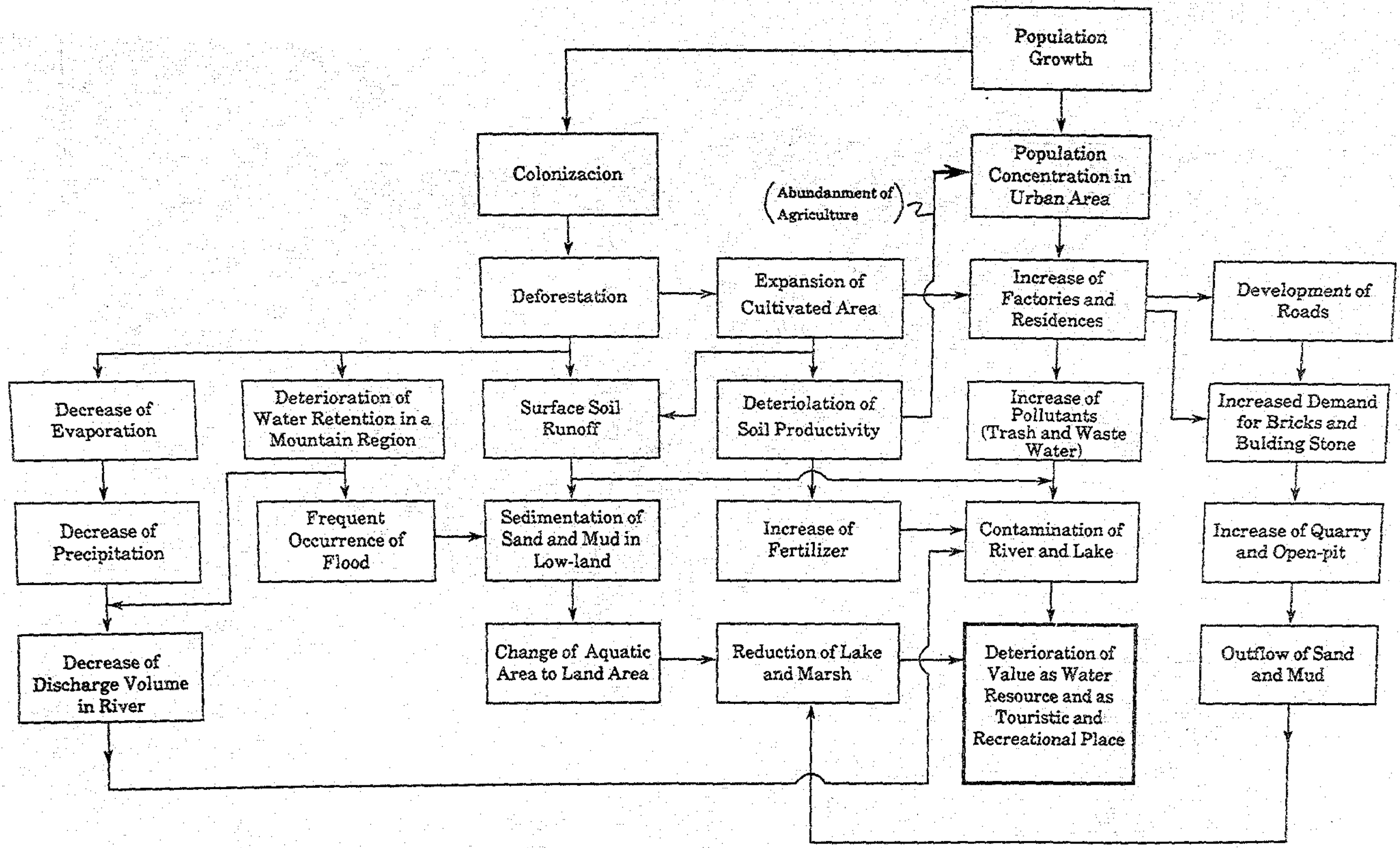


Fig S9.11 Relation between Human Activities and Environmental Change in the Lake Ypacarai Basin

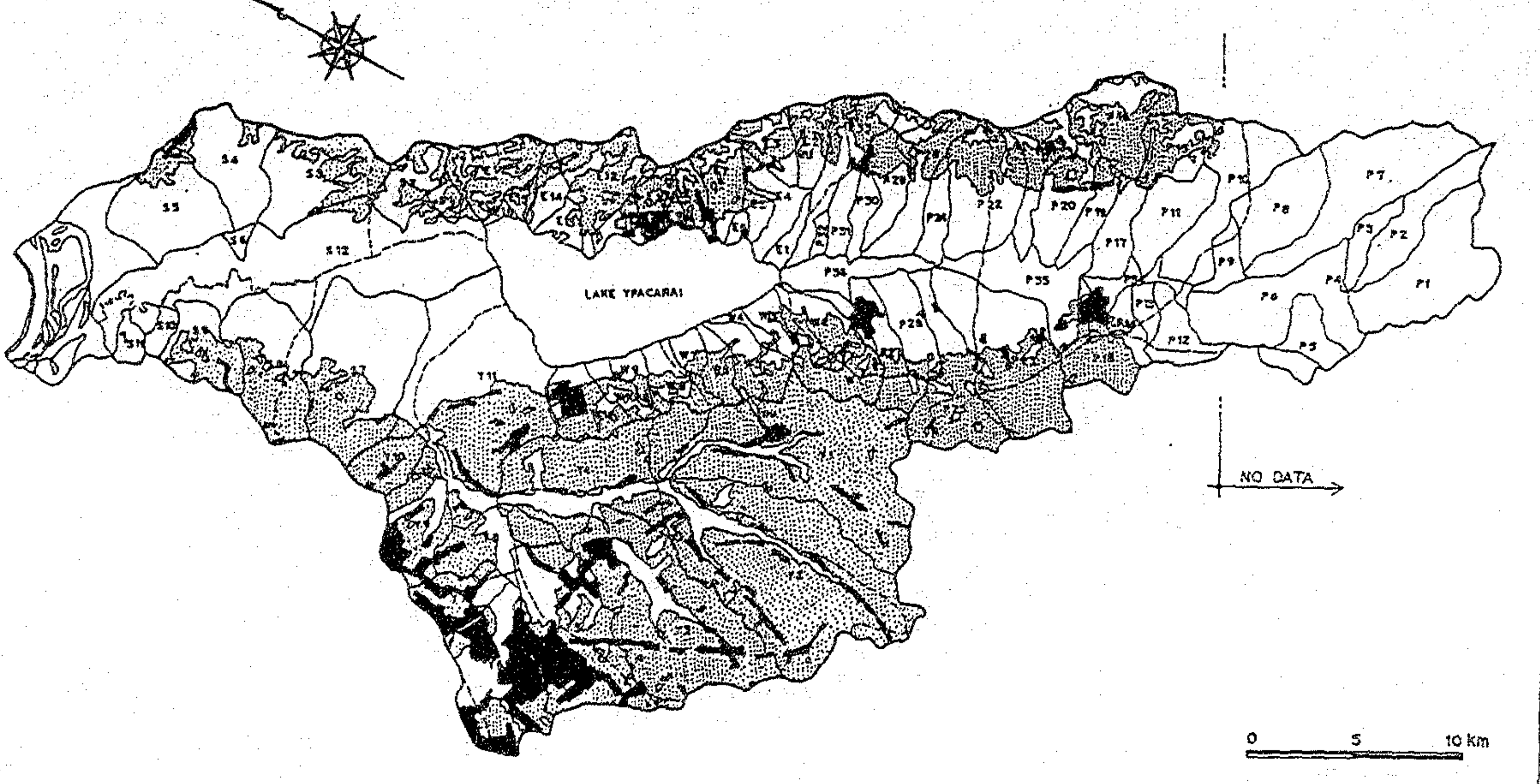


Fig. S9.12 Urban Area in the Lake Basin in 1965

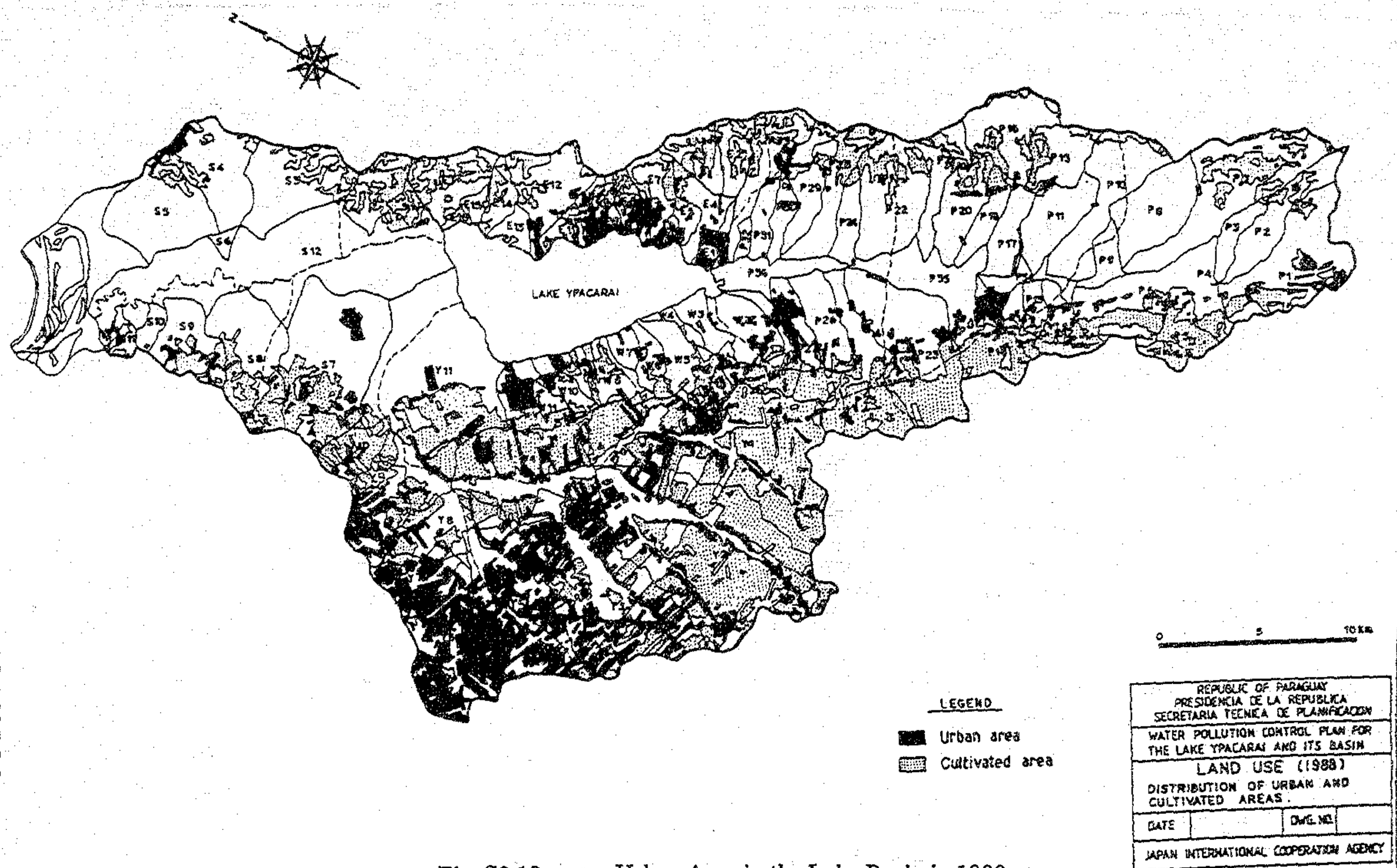


Fig. S9.13 Urban Area in the Lake Basin in 1988

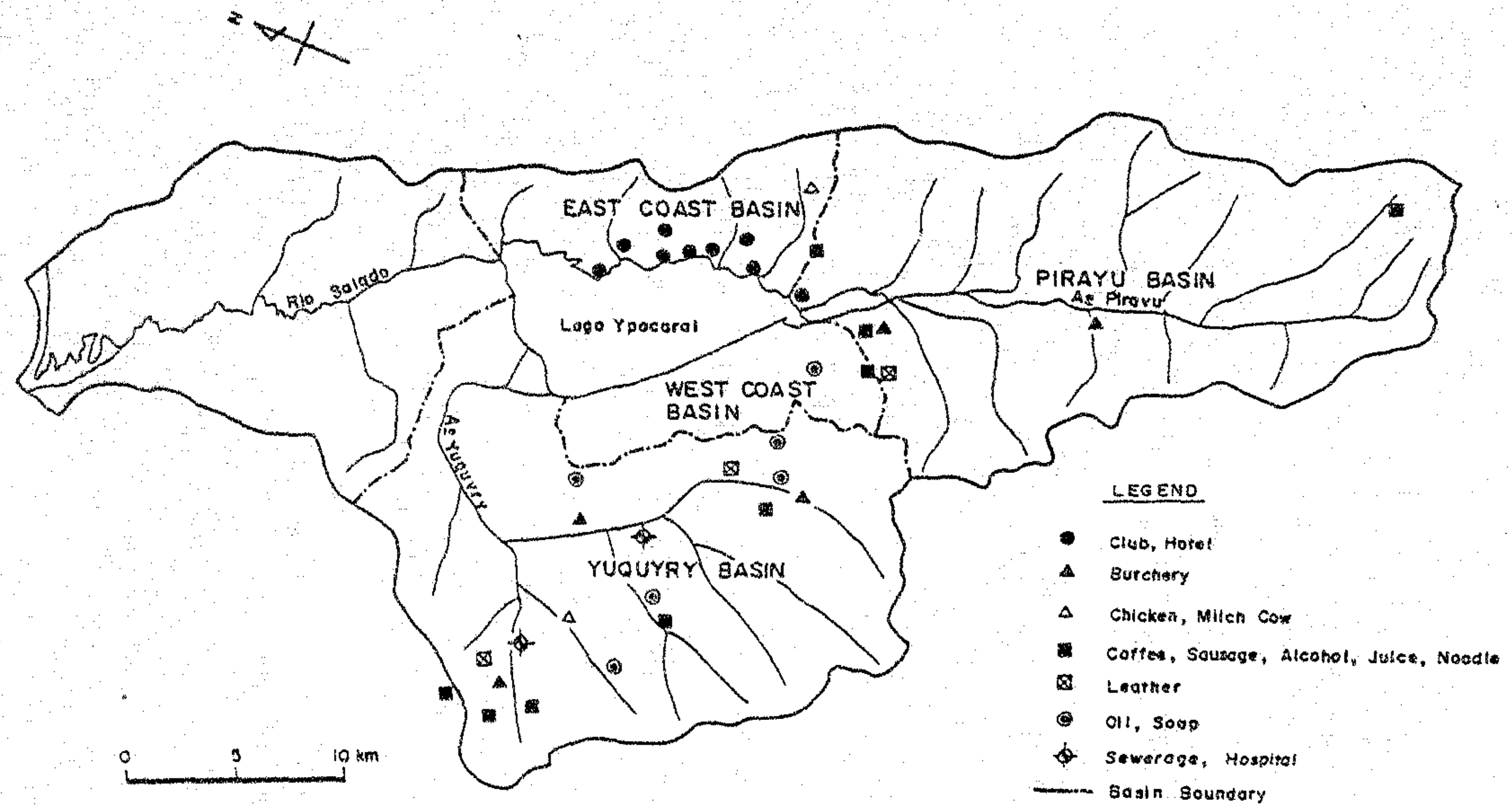
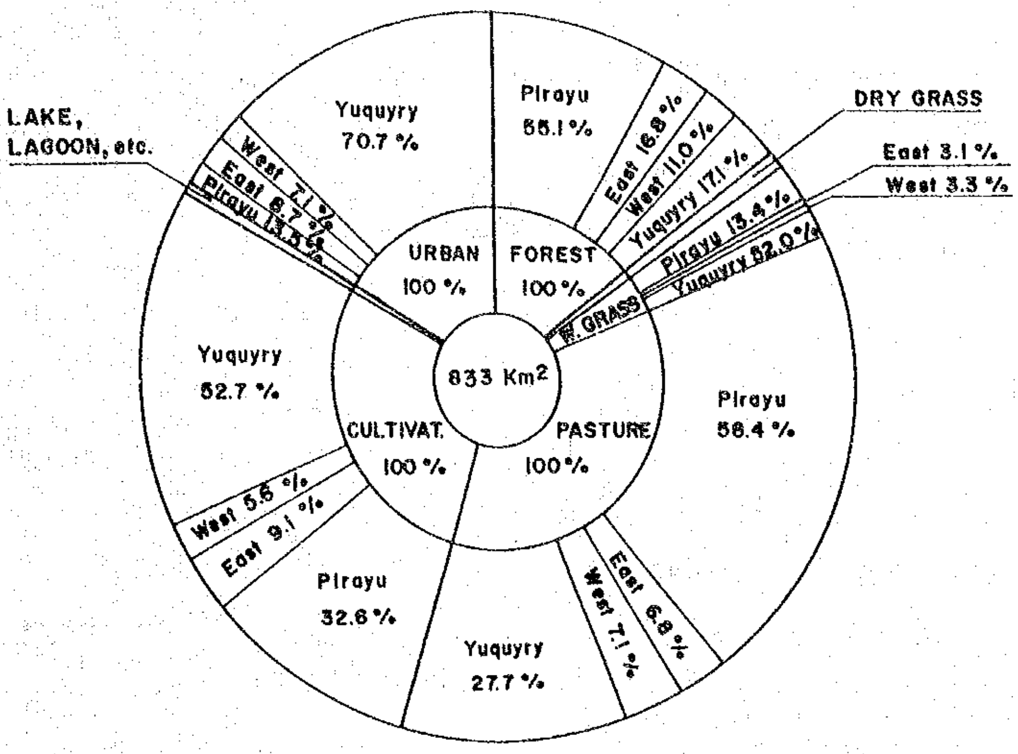


Fig. S9.14 Distribution of Main Point-Pollution-Sources in the Lake Basin



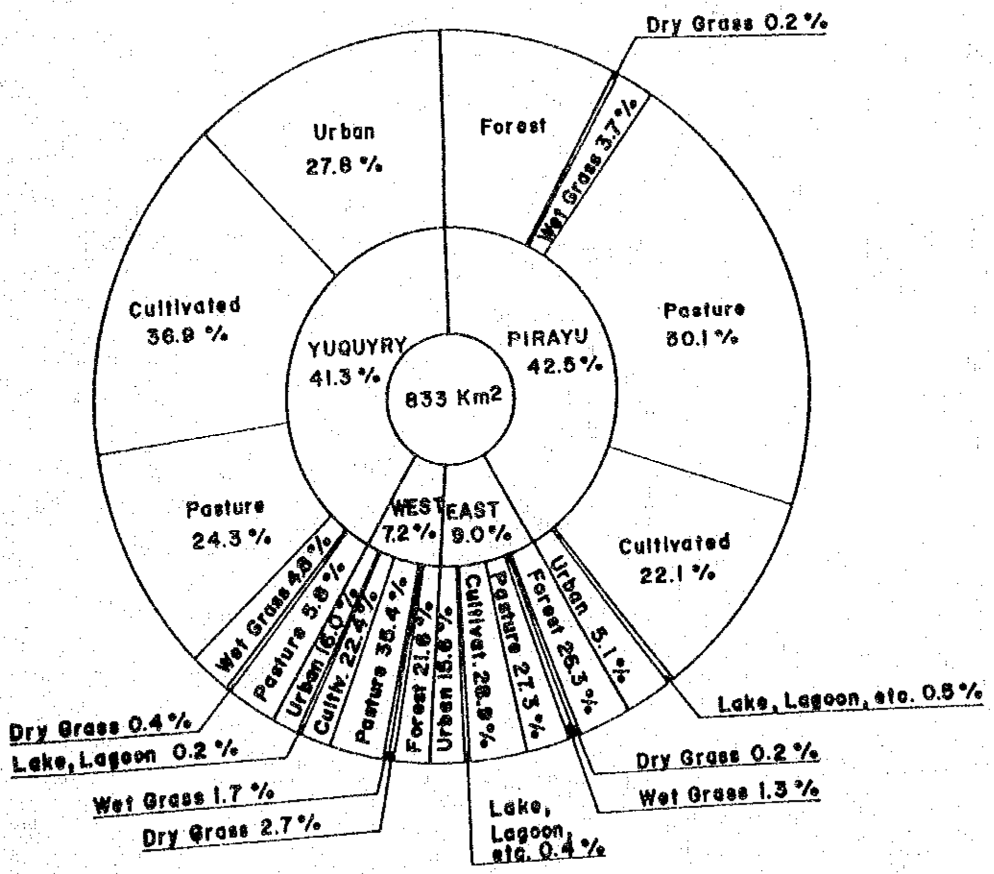


Fig. S9.15 Land Use Area by Basin and by Type of Use

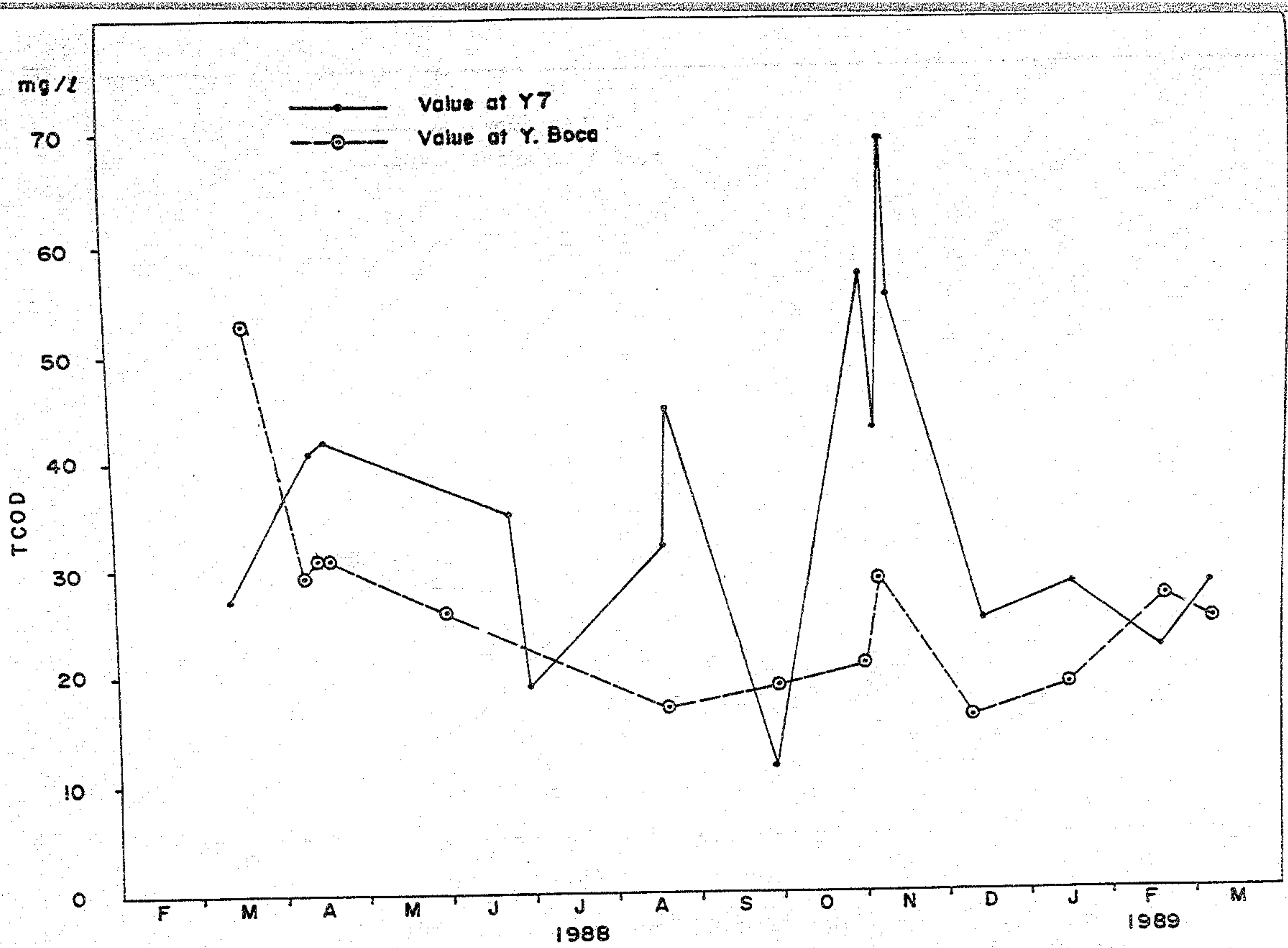


Fig. S9.16 Comparison of the Yuquyry River Water Qualities upstream and downstream of the Marsh (COD)

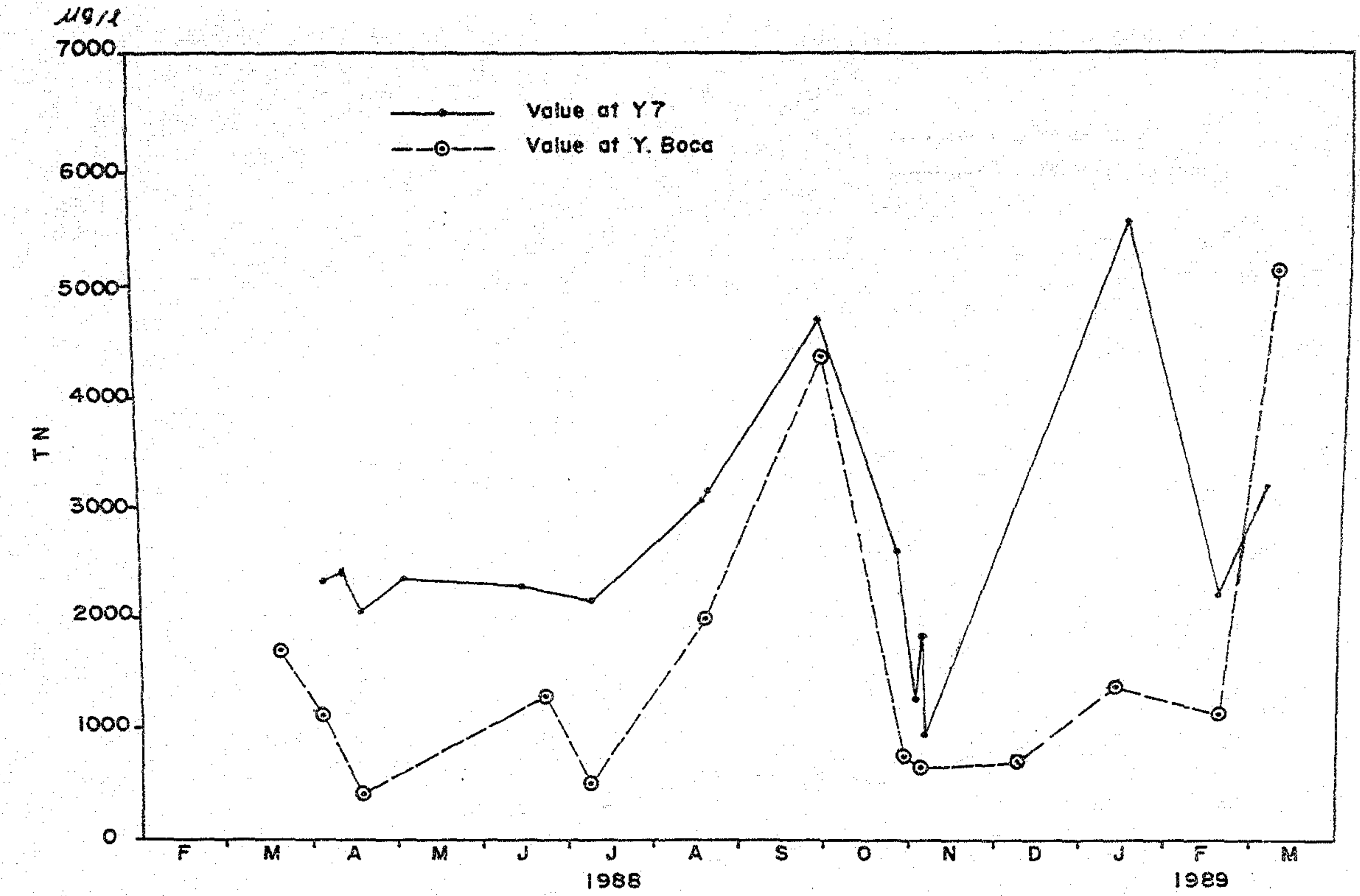


Fig. S9.17 Comparison of the Yuquyry River Water Qualities upstream and downstream of the Marsh

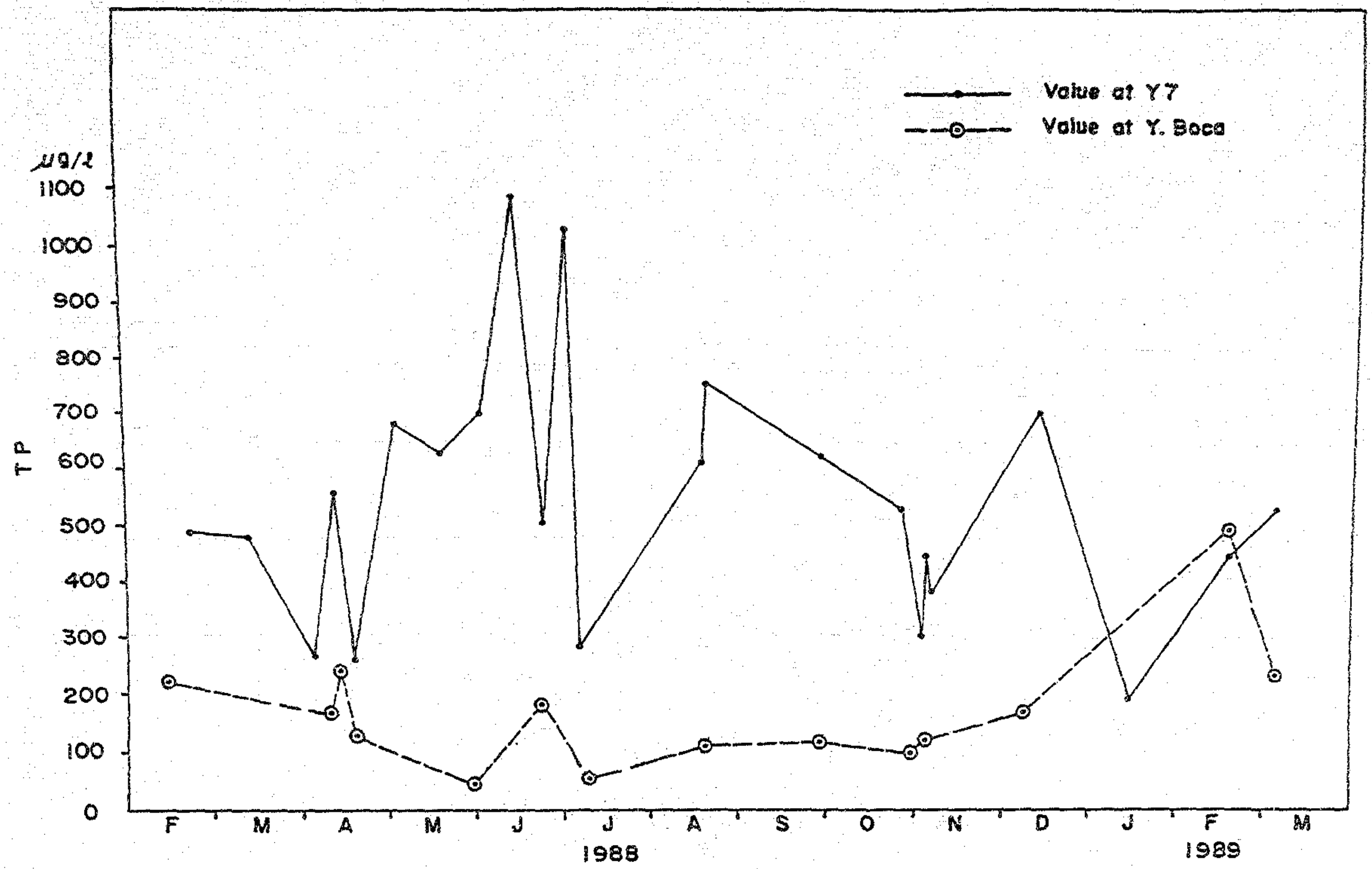


Fig. S9.18 Comparison of the Yuquyry River Water Qualities upstream and downstream of the Marsh (TP)

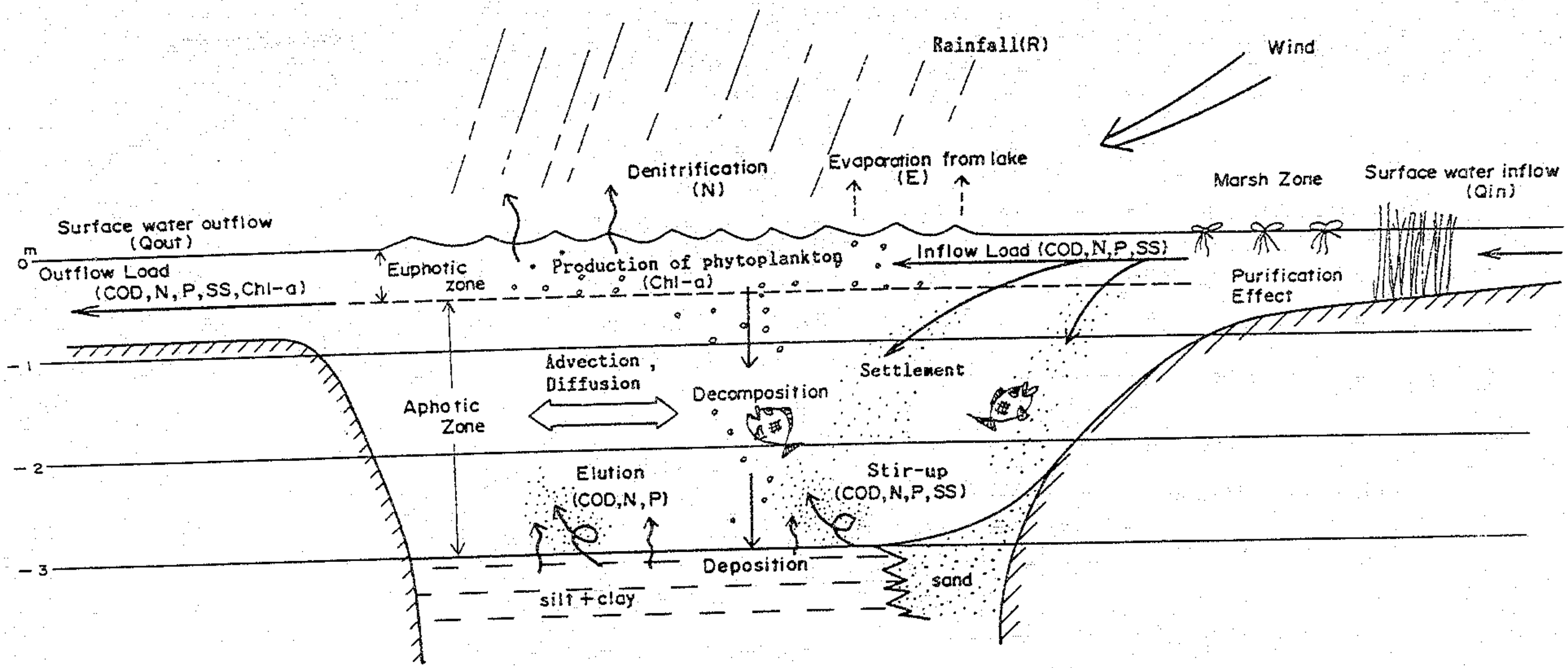


Fig. S9.19 Behavior of Pollutants in the Lake

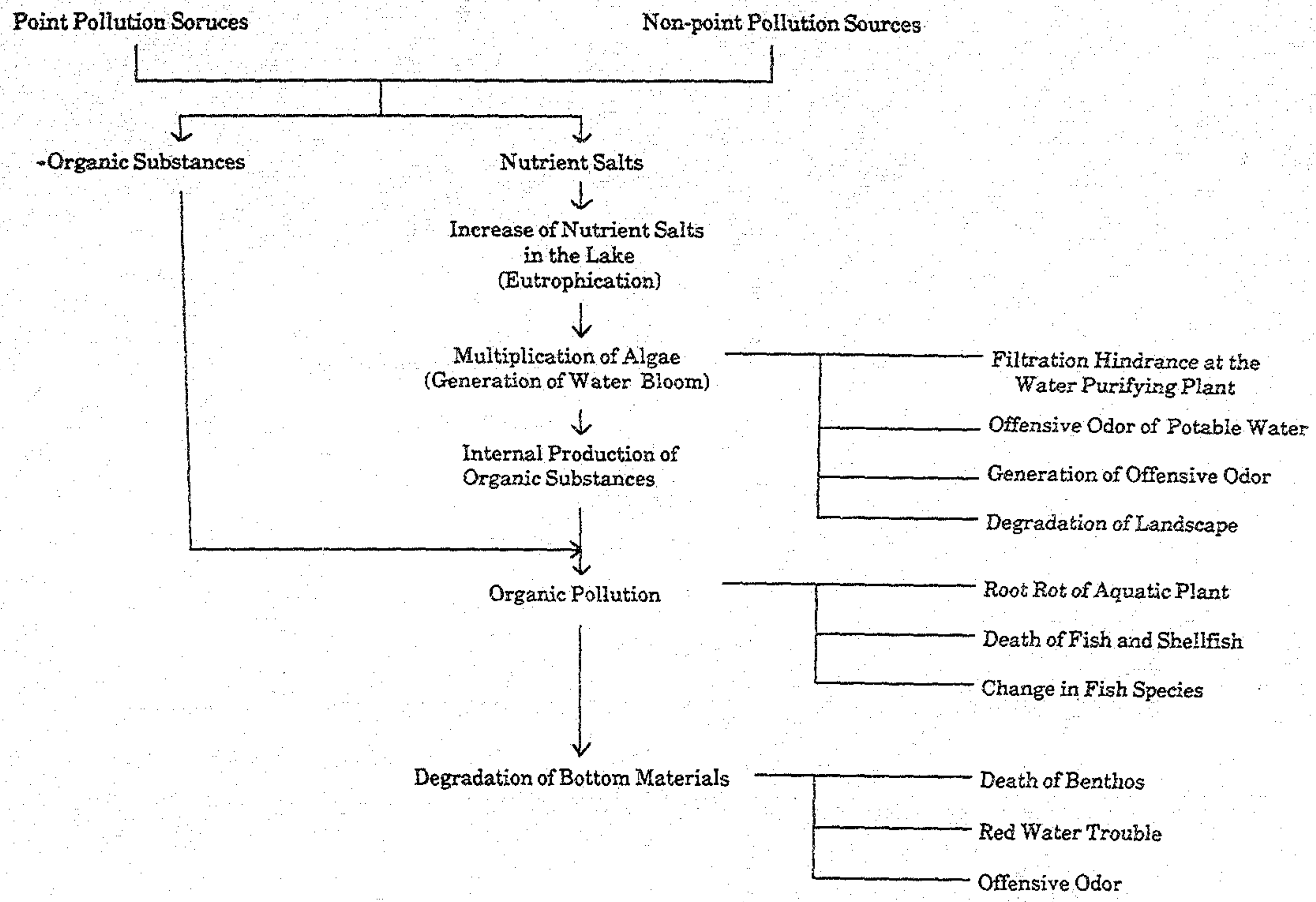


Fig. S9.31 Influences by Organic Pollution and Eutrophication on Water Use and Environment

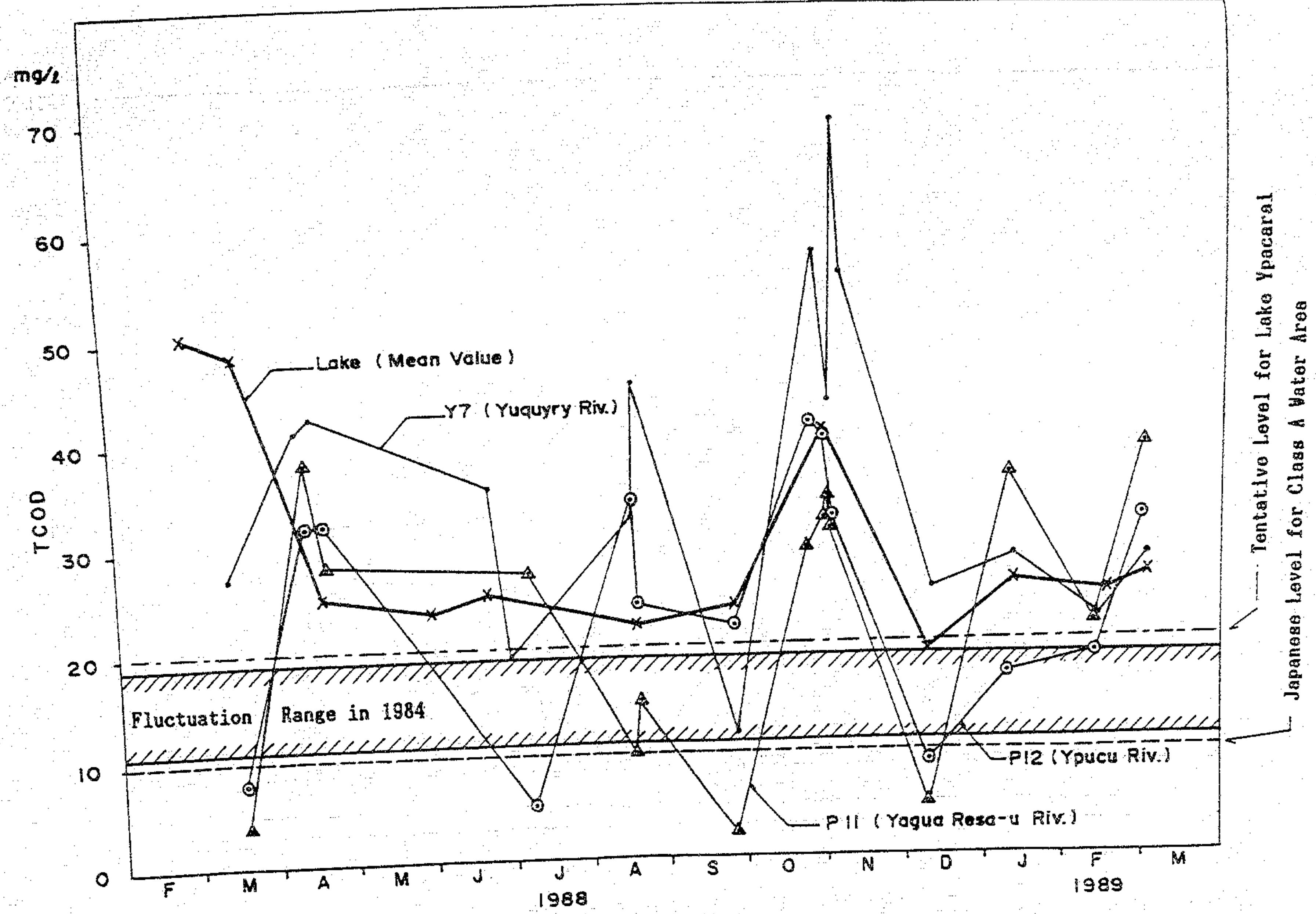


Fig. S9.32 Present Water Quality and the Tentative Water Quality Standard (TCOD)

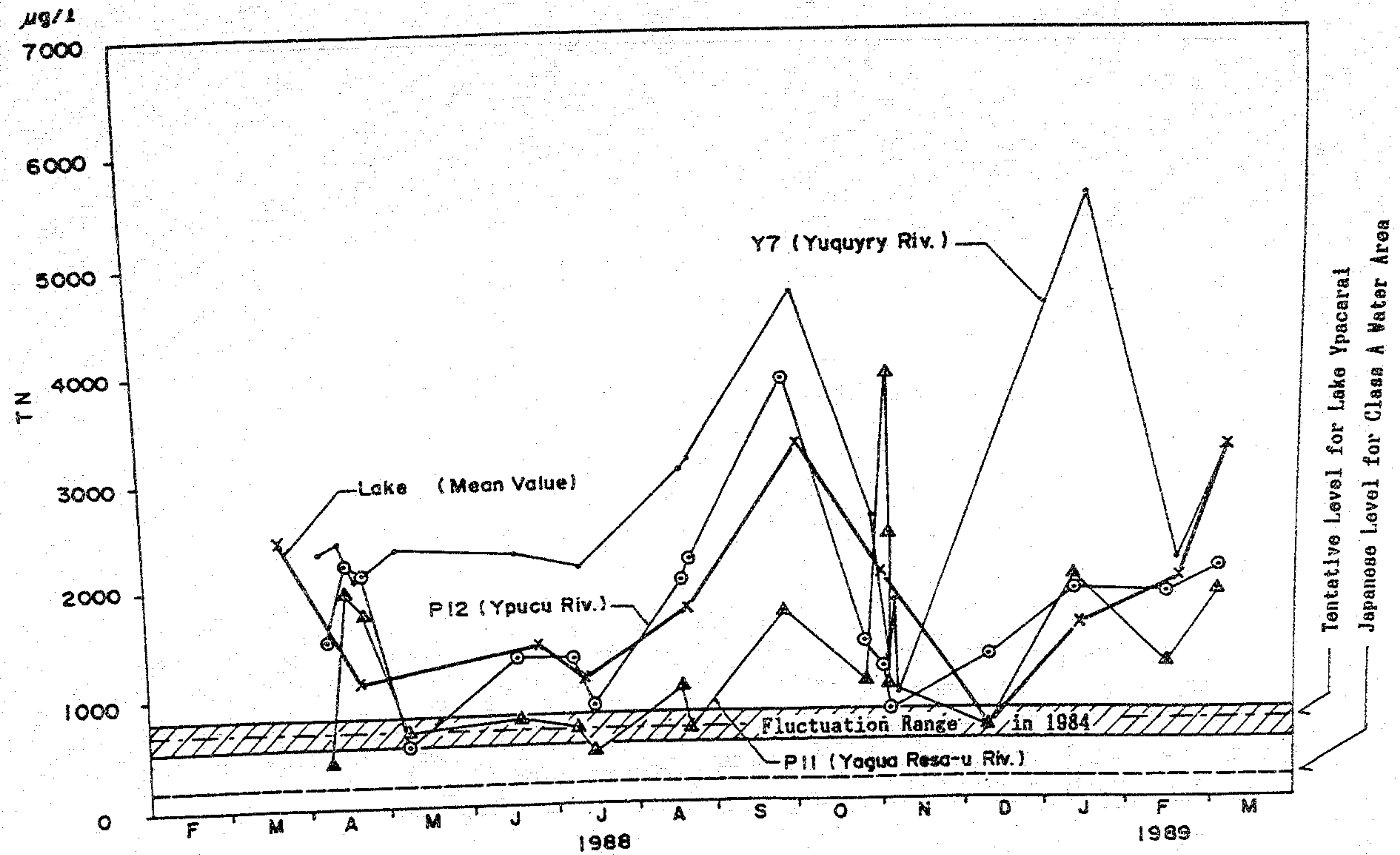


Fig. S9.33 Present Water Quality and the Tentative Water Quality Standard (TN)

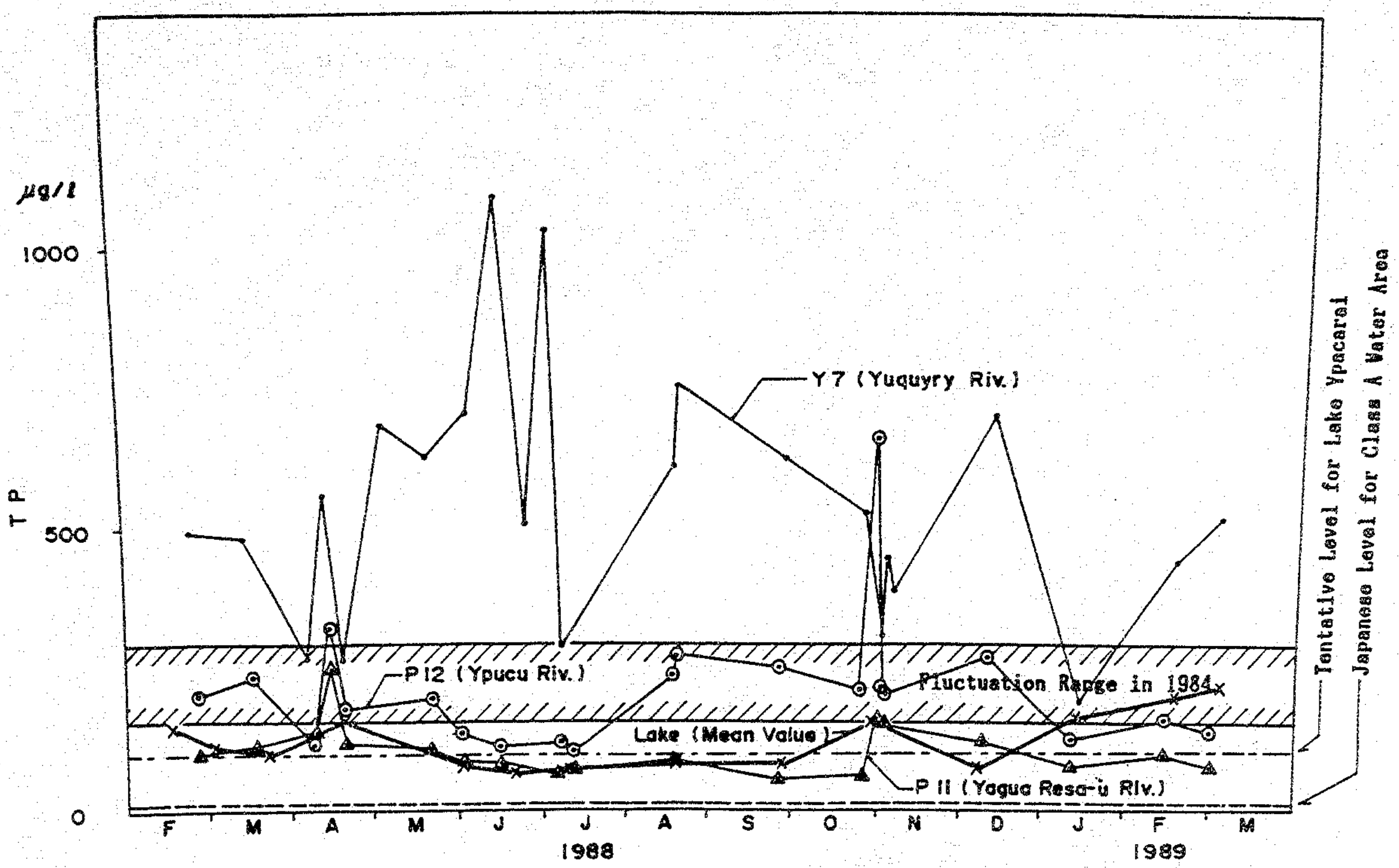


Fig. S9.34 **Present Water Quality and the Tentative Water Quality Standard (TP)**

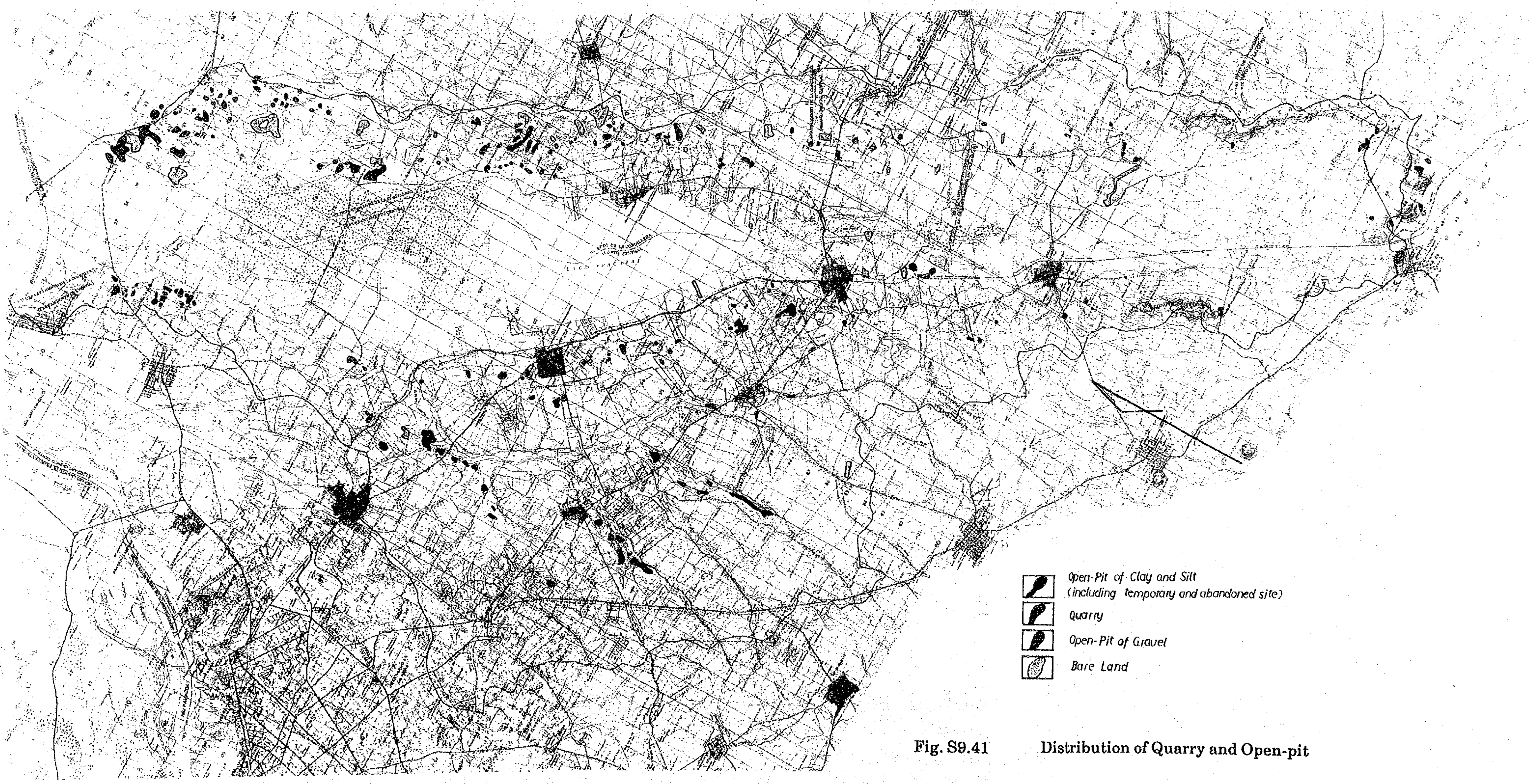
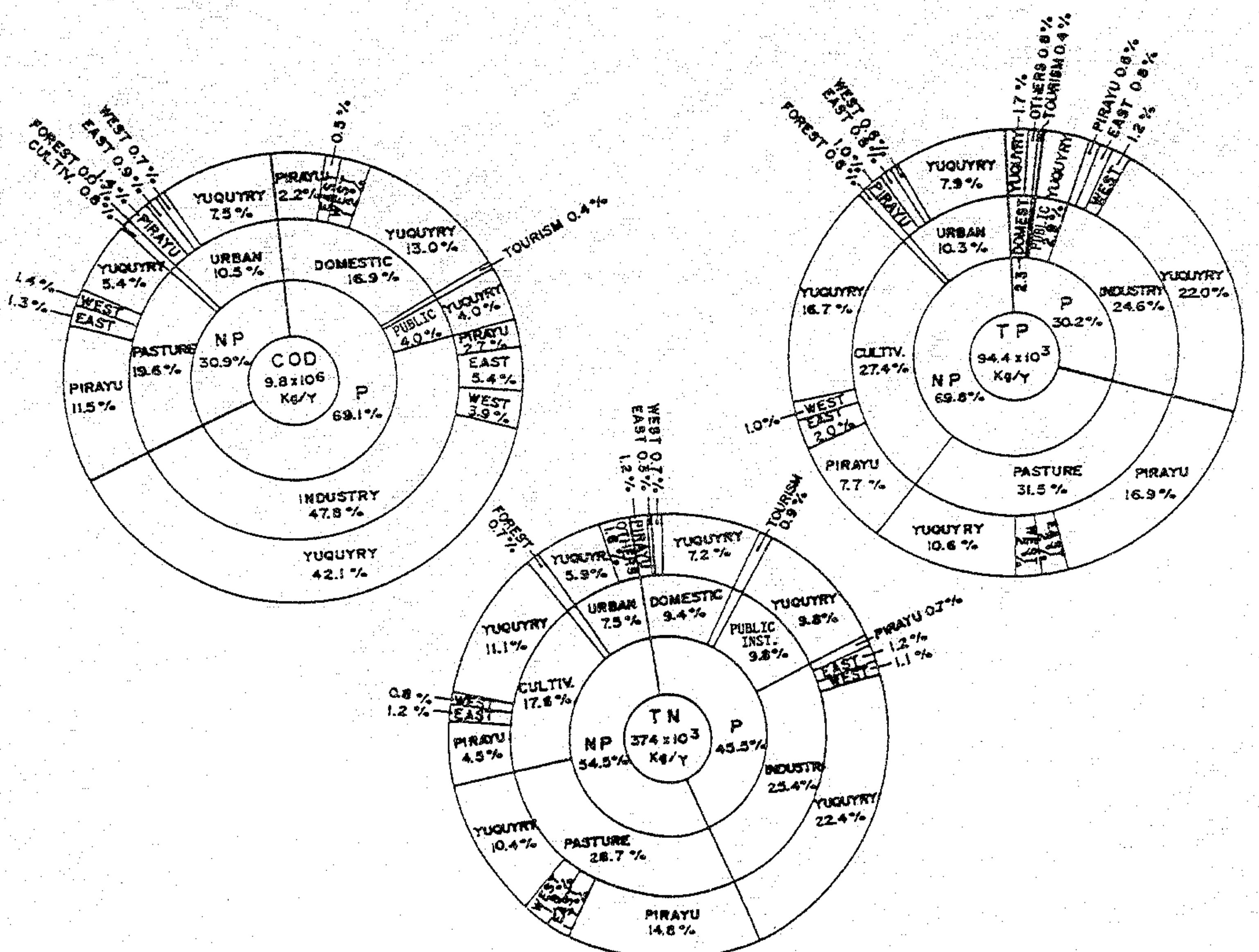


Fig. S9.41 Distribution of Quarry and Open-pit

Fig. S9.51 Breakdown of Inflow Load by Pollution Source and by Basin



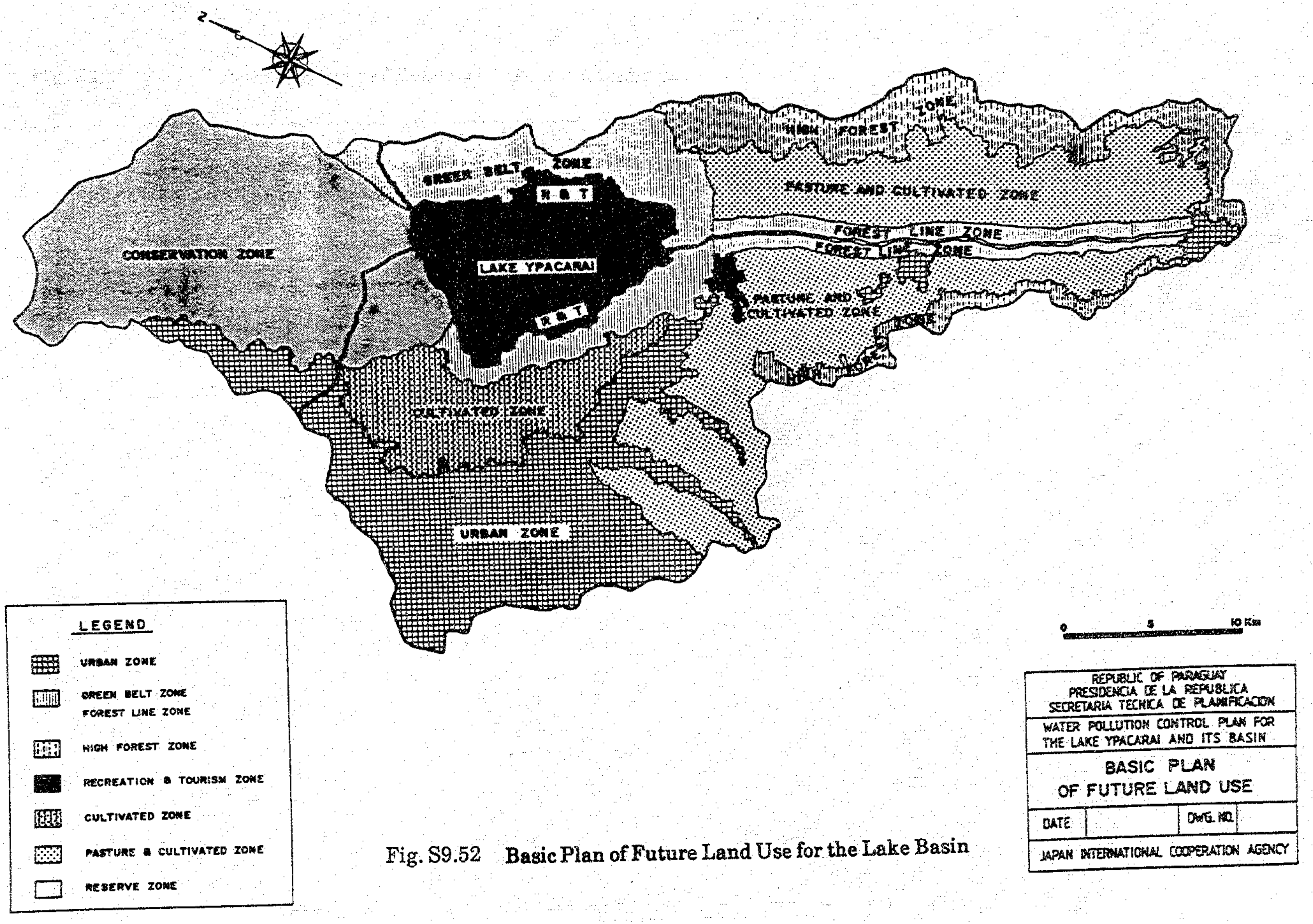
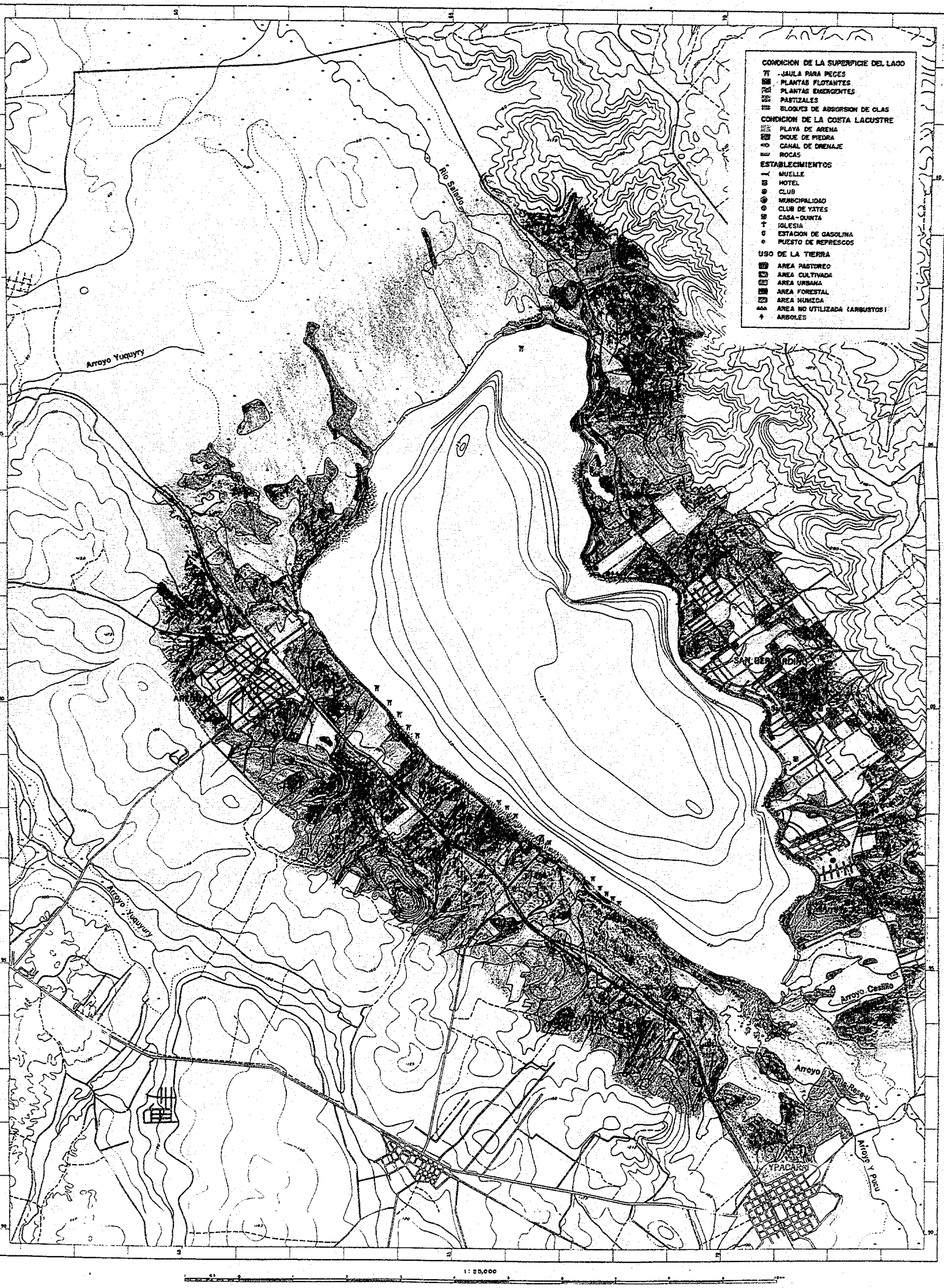


Fig. S9.52 **Basic Plan of Future Land Use for the Lake Basin**

Fig. S9.53 Present Status of Ypacarai Lake Surroundings



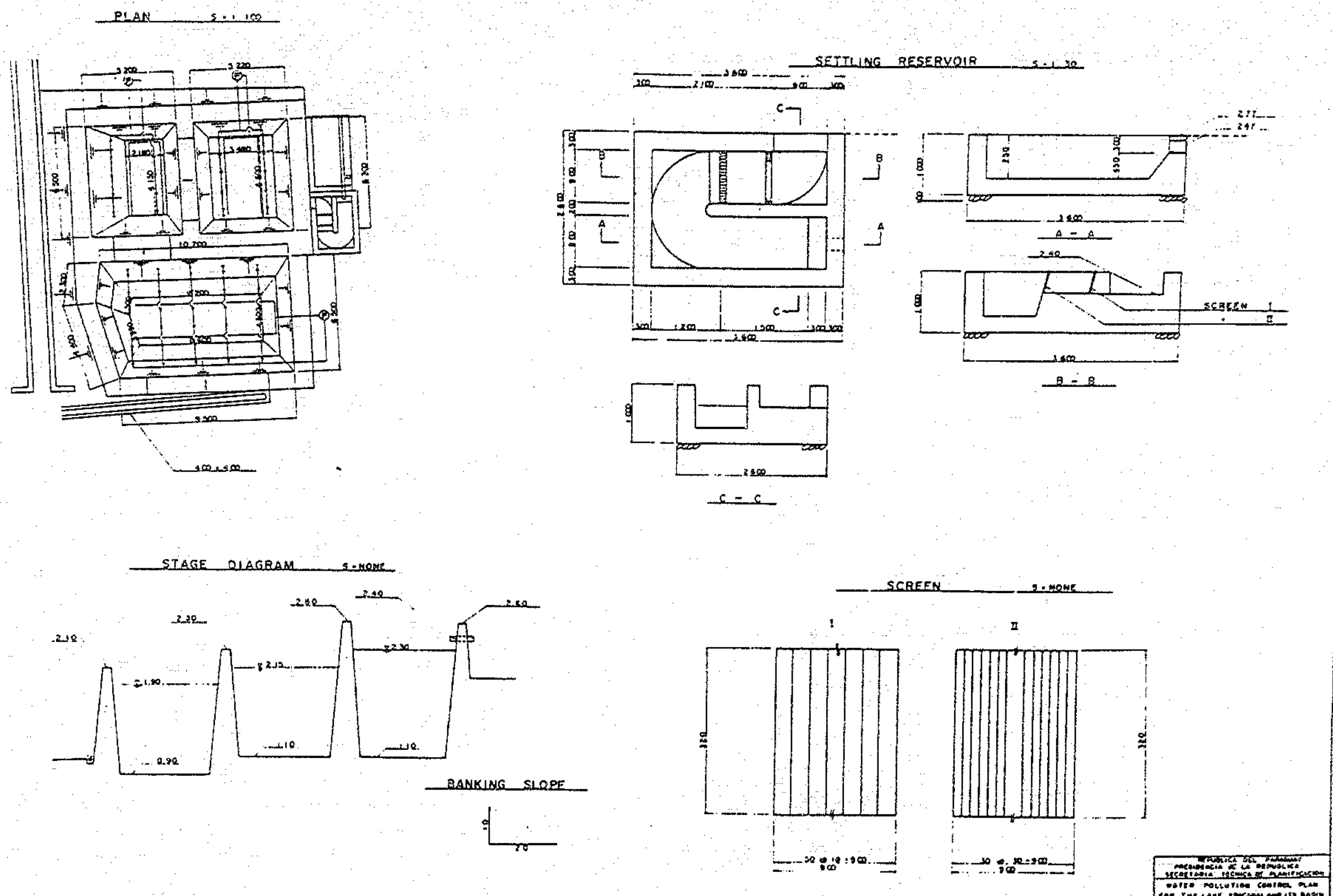


Fig. S9.91 Plan for Oxidation Pond System Set-up at the Butchery in Aregua

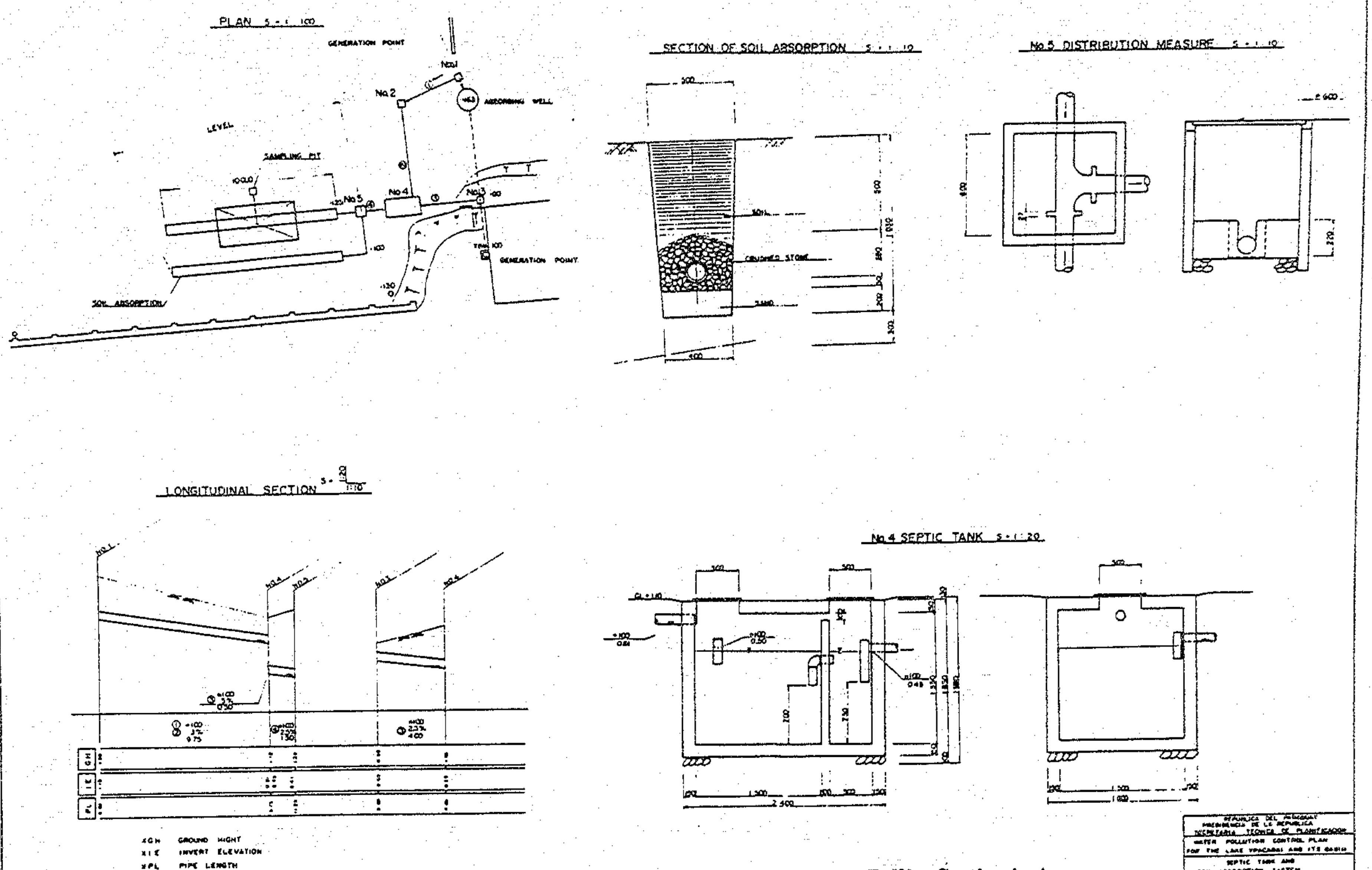


Fig. S9.92 Plan for Soil Absorption System Set-up at the Pollice Station in Aregua

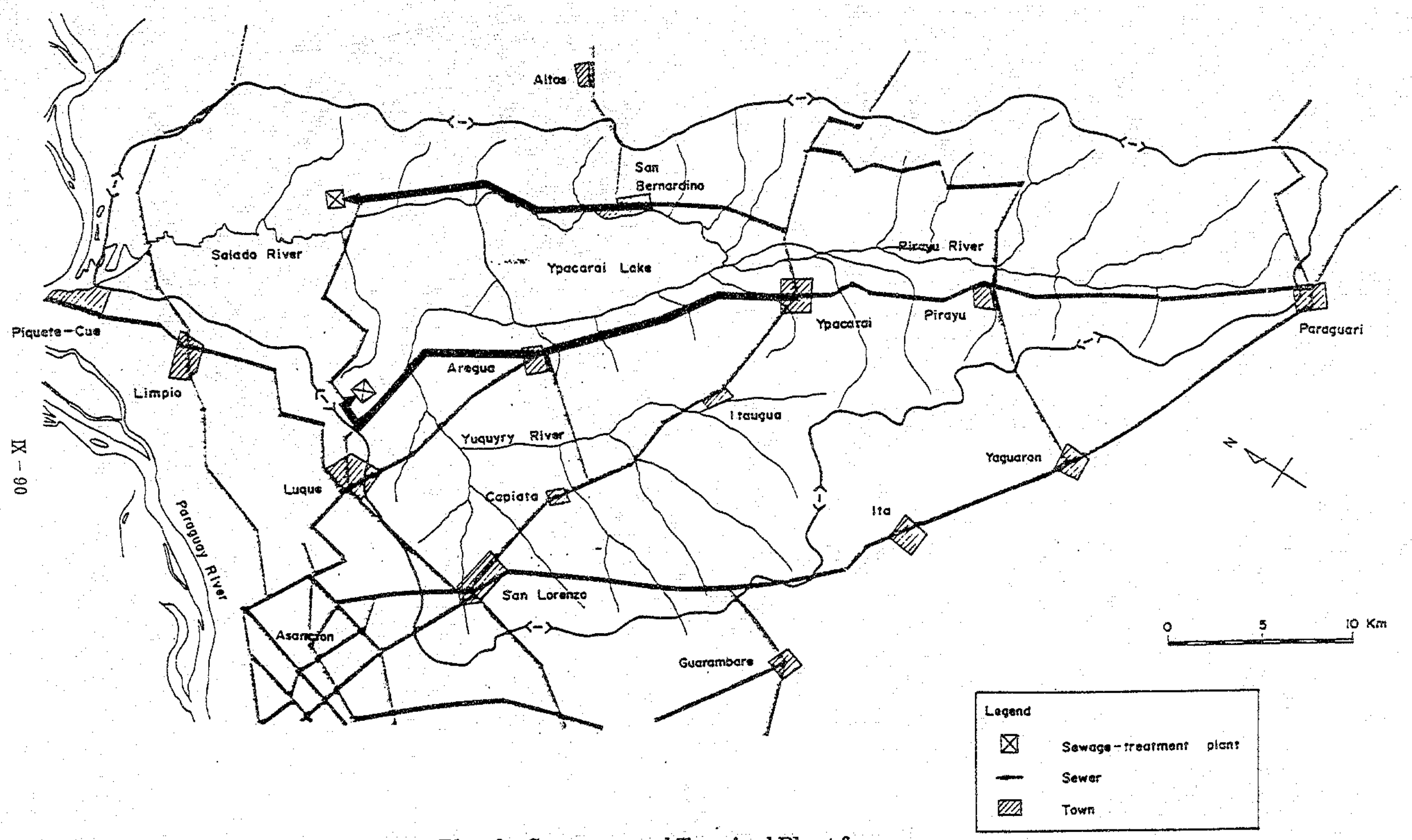
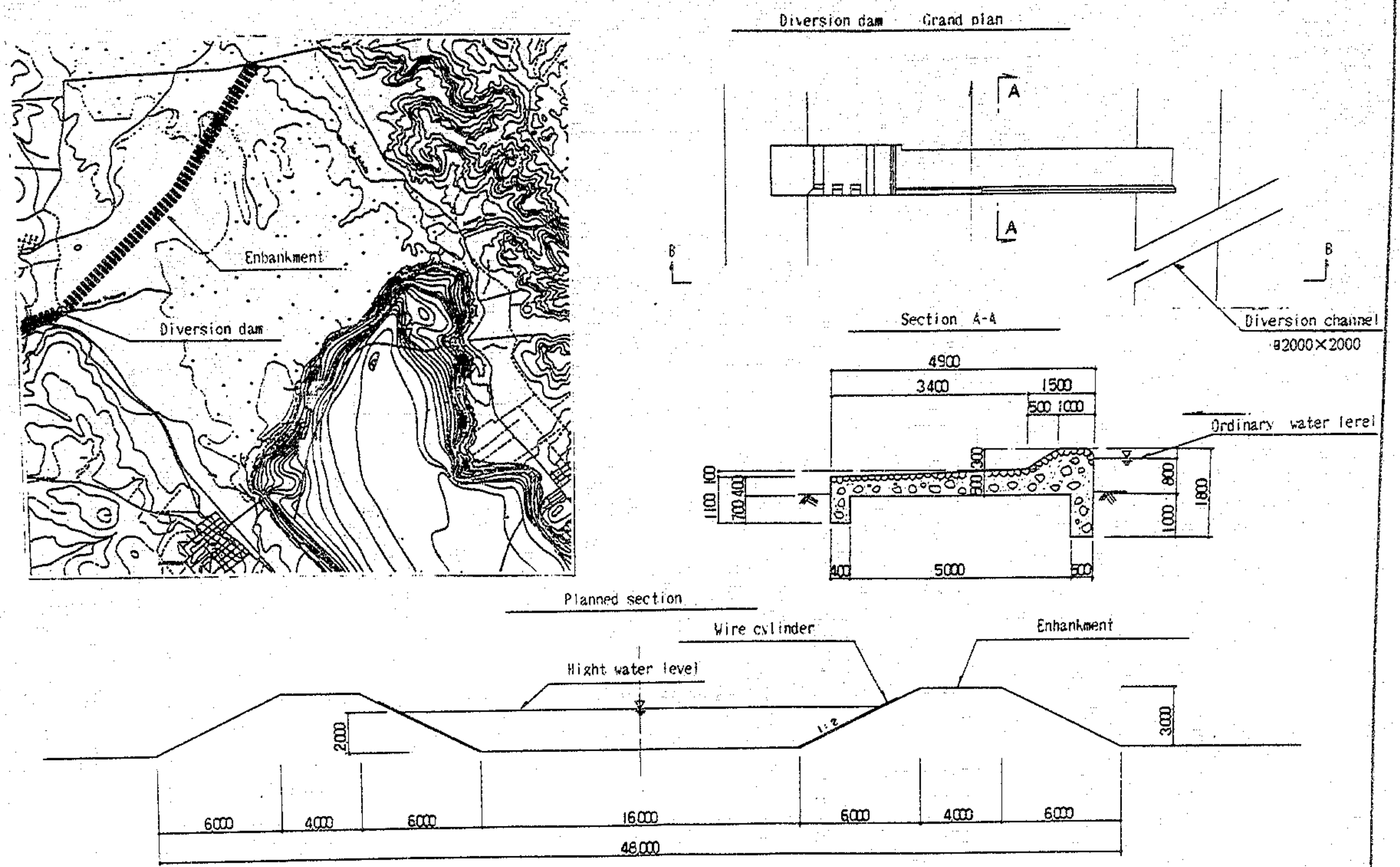


Fig. S9.93 Plan for Sewerage and Terminal Plant for a Given River Basin



REPUBLICA DEL PARAGUAY
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SECRETARIA TECNICA DE PLANIFICACION

WATER POLLUTION CONTROL PLAN FOR THE LAKE YPACARAI AND ITS BASIN

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Fig. S9.94 Plan for Construction of the Yuquyry River Flood Control Channel

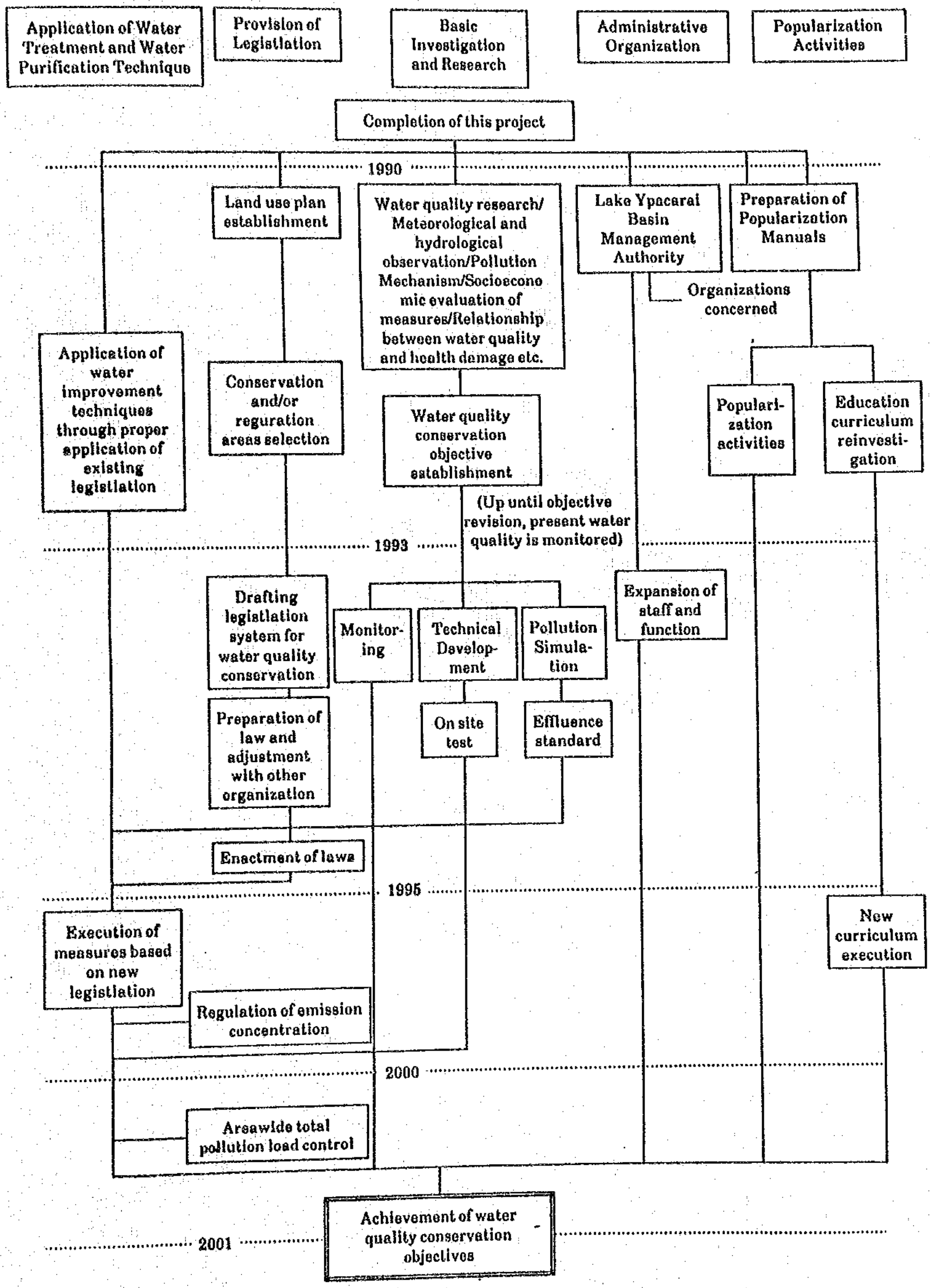

Fig. S9.111 Yeary Plan for the Water Quality Conservation

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